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TNO report

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Value creation in Retrofitting Housing Stock: an analysis of business opportunities

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Executive Summary

There is a common and shared, social, long-term goal: achieving future-proof housing, in this project meaning that housing should become at least climate-neutral. Deep retrofitting is necessary for this goal. This is known to be a difficult goal. There are a lot of barriers and only a few drivers. Activities in deep retrofitting remain stuck and it appears extremely difficult to scale up this process.

The ValueFit Accelerator project was aimed at developing a validated business model for a value creation approach connected to deep retrofitting. The research team consisted of TNO, Chalmers University and Imperial College. The research team condensed the problematic situation around deep retrofitting to the conclusion that there is a mismatch between the supply and the demand side. The demand side perceives that solutions are too expensive or even absent whereas the supply side is convinced that attractive and cheaper solutions could be offered if the demand volume would be higher. The intended solution for this mismatch was to connect supply and demand with a company that creates value for the demand side, so causes a substantial market for the supply chain. The project team worked out four alternative business models for such a company. The most far-reaching model was a district development company, taking a lead in formulating the multi owner/ discipline programme of requirements first, arranging the negotiations with investment agencies and coordinate the (integrated) project procurement and execution in the end. Setting up guarantees on the performance to the end users (inhabitant) on the one side, and the obligations to the suppliers on the other side. For the validation, interviews (and workshops) were organised to test and harvest feedback on the business models drafted.

The validation led to the following results. The interviewees acknowledge the necessity and momentum for establishing a business model like the drafted district development company. This business model was also the most popular among the interviewees. They endorsed our reframing of deep retrofitting to value creation, sometimes with an even broader focus like “better living”. But although everybody endorsed the need for a development company, not one interviewee was willing to state that it would take the lead for setting up such a company. The reasons given for this are related to the risks and complexity of entering into such an endeavour.. Hence, the project team has not succeeded to find a positively validated business model, meaning that our primary goal has not been achieved.

The most important conclusion from the ValueFit Accelerator project is one that also has a clear political message. A widely shared sense of urgency around deep retrofitting is emerging: there is common agreement on the necessity of speeding up large scale deep retrofitting actions, projects and programmes for the existing built environment. At the same time, many players in the field are resisting, hesitant and feel aversion to act accordingly. All parties seem to have good arguments for not making the first move. The present situation is a typical prisoner’s dilemma and this dilemma has to be framed as a classical systemic market failure.

At the same time the project team has met a number of interested stakeholders, willing to participate in experimenting, developing and demonstrating the basic principles of the establishment of such a district development company. These interested parties can be found on different sides of the spectrum, from financial institutions, regional authorities, housing associations, grid operators, local authorities to renovation and maintenance contractors. These parties have shared ideas of projects to launch demonstration of parts of the puzzle.

Within the conclusions we clearly formulate the objective to work on a resubmission of the ValueFit demonstrator proposal, in the circumstance that the Climate-KIC organisation is willing to alleviate the evaluation criterion of having a validated business model included.

Contents

1 Introduction

The existing residential building stock is responsible for around one third of the total energy demand and greenhouse gas emissions in Europe. Deep CO_2-emission reduction for this stock is needed to reach the goals of 'the Paris Agreement'. This is also stated as one of the main challenges of the Urban Transitions theme of Climate-KIC. A lot of words are used for the activity that is needed to achieve this deep reduction. We will use the word "deep retrofitting". With deep retrofitting we mean the renovation or rebuilding (of parts) of a building with the aim to make them climate-neutral. There has been a lot of activity in Europe in this field due to European legislation on efficient buildings (EPBD, 2002). Most of these deep retrofit initiatives, however, remain stuck at experiments or small scale projects and it appears extremely difficult to scale up this process, to become common practice and thus to fulfil the ambitions for deep retrofitting on the larger scale.

In September 2016, we[1] offered a proposal for a Demonstrator to the Climate-KIC program Urban Transitions (UT) with the name "ValueFit". This proposal was dedicated to addressing the challenge of deep retrofitting. Climate-KIC appreciated the idea, but also indicated that the proposal lacked to present a credible business model for the ValueFit approach. We got the opportunity to develop and validate the business model by means of an Accelerator project.

This report summarizes the activities and the results of that Accelerator project. The structure of the report is as follows:

- §1: introduction to the project;
- §2: explanation of the challenges of deep retrofitting in more detail;
- §3: description of the development and validation of the business models;
- §4: reflection on the current state of deep retrofitting;
- §5: conclusions and recommendation.

[1] "We" = the consortium of TNO, Chalmers University and Imperial College. We will sometimes call ourselves "the ValueFit team".

2 Context and challenges for retrofitting

Necessity and possibility
The residential building stock is responsible for around one third of total energy demand and greenhouse gas emissions in Europe (Economidou et al, 2011). Real estate is thus part of the emissions problem, but it is also part of the solution, identified by many as having the greatest potential at the lowest cost of any other economic sector for cutting carbon emissions (Vanags & Butane, 2013; IPCC, 2014).

Residential buildings make up three fourths of the European building stock and 80% of these buildings were built more than 25 years ago. The annual production of new dwellings in 2014 in Europe ranges from 0.45 to 1.15% of the housing stock (ZEBRA2020, 2017a). Assuming an average of 1% newly built per year, approximately 70% of present dwellings/buildings will still be in use by 2050.

It has been shown that significant energy savings can be achieved at reasonable costs, but for energy savings above 30–40%, the costs rise steeply (Jones et al, 2013). Deep retrofitting of the existing building stock offers a large potential (Wilkinson et al, 2007), although addressing new buildings is also urgent because buildings and energy systems built today will shape their energy use for the coming 25 years and beyond (Robert & Kummert, 2012). In the market of new buildings, the uptake of near zero-emissions building (nZEB) across Europe is monitored in several European countries, and represents a wide range of realisation (as a % of the total new housing construction) differences between countries (ZEBRA2020, 2017b). Starting from 2021 all new buildings should be nZEB in the European Union (EPBD, 2002).

This all adds up to the conclusion that both the necessity and the possibility for deep retrofit of the existing building stock are large. During the last years, the awareness regarding this urgency has grown substantially among the stakeholders involved (housing associations and other proprietaries of building stock, administrations, etc.). A survey held under housing corporations in the Netherlands revealed that nearly two third agrees with the ambitions and objectives as laid down in the Dutch ‘Agreement on Energy for Sustainable Growth’ (Corporatie Survey, 2017).

Speed and process of retrofitting
ZEBRA2020 (2017c) has developed an indicator for renovation that is as similar as possible to the major renovation definition in Article 2 of EPBD (2002), the *equivalent major renovation rate*. This rate in 2014 varies for the 14 monitored countries between 0.08% for Spain until 2.4% for Norway (ZEBRA2020, 2017c). Such pace of retrofits means that in the best performing country the whole building stock would be renovated somewhat more than 40 years. In other countries this pace is much slower, e.g. the renewal rate of the Swedish residential stock is only 0.6% (Boverket, 2014) and this would take more than 150 years to be completed.

Deep retrofitting will mainly take place in cities and should recognize the unique legacy of the existing built environment and infrastructure in each city. This means there is no single blueprint for retrofitting in a city (WBCSD, 2010). The

administration of a city plays a critical role in targeting sustainability through socio-economic development and technological innovation (Wu, 2014). This administration is thus a key player to put deep retrofitting on the agenda.

It is also crucial to choose the most suitable scale to focus on. In a project in Germany, the concept of addressing retrofitting only on single buildings has been evaluated. This single building concept misses the essential synergies needed for the goal of deep reduction (Conci and Schneider, 2017). There is growing evidence (and also conviction) that a neighbourhood is the best starting point for implementing deep retrofitting (Roselt et al, 2015; Conci & Schneider, 2017; Kurkowska et al, 2017). Energy-efficient urban redevelopment involves substantial intervention in our surrounding environment. Neighbourhoods (or districts) are the linking pin between higher-level plans/concepts and practical building-related energy efficiency measures. At this level, the scale of the interventions is manageable and most likely the implementation is also more resource-efficient (Conci and Schneider, 2017).

In summary: the speed of the retrofitting process is much too slow. The focus of the process of retrofitting should be on urban neighbourhoods. This process must be tailor-made and take into consideration the project specific framework conditions.

Barriers (and some drivers)
Despite its importance, deep retrofitting remains a challenge. This condition of being stuck has led to a lot of activities to identify the drivers and barriers for the uptake of deep retrofits. Pitt et al (2009) rank the importance of eight different topics as drivers and barriers for sustainable buildings in general. Karlsson et al (2013[2]) categorise drivers and barriers for retrofitting in five domains: technical, financial, social, environmental/health, and organisational/legal. This categorisation roughly fits to the results of other studies (Economidou et al, 2011; Vandewiele et al, 2015; De Groote & Lefever, 2016; Veenstra et al, 2016). The barriers (and some drivers) from these and other studies are summarised in the next table.

Conditions	
Formal regulations	European building industry highly regulated e.g. building codes, energy market barriers
	Existing policies and subsidies favour incremental rather than radical innovation
	Structure of existing building stock and its historical & cultural values creates barrier
	Tendering processes and subsidies are too prescriptive
Informal cultures	Risk averse behaviour e.g. uncertainty about payback period
	Difficulties in understanding different cultures and languages
Activities	
Capabilities	Insufficient knowledge exchange between actors
	Skill and management shortages in contractor market and professional services
	Lacking reduction of disruption for residents' comfort and safety during the renovation
	Small companies lack skills and resources for R&D, innovation and change
Stakeholder interaction	One-off projects hinder innovation diffusion and investments
	Public private partnership weakly developed

[2] This report gives a very useful insight in the current practice (and lack of progress) of nZEB retrofits in five European countries: Sweden, Poland, France, Spain and Norway.

Market	
Market structure	New actors and solution are limited by current market dominance
	Fragmentation and lack of differentiation
	Problematic to obtain finance - lacking business models and long-term credits
	High upfront cost
Market demand	No natural demand - competing purchase decisions with more attractive options
	Lacking communication and trust between stakeholders
	Lack of proven solutions and alternative technologies
	Uncertainty about future energy prices
	Low stakeholders' awareness of energy, cost and carbon saving
Imperfections	Split incentive barrier
	Unfair competition by fossil fuels as externalities are not priced

These barriers can be summarized into the following categories:

- **Lack of collaboration –** A deep renovation project requires interaction and collaboration of different stakeholders at different stages of the process. In particular the collaboration between tenants and housing associations is essential at all stages (complaints, financial burden or profit, behaviour and use of energy, expectation management). Similarly, a good collaboration between local authorities, housing associations and other stakeholders is essential to enable innovative approaches to allocation of costs and benefits, shared target setting and alignment of value. Still, in most projects this necessary collaboration does not work very well and the different stakeholders act as separate entities. For example, renovation of dwellings is not optimally combined with opportunities and challenges on a district scale, such as replacement of the gas or sewer network. The most common approach to deep renovation is still a single-building scope. Thus, increasing the scope of a renovation to district-level and considering other benefits that might result, is needed and requires collaboration with other stakeholders.
- **Procurement methods are not fit-for-purpose** - One of the major problems in the building sector is the gap that exists between the demand side (i.e. proprietaries of building stock) and the supply side. The level of confidence between the two sides is rather low. Despite some innovative approaches, procurement is done in a traditional, more or less purely prescriptive way. This puts serious restrictions to getting the best value for money and leads to a low penetration of innovation into the building sector. What is needed for value creating in retrofit is to use a more flexible set of instruments for performance or even value-based procurement.
- **Fragmented Supply Chain** – The supply chain solutions are delivered in a separate manner and there is little liaison between stakeholders coming into play at different stages. This means that necessary synergies and opportunities are not leveraged (e.g. an energy consultancy preparing the renovation plan will very often not be aware of the latest innovative solutions that exist on the market).
- **Little learning and sharing of information** – The building sector can be characterized as one-off and so is the renovation of existing stock. This hampers the diffusion of innovation. There are few incentives for the different stakeholders to share the knowledge in the current setup in which the supply chain is really fragmented. The exception is “general contractor” who makes the money out of utilizing the existing synergies, avoiding inefficiencies and building cheaper with fewer resources etc. If all the (theoretical) knowledge available

would be used in a synergetic manner, the activated synergies in the practice could be large.

- **Lack of supporting legislation** – Current governmental policy on energy performance of the existing built environment insufficiently enables roadmaps to zero energy built environment, nor imposes parties to align their activities towards zero energy solutions. Moreover, the government does not adequately facilitate a transition towards fast and cost effective solutions with a desired energy performance. Predictability in law- and regulation and policy is a very important pre-condition in creating trust among all parties. Legislation and regulation at a national and EU level should be developed to create the prerequisites for better conditions and incentives for deep retrofitting. This includes both energy and building regulation, e.g. on energy performance standards for retrofitting. For the next years ahead, the most important policy aspect will be the planning of phasing out natural gas in the Netherlands: if and when that happens, it will cause a serious mind shift and innovation impulse (*Veenstra et al, 2016*).

2.1 Conclusion

The analysis of context and barriers above has been updated and validated since the first ValueFit proposal was put on the table. The outcome of the analysis, however, still has the main message and the same basis on which the proposal was built. The conclusion is that deep retrofitting suffers from a mismatch between the demand and the supply side. The demand side perceives that solutions are too expensive or even absent; and the supply side tells us that there could be attractive and cheap(er) solutions when and if the demand would be substantially higher. This results in a situation with no real demand and no real customer for deep retrofitting. This mismatch results in a situation that is characterised by case-by-case approaches of contractors and by ad-hoc custom-made solutions for customers. This situation leads to individual consumers that are more or less content but:

- It prevents the uptake of innovations for retrofitting into the market because these innovations need a bigger market to become cost effective;
- It prevents the developments of common approaches on the local scale (like a district) in which one optimizes the energy supply and demand on that district scale.

We summarize this conclusion as: there is a structural mismatch in the innovation system, or, more popularly, this alludes to a structural market failure.

3 Validation of business models

In §2 we summarised the challenge for deep retrofitting as a market failure, a structural mismatch between demand and supply in the building chain. The ValueFit team was and is convinced that this market failure could (partly) be tackled by an effective “connector” between supply and demand. This connector could be a company. This connector could get the demand to a level that could help innovation in renovation from a promise into reality. This connector will also translate the desires of the demand side into practical implementation by the supply side. The connector is thus aimed at disclosing the bigger demand and to improve the demand-supply chain. We will shortcut this aim to the phrase that the connector will “organise the demand-supply chain”. This project was dedicated to find a business model for this connector and to validate that business model. This goal was carried out in the following steps:

- Develop business models for this company (§3.1).
- Validate these models with representatives from the relevant stakeholders (§3.2).
- Conclude whether (and which) business models are feasible (§3.3).

3.1 Business models

The objective of the business models was to define a company that will organise the demand. The challenge is to organise the demand-supply chain in such a way that it is (i) feasible and efficient for the market for deep renovation to kick start and (ii) includes local optimisation of demand and supply for energy. In the business model canvasses we have explained how such a company can be(come) financially sound. In Annex 1 the development of the business models is explained. We finally arrived at four business models for which the feasibility has been explored during the project:

1. The development company
    a. District oriented – Future-Proof District Developer Inc. – This developer focuses on multi-client district renovation projects. Having various owners and assets in one district (housing (private, coop), public streets and parks, energy grid operators, water infrastructure), requires to align the different stakeholders needs and requirements into one programme of requirements with regard to future proof renovation. This company will become the spider in the web for organising the alignment, formulating the programme, and attracting the investment capacity to launch the district renovation.
    b. Housing association oriented – Future-Proof Housing Developer Inc. – This developer focuses on the housing market, primarily on the large housing owners in the rental sector, for instance the social housing associations (NL), or housing cooperatives in other parts of Europe. For this housing developer, more mono-disciplinary projects acquiring, important to become an expert in the financial and regulatory arrangements for this sector. Acting as overall process-organiser, and risk taking intermediary between demand (housing association and tenants) and supply (finance, system and product suppliers).

2. The service company – Future-Proof Housing Support Company – This support company is not in the process on a risk taking basis, but is receiving budget for performing a process supporting role in the set up, drafting and organisation of the deep retrofitting projects for large housing owners like housing association. The service offered needs to be worth investing in it for the large players, and having a good track record on successful projects they have supported is crucial to make any chance in this competitive market segment.
3. The product company – Future-Proof Housing Tool Inc. – Not risk taking development itself, not the supporting role in the process, but singular development and sales of (ICT) tooling to help stakeholders in the field to formulate good programme or requirements, set up a proper project organisation and make use of the available financing/ subsidy schemes available. This company is a more traditional product supplier, in this case advanced type of ICT supporting tools. A highly competitive market too.

The here above mentioned business models are described in greater detail and framed in the so called business model canvas, which can be found in the Appendix A.

3.2 Validation approach

The first step was to choose a couple of relevant stakeholders. In the Netherlands we first made a longlist of about 30 stakeholders. Finally, we interviewed 14 parties.

Sector	Entity	Interview date
Building & Engineering	Smits Vastgoedzorg	16-3-2017
	Innax	3-4-2017
	BAM*	15-3-2017
Cities/municipalities	Den Bosch	21-2-2017
	Rotterdam	9-3-2017
	Wageningen	16-3-2017
Regional auhorities	Gelder Energieakkoord*	19-6-2017
Finance	BNG	6-03-2017
	ING	14-03-2017
	Oost NV	19-6-2017
Developer	AM*	15-3-2017
	AM (second time)	14-6-2017
Utility Company	EnNatuurlijk	5-4-2017
Housing Associations	Mitros	13-3-2017
	woCom	22-02-2017
	Portaal	18-04-2017

* AM & BAM were interviewed together; Gelders Energieakkoord and Oost N.V were also interviewed together.

In London a validation workshop was held by TNO and Imperial College, April 12th, at the venue of MottMcDonald. At the table were the E3Group (SME developer), EnergieSprong (building and engineering), Engie (building and engineering), Get-Living-London (Landlord; housing association), GLA (Greater London Authority), KnightFrank (finance, broker), MottMcDonald (building and engineering;

representative is also director of Climate-KIC SSD flagship program). In this workshop the Dutch experience was mirrored with the UK experience in deep retrofitting and also the business models were validated (but in a less detailed way as in the Dutch interviews).

In the Swedish setup, a series of interviews (non-structured qualitative interviews) have been conducted in fall 2016 and throughout winter/spring 2017.The interviewees are representing energy utility companies (Gothenburg energy), real estate owners (Framtiden; Riksbyggen, HSB), local authorities (Gothenburg, Malmö) as well as consultants (Tyrens, Passivhus centrum).

3.3 Validation results

On validating the business models, the answers given in the Dutch validation interviews were very clear:

- Out of the three basic business models there is only one that could have a market value: the development company. The service company does not fill a gap in the market. The demand side parties were not willing to buy their services. The supply side parties stated that in such a case existing building consortia could do that job as well. The product company does not have any sales according to the reaction of the Dutch interviewees (there does not seem to be a need for this tool). The exact service of this development company varies per demand/stakeholder.
- The downside of this positive valuation of the development company is: under the current circumstances there is no market demand for this company. The district developing company does not have an existing client organisation (there is no single entity that owns a district and all its physical artefacts). The administration of a city or municipality has some jurisdiction in a district but it has to form a co-operation entity to cover the whole district. Such PPP entities are not readymade. The development company that focuses on housing associations, however, does not have that barrier. There are clients for this company. But these clients are, at the moment, not very eager to start developing outside their boundaries (outside their own building stock) and sometimes (at least in the Netherlands) they are legally forbidden to do this.

The Dutch round of interviews showed us that the business models we developed couldn't be validated positively at this moment. The development company (whether for a district or for a housing association) does fill in a gap, but the market demand is still unfocused; and the demand is not aligned by all demand side parties.

The workshop in London confirmed the outcome of the Dutch interviews. In the UK the situation could be defined as even a bigger challenge, due to the stricter legislation on property and the more distant role of local authorities. The UK parties also mentioned the problem of funding the retrofit and the high transaction costs.

The Swedish interviews revealed barriers on various levels, such as knowledge gaps especially on the multi-building scale, large sectorial fragmentation, educational demands, missing tools, owner-occupant dilemma, short-term economic thinking as well as other political priorities than energy efficiency such as affordable new housing solutions. The overall agreement was that the current economic framework conditions including low energy prices are the most crucial barrier to encourage nZEB renovations on a larger scale.

3.4 Conclusions

All activities carried out in this Accelerator project led us to the following conclusion:

- We observe an increasing momentum regarding deep retrofitting with stakeholders in the public as well as the private sector.
- Despite the increasing momentum deep retrofitting is still suffering from serious market failures to come off the ground.
- Classic business model do not work in the case of a market failure (and therefore we were not able to validate the models in a positive way). To tackle the market failure, something else must be done. In the next 2 sections we will give our reflections on this issue.

4 Reflections on the current state of “deep retrofitting”

In this section we will provide two reflections on what has been observed during the validation process and we will end with some other lessons learned.

4.1 How to tackle the market failure?

From §2 we have learned that deep retrofitting is only useful when it is carried out at an appropriate scale: neighbourhood or district level. At this very moment (2017) the stakeholders in a certain district have different attitudes and positions towards deep retrofitting. The authorities of a city (or municipality) can have ambitions with regards to sustainable housing, but they also have such a diversity of other roles and responsibilities that they can “hide” behind this diversity when it comes to feeling the pain: “this district was not very suitable for deep retrofitting because of the priority on … (e.g. safety, economic development, more playgrounds, etc.)”. The authorities also do not have the power to enforce their ambitions or cooperation in a district, because of the lack of legal, regulatory and financial means. The gain for (social) housing associations mostly is not large and certainly this gain is not easy to catch (they have to cooperate with other, often unfamiliar parties like the utility company and other district stakeholders). These associations formally are not responsible for more than their building stock, so they do not feel any pain of not achieving district goals. The building contractors seem to be willing and able to offer broader solutions that could fit to the deep retrofitting at district scale. But they say that they are not asked nor paid to do it, they are only asked to present the lowest cost option without district level challenges in it. The energy or utility companies in some way could connect the energy exchange in a district and they could initiate activities that would stimulate deep retrofitting, but they sometimes are not legally allowed to interfere with the energy use of their customers and they do not “participate” in the gain of deep retrofitting. They mostly only feel the pain of it (loss of income; increase of costs of the network). The suppliers of the building sector and the energy sector claim that they have enough innovations at the table (for deep renovation, for renewable energy solutions, for heat networks, etc.) but they need to go through the learning cycle, which in practice means that their solutions are rather expensive now and the costs will only decrease after a lot of applications (learning by doing) and scaling-up which allows them to industrialize their processes.

In short, some stakeholders see some gain, most do not see enough gain for deep retrofitting; but most of all: none of them feels any pain for not doing it. This is a typical prisoner’s dilemma: for a real demand one needs well defined customers and to get such customers one needs to cooperate at the district scale and in the current (market) situation the individual gains of not cooperating are bigger than the pains. In economic terms this prisoner’s dilemma is called a “market failure”. The market alone cannot solve a market failure; it can only be solved by some kind of societal (government) intervention. This requires a systemic approach; integrated technical and social innovations and adaptive learning.

What kinds of interventions are needed to tackle this market failure? Some (partial) answers or solutions, suggested in the validation interviews and workshop, are:

- A city authority should have the ability, the responsibility and the financial means to organise a district-wide deep retrofitting.
- A PPP district entity (of the city authority and all currently present (social) housing associations and utility companies) could start deep retrofitting of the district by tendering by dialogue (see e.g. http://www.copper8.com/en/projects/sustainable-redevelopment/).
- Define and implement national goals and legislation for renewable heating.

These solutions could be attractive ones but they also have problems and some serious drawbacks. The first, for instance, does not really seem to fit to the expectations of citizens, voters and house owners towards the service attitude of the public authorities. This solution could be easily be framed as “enlightened dictatorship”, especially when decisions of the authority overrule some normal procedures of the constitutional state (like ownership rights and the right to participate). The second solution also has some issues in legitimization and requires careful orchestration which entities should form the PPP district entity. However, over the last 5 – 10 years we have seen major progress in this area, e.g. through (newly raised) Energy Service Companies (EsCo’s). On the basis of the interviews held with Dutch stakeholders we believe that EsCo’s or a similar kind of entity might play an important role to get deep retrofitting at a neighbourhood or district level off the ground.

In the Netherlands, we see first steps towards the third solution by a national government position that the residential sector should be “natural gas free” in 2035. This position has been broadcasted a couple of times last year and the impression is that it already is an undeniable political principle at national level. Next to that a lot of municipalities want to become climate neutral somewhere between 2030 and 2050. We already see some change in attitude and in investment rules for housing associations and energy companies. And we have observed that municipalities have become more eager on energy efficiency improvement at residential level. In a rational sense this fits to the goals of the Paris Agreement and we therefore assume that in other countries the direction of change is more or less in the same direction. At the same time we observe that the entities that want to implement these national goals (in the Netherlands mostly: city authorities and local citizen groups focused on sustainable energy) struggle with the large diversity of interest, desires, means and scheduling of local actors.

In short, none of these solutions on their own will solve the market failure, even when they would overcome the serious drawbacks we mentioned. But each of the solutions could, when properly embedded in a learning environment, give some clues on what is needed for the desired deep retrofitting of the built environment. This also emphasizes our impression that we still do not really understand how to solve the dilemma of the mismatch between demand and supply. In the coming period one needs to experiment in real large-scale projects to learn more about tackling this market failure and to apply and learn from innovative solutions.

4.2 Value: from deep retrofitting to *Better Living*

One important aspect around deep retrofitting is the concept of “value”. The original proposal had the name “ValueFit” on purpose; we wanted to prove that deep retrofitting as carried out in the original proposal would lead to value creation in the

whole building chain. At this moment in time, we have to conclude that every actor in this chain has its own definition of value and this divergence in definition is part of the origin of the market failure. We are still convinced that bringing more convergence on the value of housing could be the key factor to tackle the market failure. We think it would be useful to develop a broader and acceptable definition of value. This development of the concept of value should be a development trajectory in co-creation between (applied) science and stakeholders in deep retrofitting and or district development. Project developers and investors in the built environment ought to be included in such a development. When we can convince investors (e.g. pension funds) that this new concept fits better to their needs than the current practice, then, we guess, part of the market failure could be solved. Below we give some ideas on how to develop that new concept of value.

The mismatch in the demand-supply chain is not only economic; there is also a mismatch between residents, investors, owners, contractors, suppliers and societal challenges. The wishes, desires, needs and dreams of residents, for instance, do not fit with the ideas of professionals to create a market for deep renovation. And there are a lot of other misfits. From other projects (like FosterREG, Energiesprong, and "Nul op de Meter[3]") we have drawn the conclusion that a proposition that uses the concepts "deep renovation", "deep refurbishment" or "zero energy housing" is not attractive for residents and also not really attractive for housing associations, investors and others. It is not the main driver for investments.

What do residents (both home owners and tenants) want? They are focused on convenience and facilities: pleasant kitchens and bathrooms, nice temperature. They also prefer a house that fits to their physical condition ("age-proof" or "care-proof") and to the development of their household (without children, with small children, with older children, without children again). Some already want pieces of smart living and so on.

What do the investors want? They have other objectives than residents. They want buildings that will last as long as possible. They want buildings that are and stay attractive to live in for residents (meaning: continuing revenues). And they want buildings with predictable and low maintenance cost.

As argued above, we think that tackling the market failure could be supported by a broader definition of value and thus by a broader proposition for deep retrofitting. A proposition that includes the following aspects of housing:

- attractive and convenient to live in;
- age-proof, lifetime-proof and care-proof;
- fit for smart living;
- climate neutral (in combination with the local energy system);
- predicable and low maintenance costs;
- sustainable (increasing?) value;
- fit for the circular economy;
- and possibly other (new) ones.

[3] Zero on the Meter, meaning that on an annual average base the gas and electricity metering results in no external demand for energy at all.

Such a proposition also leads to deep retrofitting but it is much more attractive to the stakeholders at the demand side of the building chain: residents, owners, and investors. Such a broad proposition would better connect to the wishes of the demand side. We suggest using the word “Better Living” for this broad proposition. We suggest for the next step in ValueFit the following motto: *Housing for better living. Create and maintain value in housing investments.*

4.3 Lessons learned

In this section, we will give some lessons learned in bullet form.

- The “cry” for a business model that helps to overcome the barriers identified seems to be present everywhere. Nevertheless, we also observe that we live in a market failure situation and there seem to be no “classical” business models to realise the necessary scale up potentials. We are facing a classical trade-off situation (energy efficiency/conservation vs. economic optimisation) that cannot be solved with a classical business model. We observe a need for another approach for assessment of value created and allocation of value (benefits) and costs involved in multi-stakeholder processes. This might also include an internalisation of external benefits that could be beneficial/necessary to positively affect the cost-benefit calculations. This could trigger larger and more substantial efforts, such as a shift in property valuation on a global scale (Royal Institute of Corporate Surveyors), introduction of a more meaningful carbon taxation etc.
- In this project (but also in a couple of parallel projects) we conclude that a lot of stakeholders we contacted have started to take early steps in “deep retrofit”-like activities in the built environment. So the conclusion is not that there are not enough activities. What we observe, however, is that these activities are isolated or detached. One of the currently phrased solutions for this disconnectedness is: knowledge sharing. At the same time we see that this knowledge sharing is defined in a very lean way: activities in which persons tell each other what they have done. This is indeed sharing, but it does not lead to learning and it certainly does not lead to the necessary improvement of the professional practice that is needed to speed up the sustainable innovation in the built environment. Next to innovative and sustainable activities we need a more structured and professional learning environment.
- We have doubts on some perceptions of the stakeholders involved. They mostly state that there is no need for additional tooling or services, but we see in practice that their knowledge and their experience in analyses and considerations do not include integration of the domains. They also claim to be able to cooperate on the district scale, but they are not very well equipped with personnel that are able to cooperate with “normal citizens” (see also the barriers in §2). Although not a direct result from our validation, we still think there is a need and a market for tools that support integration and participation.
- Although this validation showed that there is no positively validated business model, we still see possibilities for one or more positive business case(s). There are certain situations in which the service we offered in one of the business models could achieve a positive balance sheet. We see possibilities for the tool as a product and for the housing association developer.

5 Conclusions and Recommendations

The conclusions and recommendations are divided into next steps for the ValueFit related activities (§5.1) and recommendations for Climate-KIC in general around this theme (§5.2). All conclusions and recommendations are given in bullet form.

5.1 Next steps for the ValueFit approach

- From the ValueFit accelerator project we have found that stakeholders from different sectors are of the opinion that (despite the current situation of market failure) large-scale retrofitting on the basis of a financially viable and sustainable business model is within reach. The momentum for this seems to be higher in the Netherlands than in the United Kingdom or Sweden at present. Most of these stakeholders also have (initial) ideas how to shape such business models. However, we didn't find any stakeholder who could present a solid and convincing business model based on experience. Moreover, the ideas for business models still differ from each other, ranging from fully business driven to (largely) public driven e.g. as a "societal EsCo".
- Each of the partners (TNO, Imperial College, Chalmers University) involved in the ValueFit Accelerator project have found some initial leads to initiate new projects in the area of deep retrofitting. If coming off the ground such projects would be of a "one-off nature", meaning they would support single retrofitting initiatives without harvesting from the experiences/results obtained. Although this would support individual deep retrofitting activities, it is highly unlikely that this will stimulate a breakthrough at a larger scale.
- Deep retrofitting of building stock requires a systemic innovation approach, containing elements of both a technical, societal, financial and governance nature. In order to make steps forward it is required to create space for experimenting, harvesting from experiences/results and learning. The ValueFit team is convinced that demonstrator projects are a highly suitable vehicle to make progress in this respect. Deep retrofitting initiatives, acting as case studies, should be at the basis of these demonstrators.
- We have found a number of stakeholders around deep retrofitting initiatives who are keen to co-operate with Climate-KIC in a ValueFit demonstrator project (see Appendix B).
- Currently the market for large-scale deep renovation is detained by a structural systemic market failure (see Chapter 2), which isn't to be solved via a business model easily. Hence the effort and intellectual input from all participants, we have not been able to validate such a business model, acting as a key to unlock this huge market potential. Although it is stated within the Climate KIC requirements for a demonstrator project to have a validated business model, we argue to loosen the requirement in this case to the extent, that formulating one or more positive business cases (being actual retrofitting projects of building complex or neighbourhood level), can sufficiently serve as to demonstrate on scale and size, effective mechanisms (innovative procurement, collaboration, novel integrated techniques and financial arrangements) to help overcome the systemic market barriers in the long run.

5.2 Other recommendations for Climate-KIC

- We have learned that it does not make sense to try to validate a business model in a case where there is a real market failure. We do not know the possibilities of Climate-KIC to act in this field, but the least it can do is reflect on this outcome and act accordingly:
    - Climate-KIC (as an EU innovation community) should address the issue of the market failure at the proper tables in Brussels and in the Member States (policy-makers, politicians). It needs to be on the policy agenda. And it should also be on the research agenda (see §4.1)
    - Climate-KIC could reconsider the constraints of a Demonstrator project (is a validated business model really necessary when the current situation can be characterised as a market failure?). We are convinced that innovative activities are possible and necessary in this field of deep retrofitting; that these activities are rather relevant for the goals of Climate-KIC; and these activities can only happen with the kind of budget of a Demonstrator.
- We hope and expect that Climate-KIC will endorse the next steps of ValueFit as described in §5.1. Meaning that they will spread the lessons we have learned, will incorporate these lessons into their own dissemination material and strategy documents and also encouraging others to learn from this project and challenge them to find even better solutions.
- We recommend writing a Climate-KIC “white paper” on the lessons learned on a European scale. Based on the white paper, discussion with relevant stakeholders should be established, e.g. facilitated by the DG Energy. This shall lead to an action plan on the European level.

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Appendix A: Description of the business models

This appendix describes the business models that were used in the validation. These models designate the company that could help to organise the demand-supply chain for the case of future-proof housing. In the beginning of 2017 the research team has chosen to start with four types of companies. This appendix contains the motivation behind the choice for the four companies (§1), a brief description of the four companies themselves (§2) and an explanation to the canvasses that were created and used (§3).

Motivation behind the choice for four companies

As for all companies, the two main tasks for the company are (i) to find the proper customer(s) and (ii) to produce a sustainable and attractive value proposition. Finding the proper customer is not an easy task. For instance, when you look at a future-proof retrofit task in a city district, there will be a lot of different stakeholders involved, all with different interest and agendas: the city government, the owners of the buildings, the utility companies, the residents, the residing businesses, etc. None of them has a hierarchical leading position: the city government has some formal privileges in planning, but it cannot achieve future proof retrofit on its own, it needs other stakeholders to get the job done. So for future-proof retrofit of a district, the company is looking at several customers at once.

In the first effort to come to a company that could get future-proof retrofit of a district on a higher level, the idea of a district development company was launched. That would be a company that operates more or less the same as a (building, single location) development company: it develops a plan, it arranges the organization (contractors, engineers, supply) and the finance, it executes the plan and finally it transfers the ownership of the location to other entities (residents, business, etc.). This form of company could be an attractive one to kick start this retrofit market: a company that can take over all technical responsibilities and also will be able to cover all commercial and financial risks. But it has to operate in a more complex situation than a “normal” development company. The risks are certainly higher and some risks may be perceived as too difficult to manage because of the big diversity of stakeholders involved.

Suppose we would only have the development company as a business model to validate. We estimated that the chance was too high that the stakeholders would not find this model feasible. And then we would have to start from the beginning with a new business model. That was the reason that we concluded that it would be better to start the validation with a number of business models, models that would cover a broader playing field. The validation process would deliver the preferences of the stakeholders and this process would also give more insight in the pro and con arguments of each stakeholder.

This reasoning led to the idea that next to a development company also a service company and a product company could play a role in this phase of the project. The service company would do more or less the same as the development company, except that it does not carry any financial risk of the execution, it will help the stakeholders in achieving their common goals. The product company produces a very efficient and effective tool for the process of achieving future-proof retrofit or housing. But this company does not support the process nor does it take any risk of the execution.

While discussing the development company, we also decided that it was better to define a company that has a different customer: institutions that have lots of buildings in possession and which have in

some way or another a public function, we call them for the time being "housing associations[4]". When the company can take over the retrofit actions of several housing associations this can also lead to the desired growth in the demand. This means that the final rough choice for the company can be given by four business models:

1. The development company
   a. District oriented – Future-Proof District Developer Inc.
   b. Housing association oriented – Future-Proof Housing Developer Inc.
2. The service company – Future-Proof Housing Support Company
3. The product company – Future-Proof Housing Tool Inc.

In the text below the canvasses are given for all four companies. For the most complex one (1a) we will also give a short textual explanation.

Illustrating the companies

In the next subsections we will shortly illustrate each company separately. In this introductory paragraph we will describe the main similarities and differences.

All four companies essentially use the **Triple Tool** that was described in the Climate-KIC Demonstrator proposal. This tool consisted of three parts: (i) Deep Retrofit Initiatives Archetypes, (ii) Retrofit Labelled Solutions Packages and the (iii) Value Chain Accelerator. The Triple Tool in this step of the ValueFit project still is a black box; we more or less assume that each company has found a way to materialize this Tool in such a way that it fits the purpose of the company. The tool is strictly seen not necessary for the companies to tackle the challenge, but we wanted to stick to our idea that this could be a valuable tool (see our earlier Demonstrator proposal). In the validation step, we can learn what the added value of the tool could be and under what conditions it will be useful in the different models. This can also help us in developing tools (in general) for making the building process sustainable.

The main difference between these companies can be found on two factors: risk ownership and standardization. The development company takes all the risks of the whole retrofit project and it does not need to standardize the tool because the tool is only used internally in the company. The product company does not take any execution risk at all, it only provides the tool but the tool needs to be standardized in an advanced way. The service company has a mixture of both.

Business Model Canvasses

We have used the Business Model Canvas as the tool to sketch a business model. This model consists of nine segments centred on the main issues: the value proposition and the customer. For each of the nine segment of the canvas we will give some more background to the text in the canvasses. But, we guess, most will be self-explanatory. The following description accompanies the canvasses given in the final figures at the end of the paragraph.

Customer Segments

As explained in the project approach the big challenge is to address a real demand and to find "the customer". We have chosen two scenarios for the customer: (i) collective of customers which have interest in a certain district and (ii) housing associations. The collective of customers consists at least

[4] In the Netherlands the most common one ("woningcorporaties") has a public goal to provide affordable housing for lower income households. In Sweden it can refer to the public housing activities of municipalities. If someone has a better name for this kind of institutions: suggestions are welcome.

of the municipality, one or more housing associations and the energy company. The collective can also include other stakeholders. For the development companies we have chosen that they focus on one of these two markets. For the other two types of companies we assume that they can support both markets.

Value Proposition

This is the essential point of each canvas. For all four we have defined this proposition in such a way that it should be attractive for the chosen customers. Each proposition contains a direct financial advantage (e.g. lower costs, higher quality/better performance for the same costs, higher ROI) and/or a "process" advantage, meaning that the customers can reach the same results in less time, with lower effort etc.

Customer Relationships

In this canvas we assumed that the company is a part or an offspring of an already existing company or institution with good relation with the described key partners and customers. This means that there is already some form of relationship, but it needs to be redefined in some ways.

Channels

This very much depends on the company type. The district development company on the one hand has abundant opportunities to reach his customers (since they are very diverse) but on the other hand there are no or hardly any existing collective customers to target directly. This is an item in the canvas that needs some extra attention after we have refined the other parts.

Revenue Streams

The revenues have been divided into direct payments for services and products and into profit sharing with the supply companies.

Key Resources

The first but not the most important resource is the triple tool. For the development and the service companies this needs to be supplemented by personnel that has the capability to understand and integrate all the issues around deep retrofit and is also able to conduct local engagement processes. The development companies also need to have firm agreements with investors or financial institutions to be able to pre-finance projects and to cover rather high risks.

Key Activities

The key activities differ for each company. The development companies are more focused on designing, contracting and local engagement. The product company is more focused on developing and maintaining the triple tool product.

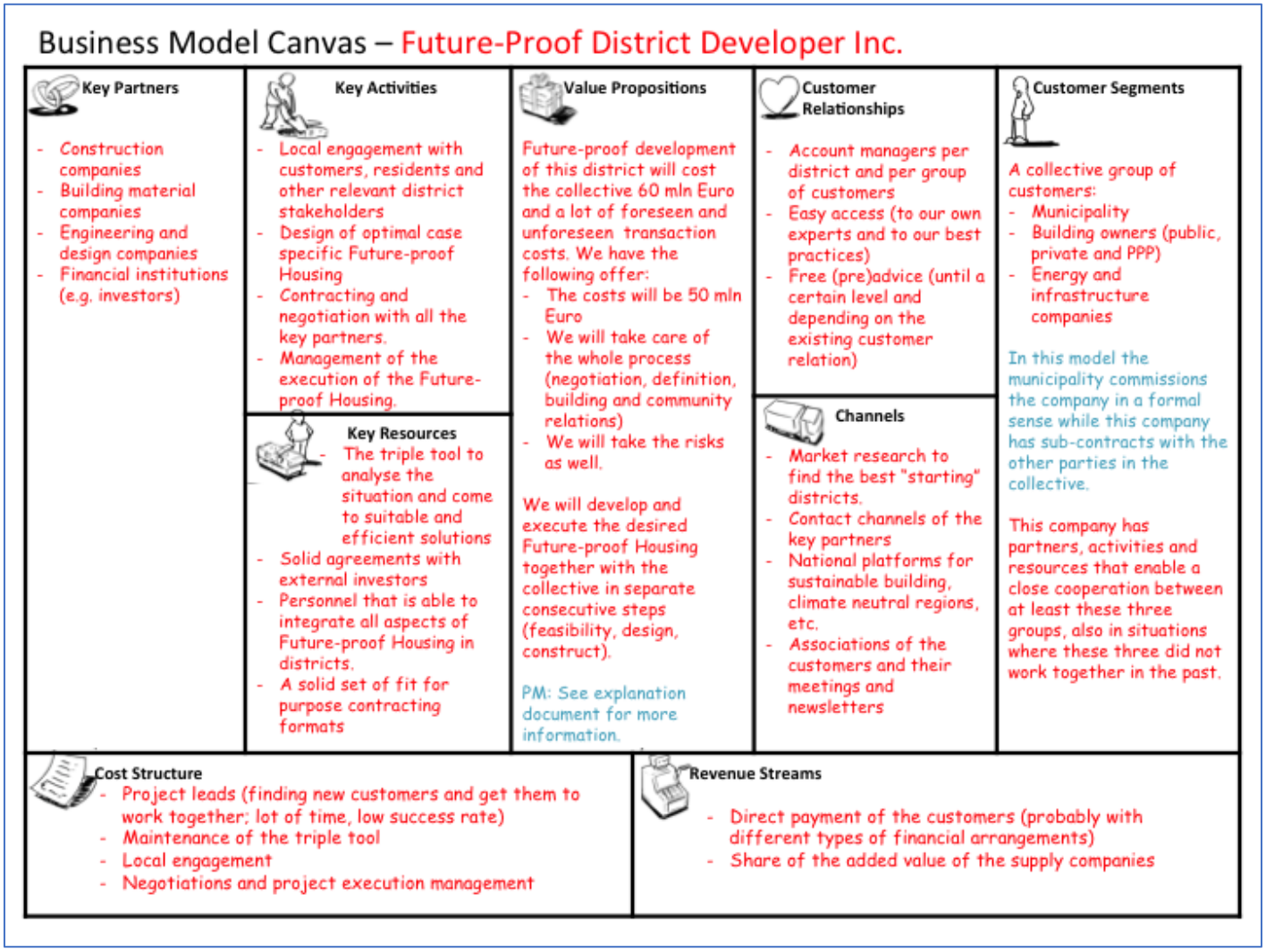
Partners

A lot of partners can be used. We have focussed on the supply and support side of deep retrofit. Those parties have an interest in being a real partner because they can obtain added value of the corporation (could be money, could be knowledge, could be better relations with the consumer). The ones we see as likely partners are construction companies, building material companies, engineering and design companies, and financial institutions.

Cost Structure

The (relative) costs differ per company. The product company needs a lot of development and maintenance of the tool and it relatively needs a lot of acquisition and advertisements. The development companies have next to that a lot of highly qualified personnel to pay and they need to have a good coverage for pre-financing, risks and contracting costs.

Future-Proof District Developer Inc.



This company has to deal with collective group of customers in the district. This collective contains at least the following parties:

- Municipality;
- Building owners (public, private and PPP);
- Utility (energy and infrastructure) companies.

We assume that this company is able to organise this customers in such a way that the municipality will formally operate as the commissioner of the future-proof district retrofit project. In order to get that commission, the company needs to bring in contracts with the other (paying) stakeholders that support the project and it needs to deliver LOI's of other involved stakeholders. These contracts and LOI's are needed for the municipality to be able to decide on the commission. The company has partners, activities and resources that enable a close cooperation between at least all stakeholders in the district, also in situations where these actors did not work together in the past.

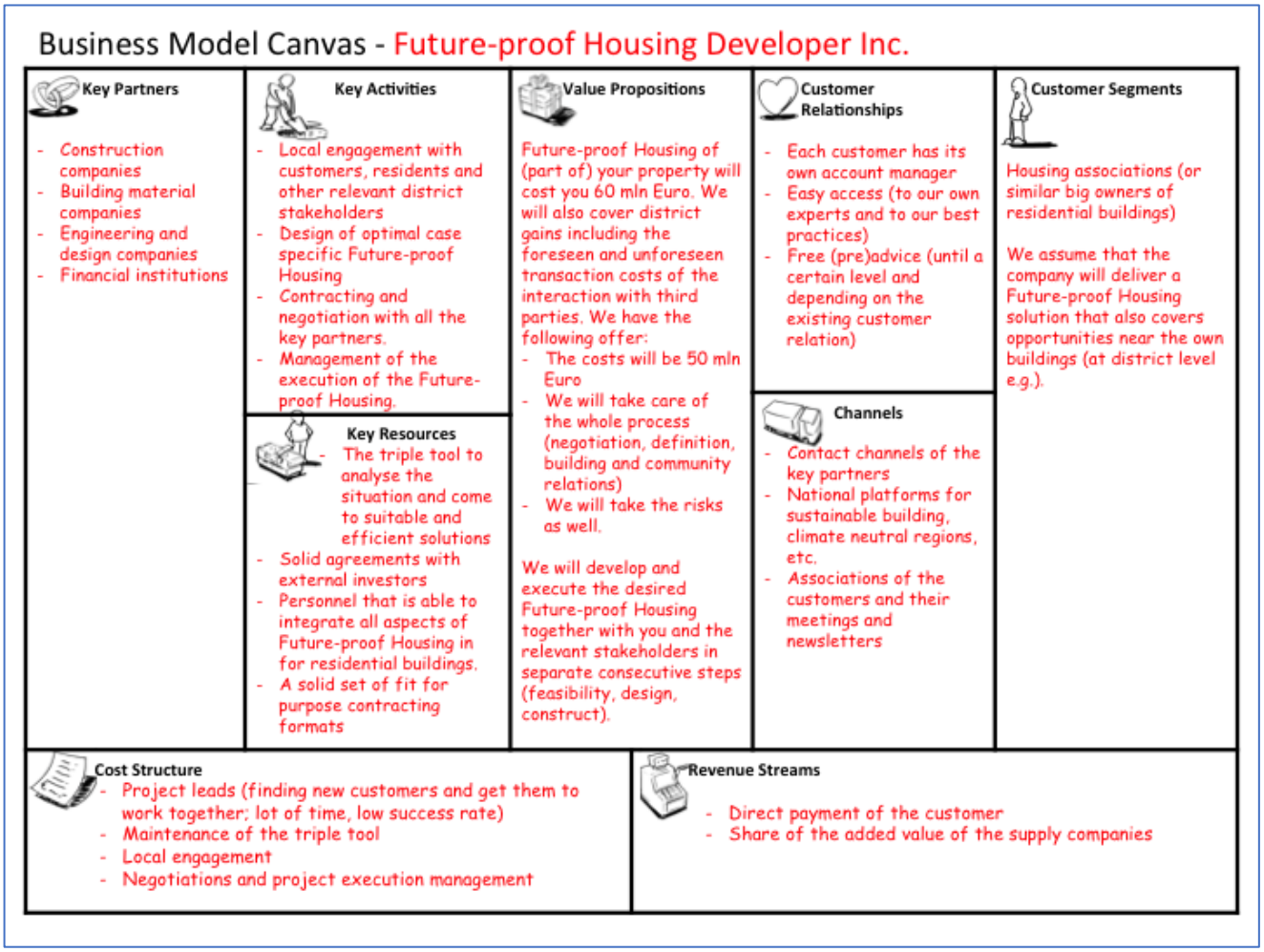
What is the offer of this company? If the stakeholders would do the retrofit of this district each on their own, the retrofit would cost 60 mln Euro and a lot of foreseen and unforeseen transaction costs. The company has the following overall offer:

- The costs will be less, e.g. 50 mln Euro
- It will take care of the whole process (negotiation, definition, building and community relations)
- It will take the operational and financial risks as well.

For each party the proposition will be tailor-made:

- Municipality:
- Building owners:
- Utilities:

Future-Proof Housing Developer Inc.

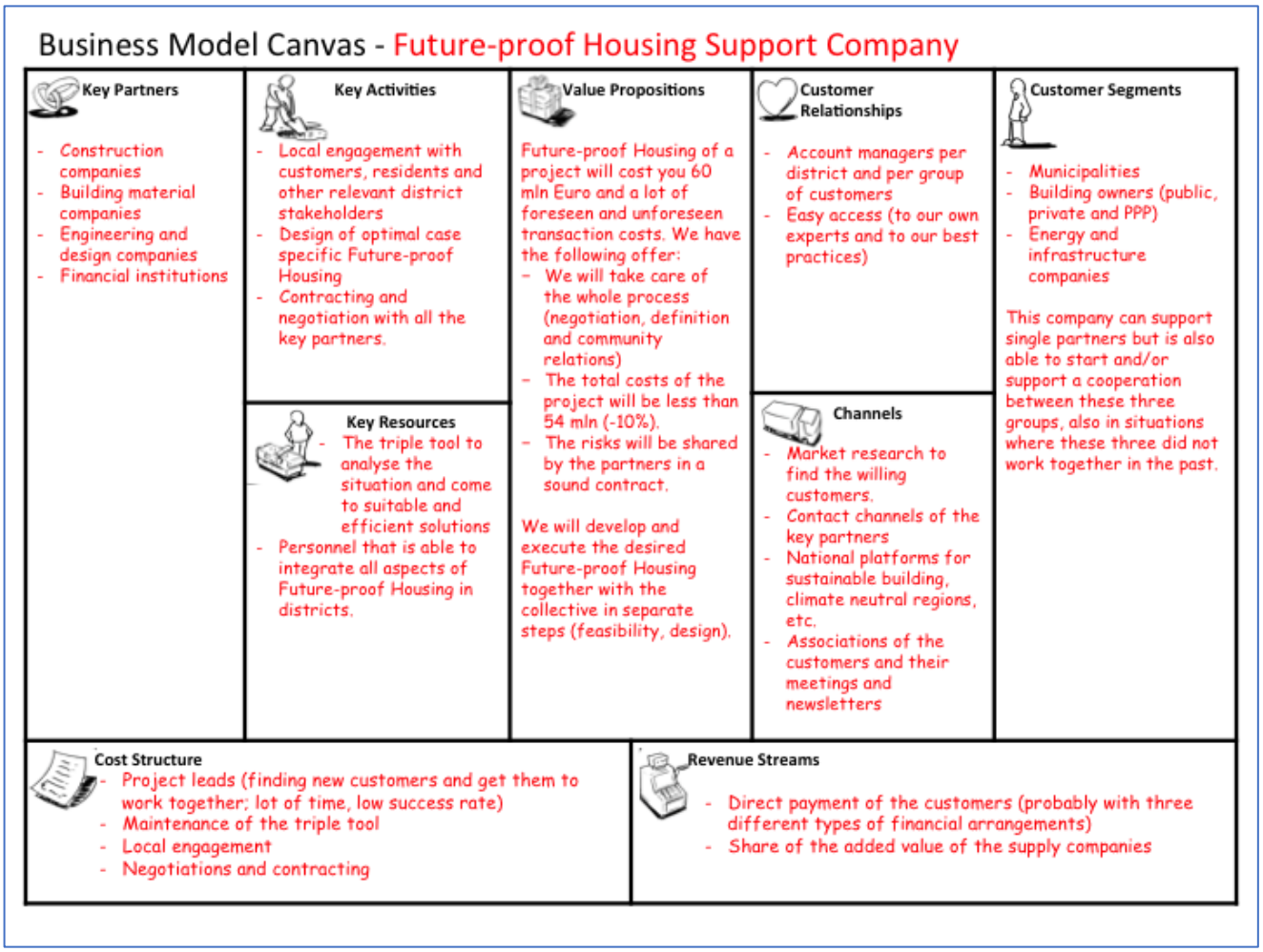


This development company is the same as the first one, except that is only deals with one customer: the housing company. We assume that this company is able to organise deep retrofitting for a district as a “extension” of the housing association and is able to organise this challenge with the other parties in the district. The company needs to bring in contracts with the other stakeholders and it needs to deliver LOI’s of other involved stakeholders. These contracts and LOI’s are needed for the municipality to be able to decide on the commission. The company has partners, activities and resources that enable a close cooperation between at least all stakeholders in the district, also in situations where these actors did not work together in the past.

What is the offer of this company? If the housing association would do the retrofit of his housing stock on its own, the retrofit would cost 60 mln Euro and a lot of foreseen and unforeseen transaction costs. The company has the following overall offer:

- The costs will be less, e.g. 50 mln Euro.
- It will take care of the whole process (negotiation, definition, building and community relations).
- It will take the operational and financial risks as well.

Future-Proof Housing Support Company



This company has to deal with collective group of customers in the district. This collective contains at least the following parties:

- Municipality
- Building owners (public, private and PPP)
- Utility (energy and infrastructure) companies

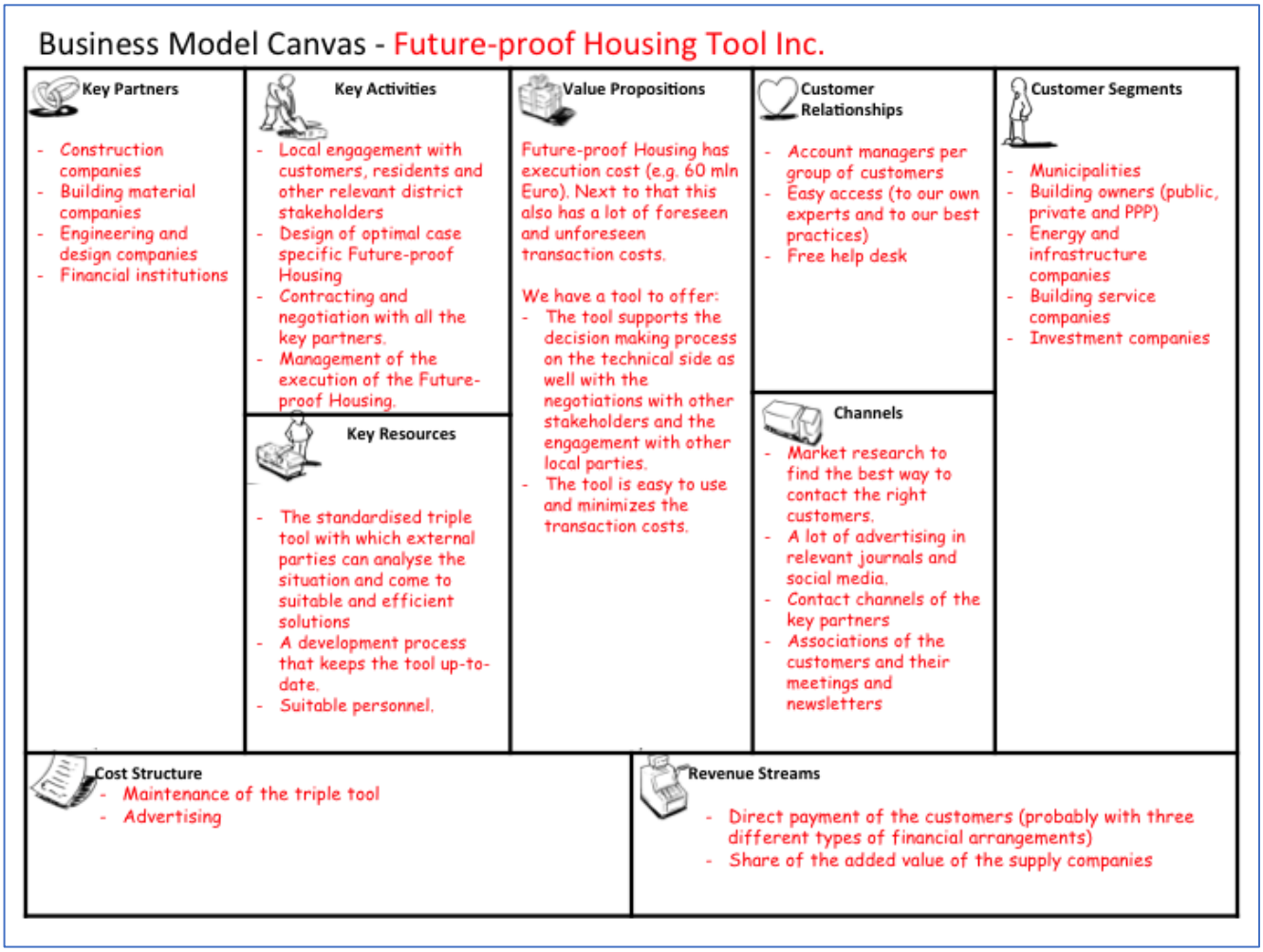
This company supports the municipality (the only public decision maker in a district) in organising the stakeholders in such a way that the municipality can formally operate as the commissioner of the future-proof district retrofit project. In order to get that commission, the company needs to bring in contracts with the other (paying) stakeholders that support the project and it needs to deliver LOI's of other involved stakeholders. These contracts and LOI's are needed for the municipality to be able to decide on the commission. The company has partners, activities and resources that enable a close cooperation between at least all stakeholders in the district, also in situations where these actors did not work together in the past.

What is the offer of this company? If the stakeholders would do the retrofit of this district each on their own, the retrofit would cost 60 mln Euro and a lot of foreseen and unforeseen transaction costs. The company has the following overall offer:

- The costs will be less, e.g. 50 mln Euro.
- It will take care of the whole process (negotiation, definition, building and community relations).

This company is more or less similar to the first company with one major difference: it will only support the process and will not take any liability at all in financial terms.

Future-Proof Housing Tool Inc.



This company makes and maintains a complex tool (the Triple Tool mentioned earlier) that is assumed to be necessary, or at least very helpful, for those who want to implement deep retrofitting on a district level.

Appendix B: Stakeholders interested to co-operate with Climate-KIC in a ValueFit demonstrator project:

As stated in §4.3 all partners involved in this validation exercise have found response and information indicating for one or more positive business cases after all. Hereunder we will work out some of theme:

- In the ValueFit demonstrator proposal submitted October 2016 the district “De Nude” in Wageningen has been presented as a case study. The challenge here is to transition the district with approximately 1000 dwellings into a “future-proof” area, including no dependency on natural gas as a resource for heating and cooking. The Municipality of Wageningen and housing corporation De Woningstichting have confirmed their commitment to include De Nude as a case study in the ValueFit project. In addition the Regional Development Company Oost N.V. and the Gelders Energieakkoord have expressed their interest to become involved as a potential participant in the demonstrator case.
- Imperial College London and TNO are exploring further possibilities to apply the ValueFit approach, in collaboration with a SME called E3Group and their activities in Kent (UK).
- The Swedish team is continuously working in collaboration with the German partners on identifying new approaches, e.g. based on, or within the DREEAM project (Investor Finance Initiative). Over the summer, Chalmers and the city of Malmo will be explore further collaboration for a demonstration case.