

Dwelling as cash machine

An explorative study towards dwelling-generated revenue to reduce housing expenses



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PREFACE

The endangered housing affordability is a topic of everlasting debate amongst both scientists and politicians. This debate features a clash between a free market and state-oriented rationale. Both sides acknowledge the importance of housing affordability, yet disagree on the means to safeguard this goal. Throughout the years, both camps have witnessed difficulties in the contemporary reality of the housing market. The essence of the debated topic, however, sometimes seems to be overshadowed. I am strongly convinced an affordable home and pleasant living environment are cornerstones of a well-functioning welfare state.

"After health, the housing situation may be the most important aspect in people's lives. Our identity is partly built on it. Housing and housing policies are strongly connected to social themes. For example, in the nineteenth century, this was health policy. Now these include sustainability, integration and health care." - Peter Boelhouwer, professor housing systems, as quoted by Van Weersch (2016)

Acknowledging the ideological squabble on housing affordability, we should never forget – as obvious as it seems – to realize one's right on safe and pleasant housing concerns a necessity in every human life. Whereas for some people this recognition only is enough to argue rent-free state accommodation should be a universal human right (Noor, 2017), I have aimed to come up with a new perspective. What I propose in this study could lead to new means to help ensure housing affordability. To this end I have asked myself the question: Could the very home itself generate additional revenue streams to support its affordability? After conducting this research, I am convinced that it can.

There are many people and organisations I would like to thank for their (indirect) contribution to this thesis. In the first place, ERA Contour, for allowing and facilitating me to conduct this research. Marius and Erik, our weekly meetings were a truly great help along the road. The great atmosphere at the office, with all its colleagues and co-graduate students, was a – sometimes more than welcome – distraction from the world of dwelling-generated revenues. Furthermore, I would like to thank everyone who participated in the Expeditie Gratis Wonen (and its founding companies AM, BAM Wonen, Bouwinvest, Eigen Haard, and TBI WOONlab), especially the members of my digital living team. Special thanks goes to its facilitators, and Rick van den Bos, who were more than happy to function as experts in my research project.

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I could not have been more grateful for the time I had at ERA Contour and the Expeditie Gratis Wonen and the professional and personal progress I have made during this time. Hereby, I proudly present you my master's thesis *Dwelling as cash machine*.

Jelrik van der Sijde

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ABSTRACT

Housing affordability is a growing problem in the Netherlands. Approximately 15% of all households has a housing cost overburden rate (i.e. spending more than 40% of the household's disposable income on the total housing expenses). This research explores a new way to contribute to housing affordability. *Dwelling-generated revenue* is introduced as umbrella concept to catch all potential ideas that may lead to revenue generated by a dwelling or its affiliated services that can be used to reduce housing expenses. A taxonomy of dwelling-generated revenue options is presented. Revenue options can be either object (i.e.: dwelling) or subject (i.e.: resident) bound. Object related revenues are selling a surplus of energy, third party compensation and (sub)letting. Subject related revenues are the monetization of in-home generated data and monetization of recyclable household waste. Through a multi-criteria analysis, in which five housing and innovation experts judged the revenue options, the most promising options are determined. The implementation of those options in the social housing sector is discussed, since most households with payment risks are found within sector.

Keywords: housing affordability, user costs, housing expenses, innovation, exploratory, dwelling-generated revenue, taxonomy, multi-criteria analysis, expert judgement, affordable housing, social housing, data monetization, surplus energy dwelling, subletting, Airbnb

SUMMARY

Living in a pleasant and affordable dwelling is one of the most essential human needs. In the Netherlands 8.8% of all households struggle to pay their housing expenses and more than 15% of all households has a housing cost overburden rate (i.e. spending more than 40% of the household's disposable income on the total housing expenses). This housing affordability problem does not limit itself to low-income households, as, although less frequently, middle- and high-income households are affected by it as well.

Housing affordability can be operationalized via two main theoretical approaches. First, when a dwelling is considered a capital asset, the user costs of capital are the costs of consuming one unit of the produced service of that asset: the housing services. Within this approach, the changing house price is crucial. The second approach is based on a cash flow with out-of-pocket expenses, in which the changing house price plays a smaller role. Since the aim of the current research is to reduce housing expenses on the consumer level, the latter approach is applied in this research. This research discusses the existing possible ways to reduce housing expenses and argues that the existing means to reduce housing expenses are relatively confined. It is asked whether new developments can lead to new ways to reduce housing expenses. An exploratory research towards a new way of reducing housing expenses is proposed by asking the following research question: *'In what ways can housing expenses be reduced by dwelling-generated revenue?'* *Dwelling-generated revenue* is introduced as umbrella concept to catch all potential ideas that may lead to revenue generated by a dwelling or its affiliated services. It is assumed that the generated revenue is directly used to lower the housing expenses. A taxonomy is presented that categorises dwelling-generated revenue options. Revenue options can be either object (i.e.: dwelling) or subject (i.e.: resident) bound. In order to define the categorisation at play, one should ask what the main source of the revenue option is. Object related revenues are selling a surplus of energy, third party compensation (for either advertisement, internal facilities or external facilities), and (sub)letting. Subject related revenues are the monetization of in-home generated data and the monetization of recyclable household waste. Many examples of revenue options can be placed within these categories.

Using a multi-criteria analysis, the revenue options are compared, taking into account criteria representing the feasibility of the business case and social, juridical and technical criteria related to the overall feasibility. Five housing and innovation experts are requested to judge the discerned revenue options on the above criteria in order to determine the most promising options. The results of the analysis reveal that '(Sub)letting every corner of a dwelling', 'Dwelling as power plant', and 'Monetizing in-home generated data' are identified as the most promising options to contribute to the reduction of housing expenses. These options deserve short-term attention in order to determine to what extent they can reduce the housing expenses and how and where they can be implemented. It has yet to be determined which revenue option is most suitable in which situation. Such a conclusion will be highly dependent on the identified external factors tenure, target group, location and institutional context.

The implementation of the three most promising revenue options within the social housing sector is discussed, since a reduction of housing expenses is deemed most relevant in this sector. The implementation trajectory is discussed with two legal counsels of Amsterdam based housing association Eigen Haard. All three options are ought to be feasible. In order to test the actual effects of these options, implementation in small-scale pilots is required. The *dwelling as power plant* can successfully be implemented by introducing a variable, yet maximised, energy performance compensation. Implementing *subletting* in a regulated manner is possible as well. This requires a change of mentality among housing associations and policy makers whereby subletting is seen as an alternative way to

contribute to housing affordability instead of abuse of a subsidised home. The most important rule to regulate the implementation of subletting in the social housing sector is that no profit may be generated. The revenue may maximally cover the costs of the rent. In order to implement the monetization of in-home generated data in the social housing sector, it is important tenants give their unambiguous consent on sharing their personal data. Furthermore, it should be prevented that one feels urged to share its data in order to have an affordable rent. This can be realised by not offering the related discount at the start of the tenancy agreement.

This research shows housing expenses can be reduced by dwelling-generated revenue in two principal ways. First, part of the revenue options can be implemented on a large scale so that as many households as possible can benefit from it. Second, one or more revenue options might be suitable on only a relatively small scale, yet generating a rather big revenue. This way a relatively small group could benefit from a relatively high reduction of housing expenses. There is one fundamental assumption underlying this statement: the revenue is directly used to lower the housing expenses. In order to implement dwelling-generated revenue successfully as a concept to reduce housing expenses this assumption should be honoured. Several risks could trouble the contribution of dwelling-generated revenue to a reduction of the housing expenses. First, the revenue obtained may not be used to reduce the housing expenses but spent elsewhere. However, falling outside the goal of this research, it could contribute to the overall living conditions or social participation of households with payment risks. Second, the long-term durability of reduced housing expenses remains questionable. If dwelling-generated revenue options start to receive general recognition, commercial parties may start to anticipate upon the profits to be made reducing the height of the revenue for the resident. Third, there is a probability of revenues being capitalised within the house price. Consequently, a revenue option may limitedly reduce the housing expenses for one generation of residents.

In order to increase the housing affordability effectively, it is desirable that the households that currently have a payment risk can benefit from dwelling-generated revenue. Therefore, the (most promising) revenue options should be eligible for low- and middle-income households and their housing situation. However, this is not necessarily true for all options and has yet to be determined.

Above all this research intends to provide a new perspective on contributing to the reduction of housing expenses and, therewith, housing affordability in the Netherlands.

SAMENVATTING (*DUTCH*)

Wonen in een prettige en betaalbare woning is een van de meest essentiële basisbehoeftes. In Nederland heeft 8.8% van alle huishoudens een betaalarisico en meer dan 15% kampt met een overbelasting van de woonlasten (d.w.z.: meer dan 40% van het besteedbaar inkomen wordt uitgegeven aan de totale woonlasten). Dit betaalbaarheidsprobleem beperkt zich niet tot huishoudens met een laag inkomen. Ook huishoudens met midden- en hogere inkomens hebben er, hoewel relatief minder vaak, last van.

De betaalbaarheid van wonen kan met twee theoretische benaderingen worden geoperationaliseerd. Ten eerste, wanneer een woning wordt beschouwd als investeringsgoed, zijn de gebruikskosten van het kapitaal (de woning) gelijk aan de kosten van het consumeren van een eenheid gegenereerde diensten door dat kapitaalgoed: de woondiensten. In deze benadering speelt de veranderende woningprijs een belangrijke rol. De tweede benadering is gebaseerd op een kasstroom met woonuitgaven, waarin de veranderende woningprijs een kleinere rol speelt. De tweede benaderingswijze is toegepast in dit onderzoek, omdat het doel van dit onderzoek is om de woonlasten te verlagen op het niveau van de consument. Dit onderzoek bespreekt de bestaande mogelijkheden om de woonlasten te verlagen en stelt dat deze mogelijkheden relatief beperkt zijn. Een verkennend onderzoek naar een nieuwe manier om woonlasten te verlagen is daarom uitgevoerd door het stellen van de volgende onderzoeksvraag: *“Op welke manieren kunnen de woonlasten worden verlaagd door woning-gegenereerde opbrengsten?”*. De term *woning-gegenereerde opbrengsten* is geïntroduceerd als paraplu-concept om alle potentiële ideeën te verzamelen die zouden kunnen leiden tot een gegenereerde opbrengst door de woning of aanverwante diensten. Er is aangenomen dat de gegenereerde opbrengst direct wordt ingezet om de woonlasten te verlagen. In een taxonomie zijn alle woning-gegenereerde opbrengstopties gecategoriseerd. Opbrengstopties kunnen gebonden zijn aan enerzijds het object (*het huis*) en anderzijds het subject (*de bewoner*). Om te kunnen bepalen onder welke noemer een opbrengstoptie valt, moet men zich afvragen wat de bron van de opbrengstoptie is. Object gerelateerde opbrengsten zijn het verkopen van een surplus aan energie, compensatie van derden (voor advertenties, interne faciliteiten of externe faciliteiten) en (onder)verhuur. Subject gerelateerde opbrengsten zijn het moneteriseren van in het huis gegenereerde data en het moneteriseren van recyclebaar huishoudelijk afval. Veel voorbeelden van opbrengstopties kunnen in deze categorieën worden ondergebracht.

Met behulp van een multi-criteria analyse zijn de opbrengstopties vergeleken, rekening houdend met criteria die de haalbaarheid van de business case vertegenwoordigen, alsmede sociale, juridische en technische criteria gerelateerd aan de algehele haalbaarheid. Vijf innovatie- en huisvestingsexperts zijn gevraagd om de onderscheiden opbrengstopties op bovenstaande criteria te beoordelen om de meest kansrijke opties vast te stellen. De resultaten van de analyse laten zien dat de '(Onder)verhuur van alle hoeken van de woning', 'De woning als energiefabriek' en 'Moneteriseren van in het huis gegenereerde data' zijn geïdentificeerd als de meest kansrijke opties om bij te dragen aan het reduceren van de woonlasten. Deze opties verdienen aandacht op de korte termijn om te bepalen in hoeverre ze de woonlasten kunnen verlagen en hoe en waar ze kunnen worden geïmplementeerd. Er moet worden uitgezocht welke opbrengstoptie past in welke situatie. Dat zal sterk afhankelijk zijn van de geïdentificeerde externe factoren eigendomsvorm, doelgroep, locatie en de institutionele context.

De implementatie van de drie meest kansrijke opties in de sociale huursector is besproken, omdat een verlaging van de woonlasten het meest relevant wordt geacht in deze sector. Het implementatietraject is besproken met twee juristen van de Amsterdamse woningcorporatie Eigen Haard. Alle drie de opties

zijn haalbaar geacht. Om de daadwerkelijke effecten van deze opties te testen, is het vereist om de opties eerst in kleinschalige pilots op te starten. *De woning als energiefabriek* kan succesvol geïmplementeerd worden door het invoeren van een variabele, gemaximaliseerde, energieprestatievergoeding. Het implementeren van gereguleerde *onderverhuur* is ook mogelijk. Hiervoor is een mentaliteitsverandering onder woningcorporaties en beleidsmakers vereist waardoor onderverhuur wordt gezien als een alternatieve manier om bij te dragen aan betaalbaar wonen in plaats van als misbruik van de gesubsidieerde woning. De belangrijkste regel om de implementatie van onderverhuur gereguleerd in te voeren in de sociale huursector is dat er geen winst mag worden gemaakt. De opbrengst mag dus maximaal de huurprijs dekken. Om het monetariseren van in het huis gegenereerde data in te voeren in de sociale huursector, is het belangrijk om de ondubbelzinnige toestemming van huurders te verkrijgen voor het delen van hun persoonlijke data. Daarnaast moet het voorkomen worden dat men zich verplicht voelt om zijn data te delen in ruil voor een betaalbare huur. Dit kan worden gerealiseerd door de gerealiseerde korting niet aan het begin van de huurovereenkomst aan te bieden.

Dit onderzoek toont aan dat woonlasten kunnen worden verlaagd door woning-gegenereerde opbrengsten op hoofdzakelijk twee manieren. Ten eerste, een gedeelte van de opbrengstopties zou op grote schaal kunnen worden geïmplementeerd zodat zoveel mogelijk huishoudens daarvan kunnen profiteren. Ten tweede, een of meerdere opbrengstopties zijn wellicht slechts geschikt op een kleine schaal, terwijl ze een grote opbrengst genereren. Op deze manier zou een relatief kleine groep van een relatief grote verlaging van de woonlasten kunnen profiteren. Een fundamentele aanname ligt hieraan ten grondslag: de opbrengst wordt direct gebruikt om de woonlasten te verlagen. Om woning-gegenereerde opbrengsten succesvol te implementeren als concept om woonlasten te verlagen, moet aan deze aanname worden voldaan. Er bestaan verschillende risico's die een bijdrage aan het verlagen van de woonlasten in de weg zouden kunnen staan. Ten eerste, de verkregen opbrengst wordt niet ingezet om de woonlasten te verlagen, maar elders gependeed. Hoewel het buiten het doel van dit onderzoek valt, zou de opbrengst alsnog bij kunnen dragen aan de algehele leefomstandigheden en de maatschappelijke participatie van huishoudens met een betaalrisico. Ten tweede, het blijft de vraag of de verlaagde woonlasten op de lange termijn houdbaar zijn. Als de woning-gegenereerde opbrengsten algemene bekendheid vergaren, zouden commerciële partijen kunnen anticiperen op de winst die er te behalen valt en daarmee de opbrengst voor de bewoner kunnen verlagen. Ten derde bestaat er een kans dat de opbrengsten worden gekapitaliseerd in de woningprijs. Zodoende kan het effect van de verlaagde woonlasten zich beperken tot één generatie bewoners.

Om de betaalbaarheid van wonen te vergroten, is het gewenst dat juist huishoudens die momenteel een betaalrisico hebben profiteren van woning-gegenereerde opbrengsten. Daarom zouden de (meest kansrijke) opbrengstopties geschikt moeten zijn voor huishoudens met een laag- en middeninkomen en hun woonsituatie. Toch is dit niet noodzakelijk het geval en dat zal dan ook nader bepaald moeten worden.

Bovenal beoogt dit onderzoek een nieuw perspectief te bieden op het bijdragen aan woonlastenverlagingen en, daarmee, aan de betaalbaarheid van wonen in Nederland.

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LIST OF ABBREVIATIONS

BTIV	<i>Besluit Toegelaten Instellingen Volkshuisvesting</i> (English: Decree Accepted Institutions Public Housing)
EGW	<i>Expeditie Gratis Wonen</i> (English: Expedition rent-free living)
EPV	<i>Energieprestatievergoeding</i> (English: Energy Performance Compensation)
IoT	Internet of Things
PV	Photovoltaic
MaaS	Mobility as a Service
MCA	Multi-Criteria Analysis
SJT	Social, juridical, and technical
WBP	<i>Wet bescherming persoonsgegevens</i> (English: Personal Data Protection Act)
WSN	Wireless Sensor Networks
WWS	<i>Woningwaarderingstelsel</i> (English: Rent points system)

LIST OF DEFINITIONS

Dwelling-generated revenue	The umbrella concept to catch all potential ideas that may lead to revenue generated by a dwelling or its affiliated services.
Near zero energy dwelling	A dwelling with close to zero energy consumption. The amount of energy produced on site is almost equal to the amount of energy consumed within the dwelling.
Net zero energy dwelling	A dwelling with net zero energy consumption. The amount of energy produced on site is almost equal to the amount of energy consumed within the dwelling.
Zero bill homes	A performance-based contract in which residents are guaranteed to have no energy bill. Therefore, these kind of dwellings are built and designed for compensating a higher than average energy consumption.

1. INTRODUCTION

In this chapter, the context of this thesis is introduced, followed by a problem identification and the outline of this thesis. Note that the research question is introduced in chapter 3 after a brief overview of the topic housing affordability in chapter 2.

1.1 CONTEXT

Living in a pleasant and affordable dwelling is one of the most essential human needs. Within the Netherlands, the primary tool to ensure affordable housing for low-income households is the social housing system in which semi-public housing associations provide rental dwellings at relatively low rents. Middle- and higher-income households are expected either to rent a dwelling in the private sector or to buy a dwelling. Despite the fact Dutch housing policy aims to provide affordable and pleasant dwellings (Rijksoverheid, 2016), still 662.800 households (403.600 rental and 219.200 owner-occupier households) are at risk of not being able to pay for their housing expenses and basic living expenses (Blijie & Gopal, 2015). Strikingly, 8.8% of all households in the Netherlands struggle to pay their elementary expenses because of seemingly too expensive housing. Furthermore, the Netherlands counts 31.000 individuals that cannot afford any housing expenses at all (CBS, 2016a), i.e. the homeless. The national government, municipalities, Aedes (umbrella organisation of housing associations) and the Woonbond (advocate of tenants) acknowledge that ensuring affordable housing is one of the biggest challenges in the forthcoming years (PBL, 2016).

1.2 PROBLEM IDENTIFICATION

The question whether housing expenses are objectively too high in the Netherlands can only be answered by relating the housing expenses to the disposable household's income. Housing affordability is operationalized by Eurostat, the statistics bureau of the European Union. When more than 40% of a household's disposable income (net of housing allowances) is spent on the total housing expenses (net of housing allowances) a household is considered overburdened. Mortgage or housing loan interest payments for owners and rent payments for tenants are included in the total housing expenses as well as costs for utilities, routine maintenance and structural insurance (Pittini, 2012). According to the most recent available data set of the EU-SILC (Statistics on Income and Living Conditions), the Netherlands scores relatively poor as country having the fourth highest overburden rate of 15.4% of the total population, compared to the EU average of 11.4%. Only Greece (40.7%), Germany (15.9%) and Denmark (15.6%) score worse than the Netherlands. The relatively high score of the Netherlands is partly explained by the low housing deprivation rate and low overcrowding rate in the Netherlands (Eurostat, 2015). Based on the three-yearly housing survey (*WoOn*) in the Netherlands, the average net rate between total housing expenses and the disposable income has increased from 33.9% to 36.0% in the rental market, while it has decreased from 30.1% to 27.2% in the buy market from 2012 to 2015. Another noteworthy fact is that, within the group that is eligible for receiving housing allowance in the Netherlands, the number of people living in a more expensive dwelling has increased from 367.000 to 528.00 (Blijie, Gopal, Steijvers, & Faesse, 2016). It can be concluded that housing expenses in relation to income in Netherlands are relatively high within the EU.

The amount of housing expenses correlates strongly with the height of the house price, reflected within the rent (in case of tenancy) or monthly mortgage costs (in case of owner-occupancy). From the mid 1980's until the credit crunch in 2008, house prices have been rising almost constantly (Figure 1). The credit crunch has temporarily interrupted this decline, but the price is about to reach pre-crisis level again in late 2017 (Boumeester, 2016). The expected price increase is welcomed by owner-occupiers, since the value of their property will increase. However, for potential starters it further increases the housing expenses. The fierce recovery of the house prices is especially felt within the four big cities (respectively Amsterdam, Rotterdam, The Hague and Utrecht) due to the high demand for houses in urban regions. The demand in these cities is bound to keep increasing, since the four big cities have to process approximately one third of the national population growth until 2030 (Kooiman, De Jong, Huisman, Van Duin, & Stoeldraijer, 2016). In Amsterdam the pre-crisis level has already been surpassed (Boumeester, 2016). The increased demand in the owner-occupancy market by potential starters is also affected by the developments in the rental market. The fast growing prices in the private rental sector and the increased waiting time in social housing sector in cities makes the rental market a less attractive alternative to buying a house (Boumeester, 2016).



FIGURE 1: THE ACTUAL AND ESTIMATED MEAN HOUSE SELLING PRICE (NOMINAL), 1971-2016

Source: Boumeester (2016), translated

1.3 SCOPE AND RELEVANCE

With the expected increase of house prices in the forthcoming years, housing expenses (for starters) are bound to increase simultaneously. Although potentially mitigated by the relatively low interest rates. Housing affordability in the Netherlands is thus at risk. The goal of this research is to develop ideas that might increase housing affordability in the Netherlands. To this end the options are explored that may reduce housing expenses. Therefore, the aspects that influence the total housing expenses should be determined as well as the known options to cut the expenditures. The possibility to enhance the affordability by increasing the disposable income by labour or tax regulations falls beyond the scope of this research. Instead, special attention is paid to an alternative solution: the possibility to turn the dwelling at stake into a generator of revenue. Research so far is largely focused on building costs minimisation and the influence of national housing policies on affordability. By exploring a relatively novel approach towards housing affordability, this research could be of considerable practical relevance whilst developing innovative solutions in the short term. The current study aims to facilitate the reduction

of housing expenses and potentially increase the purchasing power of households. Once new ways for reducing housing expenses are explored, it could additionally lead to business opportunities for either new or existing businesses active on the real estate and construction market.

1.4 THESIS OUTLINE

The structure of this report is as follows. Chapter 2 discusses the two main approaches of looking at housing affordability and describes the current ways of reducing housing expenses. This leads to the introduction of a new concept to reduce housing expenses by revenue generated within a dwelling. Chapter 3 then sets out the goal and the question of the research, followed by a description of the methodology and research designs. In chapter 4, inspiration sources for revenue options are discussed. This chapter includes a review of the mechanisms behind low-priced products and a brief trend analysis. Subsequently, a taxonomy of revenue options is presented in chapter 5. These options are then compared on their potential in chapter 6 in a multi-criteria analysis. In chapter 7, it is discussed how the most promising revenue options can be implemented in the sector with most housing affordability issues: the social housing sector. Answers to the research questions are presented in the conclusion in chapter 8. Finally, the results are interpreted, the limitations of this research are presented and recommendations for further research are given in the discussion in chapter 9.

2. HOUSING AFFORDABILITY

In this chapter, the current knowledge on ways to increase housing affordability is presented. First, ways to operationalize affordability through either user costs or expenses are discussed. Second, the housing expenses for owner-occupancy and tenancy are specified. Third, determining factors of housing expenses are explained followed by an explanation of the most influential factor: the house price. Fourth, the ways and difficulties to reduce housing expenses are discussed. Finally, suggestions for new ways to save on housing expenses are examined.

2.1 HOUSING EXPENSES VERSUS USER COSTS

Affordability as such cannot be measured, yet housing expenses and user costs are two ways through which affordability can be operationalized. The first concept, short-term affordability, is based on the expenses on housing on the consumer level and is a cash flow based on out-of-pocket expenses. The second concept, long-term affordability, can be expressed through the user costs attributed to housing consumption and derives from the neo-classical economic perspective in which a dwelling can be seen as a capital asset that generates one or multiple services that are consumed. In case of a dwelling, these are the housing services. The user costs of capital are the costs for the consumption of one unit of housing services in a given period (Haffner & Heylen, 2011). Included in the user costs is the required rate of return after having taken the income tax and additional costs (such as maintenance, depreciation, insurances, risks and other kinds of tax) into account. In tenancy the user costs would be equal to the rent and in owner-occupancy a fictitious price is paid for the consumption of the housing service: the imputed rent (Haffner & Van Dam, 2011).

Both concepts deal differently with the tax treatment of the investment in owner-occupied dwellings. Short-term affordability based on expenses takes debt financing into account, while the long-term affordability includes interest costs of equity financing (i.e. the interest that one alternatively could have received over its equity) (Haffner & Heylen, 2011). An essential difference between the two concepts is the way in which the changing (market) value is incorporated into the calculation. Within user costs, the changing value is one of the most important variables, while the housing expenses do not directly consider the changing value. This is perfectly shown by Haffner and Heylen (2011) in their comparison of user costs and expenses: in 2005 owner-occupied dwelling in Flanders and the Netherlands had *negative user costs* (i.e. revenues) as a result of a high expected capital gain. The capital gain or loss as the result of a changing house price can thus heavily influence the user costs.

Taking into account the purpose of this research, it is expected that the impact of intervening measures on affordability can be made clearest via the short-term affordability approach based on housing expenses. In case of a long-term affordability approach based on user costs, a changing house price as result of economic factors could heavily distort the effect of certain measures. The development of the housing price is further discussed within paragraph 2.4. Special attention has to be paid to situations in which the house price is expected to rise because of a substantial investment aimed at reducing housing expenses. The increased house price rise cannot be incorporated as a separate cash flow, but may be an important consideration when comparing certain measures.

2.2 HOUSING EXPENSES

The three-yearly housing survey in the Netherlands, *WoOn*, contains a clear definition of what is considered as housing expenses for both owner-occupancy and tenancy. The average expenses for both situations in 2015 are included *Table 1* and *Table 2*.

TABLE 1: OWNER-OCCUPANCY HOUSING EXPENSES (2015)

Expenditures		Average expense [€/month]	Specification	
	Gross mortgage costs	670		
+	Maintenance	53		
+	Additional owner occupancy expenses	155	Home insurance	
			Property tax	
			Optional ground lease charges	
=	Gross housing expenses	879		
-	Fiscal effect	-209	Balance of notional rental value and mortgage rent deduction	
=	Net housing expenses	670		
+	Additional housing expenses	225	Public body taxes and levies	Location dependent
			Essential utilities	Gas
				Electricity
Water				
=	Total housing expenses	895		

Source: Blijie et al. (2016), adjusted

TABLE 2: TENANCY HOUSING EXPENSES (2015)

Expenditures		Average expense [€/month]	Specification	
	Gross rent	569		
-	Housing allowance	-70	Balance of notional rental value and mortgage rent deduction	
=	Net housing expenses/net rent	499		
+	Additional housing expenses	163	Public body taxes and levies	Location dependent
			Essential utilities	Gas
				Electricity
Water				
=	Total housing expenses	662		

Source: Blijie et al. (2016), adjusted

It must be stressed that the total housing expenses are the required expenses for purely living in a dwelling. This is different from all basic living costs that include more expenses such as those for food, health care, internet, and optionally social participation. The housing expenses tables can be transformed to basic living costs tables by adding these extra expenses as Blijie and Gopal (2015) did in their research to determine the amount of households with a payment risk.

The *total housing expenses* will be referred to as *housing expenses* in the rest of this research. Housing expenses can thus also be reduced by lower taxes or lower costs for essential utilities.

2.3 HOUSING EXPENSES DETERMINING FACTORS

The housing expenses are determined through five main factors that are discussed in this paragraph.

2.3.1 INSTITUTIONAL

Many of the aspects that build up to the housing expenses are influenced by national and local governmental institutions. The property tax, leasehold prices, and several levies such as the waste collection levy and sewer levy are determined by municipalities. The water boards impose their own taxes on residents within their management region.

The national government has a strong influence on the housing expenses. The fiscal effect for owner-occupiers, the balance between notional rental value (a fictitious revenue in return for the living comfort of an owner-occupancy dwelling) and mortgage rent deduction, decreased the average gross housing expenses in 2015 by 23.7%. Within the social housing system, two subsidies exist to reduce housing expenses: one implicit and one explicit subsidy. The implicit subsidy is offered by semi-public housing associations that provide rental dwellings for a relatively low rent regulated by law. The explicit tool to ensure affordability for low-income households, housing allowance, decreased the average gross rent by 12.3% (Blijie et al., 2016). However, not all tenants receive housing allowance as their gross rent can be higher than the deregulation level or they could have an income above the income threshold.

2.3.2 ESSENTIAL UTILITIES

The expenses for energy (gas and electricity) and water are logically based on the prices of these services and one's consumption. Consumption consists of a behavioural element and the energy-efficiency of a dwelling.

2.3.3 MAINTENANCE

The maintenance expenses depend on the quality of the dwelling and the building costs.

2.3.4 HOME INSURANCE

The fee for home insurance is determined by the insurance market. This fee is location dependent and depends on the construction of the dwelling, the maintenance state and the rebuild value (VerenigingEigenHuis, n.d.).

2.3.5 GROSS MORTGAGE EXPENSES/GROSS RENT

The gross mortgage expenses and gross rent are by far the most influential factors for the housing expenses in respectively owner-occupancy and tenancy. These expenses are strongly correlated with the house price. The determination of the house price is discussed within the next paragraph.

2.4 DETERMINATION OF HOUSE PRICES

The house price is directly influenced by two main factors: the price of housing services (because of the supply and demand of housing services) and the required rate of return (because of supply and demand of owners and investors). In other words, when the demand of housing services is high, people are willing to spend more on their (imputed) rent that justifies a higher house price and makes a dwelling attractive as investment. A high house price triggers the construction market to realise more dwellings, creating an extra supply, which theoretically leads to a lower (imputed) rent and house price. However, housing supply generally reacts slowly on an increased demand because of scarce land and the time-

consuming process of realising dwellings. Insiders (owner-occupiers) benefit from a rising house price, while it toughens the affordability for outsiders (starters) (Haffner & Van Dam, 2011).

2.5 WAYS TO REDUCE HOUSING EXPENSES

Possibilities to reduce the housing expenses via the house price are limited. One could try to build more efficiently in order to decrease the required initial investment (i.e. construction costs). Many Dutch building contractors and developers offer 'concept dwellings': a partly standardized product that focuses heavily on reducing construction costs and offering an affordable low or even zero energy dwelling. Concepts for both newly built dwellings and renovations are rather common (Innovatieprogramma Energiesprong, n.d.). It is uncertain whether a reduction in construction costs would benefit the residents, since it may as well be used as extra profit margin for either developers or contractors.

There naturally is a strong tie with the energy consumption within a dwelling and its (initial) building quality. An excellent dwelling quality as realised in, for example, a net zero energy dwelling, can be economically viable in the long term depending on local circumstances (Berry & Davidson, 2015). In order to reduce housing expenses for the resident, the savings on energy – when discounted – should be higher than the investment in energy efficiency.

Another option to reduce housing expenses is to decrease the desired living standard or the quality of the dwelling, if desirable and possible from a legal and ethical point of view. An example is the Tiny Housing movement in which people consciously choose to live small – max 50 m² – and preferably flexible, in order to live more affordable (Van der Lee, 2016). Concepts such as Tiny Houses have the potential to reduce housing expenses significantly, yet their large-scale effectiveness is debatable. Market research by project developer BPD in the Netherlands, shows that the desired net living surface for rental apartments is 82m², while potential owner-occupiers desire 110m² (Joosten, Wisman, & Klaver, 2016).

The tenure choice is another way that heavily influences the housing costs. The potential capital gain or loss distinguishes owner-occupancy from tenancy. Given a required rate of return, disappointing direct return from (imputed) rent can be compensated by an indirect return from capital gain (Conijn, 1995). Yet, Shelton (1968) concluded that the capital gain/loss is a rather irrelevant criterion to determine whether it is economically wiser to own or rent. It depends largely on one's intended duration of tenancy: Shelton concluded that from four year onwards it is usually less expensive to own. The exact year in which owning gets less expensive than renting may differ in the contemporary Dutch context based on economic and institutional factors (as described under 2.3.1).

2.6 INSPIRATION FOR NEW WAYS TO SAVE ON HOUSING EXPENSES: DWELLING-GENERATED REVENUE

According to Priemus (2016) one of the trends on the housing market is the addition of a flexible layer in the cities for people that have trouble in finding a dwelling, because they cannot obtain a mortgage, the waiting lists for social housing are too long, and the private rental sector is too expensive. This flexible layer consists of temporary rental, sublet, sharing, and anti-squatting options. These are excellent examples of ways to spend less on housing. Can they and other options be used and perhaps combined to reduce housing expenses considerably? Priemus (2016) stresses how 'the internet of things' (IoT) changes the way we live within our homes. The growth of data that is generated daily does not seem to be used to its full potential (Van der Vegte, 2016). Google and Facebook use their data so efficiently that they can offer their products free. Google is now even investing in cars, via its self-driving cars program, with the potential of disrupting an entire industry. Is it unthinkable that such radical innovations could disrupt the housing market? A source of income should not only be sought in the IoT environment. A dwelling is the portal through which we consume many other products and services (from Netflix, via toothpaste to tap water). The easiest example is energy. If a dwelling generates more energy (via for example solar panels) than is consumed within the house, revenue could be generated.

The term *dwelling-generated revenue* is introduced as umbrella concept to catch all potential ideas that may lead to revenue generated by a dwelling or its affiliated services. It is expected that these ideas can be clustered in several groups such as energy efficiency and data generation. The line between generating revenue and cutting expenses cannot always be defined clearly such as in the case of energy efficiency. For instance, insulation alone does not have the potential to generate revenue, while combined energy efficiency measures do have that potential. (Combined) options will be researched based upon their potential to generate revenue.

Assumptions

Theoretically, dwelling-generated revenue can benefit the owner and/or resident of a dwelling depending on the type of revenue. This distinction makes the impact on the expenses in case of tenancy somewhat more complicated, since investments have to be made by the owner, while residents may benefit. It is assumed that the owner would increase the rent accordingly in such situations. When an owner would benefit from owner dwelling-generated revenue, it is assumed that the rent is lowered accordingly. In practice, this may turn out to be false. Yet, this aspect is neglected for now in order to reduce uncertainties within this research. The same counts for all non-red expenditures in the *tables* below: they are assumed constant in order to be able to measure the effect of dwelling-generated revenue on the housing expenses. The following *tables* show, visible in red, where the dwelling-generated revenue concept and the therefore required investment affect the cash flow of housing expenses. Moreover, it must be stressed that it is assumed that the revenue is used directly to lower the housing expenses.

TABLE 3: OWNER-OCCUPANCY HOUSING EXPENSES WITH DWELLING-GENERATED REVENUE

Expenditures		Average expense [€/month]	Specification	
	Gross mortgage costs	670		
+	Maintenance	53		
+	Required investment	X		
+	Additional owner occupancy expenses	155	Home insurance	
			Property tax	
			Optional ground lease charges	
=	Gross housing expenses	879		
-	Fiscal effect	-209	Balance of notional rental value and mortgage rent deduction	
-	Owner and resident dwelling-generated revenues	Y		
=	Net housing expenses	$670 + X - Y$		
+	Additional housing expenses	225 - Z	Public body taxes and levies	Location and tenure dependent
			Essential utilities	Gas
				Electricity
			Water	
=	Total housing expenses	$895 + X - Y - Z$		

Source: Blijie et al. (2016), adjusted

TABLE 4: TENANCY HOUSING EXPENSES WITH DWELLING-GENERATED REVENUE

Expenditures		Average expense [€/month]	Specification	
	Gross rent + A - B	$569 + A - B$		
-	Housing allowance	-70		
-	Resident dwelling-generated revenue	Y		
=	Net housing expenses/net rent	$499 + A - B - Y$		
+	Additional housing expenses	163 - Z	Public body taxes and levies	Location dependent
			Essential utilities	Gas
				Electricity
			Water	
=	Total housing expenses	$661 + A - B - Y - Z$		

Source: Blijie et al. (2016), adjusted

A = increased rent as a result of facilitating dwelling-generated revenue with a required investment
 B = lowered rent as a result of the positive balance between the required investment and owner dwelling-generated revenue

3. RESEARCH DESIGN AND METHODOLOGY

This chapter discusses the way this research is shaped. The goal of this research is discussed, as well as the research questions and the research approach.

3.1 RESEARCH GOAL

This research aims to find ways to reduce housing expenses substantially by exploring dwelling-generated revenue options. Dwelling-generated revenue is seen as an additional source of income that could help to reduce housing expenses. Researching this topic requires looking at dwellings and living from a different angle. A thorough search of the relevant literature yielded no related articles on this specific topic. Therefore, an exploratory research is proposed in order to identify the potential of dwelling-generated revenue to reduce housing expenses.

3.2 RESEARCH QUESTIONS

In order to structure the research towards fulfilling its goal several research questions are presented below. The central research question [CRQ] covers the essential aspects of this research. By breaking the central research question down into three sub-questions, this research is split into smaller researchable units. It must be noted that this research takes place within the Dutch context of housing affordability.

CRQ

In what ways can housing expenses be reduced by dwelling-generated revenue in the Netherlands?

Sub-questions [SQ]

SQ1: *Which aspects of a dwelling can potentially generate revenue?*

SQ2: *Which revenue options are the most promising?*

SQ3: *How can the most promising options be implemented?*

The first question focuses on exploring and discerning all types of dwelling-generated revenue. This step consists of researching relevant trends, business models and the categorisation of all revenue options. Subsequently, the discerned revenue options are compared on their potential to reduce the housing expenses. Therefore, revenue options are assessed on monetary as well as non-monetary criteria. The last question deals with the actual implementation of the most promising revenue options and aims to give an indication of the effect on the housing expenses.

3.3 RESEARCH APPROACH

In order to come to a sound and complete answer of the research question, several methods of study are used. The research consists of three main parts: collecting and categorizing ideas, comparing ideas, and elaborating on the most promising ideas.

The proposed research approach is depicted in *Figure 2* below.

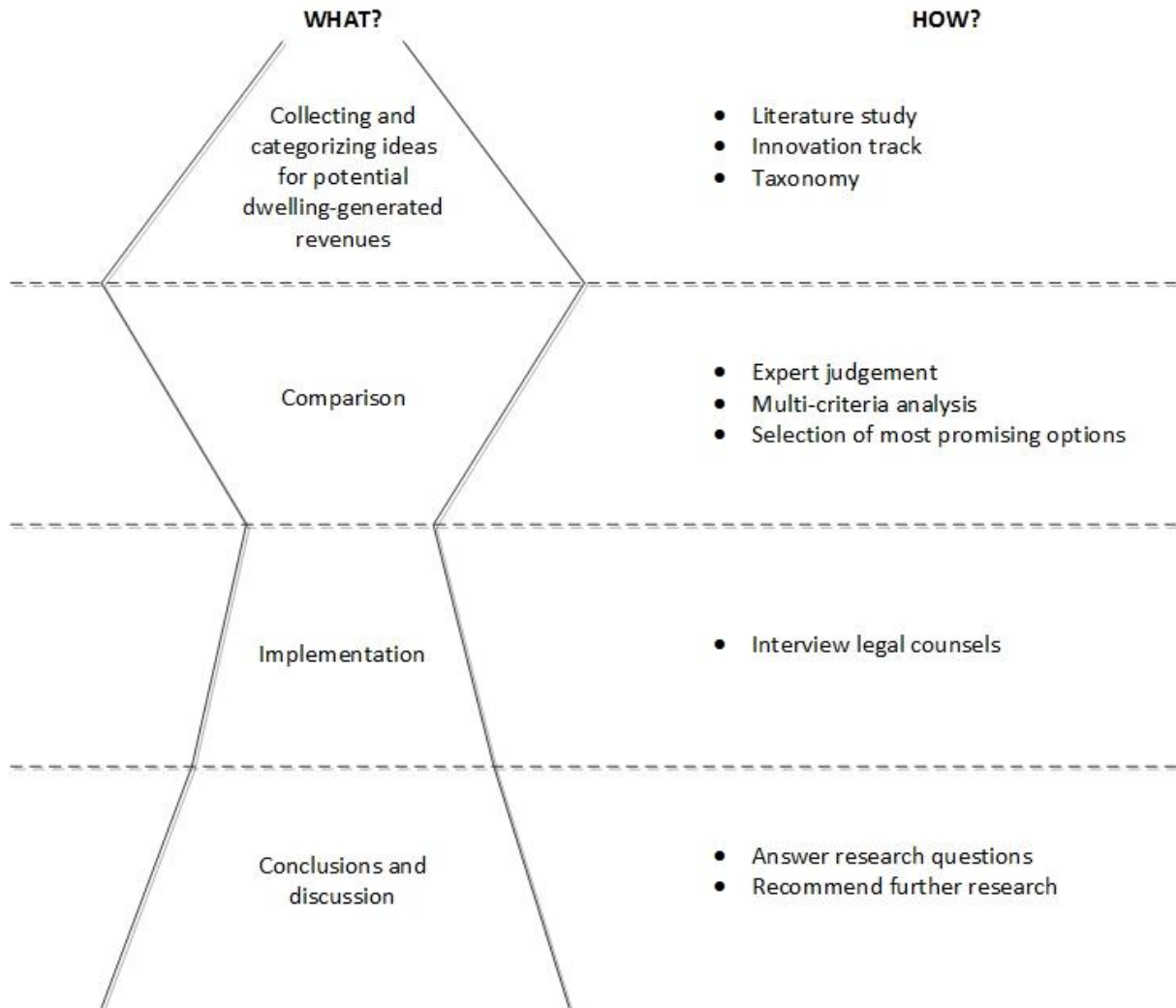


FIGURE 2: RESEARCH APPROACH

3.3.1 COLLECTING AND CATEGORIZING IDEAS

In order to collect ideas, a variety of methods is used. A literature study towards business models of successful free/extremely cheap products and societal trends is conducted to serve as inspiration for ideas. At the same time, participation in an innovation track (explained below) supports the collection and generation of ideas. Ideas do not necessarily have to fit directly within the demarcation of this research, but can provide insight in relevant potential innovations as well. All relevant ideas are categorized into a taxonomy of dwelling-generated revenue. These categories support the further exploration of these directions and function as foundation for a literature study per category in which several revenue options are discussed.

Within weekly meetings with the company mentors, the collected ideas are discussed. At the end of this phase, a validation session with four concept developers of ERA Contour is organized in which the categorization of the identified dwelling-generated revenue options is discussed (see Appendix A). Examples of identified revenue options are given in order to stimulate the group's creativity. The goal of this session is to check whether obvious revenue options within the categories are missed and to validate the identified revenue options.

Participation in innovation track

The researcher participated in the innovation track *Expeditie Gratis Wonen [EGW]* (English: *Expedition Rent-free Living*) initiated by housing association *Eigen Haard*, residential construction company *BAM Wonen*, developer *AM*, institutional investor *Bouwinvest*, and *TBI WOONlab*¹ (TBI's innovation lab focused on housing). The aim of these five companies is to give everyone access to a sustainable, affordable and comfortable housing situation in both the short- and long-term (*Expeditie Gratis Wonen*, 2016). The ultimate goal would be to realize rent-free housing forms. Around 30 participants of the participating companies are split up in four sub-groups concerned with different subjects:

- *City of tomorrow* (Dutch: *Stad van Strax*): looking at a new balance between the city and its surroundings;
- *Digital living* (Dutch: *Digitaal wonen*): explores how a dwelling can become a valuable digital node that can contribute to a significant decrease of housing expenses;
- *100% living happiness, 50% discount* (Dutch: *100% woongeluk met 50% korting*): explores how the housing expenses can be halved by using new materials and production methods;
- *Centercity*: searches for smart solutions to keep living within city centres affordable for especially younger citizens

The innovation track took place between 16 November 2016 and 15 March 2017 and used the FORTH innovation method described by Van Wulfen (2012). This methodology provides structure in the ideation phase of innovation and stands for *Full steam ahead, Observe & learn, Raise ideas, Test ideas, and Homecoming*. In the first phase, full steam ahead, the innovation assignment is formulated by the top management in five weeks. The four sub-groups were formed within the observe & learn phase, the phase in which in six weeks new opportunities are mapped. In the third phase, raise ideas, new ideas are raised during a product brainstorm and a concept improvement workshop in two weeks. The fourth step, test ideas, spends three weeks at reflecting on the ideas by the means of customer and expert feedback. Finally, in the homecoming phase, three to five new product or service concepts are presented. The FORTH method is found to be more effective than an average stage-gated innovation process. Out of 100 ideas, 78 are taken into development and 51 are introduced, while an average stage-gated innovation process leads to 21 introduced ideas (Van den Bosch, 2014). The goal of the innovation track is to come to several mini-business cases in a few months.

Within this innovation track, the researcher has participated as member of the Digital living group, since most innovative ideas are expected within this domain. The goal of participation has been to get acquainted with ideas that fit in the dwelling-generated revenue taxonomy. In the observe & learn phase, all team members have conducted several interviews members in order to identify relevant trends,

¹ TBI Woonlab is a collaboration between TBI's three developing residential construction companies (*ERA Contour, Hazenberg Bouw, and Koopmans Bouwgroep*) and TBI sister companies *Groothuis Wonen, Comfort Partners, Voorbij Prefab* and *WTH*.

innovation opportunities and customer frictions. Reports about all interviews have been written and discussed with the group in the following week (see appendix B for a list of participants).

3.3.2 MULTI-CRITERIA ANALYSIS

In the second stage of this research, the discerned revenue options are judged on their potential to reduce housing expenses. Their potential strongly depends on various factors such as the balance between the required investment and the monthly benefits, among other factors such as the scalability and its social acceptability. In order to consider all these factors, a multi-criteria analysis [MCA] is conducted. Another advantage of an MCA is the ability to include expert judgements. Objective input information to score the vast array of – sometimes relatively unresearched options – is not always available. Therefore, a group of five experts is asked to make a judgement of the potential of the options by assessing them on several criteria. *“Multi-criteria analysis establishes preferences between options by reference to an explicit set of objectives that the decision making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved”* (Dodgson, Spackman, Pearman, & Phillips, 2009, p. 20). Within this exploratory research the objective of this comparison is to rank the most promising revenue options from high to low. The MCA method is able to include monetary as well as non-monetary criteria, make use of expert judgements and able to handle ordinal variables.

A) Weighted Sum Model

The Weighted Sum Model (WSM) is the most simple and widespread MCA method. Within this model scores are standardised² and criteria are weighted based on their relative importance. The scores are then multiplied with their weights and summed up to get a score per option. A disadvantage is that only quantitative criteria can be used within this method (Reinshagen, 2007). Within this study qualitative ordinal scales (for example, very low-low-moderate-high-very high) are used to score the options on all criteria. It is assumed that the scales are linear (i.e. the relative distance between the ordinal scores are equal). Applying this logic, the ordinal scale is translated into an interval scale ranging from 1 to 5. A similar technique is applied by Namazi-Rad, Lamy, Perez, and Berryman (2012). Several specific MCA methods, such as ARGUS (De Keyser & Springael, 2010, p. 59) and methods based on fuzzy set theories (Noor-E-Alam, Lipi, Ahsan Akhtar Hasin, & Ullah, 2011), have been developed that prevent the necessity of the linearity assumption. Such methods are, however, not deemed required within this exploratory research. It is expected that the WSM method gives sufficient indication of the potential of the options.

B) Criteria

The objective of this multi-criteria analysis is to rank the several revenue options on their potential. Going back to the research goal, the height of the revenue is one of the leading factors to determine the potential of reducing the housing expenses. Apart from the height of the revenue, an option should also be feasible from a social, juridical, and technical point of view. Otherwise, implementation is either impossible or undesirable.

In order to give an indication of the height of the revenue, the mechanism behind the generation of a revenue is important. To start the generation of a revenue, an investment is required in most cases. A convincing business case is found when the investment is earned back within an acceptable amount of

² Within this study, the scores are already standardized since the same scale is applied on all criteria.

time. The complicating factor is that the costs and benefits of a revenue option may be split among several actors. In order to come to a unified set of criteria that are valid for all revenue options the business case of the revenue options has to be observed at a rather abstract level of detail without specifying which actor is going to be the investing party. If the business case is judged positively on an abstract level, the actual division of costs and benefits among actors can be determined at a later stage. The following criteria have been formulated in *Table 3* that reflect the business case.

TABLE 3: BUSINESS CASE CRITERIA

Business case criteria	Description	Scale	Explanation
Investment/costs	Indicates the height of both the initial investment and the monthly costs.	1...5 1 is very low, 5 is very high	The rate of return is higher if the investment/costs is lower.
Monthly benefits	Indicates how much benefit can be generated on a monthly basis.	1...5 1 is very low, 5 is very high	The rate of return is higher if the monthly benefits are higher.
Scalability	Indicates whether an option can be replicated easily and implemented elsewhere.	1...5 1 is very low, 5 is very high	A high scalability means an option is more viable and can reach a large amount of households.
Effect on property value	Indicates whether the implementation of a certain revenue option significantly influences the house price.	1...5 1 is a very <u>negative</u> effect, 5 is a very <u>positive</u> effect	An increased house price can be seen as indirect yield.
Innovativeness	Indicates whether an option is available on the market and has been researched.	1...5 1 is very low, 5 is very high	A high level of innovativeness is deemed positive for the viability of an option.

Note that in the processing of the results, the scale of the criterion *investment/costs* is reversed (1=5, 2=4, 3=3, 4=2, 5=1), since a low score is desirable on this criterion

The investment/costs and monthly benefits give an indication of the rate of return of a revenue option, while the scalability indicates whether an option can be replicated easily and implemented elsewhere. A high scalability is expected to increase the potential. The effect on property value can be seen as indirect yield. Its actual contribution is, however, very dependent on how this yield is shared among the actors. An increased house price as result of a revenue option could, in the long term, mitigate the effect on housing affordability for a next generation resident if the revenue is capitalised within the house price. The emphasize within this research is also on finding new and innovative options, since innovativeness correlates with product success (Szymanski, Kroff, & Troy, 2007). Therefore, this criterion is included as well.

Additionally, three criteria are included in Table 4 that reflect the feasibility of a revenue option apart from the business case: social acceptation, juridical feasibility, and technical feasibility. Experts are specifically asked to make a judgement about the *near future* juridical feasibility, since legislation may not be adjusted yet to relatively unknown and new option.

TABLE 4: FEASIBILITY CRITERIA

Feasibility criteria	Description	Scale	Explanation
Social acceptation	Indicates whether an option is deemed socially acceptable.	1...5 1 is very low, 5 is very high	A high social acceptability eases the implementation of an option.
(Near future) juridical feasibility	Indicates whether an option is legally feasible or expected to become legally possible in the near future.	1...5 1 is very low, 5 is very high	A high juridical feasibility eases the implementation of an option.
Technical feasibility	Indicates whether an option is technically feasible.	1...5 1 is very low, 5 is very high	A high technical feasibility eases the implementation of an option.

In the first step of the MCA, the revenue options are compared solely on the business case aspects. In the second step, the revenue options are compared on all criteria. This way it can be researched what the influence of social, juridical and technical [SJT] factors is on the potential of a revenue option. If an option scores better based on solely the business case aspects, it could indicate an option is financially attractive, yet not desired because of one of the other aspects. The results of the ranking are communicated with the experts at a later stage. If shifts in rank occur between the ranking based on solely the business case criteria and on the ranking based on all criteria, the experts are asked to explain the shift.

In order to specify the scalability criterion, an additional question is asked in which the experts are asked whether a revenue option is location and environment dependent. For this question, the two most common dwelling types are chosen as answer categories: suburban terraced single-family dwelling and an urban apartment. Furthermore, the answer categories of 'not location and environment dependent' and 'other, ...' are provided.

C) Expert judgement

The subjective assessment of an expert is a substitute for objective input information when such information is not available. However, shortcomings of this information should be emphasized. The quality of the expert judgement is heavily dependent on the expert's knowledge of the field. This complicates the selection of experts in this research, since revenue options in many fields of expertise are discerned. For option X, knowledge of energy systems may be required, while option Y requires knowledge of waste management. It is therefore required to select experts that have the ability to overview the consequences and potential of certain options in the right order of magnitude. Therefore, within the time limitations of this research, the facilitators of the four EGW sub-groups and the overall innovation manager of EGW are selected as experts (see appendix E). They are familiar with the line of reasoning that housing expenses can be reduced by revenues generated within the dwelling. It is

expected that this eases their judgement. All experts individually score the options on all criteria based on the provided information (appendix C). The researcher is present to answer questions.

D) Weighting

Assigning weight factors to the criteria is one of the most important steps in a MCA, since it can heavily influence the results. Therefore, the choice is made to let the experts determine their own weights. The experts individually assessed the importance of all criteria (again, on an ordinal scale from very low to very high). Alfares and Duffuaa (2006) show how the scores on an ordinal scale can be used to assign weights in a MCA. This is done via the following principle:

"After scores have been collected for the importance of the attributes, these are transformed into weights by dividing, for every respondent, the rating of each attribute by the sum of all ratings" (Edwards & Von Winterfeldt, 1986, p. 281)

$$w_i = \frac{w_i'}{\sum_{i=1}^n w_i'}$$

The weights differ between a comparison based on all criteria and a comparison based on solely the business case criteria because of the difference in the sum of the weights of the criteria taken into account.

E) Aggregation of expert scores

The process of coming to a ranking of the most promising revenue options based on several expert opinions is depicted in *Figure 3* below. Per expert, the combination of the assigned importance of criteria and the scores of all alternatives on the criteria leads to two different total scores per alternative. A total score per alternative based on the business case criteria and one based on all criteria. These scores can be directly translated into two ranking per expert based on the business case criteria and on all criteria respectively. This way the ranking per expert is purely based on the expert's own weight factors and scores. Subsequently, the average of all expert rankings leads to the overall ranking of alternatives. This means that every expert has exactly the same impact on the overall ranking. An alternative way of aggregation of the expert scores is used in the sensitivity analysis discussed below.

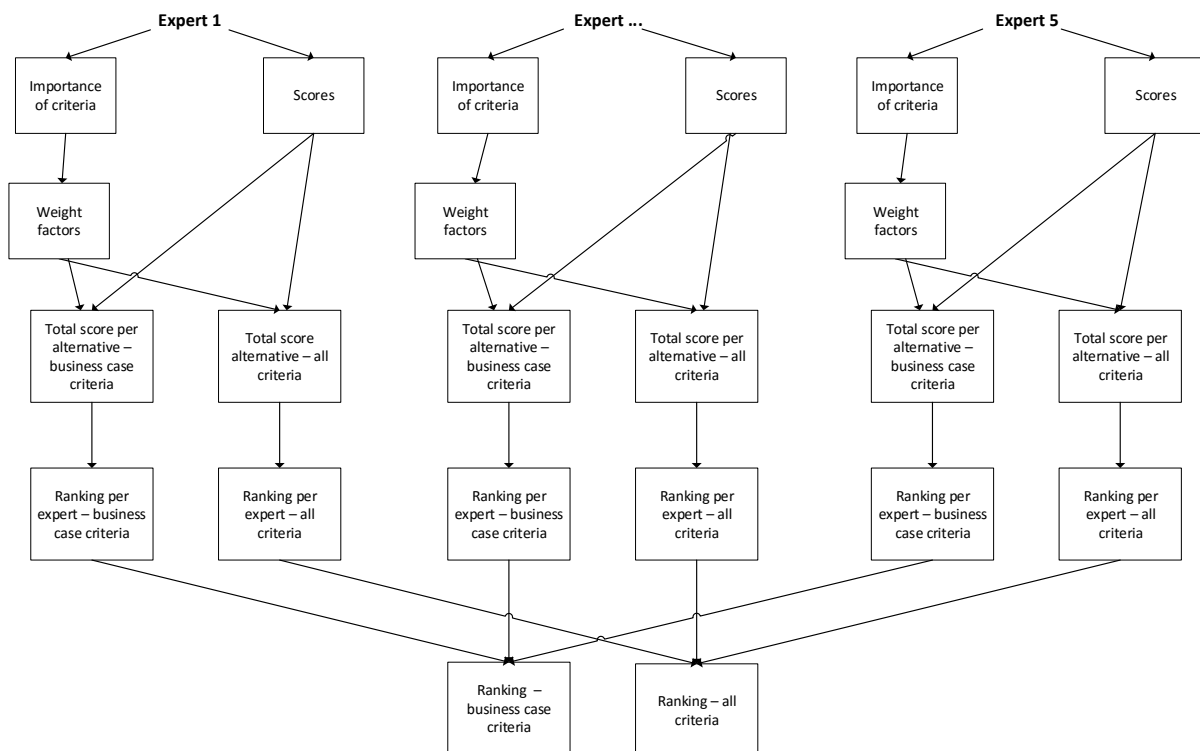


FIGURE 3: EXPERT AGGREGATION BASED ON A RANKING PER EXPERT

F) Sensitivity analysis

In order to test the robustness of the results of the MCA a sensitivity analysis is conducted in which a different weighting mechanism and form of aggregation are applied (*Figure 4*). This mechanism consists of one set of weight factors based on the combined assigned importance to the criteria by all experts. Subsequently, all expert scores per criteria are then added up and weighted in order to create an aggregated total score per alternative. The greatest disadvantage of this method is that an individual expert can have more influence on the eventual ranking than others can, when one, for instance, tends to score extremer than others do. This overrepresentation of an individual expert can be caused by an extreme score either on the importance of criteria or on the criteria of an alternative. An advantage of this model is that alternatives can be compared more easily per criteria on the aggregated score.

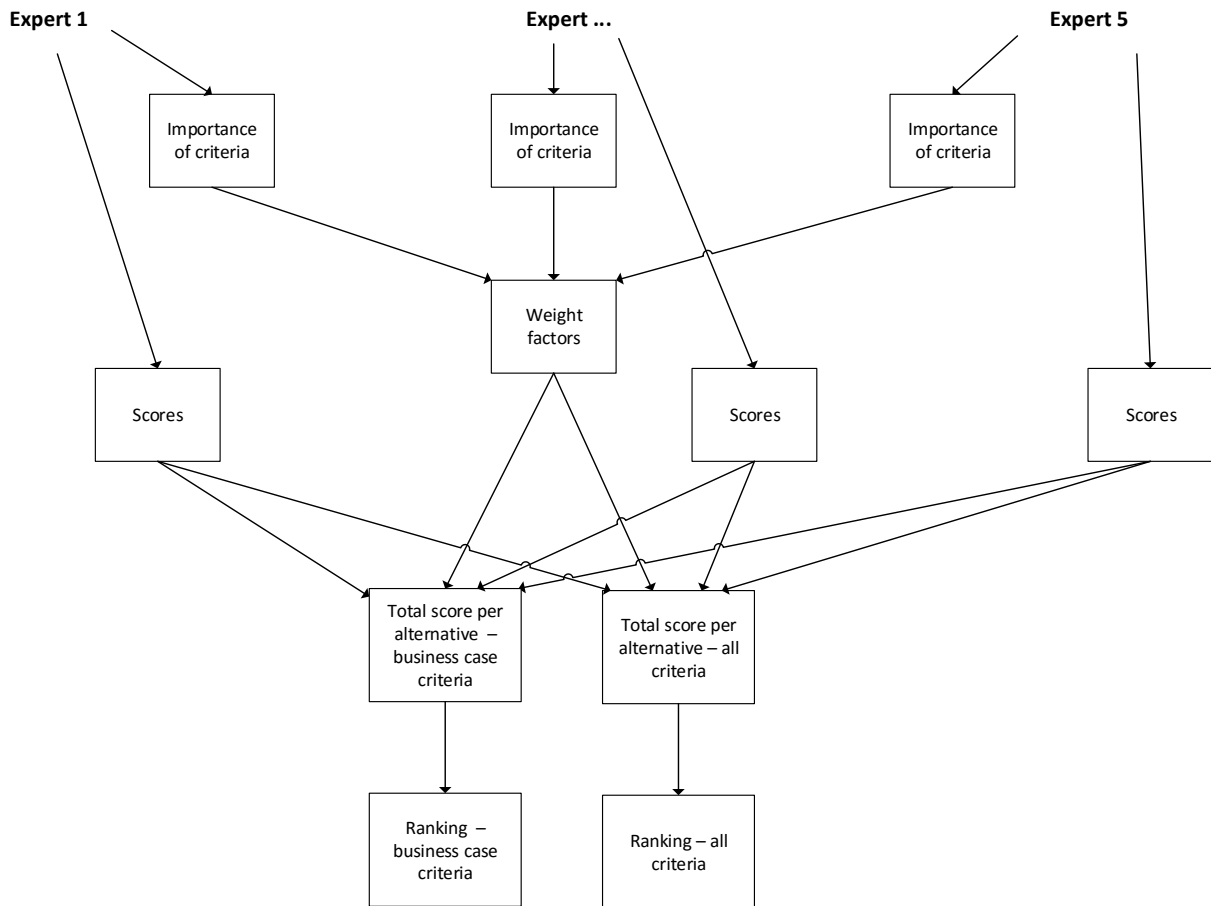


FIGURE 4: EXPERT AGGREGATION BASED ON AN AGGREGATED TOTAL SCORE PER ALTERNATIVE

3.3.3 IMPLEMENTATION OF THE MOST PROMISING OPTIONS IN THE SOCIAL HOUSING SECTOR

In the last phase, it is discussed how the most promising options can be implemented in the social housing sector. Wherever possible, this includes an example of how the costs are distributed among the parties involved. For this purpose, a semi-structured interview is conducted with two legal counsels of housing association Eigen Haard in Amsterdam in which the implementation trajectory of the most promising revenue options is discussed.

The research is concluded with an answer to the sub-research questions and the central research question itself followed by a discussion. Due to the exploratory nature of this research, new research opportunities are identified. Therefore, the section with recommended research in the discussion is quite extensive.

4. INSPIRATION FOR REVENUE OPTIONS

In order to identify new – and existing – dwelling-generated revenue options inspiration is sought within the theory of low-priced products and services to explore parallels with the housing sector. Subsequently, societal and technological trends are discussed, since they can help to produce ideas for new products or services (Van Wulfen, 2012, p. 114).

4.1 LOW-PRICED PRODUCTS AND SERVICES

The ultimate goal of this research is to increase the housing affordability in the Netherlands. Therefore, inspiration is sought in the theory about the most affordable products, free products. Subsequently, a creative model from the housing industry is discussed that facilitates lower housing expenses for students. These concepts may contribute to the generation of ideas for revenue options.

4.1.1 THE ECONOMY OF FREE

A product can become free whenever the marginal costs of distribution approach zero. This is the case with many digital products: digital distribution often comes with near zero marginal distribution costs (Anderson, 2009). Anderson's theory is built upon digital markets and *the world of bits*, as opposed to the (traditional) *world of atoms*. Anderson (2009) argues that the attraction of free will expand itself to physical products as well. Dwellings are traditionally seen as signboard of the world of atoms and a scarce product. However, the trend of digitalization is also felt within homes. From this perspective, a dwelling can be seen as computer that consists out of both hard- and software (atoms and bits). One could argue that the rise of 3D printing perhaps even turns the dwelling's hardware into a digital product. Anderson (2009) claims that the new kind of free caused by zero marginal costs of distribution is a new kind of free as opposed to the traditional forms of free that are described as:

All [traditional] forms of free boil down to variations of the same thing: shifting money around from product to product, person to person, between now and later, or into nonmonetary markets and back out again. Economists call these "cross-subsidies." (Anderson, 2009, p. 16)

Within the context of cross-subsidies, Anderson (2009) has categorised free models into four groups:

1. Direct cross-subsidy:

The cost of giving away one product or service for free (or for a very low price) is directly compensated by the benefit that is generated by another product or service. The most famous example is the *the razor and blades business model* of Gillette in which the razor is the give-away and the blades are the source of income.

2. The three party market:

A product or service can be provided for (nearly) free when a third party pays to participate in this exchange. This is the basis of Google's business model in which Google offers you a free service, while advertisements bring in revenue (Thiadens, 2009).

3. Freemium:

A product or service is available in both paid and unpaid forms. In case of digital products, the 5 percent rule is often followed: 5 percent of the user that pay for a premium version support the rest of the users that use the free version.

4. Nonmonetary markets:

Giving away a product or service without expecting money in return. In case of a gift, nothing is asked in return. However, other services or products can be utilised as means of exchange: for example labour exchange. Within the housing sector this is done within elderly care facilities, where students can live for (near) free among the elderly in return for spending hours with the elderly (Elings, 2017).

The four types of cross-subsidies may contribute to the affordability of housing if viable business models in the housing sector can be built upon these principles.

4.1.2 COMBINATION OF STUDENT HOUSING AND A HOTEL: HOTEL CASA AMSTERDAM

In the 1960's a new housing concept was introduced in the Netherlands inspired by a Scandinavian concept: Hotel Casa 400. A hotel was built by the foundation *Stichting Casa Academica* in which students could live throughout the academic year. Yet, in summer, during the peak tourist season, it functioned as a regular hotel. This way the student rooms could be rented out for a lower price to ensure their affordability. The concept is now continued at a different location. The newer version of Casa 400 is simply called *Hotel Casa* and is owned by investor *Bouwinvest*. Out of 520 rooms, 140 rooms nowadays function as full-time hotel room while 380 rooms are used as student rooms from the 1st of October until the 1st of June (Simons, 2012).

The principle of the concept is rather simple: revenues generated by the commercial exploitation of the hotel are (partly) used to lower the rent for students. In combination with platforms such as Airbnb, this concept has the potential to increase the earned revenue of (sub)rental services.

4.2 TRENDS

Within this section, an overview of relevant trends is presented. The overview of trends as identified by the digital living team of the innovation track EGW (appendix D) functioned as input.

4.2.1 SOCIETAL TRENDS

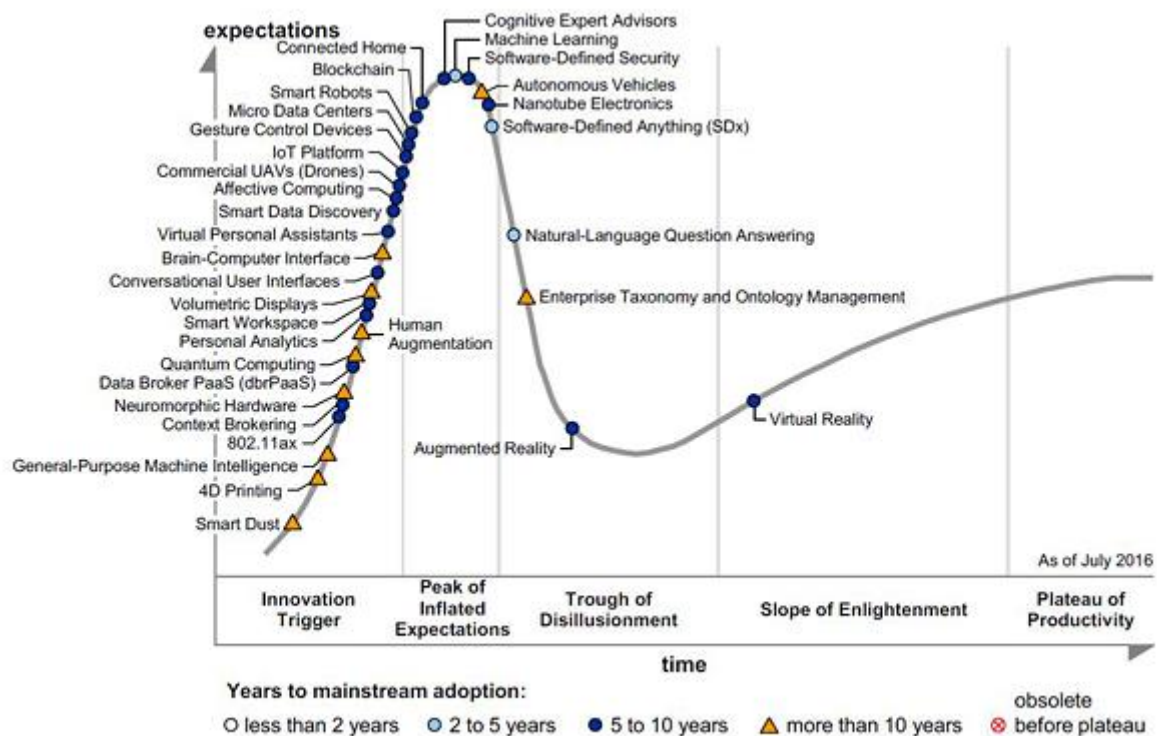
Two often heard trends, *from product to service* and *from owning to access*, can be identified as the trend of access-based consumption. Schaefers, Lawson, & Kukar-Kinney as cited in Lawson, Gleim, Perren, and Hwang (2016) define access-based consumption as: *“market-mediated transactions that provide customers with temporarily limited access to goods in return for an access fee, while the legal ownership remains with the service provider”*. An example is the growing popularity of Mobility as a Service (MaaS) in which a fee is paid for the service of getting from A to B instead of buying a means of transport (Kamargianni, Li, Matyas, & Schäfer, 2016). Another example is Airbnb, which provides short-term access to available spaces. Apart from economic considerations, other factors affect the decision whether to consume access-based. Access-based service providers emphasize that their service is either hassle free and less costly or that their service has environmental or societal benefits. In order to successfully position a new service model in the market, companies should realise what the customer’s motivation is to use such a service (Lawson et al., 2016).

The rise of the sharing economy is another popular trend. Hamari, Sjöklint, and Ukkonen (2015) refer to the *sharing economy* or *collaborative consumption* as: *“the peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services, coordinated through community-based online services.”* The sharing economy is growing rapidly. Like the access-based consumption trend, various reasons exist to participate in collaborative consumption. Sustainability, enjoyment of the activity and economic gains are important explanatory factors (Hamari et al., 2015).

Another trend worth mentioning is that of the growing popularity of the economy of abundance. The economy of abundance is a vision in which scarcity is gone and basic needs such as food, water, shelter, clothing, health care, education, and culture are abundant. This does not mean all resources are unlimited available, yet there will be sufficient for everyone (Diamandis & Kotler, 2012; Goertzel, Goertzel, & Goertzel, 2017). The question whether the economy of abundance is utopian is not discussed within this research. Yet, its approach may help generating new ideas. The concept of abundance is one of the pillars of the successful workplace sharing platform Seats2Meet (Van Woudenberg, 2016).

4.2.2 TECHNOLOGICAL TRENDS

An influential source for technological trends is Gartner's annual hype cycle of emerging technologies (O'Leary, 2008). Gartner's hype cycle of 2016 is presented below (Gartner, 2016):



An overview of many emerging technologies is depicted based on the height of the expectations and their time until mainstream adoption. The connected home and IoT (*Internet of Things*) Platform are two technologies that are expected to become available to the masses in five to ten years and may have an enormous impact on the way we live inside our homes and are therefore further discussed. The IoT is defined as: *"Interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications. This is achieved by seamless ubiquitous sensing, data analytics and information representation with Cloud computing as the unifying framework."* (Gubbi, Buyya, Marusic, & Palaniswami, 2013) IoT is often linked to Big Data. Another often heard term that requires clarification: *"Big Data concerns large-volume, complex, growing data sets with multiple, autonomous sources."* (Wu, Zhu, Wu, & Ding, 2014) IoT devices are the so-called *multiple, autonomous sources*.

According to Lindsay, Woods, and Corman (2016) nearly 50 billion devices will be connected to the internet representing a \$1.7 trillion market. A great challenge, however, still lies in the development of the smart home in which many devices are connected to the internet, since smart homes have the potential to live up to the increasing expectation of safety, security, comfort and sustainability (Lindsay et al., 2016).

4.3 CONCLUSION

Within this chapter, triggers for new dwelling-generated revenue options are researched. The four types of cross-subsidies that are identified as fundamentals of low-priced products and services may contribute to the affordability of housing if viable business models in the housing sector can be built upon these principles. The principle of cross-subsidies is rather straightforward: revenues generated by product B make up for the costs of product A. An example of this principle is presented in section 5.1.2 in which the commercial exploitation of a hotel is (partly) used to lower the rent for students.

Dominant discerned societal trends are access-based consumption and collaborative consumption. The most obvious example within the housing sector is Airbnb. The question is how much growth space there is on this market or that the market is perhaps already started to be saturated. Looked at from the perspective of the economy of abundance, one could argue many of our rooms are in fact abundant at the moment.

The rise of IoT and home automation and the resulted growth of data have a clear impact on the housing sector. The amount of data generated within a dwelling is growing significantly. When monetized, this data is a dwelling-generated revenue option.

The information gathered within this chapter functions as input for the taxonomy presented in the next chapter.

5. DWELLING-GENERATED REVENUE OPTIONS

In this chapter, all discerned dwelling-generated revenue options are discussed. Dwelling-generated revenue is introduced as umbrella concept to capture all potential ideas that may lead to revenue generated by a dwelling or its affiliated services. Based on the described inspiration in chapter 4 and meetings with the innovation track members, a taxonomy of potential revenue streams is presented in this chapter. These potential revenues have two main sources: the object (the dwelling) or the subject (the resident). This distinction is not completely black-and-white, yet it helps to provide a clear overview of all possibilities. The object branch is divided into dwelling as power plant, third party compensation, and (sub)letting. The object branch is divided into data and waste sub-branches. A complete schematic overview is presented on the next page.

Discounts/savings

Within the scheme, the link with discounts and savings is addressed. Discounts and savings are no dwelling-generated revenue, yet they represent alternatives to save on (housing) expenses. Sharing the rent with friends is, for example, one of the easiest ways to save on housing expenses. Another example of a discount is collectively buying services such as energy contracts or subscriptions such as internet. These discounts are depicted within the scheme to show explicitly the distinction with dwelling-generated revenues. Therefore, the discount/savings section is not further elaborated.

Cross-subsidies are another interesting line of thought that could help to make housing more affordable, yet they are not deemed dwelling-generated revenues and therefore only discussed briefly with this section. If cross-subsidies can apply in the housing field, living in a dwelling is the (near) give-away on which companies could build a business model. As discussed in paragraph 4.1.1, four kind of cross subsidies exist. To the author's best knowledge, there are no known initiatives that lead in the direction of viable direct cross-subsidies in the field of housing (for example, a supermarket provides a dwelling to live in, in return for guaranteed shopping income). Additionally, no known initiatives are identified as freemium options (for example, a (near) free dwelling in which you pay for additional services). Several initiatives exist on the verge of the three party model and the non-monetary market. Students are offered a cheap/free room to live in an elderly care facility in return for spending time with the elderly (Elings, 2017).

External factors

At the top of the scheme, several external factors are mentioned that influence the potential of every revenue option. The external factors are:

- *Tenure*: a tenant or owner-occupier might have interest of investing in different revenue options. Owner-occupiers are expected to invest in long-term options more easily.
- *Target group*: characteristics such as age and income among other may influence the interest in certain revenue options.
- *Location*: the location of a dwelling may influence the feasibility of a revenue option.
- *Institutional context*: the institutional context is crucial towards the practical feasibility of revenue options.

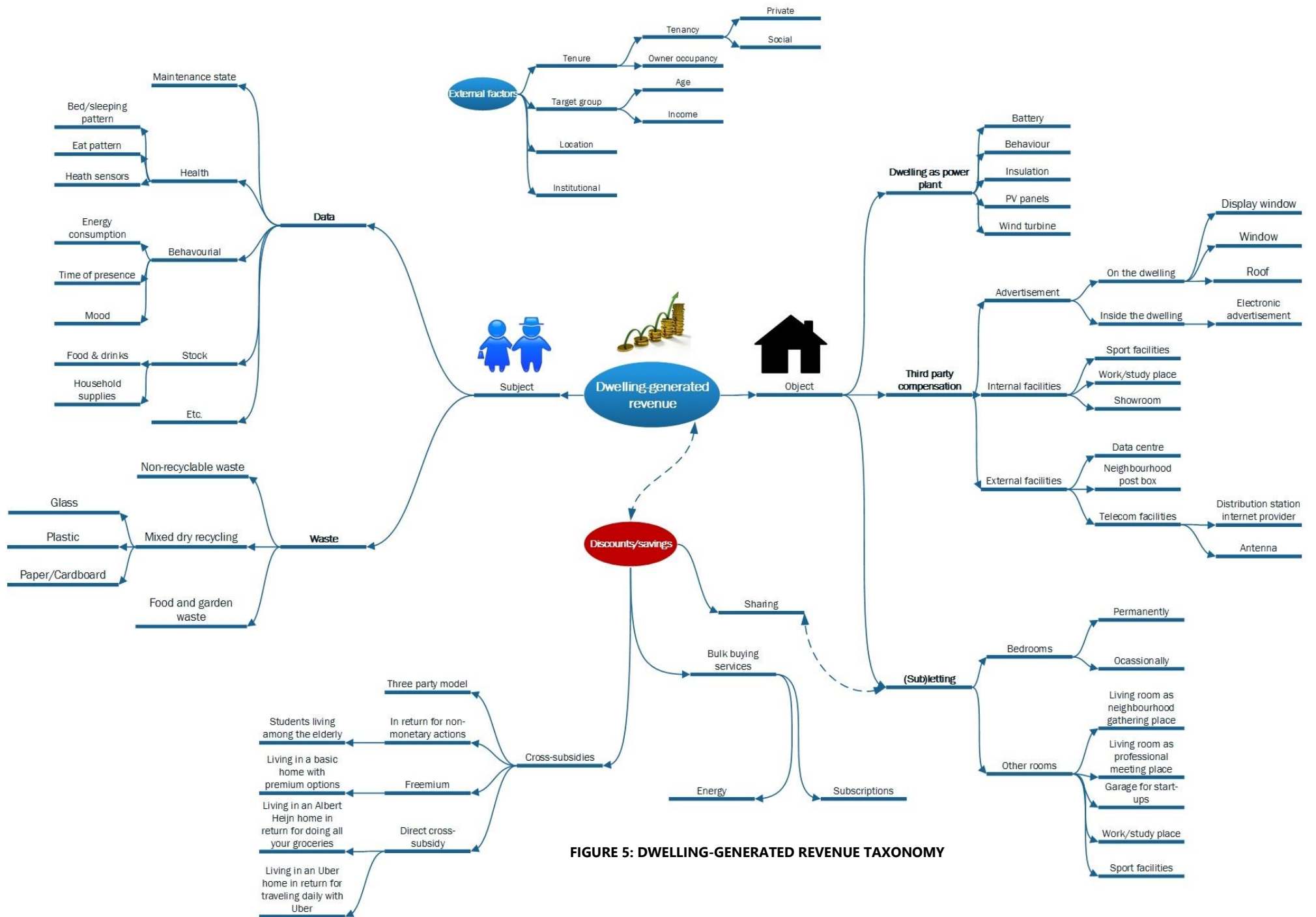


FIGURE 5: DWELLING-GENERATED REVENUE TAXONOMY

5.1 OBJECT REVENUES

Object revenues are revenues of which the dwelling itself or a physical item placed on or within the dwelling is the main source of revenue.

5.1.1 DWELLING AS POWER PLANT

The most commonly applied climate change adaptation measures in the Dutch housing sector are renovated or newly built zero (energy) bills homes (Dutch: *Nul op de meter woningen*). These dwellings are extremely well thermal insulated and generate energy through PV panels. The zero bill homes concept is closely tied to zero energy homes, with the difference being that zero bill homes potentially have to generate extra energy to compensate for an above average energy consumption. Zero bill homes merely result in a discount on the energy bill and not an additional revenue.



FIGURE 6: WINDMILLS AND SOLAR PANELS (TURBINES INFO, 2014)

Berry and Davidson (2015) have shown net zero energy dwelling can be economically viable in Australia and other warm temperate climates especially when considering societal benefits. This could indicate that a government subsidy is required in order to make individual business cases suitable. In order to transform the discount on the energy bill into an additional revenue stream, the bar has to be raised. Instead of compensating for its own energy consumption, the bar could be raised to generate a substantial additional amount of energy: a dwelling as power plant. This is called a positive energy dwelling, surplus energy dwelling or energy-plus-house.

Obstacles

First, the economic viability of the extra investment that is required to let a dwelling generate significantly more energy than its own consumption should be determined. Second, a purpose for the extra-generated energy should be sought. In the Netherlands, homeowners can currently sell their excess electricity back to their energy provider. However, there is uncertainty whether the national regulation that enables selling excess electricity will be continued after 2020 (Kamp, 2015). Therefore, it is relevant to look at other options to utilize additional energy effectively. One example is a photovoltaic battery system that enables energy to be stored for later use and thus enables peak-shaving as discussed by Linssen, Stenzel, and Fleer (2017). The energy surplus can be used to charge an electric vehicle and so reduce the costs of mobility. When stored, the energy is easier to redistribute and, potentially, to sell. Energy supplier Eneco started a pilot in which customers with PV panels can invest in a Tesla battery and get a yearly reimbursement of 650 euro – after an initial investment of 7500 euro – for their help in peak-shaving the supply and demand of the electricity grid (Eneco, 2016).

Within the Netherlands the Heijmans BrightHouse is the first dwelling that is designed to deliver a surplus of energy with a performance based contract ("Je huis als energiefabriek: Vijf vragen aan Theo Smits," 2015; RVO, 2015). Research institute TNO stimulates the production of surplus energy dwellings as well (Keizers, 2017). Bazilian et al. (2013) show that the prices of photovoltaic systems have reduced significantly over the years to a level they are competitive with other sources of energy. It is expected that the price of the required technologies, such as PV systems, will decrease further leading to the financial and economic feasibility of higher surpluses of energy.

5.1.2 THIRD PARTY COMPENSATION

Revenue can be generated by receiving compensation for having or allowing certain attributes in or on a dwelling. Three main types of third party compensation can be identified: advertisement, internal facilities, and external facilities.

Advertisement

Receiving a compensation for publishing advertisement is nothing new. On the outside of a dwelling, it can be placed on a billboard or a mural painting. The Dutch start-up AddMyWindow now offers a platform through which you can offer your window (preferably in city centres) as a potential location to place advertisement on/behind. Kuhlman of the National Outdoor Advertising Advisory Board expects this type of advertisement is not going to be big, since it is too fragmented and does not reach huge crowds (Vossers, 2015). AddMyWindow promises a reward of up till €150 per window per month. A variation on this



FIGURE 7: WINDOW ADVERTISEMENT (ISTOCK & NRC Q, 2015)

principle is the principle of window displays: artists are sometimes willing to pay for exhibiting their creations behind windows in popular walking areas (appendix A). Apart from billboard and window advertising, a third type of on-dwelling advertisement can be identified: rooftop advertisement. Rooftop advertising, or *roofvertising*, is applied around airports where they can be seen from arriving and departing planes. With the rise of aerial mapping services such as Google Maps and Bing Maps, rooftop advertisements could have a potentially enormous crowd. In the USA several companies such as RoofAds and RoofShout already focused on this market back in 2006 (Glasner, 2006). Obstacles for all types of on-dwelling advertisement may be found in local advertisement legislation, willingness of the dwellings' owners, and the type and location of a dwelling.

In-house advertisement, as opposed to on-house advertisement, is advertisement placed within a dwelling focused on the resident of a dwelling. The easiest way to present in-house advertisement would be on digital screens that are integrated within a dwelling such as the Wize Mirror. The Wize Mirror is a smart mirror developed by a group of European scientists that is able to display feedback on one's health (Colantonio et al., 2015). The step towards advertisement on a smart mirror, wall or unused television is technologically small. The opposition towards such an application may, however, be enormous.

Internal facilities

When certain facilities in a dwelling are not only in the interest of the resident, but also in the interest of a third party, that facility may be eligible for a third party compensation. Having, for example, proper facilities for working at home may be in the direct interest of one's employer, since less office space is required and the flexibility of employees increases. At the moment, Having – and using – a work place at home (*teleworking*) is also an extremely effective way to reduce road congestions and other negative externalities of transport such as air pollution (Van Lier, De Witte, & Macharis, 2012). Currently, the Dutch Ministry of Infrastructure and the Environment is funding programs in which commuters are rewarded to avoid traffic rush hours (Dutch: *spitsmijden*) up to €120,- per month (Wild! Van De Spits, n.d.). This policy instrument is found to be effective in reducing congestion (Knockaert, Tseng, Verhoef, & Rouwendal, 2012). Knockaert et al. (2012) argue that different travel moments around peak times are

considered closer alternatives than teleworking or modal shifts. However, teleworking has a bigger potential to reduce negative externalities related to the environment, since it merely changes departure times while teleworking can completely remove the need of transport. Therefore, policies towards the stimulation of teleworking through compensation for home offices could potentially lead to higher economic benefit than its alternatives.

Apart from the workplace at home, other facilities within dwellings can be thought of that are (indirectly) in the interest of other parties. When, for example, one has a fully equipped fitness room it may benefit one's general health condition. That may potentially help to reduce absenteeism and health care costs. Another known option is the showroom function of a dwelling. IKEA compensates €800 per photoshoot per day and €2000 per film shoot per day (appendix A).

External facilities

When third parties have an interest in placing facilities on someone's property, compensation is ought to be paid. A mobile operator is, for example, often dependent on property owners for the placement of its antennas on rooftops. Not much official information is known about the compensation for such facilities, though some limited available documentation exists on this matter. Housing association De Key in Amsterdam received up till €250 per month for having a KPN antenna on the rooftop of an elderly care (Van Veen, 2007). Councillor Deene of the Belgian city Gent published information of the local municipal real estate agency in which it is shown that approximately €600-900 was received per antenna on, among others, churches and sports clubs (Deene, 2013). Compensations logically will depend on location and building height, yet these numbers give a rough indication of the order of magnitude. The biggest obstacle for this kind of revenue is expected to be the limited scale of implementation. Mobile operators normally determine a radius around an ideal spot in which a new antenna is desired in which they search for the most optimal buildings (Antennebureau, n.d.).

More external facilities exist for which one could receive a compensation. Neighbourhood distribution stations of internet providers such as Ziggo and KPN might be placed on private property and might be a source of compensation. A variation is the neighbourhood mail box that could be placed in one's garden or outer wall. *Parcer* is a Dutch start-up that provides an e-mail box in which parcels can be delivered without the owner being home (Parcer, n.d.). Theoretically, it could be possible to place a neighbourhood version on/in one's property and to receive compensation for it. Another Dutch start-up, *Nerdalize*, places high performance servers within homes. Traditionally, data centres require intensive, energy consuming, cooling installations. Nerdalize puts the waste heat of servers to use by placing it decentrally in people's homes. Its business models lies in offering cloud-computing capacity for a low price. Nerdalize reimburses the electricity costs of the server, while the 'waste heat' replaces the traditional heating system of a dwelling. This could result in a reimbursement on the electricity bill of up till €25 per month (€300 per year) (Nerdalize, n.d.; Reijerman, 2015).

5.1.3 (SUB)LETTING EVERY CORNER OF A DWELLING

Generating revenue by (sub)letting (part) of a dwelling is nothing new. The most commonly (sub)let part of the dwelling is the sleeping room. This can be done on a long-term base (student room) or temporarily (via for example *Airbnb*). Airbnb hosts in Amsterdam earned, on average, 3800 euro by renting out their dwelling 28 nights (De Waard, 2016). That is an average of 135 euro per night. These prices cannot be generalized towards the rest of Netherlands. However, potentially there are many other rooms that might be (sub)let and that thus can generate extra revenue within a dwelling. This requires a rather straightforward economic approach in which the dwelling is seen as a product that can be used more efficiently. For example, on working days, many dwellings are unoccupied during the day and even at night, not all sleeping rooms are used.



A dwelling can offer much more than just an overnight stay. A room equipped as home office may be let during the day when unused. Initiatives as *Seats2Meet for Locals* and *DeskToday* already facilitate offering working places at home. *Storage Share* facilitates the (sub)rental of storage spaces. Another unexplored possibility is to let at home sports facilities such as a fitness room. From this economic perspective, there are many possibilities. A living room or garden could function as neighbourhood gathering place and a vacant garage could be rented out to a neighbour with an extra car. Developments such as digital (remote controlled) locks could play an enormous important role in granting (one-time) access to one's dwelling.

An interesting addition to this potential form of revenue is the Casa 400 model. Casa 400 is a concept in which two functions are combined. In the peak tourist season in summer, Casa 400 is exploited as hotel, while the rooms function as student housing the rest of the year. This model might be applied broader: if one is willing to leave its house a certain period per year in order to facilitate renting out the dwelling, the housing expenses could be reduced.

Obstacles

Apart from legal constraints, the biggest obstacle could be the willingness of people to let strange people into their homes. As identified by Smith (1994), continuity, privacy, self-expression, social relationships, warmth, and the physical structure are the essential characteristics of one feeling at home. Especially the continuity and privacy aspects may be endangered when one's dwelling is rented out. On the other hand, it may offer new social relationships that could contribute to the feeling of home. Ikkala and Lampinen (2015) have conducted a qualitative research in which they interviewed 11 Helsinki stationed Airbnb hosts about their motivations to monetize network hospitality. They found that all respondents were motivated to monetize network hospitality for both social and financial reasons. These conclusions cannot be generalized based on this research, yet it gives an indication of why people decide to participate in such a platform.

5.2 SUBJECT REVENUES

Subject revenues are revenues of which the resident (either tenant or owner-occupier) living inside a dwelling is the main source of revenue.

5.2.1 Data monetization

The home automation market is growing with an enormous pace and becomes more and more affordable to the masses (Khedekar, Truco, Oteyza, & Huertas, 2017). According to Risteska Stojkoska and Trivodaliev (2017) smart home objects inside homes will be commonplace within several years. Wireless sensor networks (WSN) are able to monitor almost every characteristic (temperature, movement, sound, light, pressure, etc.) within homes. Moreover, many formerly *dumb* devices are becoming smart (i.e. connected to the internet). Refrigerators, lamps



FIGURE 8: SMART HOME (JOHANSSON, 2015)

and televisions can be controlled with an app and become part of IoT. The enormous amount of data that may be generated within a dwelling by simply living in a dwelling is enormous. This could be data about someone's health, stock (household supplies, food, and drinks), and behaviour (time of presence, energy consumption), among others. Apart from subject driven data, object driven data could also be collected. For instance, sensors could also monitor the maintenance state of a dwelling. The question is how valuable this data is and, subsequently, how this data can be monetized.

The widespread use of smart phones and internet applications and its generated data has created a multi-billion dollar industry in which consumer data is being traded. This data has value in multiple domains such as targeted marketing, credit and loan evaluation, medical research, and crime analysis among others. However, currently data is mainly being traded by organizations with no interference of individuals. Via opt-ins many customers give organizations permission to sell their personal data (Bataineh, Mizouni, Barachi, & Bentahar, 2016). According to Gartner (2015), there are also many organizations that undervalue the monetary value of their customer data. It is unknown whether individuals – data producers – are sufficiently aware of the potential monetary value of their personal data. Companies as Google and Facebook are known to earn much of their revenue by being able to offer profiles of that can be used for a target marketing campaign (Bataineh et al., 2016). Moreover, there are multiple parties that generate profit from being active in different parts of the data analytics pipeline (data integration, data storage, core analytics and data presentation). Other parties such as IBM, Microsoft, and Oracle have integrated all these activities into one business (Risteska Stojkoska & Trivodaliev, 2017). Data brokers are accused of a lack of transparency (Kreiken, 2016).

Obstacles

In order to let individuals benefit from their own data a data monetization platform is proposed by Bataineh et al. (2016) using two-sided market theory. Bataineh et al. (2016): *"In this platform, the data is viewed as an economic good and the data sharing activity is considered as an economic transaction."* This model comprehends a market place in which a data broker matches the supply and demand of the data. Individuals are compensated directly by the data broker. This requires a rising awareness of the monetary value of personal data and an acknowledgement of the data producers as owners of their data. Start-ups such as *Datacoup* (USA) are trying to fill this gap. Datacoup (n.d.) states within its mission: *"The first*

and most important step is getting people compensated for the asset that they produce." A Dutch alternative for Datacoup, with the same philosophy, is *dime* (acronym for *data is me*). According to dime (2016) one's social media data can be worth 0 to 10 euro per month based on the data demand. Luth Research pays approximately 100 dollar per month to give up your complete online privacy and track everything you do online on all your devices (Heck, 2014).

If all aforementioned conditions would be met, there still are two obstacles for monetizing in-home user data. First, the willingness to sell personal data. It could be that the awareness of the value of one's data has a negative effect on the willingness to sell the data. According to a research conducted by Intel (2016), 66 percent of their respondents was willing to share smart home data for money. Second, the quality and added value of in-home generated data has yet to be determined on the market.

5.2.2 MONETIZING RECYCLABLE WASTE

Based on data from 2013 to 2015, the amount of household waste per person is relatively constant: it varies between 495-498 kg per person (CBS, 2016b). According to the benchmark of household waste in 2015 conducted by the *NVRD* (public association of municipalities and waste management companies) and *Rijkswaterstaat* (agency of the Ministry of the Infrastructure and the Environment concerned with public infrastructures), the average amount of household waste was 485 kg per person. In 2015, 58% of this waste was sorted for recycling purposes. Policy goals are set to raise this percentage to 75% in 2020 (NVRD, Rijkswaterstaat, & CyclusManagement, 2016). The strong focus on increased recycling is not only desired from an environmental perspective. A societal cost-benefit analysis conducted by Warringa, De Bruyn, and Bijleveld (2013) shows that increased recycling is economically feasible in the Netherlands.



FIGURE 9: GARBAGE CAN FILLED WITH CASH (KIMBROUGH, 2013)

Several policy instruments are used in the Netherlands to stimulate the sorting of waste. *Diftar* is a method of price differentiation in which household have to pay extra public levy for using the municipal waste collection facilities. This is proven to be an effective policy instrument (NVRD et al., 2016). An alternative to *diftar* is the reward system *Afval loont* in which households are paid a price per waste type per kilogram. This system was introduced as a pilot project in the municipality of Pijnacker-Nootdorp and was found to be effective in increasing the waste sorting percentage and decrease the amount of non-recyclable waste. An average household can earn approximately €50 per year via this program (Gemeenschappelijke Regeling Regionaal Reinigingsbedrijf Avalex, 2012).

Obstacles

The question is whether such a reward system could be implemented on a large scale. Municipality of Pijnacker-Nootdorp (2012) have stopped the pilot because of financial reasons. However, the initiative is still active within three municipalities: Barendrecht, Rotterdam and Noordwijk. According to *Afval Loont* (n.d.) Noordwijk started in January 2017, while The Hague and Krimpen aan den IJssel are expected to follow later in 2017. This may indicate there is still a future for this kind of reward system.

5.3 REVENUE OVERVIEW

Within this chapter, several indications of possible revenue streams have been sketched. The discussed revenue options are summarised within the *table* below.

TABLE 5: REVENUE OVERVIEW

Revenue options	Potential revenue [€/month]	Explanation
Dwelling as a power plant	55	Based on Eneco Crowdnett pilot
Advertisement: billboard/mural	?	To be determined
Advertisement: window	150	Per window; Based on AddMyWindow
Advertisement: display window	?	To be determined
Advertisement: rooftop	?	To be determined
Advertisement: electronic advertisement indoor	?	To be determined
Workplace at home	120	Based on the SpitsMijden project
Furniture photoshoot	800 (film: 2000) one-time compensation	Based on an IKEA photoshoot
Antenna	250-900	Based on references in the Netherlands and Belgium
Neighbourhood internet distribution station	?	To be determined
Neighbourhood mail box	?	To be determined
Decentralized server as heater	25	Based on Nerdalize estimations
(Sub)letting every part of a dwelling	+ - 135	Based on one night rental in Amsterdam in 2015
Monetizing in-home generated data	?	To be determined
Monetizing recyclable household waste	5	Based on the Afval Loont pilot

In the next chapter, these revenue options are judged on their potential using a multi-criteria analysis.

6. MULTI-CRITERIA ANALYSIS

Within this chapter the multi-criteria analysis, as discussed in paragraph 3.3.2, to compare the revenue options on their potential is executed. The five experts assess the revenue options on the criteria discussed in paragraph 3.2 (investment/costs, monthly benefits, scalability, effect on property value, innovativeness, social acceptability, juridical feasibility, and technical feasibility) based on the information found in appendix C.

6.1 REVENUE OPTIONS

The aim of this MCA is to compare the revenue options on their potential. In order to make a fair comparison of the ideas, the ideas are compared on a relatively equal level of detail. Therefore, several specific discerned ideas are combined and presented on a more abstract level to the experts. The advertisement options of billboard/mural, window, display window, and rooftop are combined into the overarching layer of outdoor advertisement (as depicted in *Figure 5*). This way, the principle concept of outdoor advertisement is still covered and compared to ideas on a relatively same level. The emphasize lays on comparing abstract ideas rather than concrete options. At this point it is thus deemed less relevant which specific type of outdoor advertisement is most promising. The same counts for the antenna and neighbourhood internet distribution station options. Those options are also combined into their overarching layer telecom facilities. This reduces the amount of revenue options from 15 to 11. The eleven revenue options now represent eleven different concepts with an own line of thinking that can be assessed by the experts. The list of input options for the MCA is as follows:

1. Dwelling as power plant
2. On-house advertisement
3. In-house advertisement
4. Workplace at home
5. Furniture photoshoot
6. Telecom facilities
7. Neighbourhood mail box
8. Decentralized server as heater
9. (Sub)letting every corner of a dwelling
10. Monetizing in-home generated data
11. Monetizing recyclable household waste

6.2 RESULTS

The MCA and the sensitivity analysis are performed in appendix F and G respectively based on the input data from appendix E. *Table 6*, below, gives an overview of the ranked options based on an averaged ranking per expert. The second column presents the ranking based on the business case criteria (investment/costs, monthly benefits, scalability, effect on property value, and innovativeness) and the third column presents the ranking based on all criteria (business case criteria + the social acceptability, juridical feasibility and technical feasibility). The last column gives insight in the shift in rank because of the inclusion of social acceptability, juridical feasibility and technical feasibility. This gives insight in what revenue options have a potential strong business case, but are less feasible based on social, juridical and technical factors, or vice versa. Two out of five experts explained the occurred shift in rank due to the

inclusion of the social, juridical, and technical [SJT] criteria (see *Appendix I: Feedback experts on MCA results*).

TABLE 6: RANK BASED ON AVERAGED RANKING PER EXPERT

Revenue option	Business case criteria	All criteria	SJT shift*
(Sub)letting every corner of a dwelling	1	1	0
Monetizing in-home generated data	2	2	0
Dwelling as power plant	3	3	0
Furniture photoshoot	3	5	-2
Workplace at home	5	4	1
In-house advertisement	6	8	-2
Monetizing recyclable household waste	7	6	1
Neighbourhood mail box	8	6	2
Decentralized server as heater	9	9	0
On-house advertisement	10	10	0
Telecom facilities	11	11	0

* SJT shift = Shift in rank because of social, juridical, and technical criteria

The inclusion of the SJT criteria has the highest impact in the middle of the table. The top and bottom three options remain stable indicating those options score constant on both business case and SJT criteria. The most promising options based on the averaged ranking per expert are (sub)letting every corner of a dwelling, monetizing in-home generated data, and dwelling as power plant. The least promising options are decentralized server as heater, on-house advertisement and telecom facilities.

In the middle of the table, however, five shifts occur due to the inclusion of the SJT criteria:

1. The furniture photoshoot falls from the third to the fifth place.

Both Van den Wall Bake and Draijer (appendix I) state this shift is probably due to the lack of social acceptance of this option. The business case might be relatively attractive, yet support seems to be lacking.

2. The workplace at home option climbs one position from the fifth to the fourth place.

There is some discrepancy between the answers of the experts. Van den Wall Bake links the shift to his expectation this option is socially more attractive than the furniture photoshoot, while Draijer emphasizes the relative high juridical and technical feasibility (appendix I).

3. In-house advertisement drops from the sixth to the eighth position.

Both experts explicitly refer to the lack of social acceptance for this option, since the serenity of the home may be endangered (appendix I). This may indicate that support is currently lacking.

4. Monetizing recyclable household waste climbs from the seventh to a shared sixth position.

According to Draijer, this shift cannot be explained. Van den Wall Bake expects the shift is due to trend of societal support for waste separation and the circular economy (appendix I).

- Neighbourhood mail box climbs from the eighth to a shared sixth position.

Draijer explains the shift by the lack of a solid business case, while the option has no real obstacles based on the SJT criteria. Van den Wall Bake emphasizes the latter, by stating the social and technological simplicity (appendix I).

The ranking based on the ranking per expert has one disadvantage: it has a relatively high chance of options ending on the same rank, since the overall ranking is based on the average of all individual expert rankings on a scale from one to eleven. In the business case comparison there is a shared third place, while in the comparison based on all criteria, there is a shared sixth place.

Sensitivity analysis

In order to the robustness of the results, a sensitivity analysis with a different ranking method (see paragraph 3.3.2) is conducted. In this method, all scores per option and criteria from all experts are added up and then weighted with average weight factors. Just as *Table 6*, *Table 7* depicts the ranking of the revenue options based on the business case criteria, all criteria and the shift in rank because of the social, juridical and technical criteria.

TABLE 7: RANK BASED ON THE TOTAL SCORE PER OPTION

Revenue option	Business case criteria	All criteria	SJT shift*
Monetizing in-home generated data	1	3	-2
(Sub)letting every corner of a dwelling	2	2	0
Dwelling as power plant	3	1	2
In-house advertisement	4	8	-4
Workplace at home	5	4	1
Monetizing recyclable household waste	6	7	-1
Furniture photoshoot	7	6	1
Neighbourhood mail box	8	5	3
On-house advertisement	9	9	0
Decentralized server as heater	10	10	0
Telecom facilities	11	11	0

*SJT shift = Shift in rank because of social, juridical, and technical criteria

In this case, the SJT criteria result has impact in both the top as the middle of the table. The monetizing in-home generated data option shifts from the first to third rank, while the dwelling as power plant option climbs from the third to the first rank. Within the middle of the table, the shifts are extremer than in the original ranking. In-house advertisement sees a strong decline with a shift from rank four to eight. The neighbourhood mail box climbs three positions because of the SJT criteria. Workplace at home and the furniture photoshoot both climb one position, while monetizing recyclable household waste loses one. It must be noted that within the original ranking, furniture photoshoot fell one place, while monetizing recyclable household waste won one. Therefore, the results of the SJT shifts are not completely robust. However, the top and bottom three are equal to those the original ranking mechanism, although in a different order. Therefore, with the goal of this comparison in mind, the results are deemed robust for determining the most promising three revenue options.

Environment and location dependence

Based on a small survey among the experts (appendix E), an indication of the environment and location dependence of the revenue options can be given. The options dwelling as power plant and (sub)letting every corner of a dwelling, are judged not location and environment dependent. Most other options are judged not location and environment dependent by four out of five experts. In-house electronic advertisement, workplace at home, decentralized server as heater, and monetizing in-home generated data are all are judged one time to function best in an urban apartment. Neighbourhood mail box and monetizing recyclable household waste are judged one time to function best in a suburban terraced single-family dwelling. Three other options have specific comments. On-house advertisement is judged to function best at urban apartments and, especially, in city centres. This most likely is due to the fact outdoor advertisement is mostly placed in crowded spots. The furniture photoshoot answers are divergent, yet, one expert lay the emphasis on designer homes. This could be an indication a high architectural value is one of the most important requirements. Answers on telecom facilities were highly split between not location and environment dependent, urban apartment, and the countryside. One expert emphasized the need for the tallest urban apartment in an area, most likely referring to the antenna revenue option.

6.3 CONCLUSION

The three discerned revenue options with the most potential, in random order, are:

- (Sub)letting every corner of a dwelling
- Monetizing in-home generated data
- Dwelling as power plant

These three options are deemed the most promising of all revenue options. Based on the revenue overview in paragraph 5.3, it is no surprise that (sub)letting is seen as a high potential revenue option. Solely by (sub)letting a room for one night per month, a relatively high revenue is gathered. This amount can grow further by (sub)letting many other rooms. The dwelling as power plant option is estimated to have a solid business case and is found to be extra feasible based on the SJT criteria. As described in paragraph 5.2.1, there is much uncertainty about the financial potential of the monetization of the in-home generated data. However, its potential is clearly recognized by the experts.

7. IMPLEMENTATION OF THE MOST PROMISING OPTIONS IN THE SOCIAL HOUSING SECTOR

In this chapter it is discussed how the most promising revenue options can be implemented in the social housing sector. In chapter 5, dwelling-generated revenue options were discerned and placed within a taxonomy. Four external factors were determined (tenure, target group, location and institutional context) that influence the potential of every revenue option. These external factors have therefore not placed a limiting role in discerning the revenue options. In chapter 6, in which the most promising revenue options were selected, the external factors may have played an implicit role in the expert judgements. For example, in order to determine the scalability of an option one can be expected to make an estimation whether an option is applicable in different tenure situations or locations. This chapter is focused on an implementation in the social housing sector, since most households with housing affordability issues are found within the social housing sector. Therefore, in this context, successful implementation within this sector is deemed most relevant. This chapter is focused on juridical and social aspects of the implementation, assuming all options are financially and technically feasible. The institutional context of the social housing sector is briefly outlined, followed by an implementation guideline per revenue option. Two legal counsels of Amsterdam based housing association Eigen Haard, Martijn Kerkhof and Danny Koning, were interviewed to identify both juridical obstacles and possibilities (see appendix H).

7.1 INSTITUTIONAL CONTEXT

The Housing Act 2015 (Dutch: *Woningwet 2015*) and the Decree Accepted Institutions Public Housing (Dutch: *Besluit Toegelaten Instellingen Volkshuisvesting [BTIV]*) provide the regulating context in which Dutch housing associations operate. These regulations prescribe that housing associations should focus on their core task of providing affordable housing to low-income households or other households that have problems with finding proper housing. Activities supporting the core task are called *activities in the service of general economic interest* (Dutch: *Diensten van Algemeen Economisch Belang, [DAEB]*). Only 10% of all funds may be spent on non-DAEB activities (Veenstra, 2016).

It can be argued that dwelling-generated revenue options are DAEB activities since they help to ensure housing affordability. This statement is acknowledged by both interviewees Koning and Kerkhof (appendix H). They add that Eigen Haard makes as less distinction as possible between DAEB and non-DAEB property, since households living in non-DAEB property (above the social rent threshold) can still have affordability issues). In practice, it may be required to perform a juridical or administrative separation if an activity turns out to be a non-DAEB activity. If necessary, a partnership with a private partner can also be initiated in such situations.

Rent law

The implementation of a revenue option may include the spread of costs and benefits among housing associations and their tenants. Rent law forms the foundation for the tenancy agreement between the housing association and the tenant and can therefore play an important role. Rent law (or tenancy law) falls under the Dutch private law and describes all rights and duties of both lessors and tenants. Specifications can be found in art. 7:201-310 BW. Within rent law, special attention is paid to the letting of housing accommodation. In the context of implementation of dwelling-generated revenue options in the social housing sector, one aspect must be emphasized. Within this research, it is argued that

dwelling-generated revenue has the potential to lower the rent if a revenue option benefits the owner of a dwelling. A housing association, as a social landlord, is assumed to lower the rent accordingly.

In the social housing sector, the maximum rent is determined based on the rent points system (Dutch: *Woningwaarderingstelsel, [WWS]*). The rent points system is described in the Implementation Act Housing Rental Fees (Dutch: *Uitvoeringswet Huurprijzen Woonruimte*) and Resolution Housing Rental Fees (Dutch: *Besluit huurprijzen woonruimte*). Points are assigned to a dwelling for elements such as the number of rooms and the value based on the Valuation of Immovable Property Act (Dutch: *Wet Onroerende Zaak waarde [WOZ waarde]*) (Rijksoverheid, n.d.-a). Attention should be paid to the effect of the implementation of a revenue option on the number of points assigned to a dwelling, since it may increase the maximum theoretical rent.

Flexible regulations

Kerkhof & Koning (appendix H) state that it is often unknown whether new initiatives are legally feasible. Especially, with the Housing Act of 2015, some areas remain grey and the implementation therefore is a matter of trial-and-error. It must be stressed that the implementation trajectory of all revenue options can best be started on a small scale first. This provides necessary space for flexible application of laws and regulations. Within small-scale pilots, effects of the revenue options can be measured and more obstacles can be identified. The *Green Deals* approach, a method in which the government actively helps to implement new and sustainable initiatives by removing obstacles, is found to be effective. As suggested by Gooskens, Van Mil, and Modderman (2016), the underlying support structure can be applied in other sectors as well. Such an approach may help smoothen the implementation of the dwelling-generated revenue concepts in the social housing sector.

The institutional context is summarised within the *table* below.

TABLE 8: INSTITUTIONAL CONTEXT

Law	Specification
Housing Act 2015	Determines the playing field of housing association (DAEB/Non-DAEB)
Rent law	Rights and duties of lessors and tenants
Implementation Act Housing Rental Fees; Resolution Housing Rental Fees	Rent points system

7.2 IMPLEMENTATION OF *DWELLING AS POWER PLANT*

For the implementation of the *Dwelling as power plant* revenue option, inspiration can be found in the way housing associations deal with the renovation of their stock into net zero energy dwellings. In order to create a viable business case for housing associations, the energy performance compensation (Dutch: *Energieprestatievergoeding, [EPV]*) was introduced. Through this arrangement, property owners can agree with tenants on an additional monthly fee to compensate for their investment in the dwelling in return for guaranteed energy performance (RVO, n.d.). The idea behind this compensation is that tenants benefit from the renovation. The total housing expenses do not increase for the tenant, since monthly energy costs are significantly reduced and living comfort increases. See the *table* below for a simplified example. It must be noted that points in the rent points system are awarded when a dwelling gets a higher energy label as result of a renovation (for example, from label C to B). Therefore, the theoretical maximum rent is also increased. This way the housing expenses could still be higher after the renovation if the housing association decides to increase the rent accordingly (Heeger, 2014). Kerkhof (appendix H) nuances this claim by stating Eigen Haard almost never rents out dwellings for the maximum theoretical rent price.

TABLE 9: CURRENT SITUATION - TENANCY HOUSING EXPENSES WITH ENERGY PERFORMANCE COMPENSATION

Expenditures		Expense [€/month]	Expenditures		Expense [€/month]
	Net housing expenses	499		Net housing expenses	499
+	Energy costs (paid to energy supplier)	120	+	Energy Performance Compensation (paid to the housing association)	120
+	Other housing expenses*	43	+	Other housing* expenses	43
=	Total housing expenses	662	=	Total housing expenses	662

*These expenses are aggregated from tables in chapter 2 and are assumed constant.

Variable Energy Performance Compensation

Assuming that the creation of a surplus energy dwelling (in newly built and/or renovation situations) is a feasible investment, the spread of costs among housing associations and tenants can follow the same pattern as in the creation of net zero energy dwellings. The only question is how the actual positive cash flow, which is assumed to flow back to the housing association, is translated into a reduction of the housing expenses. An option is to create a variable Energy Performance Compensation. The height of this compensation can be maximised in order to guarantee that the housing expenses do not increase just as is intended in the current Energy Performance Compensation. However, if the revenue is high enough, as result of a high-energy production, this number could be close to zero or even turn out to be negative (i.e. further reduction of housing expenses). An example of the impact on the housing expenses is presented in the *table* below.

TABLE 10: PROPOSED SITUATION - TENANCY HOUSING EXPENSES WITH VARIABLE ENERGY PERFORMANCE COMPENSATION IN A SURPLUS ENERGY DWELLING

	Expenditures	Expense [€/month]	Specification
	Net housing expenses	499	
+	Energy Performance Compensation	X (from Y to 120)	Y is lower than 120 and can be negative
+	Other housing expenses*	43	
=	Total housing expenses	542+X	

*These expenses are aggregated from tables in chapter 2 and are assumed constant.

According to Kerkhof (appendix H), housing associations are willing to cooperate as long as it is shown this option can reduce housing expenses. Therefore, within the implementation trajectory, the concept may be proven in a pilot first. Kerkhof and Koning (appendix H) state this option could be implemented in their DAEB and non-DAEB property, since the rent itself is not affected.

Potential encountered obstacles during the implementation of the *dwelling as power plant* in the social housing sector are summarised in the *table* below.

TABLE 11: POTENTIAL IMPLEMENTATION OBSTACLES DWELLING AS POWER PLANT

Aspect	Specification	Obstacle?	Explanation	Solution
Housing Act 2015	Determines the playing field of housing association (DAEB/Non-DAEB)	No		
Rent law	Rights and duties of lessors and tenants	No		
Implementation Act Housing Rental Fees; Resolution Housing Rental Fees	Rent points system	Potentially	An increased rent could mitigate the reduction of housing expenses	Housing associations should not utilize the opportunity to increase rents

7.3 IMPLEMENTATION OF (SUB)LETTING EVERY CORNER OF A DWELLING

For the implementation of *(Sub)letting every corner of a dwelling* inspiration can be found within the discussion about subletting social housing in Amsterdam. Housing association De Key wanted to start a pilot in which students were allowed to sublet their dwelling for a maximum of 30 days per year. De Key argued it was unfair that social tenants did not share in the popularity of Amsterdam as tourist destination (Kruyswijk & Couzy, 2016). Mayor Van der Laan agreed on this matter (as quoted by Couzy (2016)): *"It would not be strange to let social tenants profit from Airbnb as well. In a very regulated manner, whereby it is enforceable."* Van der Laan added this topic should be open for debate. These statements led to massive criticism by other housing associations and parliamentarians. Van Buren, director of housing association Rochdale, argued, among others, that social tenants do not need to profit from tourism through subletting, since they already live in a subsidised home (De Zwaan, 2016). Furthermore, the Municipality of Amsterdam has prohibited the subletting of social housing until at least 2019. Based on the caused social debate, De Key decided to cancel the proposed subletting pilot due to insufficient support (Damen & Unen, 2016).

Legal constraints

Fuelled by the downsides of services like Airbnb, such as illegal hotels and nuisance, the Municipality of Amsterdam has drawn up explicit, additional, rules on holiday rental. Services like Airbnb are, for example, obliged to pay tourist taxes and non-social tenants are only allowed to rent out their entire dwelling for maximum 60 nights with explicit permission of the property owner (and, if relevant, permission of the association of owners) (Municipality of Amsterdam, n.d.). With the growing popularity of Airbnb, other municipalities, such as Rotterdam (Bouwels & Van Heel, 2017), are bound to follow the example of Amsterdam. Local regulations can thus further limit the possibilities. In general, the act of subletting is allowed with permission of the property owner (Rijksoverheid, n.d.-b). Housing associations, however, explicitly include in their tenancy agreements that subletting is not allowed. According to Kerkhof (appendix H), traditionally, housing associations are afraid of liveability issues due to less involved subtenants and are afraid to lose control of who is living in their dwellings. Social tenants that decide to sublet nonetheless are in risk of being fined and, eventually, evicted from their home.

Removing obstacles

The principal argument that social tenants should not be able to generate revenue through their already subsidised home has to be debated. The reality that many social tenants still have problems to pay their rent, despite living in a subsidised home, seems to be overlooked. Rather than framing subletting simply as abuse of subsidy, it must be observed as an extra means to ensure housing affordability. In order to prevent abuse, the option should be implemented in a *very regulated manner* – as suggested by Van der Laan. An example is given by housing association UWoon that initiated a pilot in which tenants could request to sublet part of their dwelling. After permission is granted, the tenant is allowed to sublet part of its dwelling for six months. After this period, another request can be sent to UWoon to give the subtenant a contract for an indefinite period (Woonbond, 2015). UWoon hopes to create extra supply for starters on the housing market and to support their tenants in their financial situation by letting them generate a revenue. The tenant is, however, obliged to apply the rent points system to determine the rent fee in order to prevent abuse (UWoon, n.d.). However, if the main tenant receives housing allowance, this housing allowance shall be reduced (Woonbond, 2015), reducing the positive impact on the housing affordability. Results of the pilot are not yet available, yet the initiative shows that, with the right will, it is legally possible to arrange subrental in the social housing sector. According to Koning (appendix H), Eigen Haard has a special arrangement for subletting the entire dwelling for 1-2 years through residence stewardship. A regulated form of room rent is also available. The leading rule of both arrangements is that it is not profitable for the main tenant. It may only cover the costs of the rent plus a contribution for extra depreciation of furniture and public levies.

Kerkhof and Koning (appendix H) emphasize the lack of nuance in the discussion of subletting social housing in Amsterdam. All forms of subrental, from short to long term and from room subrent to subrental of the entire dwelling are lumped together in the discussion about Airbnb. Eigen Haard does not want to allow services like Airbnb, while Kerkhof and Koning deviate from this point of view and state it provides an opportunity for a regulated implementation in which much of the administration is handled by Airbnb. Kerkhof and Koning (appendix H) provide four rules that can be followed to allow subrental through platforms as Airbnb in the social housing sector:

1. The dwelling should remain the main residence of the tenant;
2. No change of the use of land should occur (i.e. the land use should remain residential);
3. Neighbours have to be informed;
4. No profit may be generated. This means that the monthly-generated revenue should not be higher than the rent. Complying with the additional 60-day rule of the Municipality of Amsterdam, this means the dwelling could be sublet for 60 days for the proportional rent or with a maximum yearly revenue of two months' rent.

As mentioned in paragraph 6.1.3, there are potentially many rooms in a dwelling that could be rented out for many different purposes. Kerkhof (appendix H) stated subletting, for example, an attic as storage space, is officially prohibited, yet as long as no profit is made the legal basis of a court case is questionable. Within the implementation trajectory, one should make a clear distinction between subletting part of a dwelling and subletting the entire dwelling. It should be determined to what extent subletting specific rooms for a short amount of time, such as a study room, is desirable and what price may be asked. The rent points system may be suitable to determine the rent price for subletting a specific room for an entire month, yet the incentive to sublet rooms for a short amount time may be lacking if the rent points system has to be used to determine the price.

The main obstacle is not juridical, but merely the lack of will of housing associations to arrange it. According to Koning (appendix H), housing associations look at this issue merely from an enforcement perspective, since they are afraid of abuse. Koning adds there is limited evidence against the cons of Airbnb. Five out of 800 Eigen Haard's legal cases after 2013 involved the abuse of Airbnb according to Kerkhof (appendix H). According to Koning (appendix H), there are two possible explanations: either it is a non-existing problem or it cannot be controlled in its current form. In case it cannot be controlled, regulated implementation could also contribute to an improved control.

Division of costs and benefits

It is expected that a negligible investment is required to make a room or dwelling suitable for subletting. Therefore, the housing expenses could be reduced as presented in the *table* below. Note the housing allowance may be reduced as result of the revenue. Therefore, the subletting revenue must always be higher than the reduction of the housing allowance in order to reduce the housing expenses.

TABLE 12: EXAMPLE OF TENANCY HOUSING EXPENSES WITH SUBLETTING REVENUES FOR THE TENANT

	Expenditures	Average expense [€/month]	Specification
	Gross rent	569	
-	Housing allowance	$-(70 - X)$	May be reduced as a result of the revenue
-	Subletting revenue	Y	Maximum amount may be regulated
=	Net housing expenses/net rent	$499 + X - Y$	
	Other housing expenses	163	
=	Total housing expenses	$661 + X - Y$	

X = a potential reduction of the housing allowance as result of the subletting revenue

Y = subletting revenue

Potential encountered obstacles during the implementation of *(sub)letting every corner of a dwelling* in the social housing sector are summarised in the *table* below.

TABLE 13: POTENTIAL IMPLEMENTATION OBSTACLES SUBLETTING

Aspect	Specification	Obstacle?	Explanation	Solution
Housing Act 2015	Determines the playing field of housing association (DAEB/Non-DAEB)	No		
Rent law	Rights and duties of lessors and tenants	Yes	Tenancy agreements currently not allow temporary subrental	Change of mentality in which subrental is seen as extra means to ensure housing affordability
Implementation Act Housing Rental Fees; Resolution Housing Rental Fees	Rent points system	No		
Housing Allowance Act	Determines how much housing allowance a household can receive	Potentially	Reduced housing allowance mitigates the reduction of housing expenses	If not profitable, the revenue stream could be tax-free

7.4 IMPLEMENTATION OF *MONETIZING IN-HOME GENERATED DATA*

In this section, the implementation of the revenue option *Monetizing in-home generated data* in the social housing sector is discussed. Assuming a functioning data monetization platform – as discussed in paragraph 6.2.1 – is available, several issues still have to be dealt with.

Generating data

In order to start the generation of in-home data, an investment in the data generating devices (i.e. smart home devices and/or sensors) is required. Ideally, the uniqueness of these data may be safeguarded by selecting devices without an own data stream. Popular smart home equipment from manufacturers like Samsung and Philips synchronize the generated data with their own servers. A distinction between home-related data and person-related data can probably be made (Koning, appendix H). The personal data, ideally, is made as anonymous as possible and, when offered to tenants, it should be emphasized this data will never be used against the tenant. The main question at this stage is who is going to invest in the data generators. The difficulty is that it is unknown what the market value of the in-home generated data is, and thus, which height of the investment is still responsible. In order to test to what extent this revenue option can reduce the housing expenses, it is recommended that housing associations manage both costs and benefits. The eventual profit is used to provide a discount of the rent. Tenants may receive a substantial discount on their rent for participating in a pilot.

Participants

The home-related data can probably be collected based on legitimate interest of the housing association, since it can be used to optimize maintenance plans. It must be stressed that the personal data of tenants is used as an economic good. Therefore, based on art. 8 of the Personal Data Protection Act (Dutch: *Wet bescherming persoonsgegevens* [Wbp]), one's unambiguous consent (*opt-in*) is required. Janssen (2017), director of the Data Driven Marketing Association, however, argued that an opt-in is legally feasible, yet does not necessarily lead to decisions of aware and informed citizens. Ideally, tenants can make a well-informed choice which data they are willing to share for which discount. According to Koning (appendix H), one is often not aware of the risk of sharing its data. When implementing this option one should be very aware of what data is collected and shared, and one should be able to oversee the potential consequences. Otherwise, it could lead to cases of misleading information (Dutch: *dwaling*).

It must be prevented that one feels urged to share its data in return for an affordable home. According to Van der Kloot Meijburg (2017), low-income households will have more problems resisting the temptation to trade their personal data for cheaper or free digital services making privacy a privilege for the rich. When approaching households for participation a pilot, this issue requires special consideration. According to Kerkhof and Koning (appendix H), only households that could afford the rent without the offered discount should be selected. They provided the solution never to offer the discount at the start of the tenancy agreement, since one then could feel urged to accept the offer. An alternative is therefore to offer it at a later stage.

Potential encountered obstacles during the implementation of *monetizing in-home generated data* in the social housing sector are summarised in the *table* below.

TABLE 14: POTENTIAL IMPLEMENTATION OBSTACLES MONETIZING IN-HOME GENERATED DATA

Aspect	Specification	Obstacle?	Explanation	Solution
Housing Act 2015	Determines the playing field of housing association (DAEB/Non-DAEB)	No		
Rent law	Rights and duties of lessors and tenants	No		
Implementation Act Housing Rental Fees; Resolution Housing Rental Fees	Rent points system	No		
Personal Data Protection Act	Determines under what conditions personal data may be shared	Potentially	Tenants might be insufficiently informed to give their unambiguous consent	Broader awareness of relevant themes such as the importance privacy
Ethical (social/juridical): Offering discount in return for sharing data	Social housing should be affordable without the offered discount	Potentially	One should never feel urged to share its data in order to live in an affordable home	Do not offer the discount at the start of the tenancy agreement

7.5 CONCLUSION OF THE IMPLEMENTATION

All options can best be implemented in a small-scale pilot structure first in order to be able to draw lessons from it. If flexible regulations are required, the support structure of the Green Deals may be applied.

For the dwelling as power plant option, the implementation can be based on the existing arrangement of the energy performance compensation. The housing association manages all costs and benefits and provides a maximised variable energy performance compensation to its tenants that lowers the housing expenses. A potential obstacle is the existing problem of an increased theoretical maximum rent as result of the additional awarded points in the rent points system. In the proposed solution, the variable energy performance compensation provides a feasible business case for the housing association. The rent should therefore not be increased.

For the subletting option, implementation is mainly obstructed by fear of abuse of the subsidised home. This requires a change of mentality in which subletting is seen as an alternative way to contribute to housing affordability. In a regulated manner, housing associations can choose to let their tenants generate a revenue through subletting. The emphasis must be on subletting part of their dwelling, instead of the entire dwelling. Further abuse can be prevented by regulating the maximum revenue earned per month. Four conditions are formulated for a regulated implementation of subrental through platforms as Airbnb in the social housing sector: the dwelling should remain the main residence of the tenant, no change of the use of land should occur, neighbours have to be informed, and no profit should be generated.

For the data monetization option, the housing association is ought to manage all costs and benefits, since it is rather uncertain how feasible the investment is. It is important to safeguard the uniqueness of the generated data by selecting data generators (i.e. sensors and/or home automation devices) without a separate data stream. In order to let households participate in a pilot a significant discount on the rent may be offered. Participants should be able to make a well-informed decision on whether they would like to share their personal data in return for a discount on the rent. However, it must be prevented that low-income households feel necessitated to share their data in return for an affordable rent. Therefore, it may be considered not to offer the discount at the beginning of the tenancy agreement.

8. CONCLUSION

In this chapter, an answer is given to the central research question of this exploratory research: *'In what ways can housing expenses be reduced by dwelling-generated revenue in the Netherlands?'* Dwelling-generated revenue is introduced as umbrella concept to capture all potential ideas that may lead to revenue generated by a dwelling or its affiliated services. This exploratory research has introduced a new perspective to reduce housing expenses and to contribute to housing affordability in the Netherlands. In order to come to an answer to the central research question, the three sub-questions are first answered separately.

8.1 SUB-QUESTIONS

Within this section, answers to the sub-questions are presented.

SQ1: Which aspects of a dwelling can potentially generate revenue?

Dwelling-generated revenue options can have two principal sources: the object (the dwelling) and the subject (the resident). This distinction between the two of them is not completely black-and-white, yet the separation helps to provide a clear overview of all theoretical possibilities. Within the object branch, three categories have been discerned. First, the dwelling as power plant, a dwelling in which significantly more energy is generated than consumed in order to sell this surplus of energy. Second, third party compensation can be received for having or allowing certain attributes in or on a dwelling. Three main types of third party compensation can be identified: advertisement, internal facilities, and external facilities. Third, (sub)letting (parts of) a dwelling is another revenue option. This can be sleeping rooms, storage spaces, and living rooms among others.

Within the object branch, two categories have been discerned. First, the monetization of recyclable household waste. The increasing awareness of waste as resource has resulted in pilots in which households were compensated per kilogram of recyclable waste. Second, the monetization of in-home generated data. The growth of home automation leads to an increasing amount of potential valuable personal data generated inside dwellings.

SQ2: Which revenue options are the most promising?

Based on the judgements of five experts from the housing and innovation domain all revenue options were compared. This comparison was performed in two stages. In the first stage, solely the business case criteria (investment/costs, monthly benefits, scalability, effect on property value, and innovativeness) were taken into account, to indicate which revenue options have a strong financial potential. In the second stage, both the business case criteria and the overall feasibility criteria (social acceptability, juridical feasibility, and technical feasibility) were taken into account. In both comparison rounds the revenue options '(Sub)letting every corner of a dwelling', 'Dwelling as power plant', and 'Monetizing in-home generated data' were selected as the revenue options with the highest potential.

SQ3: How can the most promising option be implemented?

The implementation of the three most promising revenue options in the social housing sector is discussed, as most households struggling with housing affordability issues are found within the social housing sector. All options are, in principal, juridical feasible and can be implemented in a small-scale pilot structure. Succeeding such a trial phase, more substantiated lessons for future implementation can be drawn. If flexible regulations are required nonetheless, the support structure of the Green Deals may be applied.

For the dwelling as power plant option, the implementation can be based on the existing arrangement of the energy performance compensation. If financially feasible, the housing association manages all costs and benefits and provides a variable energy performance compensation to its tenants that lowers the housing expenses.

For the subletting option, implementation is mainly obstructed by a lacking will of housing associations, caused by a fear of abuse of the subsidised home. In order to overcome these fears, a change of mentality amongst housing associations and policy makers is required, i.e.: subletting has to be seen as an alternative way to contribute to housing affordability, rather than as abuse. In a regulated manner, housing associations can choose to let their tenants generate a revenue through subletting. Four conditions are formulated for a regulated implementation of subrental through platforms as Airbnb in the social housing sector: the dwelling should remain the main residence of the tenant, no change of the use of land should occur, neighbours have to be informed, and no profit should be generated.

For the data monetization option, the value of the data has to be determined within a pilot. In order to let households participate in a pilot a significant discount on the rent should be offered. Participants must be able to make a well-informed decision on whether they would like to share their personal data in return for a discount on the rent. However, it must be prevented that low-income households feel necessitated to share their data in return for an affordable rent. Therefore, it may be considered not to offer the discount at the beginning of the tenancy agreement and to select only households that could afford the rent without the discount.

The discussed obstacles and their partly provided solutions are the first step towards implementation of the most promising options. Next steps can be determined after the pilot phase.

8.2 CENTRAL RESEARCH QUESTION

Based on the answers on the sub-questions the central research question can be answered.

CRQ: In what ways can housing expenses be reduced by dwelling-generated revenue in the Netherlands?

The housing expenses can be reduced by dwelling-generated revenue in two principal ways. First, part of the revenue options can be implemented on a large scale so that as many households as possible can reduce their housing expenses. Second, one or more revenue options might be suitable on only a relatively small scale, yet generating a rather big revenue. This way a relatively small group could benefit from a relatively high reduction of housing expenses. There is one fundamental assumption underlying this statement: the revenue is directly used to lower the housing expenses.

Five main categories of dwelling-generated revenue have been discerned and placed in a taxonomy. Three categories are related to the object (=dwelling): dwelling as power plant, third party compensation, and (sub)letting. Two categories are related to the subject (=resident): monetization of recyclable household waste and monetization of in-home generated data. '(Sub)letting every corner of a dwelling', 'dwelling as power plant', and 'monetization of in-home generated data' were selected as the revenue options with the highest potential by five experts in the field of housing and innovation. It is expected that these revenue options can generate hundreds of euros per month. What revenue option is most suitable in which situation has yet to be determined and is dependent on the external factors (tenure, target group, location and institutional context).

New forms contributing to a reduction of housing expenses is deemed most relevant in the social housing sector, since most housing affordability issues are found within this sector. However, dwelling-generated revenue has the potential to reduce housing expenses in all tenures. The implementation of the three most promising options in the social housing sector are found to be feasible. The dwelling as power plant can successfully be implemented by introducing a variable, yet maximised, energy performance compensation. Implementing subletting in a regulated manner is possible as well. This requires a change of mentality in which subletting is seen as an alternative way to contribute to housing affordability. For the implementation of monetization of in-home generated data, it is important tenants give fully informed permission on sharing their personal data. Furthermore, it should be prevented that one feels urged to share its data in order to have an affordable rent.

9. DISCUSSION

Within this chapter the interpretation of the results, the limitations of this research and the recommendations for further research are discussed. Due to the exploratory nature of this research, this chapter is deemed extra important, since insights and leads in this new research field are reflected upon.

9.1 INTERPRETATION OF RESULTS

(Sub)letting, dwelling as power plant, and monetization of in-home generated data are the most promising revenue options as judged by the expert. This means that, compared to all revenue options, they have the highest probability of being implemented successfully and contributing to a reduction of the housing expenses. In chapter 7, the implementation of those options in the social housing sector were discussed, since most households with housing affordability issues are found within this sector. In order for dwelling-generated revenue to function as a means to increase housing affordability, attention should always be paid to the questions whether residents (or private parties) are going to benefit from the revenue, and if so, if the right residents (i.e. with payment risks) are going to benefit.

Are residents going to benefit from the revenue?

If a dwelling-generated revenue is to contribute to a reduction of the housing expenses and thus to the housing affordability, it is assumed in the research the generated revenue is directly used to lower the housing expenses. However, in practice, two problems may occur. First, the revenue may not be used to reduce the housing expenses. If a resident benefits from a revenue, the revenue might be spent elsewhere. In this case, the revenue might not contribute to a reduction of the housing expenses, yet it must be noted that it could contribute to the overall living conditions or social participation of households with payment risks. Second, the long-term durability of a reduction of the housing expenses might be at stake. If dwelling-generated revenue options become consolidated, commercial parties might start to anticipate upon the profits to be made. This may result in a commercial exploitation of the deemed social revenue generation. For example, companies like Airbnb may increase their booking fee. Furthermore, there is a probability of revenue options being capitalised within the house price. For example, a surplus energy dwelling could have a higher market value because of the revenue it generates. In such case, a revenue option may only reduce the housing expenses for one generation of residents.

Are the right residents going to benefit from the revenue?

The aim of this research is to reduce housing expenses by dwelling-generated revenue in order to increase housing affordability in the Netherlands. Assuming the revenue does in fact benefit of the residents, the question should be asked whether the *envisioned* residents are going to benefit from the revenue. Ideally, the (most promising) revenue options should be eligible for low- and middle-income households and their housing situation. Whether these groups will actually be affected, is yet to be determined. Even in the discussed case of implementation in the social housing sector, the desired effect may be mitigated. In case of the monetization of generated data, it is even argued that households that already have payment issues are excluded, since it endangers the free choice to share personal data.

In case of sub(letting), a comparable kind of issue can be identified. Based on a study of Airbnb rental in London, distinction can be made between the social characteristics of households (sub)letting rooms and those renting out entire homes. Rooms tend to be offered in areas with highly-educated non-UK

born renters, while homes tend to be offered in areas with owners of high-end homes in terms of house price (Quattrone, Proserpio, Quercia, Capra, & Musolesi, 2016). As discussed in chapter 7, there is big distinction between renting out rooms and entire dwellings in terms of legislation as well. In order to let this option contribute effectively to a reduction of the housing expenses for households with a payment risk, this issue should be addressed.

9.2 LIMITATIONS OF THIS RESEARCH

The exploratory nature of this research, and the available time to conduct this research, have led to a constant balance seeking between providing, on the one hand, a complete overview of this research topic and, on the other hand, detailed enough descriptions of all fields discussed. Especially when discussing the vast array of revenue options many fields of expertise were touched.

The dwelling-generated revenue terminology and classification were introduced in this thesis and, hence, are kept open for debate. A definition of dwelling-generated revenue was given. Yet, it must be noted that it remains ambiguous to define whether an option qualifies as a dwelling-generated revenue option, or not. Arguably, a platform like *ThuisAfgehaald*, where one can sell home-cooked food, can be seen as subject revenue. Data generated inside a dwelling about the maintenance state is, in fact, more object than subject bound.

In order to compare the revenue options, a multi-criteria analysis was conducted in which five experts out of the field of housing and innovation were asked to make a qualitative judgement on the potential of the revenue options based on pre-selected criteria. Ideally, the number of experts would have been bigger to increase the reliability of the results. In order to increase the validity, experts from more specific fields could have been asked to judge only specific criteria in their area of knowledge. A comparison based on quantitative input data would have been preferable, because of its objective character, yet those data was not available. Within the prescribed time of this research, the judgement of the five experts were deemed fit for this exploratory research.

9.3 RECOMMENDATIONS FOR FURTHER RESEARCH

This research has roughly identified the possibilities and bottlenecks of dwelling-generated revenue options in order to reduce housing expenses. Many research opportunities can be found based on this research:

1. Design of a system in which dwelling-generated revenue leads to a guaranteed reduction of the housing expenses

Within this research, it was assumed that a dwelling-generated revenue would be directly used to reduce the housing expenses. Based on this assumption many revenue options have been discerned. However, it should be acknowledged the conclusions that were formulated are confined by the presence of this assumption. The suggested implementation of the *variable energy performance compensation* in the social housing sector is an example of such a system. Yet, this is solely one example in one tenure situation. Therefore, it should be researched whether a system can be designed in which (one of) the revenue options lead(s) to a guaranteed reduction of the housing expenses.

2. Further exploration of the dwelling-generated revenue taxonomy

The categorisation of all dwelling-generated revenue options based on the subject/object classification into the taxonomy could function as base for further research. As mentioned under 9.2, the categorisation is open for debate. The dwelling-generated revenue definition may be reformulated, the classification adjusted, or new revenue options added to the existing scheme if deemed required to develop this research field as long as it has the potential to contribute to a reduction of housing expenses.

3. In-depth research of discerned (most promising) revenue options

All revenue options, however, can be an individual research topic. Especially the most promising options deserve short-term attention. By dedicating an entire research per revenue option, much more in-depth information can be acquired. It can be researched under which types of tenure, target group, location, and institutional context a revenue option would function. Furthermore, specific research topics for the most promising options can be formulated. These include, among others:

- (Sub)letting of every corner of a dwelling
 - Which rooms have the most potential to be (sub)let?
 - Does the target group differ from that of Airbnb?
 - For what price is one willing to participate?
- Dwelling as power plant
 - How much surplus energy can a dwelling generate cost-effectively?
 - How are the costs distributed among the involved parties?
- Monetization of in-home generated data
 - Which type of in-home generated data has the most value?
 - What price are parties willing to pay for this data?
 - For what price is one willing to sell its data?
 - Can one oversee the consequences of selling its data?

4. More elaborate comparison method

The in-depth research of the discerned (most promising) revenue options can be followed by a more elaborate comparison method. Doing so, revenue options can be compared on the acquired objective input data, if those data are available by that time. It would be interesting to compare the results of that comparison with the conducted MCA based on expert judgements.

Alternatively, the MCA conducted in this research can be repeated with a different method to perform an additional check of the robustness. Potential MCA methods include the ARGUS method or methods based on fuzzy set theories.

5. Implementation of dwelling-generated revenues in other countries

If dwelling-generated revenue has proven it is able to reduce the housing expenses in the Netherlands, its applicability in other countries should be researched considering cultural, institutional and other factors. In order to increase the probability of a successful implementation abroad, it is recommended to start in countries with similar housing systems.

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APPENDICES

APPENDIX A: VALIDATION SESSION

In order to validate the categorisation and revenue options a session with four concept developers of project developer and building contractor ERA Contour (Yffi van den Berg, Erik Gathier, Ewout Smits, and Saskia van der Weerd) was organized on 20 December 2016.

The dwelling-generated revenue scheme with the subject-object distinction and the categorisation was discussed. Revenue options were suggested, such as:

- Reimbursement for storing rainwater. Having proper rain storage facilities unburdens the sewer system. However, in many municipalities, it is obliged to have rain storage facilities.
- Companies as IKEA are interested in using real kitchens as location for photoshoot and film sessions. IKEA offers €800 per photoshoot per day and €2000 per film shoot per day (Y. van den Berg, personal communication, December 20, 2016).
- Surplus energy could be sold locally within the own neighbourhood.
- Reimbursement for street nameplate on façade. However, it is generally embedded within local regulations that street nameplates can be placed on private properties.
- Artists are sometimes willing to pay for exhibiting their creations behind windows in popular walking areas.
- Every room within a dwelling can be (sub)let. Why not a shower, storage room, parking lot or garden?
- Not a revenue, but a way of reducing housing expenses: students living combined with the elderly or refugees in return for rent-free living or a lower rent.

The new revenue options could be placed within the existing overview. Therewith, the categorisation is deemed valid. Based on the feedback of the participants, the branch advertisement, is, however, placed as sub-branch of the third party compensation.

APPENDIX B: LIST OF PARTICIPANTS

The team Digital living of the innovation track EGW originally consisted of eight members and one facilitator.

Facilitator

Douwe van den Wall Bake

Company

TBI Holding

Members

Erik Havermans

Eigen Haard

Diane van Herpen

Eigen Haard

Jeroen de Heus

Bouwinvest

Rik ter Horst

Groothuis | TBI

Dennis de Jong

Bouwinvest

Joris-Jan Menken

BAM Wonen

Jelrik van der Sijde

ERA Contour | TBI

Peter Paul van Splunder*

BAM Wonen

*Attended the first 4 weeks

APPENDIX C: INPUT FOR THE EXPERT JUDGEMENT

Dear expert,

You are selected to make a judgement about the potential of several concepts that may help to make housing more affordable. Within this study, new and existing ways have been identified to reduce housing expenses by generating dwelling-related revenues. In this study, the term *dwelling-generated revenue* is used as umbrella concept to catch all potential ideas that may lead to revenues generated by a dwelling or its affiliated services.

Eleven dwelling-generated revenue concepts have been discerned. Your judgement will help to identify the most promising option(s). You are asked to assess the eleven options on business case criteria, feasibility criteria (on a scale from 1 to 5) and to make a judgement about the option's dependency on location and dwelling type. The criteria are as follows (sub divided into business case criteria, and feasibility criteria):

Business case criteria	Description	Scale
Investment/costs	Indicates the height of both the initial investment and the monthly costs.	1...5 1 is very low, 5 is very high
Monthly benefits	Indicates how much benefit can be generated on a monthly basis.	1...5 1 is very low, 5 is very high
Scalability	Indicates whether an option can be replicated easily and implemented elsewhere.	1...5 1 is very low, 5 is very high
Effect on property value	Indicates whether the implementation of a certain revenue option significantly influences the house price.	1...5 1 is a very <u>negative</u> effect, 5 is a very <u>positive</u> effect
Innovativeness	Indicates whether an option is available on the market and has been researched.	1...5 1 is very low, 5 is very high

Feasibility criteria	Description	Scale
Social acceptance	Indicates whether an option is deemed socially acceptable.	1...5 1 is very low, 5 is very high
(Near future) juridical feasibility	Indicates whether an option is legally feasible or expected to become legally possible in the near future.	1...5 1 is very low, 5 is very high
Technical feasibility	Indicates whether an option is technically feasible.	1...5 1 is very low, 5 is very high

The estimated time to assess all options is +- 30 minutes. When filling out the business case criteria it is important to assume an option is legally feasible.

In case of any unclarities, do not hesitate to ask for further explanation.

Options

Eleven options have been discerned as a potential source of dwelling related revenue generation. The options are described on a rather abstract level of detail. Their main costs and benefits are qualitatively outlined. Note that the (monthly) compensation costs that occur in many options is a potential benefit for a resident.

1. Dwelling as a power plant

Dwellings that are so energy efficient that they produce significantly more energy than they consume. The energy surplus is stored locally in a battery and can be sold within the neighbourhood or to an energy company. Such dwellings can be realised by using electricity generators, such as PV panels or a windmill, combined with good thermal insulation and energy storage capacity.

Investment/Costs	Benefits
Thermal insulation	Price per generated unit of surplus energy
PV-panels and/or windmill	Control of the fluctuations in the supply and demand of energy
Battery	
(Local) energy selling system	

2. On-house advertisement

The exterior of the dwelling can function as base for advertisement. Advertisement can be placed traditionally on walls (mural paintings and billboards) or (display) windows. Another exterior advertisement option is roof advertisement, which can be applied near airports and on popular Google Maps spots. The resident receives a monthly compensation for allowing this type of advertisement. The consideration is whether this is a lucrative advertisement option and, if yes, on what scale this option could be applied.

Investment/Costs	Benefits
Installation costs	High visibility of advertisements
Monthly compensation	Higher conversion rate

3. In-house electronic advertisement

Within a dwelling advertisement could be displayed on digital screens that are integrated within a dwelling such as an electronic mirror, electronic wall, or simply unused smart televisions. This way advertisement can be targeted very specifically at the resident of a dwelling. The resident receives a monthly compensation for allowing this type of advertisement.

Investment/Costs	Benefits
Preparation of an in-house screen	Specific targeted advertisements
Advertisement system	High visibility of advertisements
Monthly compensation	Higher conversion rate

4. Work place at home

A monthly compensation paid by the national government and one's employer for having and using a home office. For an employer this is a way to save on the rent for office space, while for the national government it can be an effective solution to reduce congestion and its externalities such as emissions. Additionally, a saving on travel allowances can be realised.

Investment/Costs	Benefits
Creating a work place proof room	Less traffic congestion and emissions
Monthly compensation	Savings on office space rent
	Savings on travel allowance

5. Furniture photoshoot

Stores such as IKEA are known to pay for photo- and film shoots within appealing dwellings.

Investment/Costs	Benefits
Set-up costs photoshoot	Attractive and unique photoshoot location
One-time compensation	
Interior	

6. Telecom facilities

Telecom providers place equipment that is required for their infrastructure on/in private properties and pay a monthly rent fee. Examples are GSM/3G/4G antennas on roofs and distribution stations for internet providers such as KPN and Ziggo.

Investment/Costs	Benefits
Installation costs	Greater coverage for telecom/internet providers
Monthly compensation	

7. Neighbourhood mail box

A big post box that could be placed in one's garden or outer wall so neighbours can pick up their post and parcels. Compensation for this service should be paid by the delivery service providers.

Investment/Costs	Benefits
Installation costs	More efficient parcel delivery
Monthly compensation	

8. Decentralized server as heater

Traditionally, data centres require intensive, energy consuming, cooling installations. Waste heat of servers can be put to use by placing servers decentrally in people's homes. The electricity costs of the server is reimbursed to the resident, while the waste heat replaces the traditional heating system of a dwelling. The computing power of the servers can be sold.

Investment/Costs	Benefits
Installation costs	Affordable computing power
Monthly reimbursement of the electricity costs	Environmental friendly heating system
	Saving on heating costs

9. (Sub)letting every corner of a dwelling

Revenue generated by (sub)letting (a part of) one's dwelling is nothing new. With Airbnb, it suddenly became easy for the masses to rent out a sleeping room or entire dwelling for a short period. Apart from sleeping rooms, more rooms might be rented out such as a storage room, garden, home office, fitness room, or even a living room as meeting place.

Investment/Costs	Benefits
Rental platform	Rental fee
Optional: furnishing	

10. Monetizing in-home generated data

The home automation market is growing at an enormous pace. The amount of data that may be generated within a dwelling by simply living in a dwelling is gigantic. This could be data about someone's health, stock (household supplies, food, and drinks), and behaviour (time of presence, energy consumption) among others. Sensors could also monitor the maintenance state of a dwelling. These data can represent value for both public and private parties. It is assumed a data broker is required to monetize the data.

Investment/Costs	Benefits
Data broker platform	Price per unit/set of data
Installation domotics/sensors	

11. Monetizing recyclable household waste

Increasing the amount of recycled household waste is one of the biggest challenges in the waste management sector. Several initiatives have started in which residents get paid per kilogram of recyclable waste to increase the awareness of waste being a potential resource. The flow of household waste can become a revenue stream for the resident.

Investment/Costs	Benefits
Waste collection system	Higher percentage of recycling
Reimbursement per kilogram of recyclable waste	

APPENDIX D: TRENDS

The Digital living team of the EGW (see appendix B) identified trends within four domains.

Demographic trends:

- Inequality
- Loneliness
- Singles
- Aging
- Urbanisation

Socio-demographic trends:

- Spirituality
- Self-reliance
- Security
- Sharing economy
- Migration

Economic trends:

- Uncertainty
- Critical consumers
- Dynamic labour market

Technological trends:

- Internet of Things
- Big data
- Virtual/augmented reality
- Circular economy
- Green-tech
- Technology in health care

APPENDIX E: EXPERT JUDGEMENTS

Within this appendix, the expert judgements are presented.

The experts are:

1. Gijs Liu [GL]
Asset manager and co-founder of the innovation lab at Bouwinvest, facilitator at EGW
2. Douwe van den Wall Bake [DvdWB]
Innovation manager at TBI Holdings, facilitator at EGW
3. Rick van den Bos [RvdB]
Former commercial director of BAM Wonen, entrepreneur, and innovation manager at EGW
4. Niek Polak [NP]
Manager area development at Eigen Haard, facilitator at EGW
5. Henry Draijer [HD]
Advisor marketing and innovation at BAM Wonen, facilitator at EGW

List of options:

1. Dwelling as power plant
2. On-house advertisement
3. In-house advertisement
4. Workplace at home
5. Furniture photoshoot
6. Telecom facilities
7. Neighbourhood mail box
8. Decentralized server as heater
9. (Sub)letting every corner of a dwelling
10. Monetizing in-home generated data
11. Monetizing recyclable household waste

TABLE 15: INPUT EXPERT 1 - GIJS LIU

Criteria	Estimated importance criteria	Options										
		1	2	3	4	5	6	7	8	9	10	11
Investment/costs	3	5	3	2	1	2	3	2	3	1	3	1
Monthly benefits	5	4	2	1	1	4	4	2	2	3	1	1
Scalability	2	5	5	5	5	1	2	3	5	4	5	5
Effect on property value	5	4	3	3	3	4,5	1	4	3	4	4	3
Innovativeness	1	2	1	2	1	2	1	3	5	2	2	4
Social acceptance	4	4	2	2	3	5	3	4	4	3	2	4
(Near future) juridical feasibility	2	5	5	2	5	5	5	4	2	3	2	5
Technical feasibility	5	5	4	4	5	5	5	4	4	4	4	4

TABLE 16: INPUT EXPERT 2 - DOUWE VAN DEN WALL BAKE

	Estimated importance criteria	Options										
Criteria		1	2	3	4	5	6	7	8	9	10	11
Investment/costs	4	3	4	3	1	1	3	1	3	2	2	1
Monthly benefits	3	2	3	2	3	1	2	1	2	5	4	2
Scalability	3	3	2	3	4	4	3	3	2	5	3	4
Effect on property value	2	4	2	3	3	3	2	3	3	2	3	3
Innovativeness	1	3	2	2	2	2	2	2	4	2	3	2
Social acceptance	4	4	2	2	4	4	2	4	4	4	3	4
(Near future) juridical feasibility	4	4	2	4	4	5	3	4	4	4	3	3
Technical feasibility	2	4	5	4	4	5	4	5	4	5	5	4

TABLE 17: INPUT EXPERT 3 - RICK VAN DEN BOS

	Estimated importance criteria	Options										
Criteria		1	2	3	4	5	6	7	8	9	10	11
Investment/costs	3	4	2	2	2	2	4	2	4	2	2	2
Monthly benefits	5	5	4	4	2	2	4	3	2	4	5	2
Scalability	4	4	4	4	4	4	2	4	2	4	5	4
Effect on property value	3	5	3	3	3	4	1	3	2	4	4	3
Innovativeness	3	3	4	4	2	2	2	2	4	4	5	2
Social acceptance	4	5	3	3	3	2	2	4	2	4	3	2
(Near future) juridical feasibility	3	4	4	4	4	4	2	4	2	4	3	4
Technical feasibility	4	5	4	4	4	4	4	4	4	4	5	4

TABLE 18: INPUT EXPERT 4 - NIEK POLAK

	Estimated importance criteria	Options										
Criteria		1	2	3	4	5	6	7	8	9	10	11
Investment/costs	4	4	2	2	1	1	3	2	4	1	3	1
Monthly benefits	4	3	2	3	3	2	3	2	3	4	4	2
Scalability	3	5	3	4	5	5	4	3	3	2	5	4
Effect on property value	2	4	2	3	3	3	2	3	3	3	3	3
Innovativeness	2	2	2	4	1	1	3	3	4	3	5	2
Social acceptance	4	5	2	2	5	3	3	4	4	1	2	4
(Near future) juridical feasibility	3	4	4	3	5	5	2	4	4	2	2	4
Technical feasibility	3	4	5	4	5	5	3	5	2	4	4	4

TABLE 19: INPUT EXPERT 5 - HENRY DRAIJER

	Estimated importance criteria	Options										
Criteria		1	2	3	4	5	6	7	8	9	10	11
Investment/costs	4	3	2	3	3	3	5	3	5	2	4	3
Monthly benefits	4	3	2	4	3	3	3	2	3	4	5	3
Scalability	5	4	2	4	2	3	4	4	4	4	5	3
Effect on property value	4	4	2	3	4	3	3	3	3	4	4	3
Innovativeness	3	3	3	4	4	4	2	3	3	4	5	3
Social acceptance	4	3	1	3	3	1	4	4	2	4	3	3
(Near future) juridical feasibility	3	4	3	3	3	2	4	5	1	3	3	3
Technical feasibility	4	4	5	4	4	4	4	4	4	4	4	4

Note that, in the next step of the MCA, the scale of the criterion *investment/costs* is reversed (1=5, 2=4, 3=3, 4=2, 5=1), since a low score is desirable on this criterion.

Environment and location dependence

In order to specify the scalability criteria, an additional question is asked in which the experts are asked whether a revenue option is location and environment dependent. For this question, the two most common dwelling types are chosen as answer categories: suburban terraced single-family dwelling and an urban apartment. Furthermore, the answer categories of 'not location and environment dependent' and 'other, ...' are provided.

TABLE 20: EXPERT JUDGEMENTS ON ENVIRONMENT AND LOCATION DEPENDENCE

	Options										
Expert scores	1. Dwelling as power plant	2. On-house advertisement	3. In-house electronic advertisement	4. Work place at home	5. Furniture photoshoot	6. Telecom facilities	7. Neighbourhood mail box	8. Decentralized server as heater	9. (Sub)letting every corner of a dwelling	10. Monetizing in-home generated data	11. Monetizing recyclable household waste
1 - GL	Suburban terraced single-family dwelling & urban apartment	Urban apartment (high density) & shops/roof	Not location and environment dependent	Not location and environment dependent	Other: Designer homes	Urban apartment & Other: tallest building in an area	Suburban terraced single-family dwelling	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent
2 - DvdWB	Not location and environment dependent	Urban apartment	Urban apartment	Not location and environment dependent	Urban apartment	Other: country side	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Urban apartment	Not location and environment dependent
3 - RvdB	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent
4 - NP	Not location and environment dependent	Urban apartment	Not location and environment dependent	Not location and environment dependent	Not location and environment dependent	Urban apartment	Not location and environment dependent	Urban apartment	Not location and environment dependent	Not location and environment dependent	Suburban terraced single-family dwelling
5 - HD	Not location and environment dependent	Other: city centres	Not location and environment dependent	Urban apartment	Urban apartment	Not location and environment dependent	Suburban terraced single-family dwelling & Urban apartment	Not location and environment dependent	Suburban terraced single-family dwelling & Urban apartment	Not location and environment dependent	Suburban terraced single-family dwelling & Urban apartment

Dwelling as cash machine

If an expert estimates that a revenue option would function in both a suburban terraced single-family dwelling and an urban apartment this estimation is interpreted as not location and environment dependent.

The options dwelling as power plant and (sub)letting every corner of a dwelling, are then judged not location and environment dependent. Many options are judged not location and environment dependent by four out of five experts. In-house electronic advertisement, workplace at home, decentralized server as heater, and monetizing in-home generated data are all are judged one time to function best in an urban apartment. Neighbourhood mail box and monetizing recyclable household waste are judged one time to function best in a suburban terraced single-family dwelling.

Three options have either specific or divergent answers:

- o On-house advertisement is judged by three experts to function best at urban apartments. Expert 1 specified that high-density areas are required for this revenue option. This connects to the judgement of expert 5 that chose 'other' and specified that city centres are required. Expert 3 deemed this option not to be location and environment dependent.
- o Furniture photoshoot is judged twice to function best in urban apartment and twice to be not location and environment dependent. Expert 1 chose 'other' and specified that designer homes are required. This may be an important characteristic for this revenue option to function.
- o Telecom facilities are judged by two to function best at urban apartment (of which one added the tallest building in an area), while two other state they are not location and environment dependent. One time the 'other' category specifying that option would work best at the countryside.

APPENDIX F: MCA STEPS – AVERAGED RANKING PER EXPERT

Per expert, the following tables are constructed based on the expert judgements from appendix E.

The weight factor is determined by:

$$w_i = \frac{w_i'}{\sum_{i=1}^n w_i'}$$

The weights differ between a comparison based on all criteria and a comparison based on solely the business case criteria because of the difference in the sum of the weights of the criteria taken into account. An example of the score of one option is given for both the comparison based on the business case criteria and the comparison based on all criteria.

TABLE 21: SCORE BASED ON BUSINESS CASE CRITERIA

Criteria	Weight factor	Options	
		1. Dwelling as power plant	
Investment/costs	0,19	0,19	0,19
Monthly benefits	0,31	1,25	1,25
Scalability	0,13	0,63	0,63
Effect on property value	0,31	1,25	1,25
Innovativeness	0,06	0,13	0,13
Score	1,00	3,44	3,44

TABLE 22: SCORE BASED ON ALL CRITERIA

Criteria	Weight factor	Options	
		1. Dwelling as power plant	
Investment/costs	0,11	0,11	0,11
Monthly benefits	0,19	0,74	0,74
Scalability	0,07	0,37	0,37
Effect on property value	0,19	0,74	0,74
Innovativeness	0,04	0,07	0,07
Social acceptation	0,15	0,59	0,59
(Near future) juridical feasibility	0,07	0,37	0,37
Technical feasibility	0,19	0,93	0,93
Score	1,00	2,63	2,63

Consequently, the ranking per expert is determined by ordering the options from high to low per expert.

The ranking per expert functions as input for determining the overall ranking of revenue options.

TABLE 23: RANK BASED ON RANKING PER EXPERT - BUSINESS CASE CRITERIA

Expert rank	Options											
	1	2	3	4	5	6	7	8	9	10	11	
1 - GL		3	9	10	7	2	11	4	5	1	7	5
2 - DvdWB		7	11	8	2	5	10	6	9	1	3	4
3 - RvdB		3	4	4	8	7	10	6	11	2	1	8
4 - NP		7	11	3	2	5	8	9	10	4	1	6
5 - HD		4	11	3	6	5	10	7	9	2	1	8
AVERAGE RANK		4,8	9,2	5,6	5,0	4,8	9,8	6,4	8,8	2,0	2,6	6,2
RANK		3	10	6	5	3	11	8	9	1	2	7

TABLE 24: RANK BASED ON RANKING PER EXPERT - ALL CRITERIA

Expert rank	Options											
	1	2	3	4	5	6	7	8	9	10	11	
1 - GL		3	9	10	7	1	11	4	5	2	8	5
2 - DvdWB		7	11	9	2	4	10	6	8	1	5	3
3 - RvdB		2	4	4	7	8	10	6	11	3	1	9
4 - NP		3	11	6	1	5	10	7	8	9	2	4
5 - HD		4	11	3	6	9	8	5	10	1	1	7
AVERAGE RANK		3,8	9,2	6,4	4,6	5,4	9,8	5,6	8,4	3,2	3,4	5,6
RANK		3	10	8	4	5	11	6	9	1	2	6

Shift in rank because of SJT factors	0	0	-2	1	-2	0	2	0	0	0	0	1
SJT=social, juridical, technical												

APPENDIX G: MCA STEPS - TOTAL SCORE PER OPTION

This MCA is performed as sensitivity analysis to test the robustness of the results of the MCA presented in Appendix F. The raw data from appendix E again functions as input.

This MCA consist of one set of weight factors based on the combined assigned importance to the criteria by all experts. Subsequently, all expert scores per criteria are then added up and weighted in order to create an aggregated total score per option.

TABLE 25: ESTIMATED IMPORTANCE CRITERIA

Criteria	GL	DvdWB	RvdB	NP	HD	SUM
Investment/costs	3	4	3	4	4	18
Monthly benefits	5	3	5	4	4	21
Scalability	2	3	4	3	5	17
Effect on property value	5	2	3	2	4	16
Innovativeness	1	1	3	2	3	10
Social acceptance	4	4	4	4	4	20
(Near future) juridical feasibility	2	4	3	3	3	15
Technical feasibility	5	2	4	3	4	18

The weight factors are then again determined by:

$$w_i = \frac{w_i'}{\sum_{i=1}^n w_i'}$$

Within this method, the actual weight factors are thus equal for all experts. Yet, they still differ between the business case criteria and all criteria.

TABLE 26: WEIGHT FACTORS BASED ON BUSINESS CASE CRITERIA

Criteria	Weight factor
Investment/costs	0,22
Monthly benefits	0,26
Scalability	0,21
Effect on property value	0,20
Innovativeness	0,12
Score	1,00

TABLE 27: WEIGHT FACTORS BASED ON ALL CRITERIA

	Weight factor
Criteria	
Investment/costs	0,13
Monthly benefits	0,16
Scalability	0,13
Effect on property value	0,12
Innovativeness	0,07
Social acceptance	0,15
(Near future) juridical feasibility	0,11
Technical feasibility	0,13
Score	1,00

All individual expert score per criteria per option are then summed up and weighted in order to come up to the ranking. See tables below:

TABLE 28: RANK BASED ON BUSINESS CASE CRITERIA

Criteria	WF	Alternatives										
		1	2	3	4	5	6	7	8	9	10	11
Investment/costs	0,22	2,41	3,73	3,95	4,83	4,61	2,63	4,39	2,41	4,83	3,51	4,83
Monthly benefits	0,26	4,35	3,33	3,59	3,07	3,07	4,10	2,56	3,07	5,12	4,87	2,56
Scalability	0,21	4,35	3,32	4,15	4,15	3,52	3,11	3,52	3,32	3,94	4,77	4,15
Effect on property value	0,2	4,10	2,34	2,93	3,12	3,41	1,76	3,12	2,73	3,32	3,51	2,93
Innovativeness	0,12	1,59	1,46	1,95	1,22	1,34	1,22	1,59	2,44	1,83	2,44	1,59
Total score	1	16,80	14,18	16,56	16,39	15,96	12,82	15,18	13,98	19,04	19,10	16,05
Rank		3	9	4	5	7	11	8	10	2	1	6

TABLE 29: RANK BASED ON ALL CRITERIA

Criteria	WF	Alternatives										
		1	2	3	4	5	6	7	8	9	10	11
Investment/costs	0,13	1,47	2,27	2,40	2,93	2,80	1,60	2,67	1,47	2,93	2,13	2,93
Monthly benefits	0,16	2,64	2,02	2,18	1,87	1,87	2,49	1,56	1,87	3,11	2,96	1,56
Scalability	0,13	2,64	2,01	2,52	2,52	2,14	1,89	2,14	2,01	2,39	2,90	2,52
Effect on property value	0,12	2,49	1,42	1,78	1,90	2,07	1,07	1,90	1,66	2,01	2,13	1,78
Innovativeness	0,07	0,96	0,89	1,19	0,74	0,81	0,74	0,96	1,48	1,11	1,48	0,96
Social acceptance	0,15	3,11	1,48	1,78	2,67	2,22	2,07	2,96	2,37	2,37	1,93	2,52
(Near-future) juridical feasibility	0,11	2,33	2,00	1,78	2,33	2,33	1,78	2,33	1,44	1,78	1,44	2,11
Technical feasibility	0,13	2,93	3,07	2,67	2,93	3,07	2,67	2,93	2,40	2,80	2,93	2,67
Score	1	18,59	15,16	16,28	17,89	17,32	14,30	17,45	14,70	18,51	17,90	17,04
Rank		1	9	8	4	6	11	5	10	2	3	7
Shift in rank because of SJT factors		1	2	3	4	5	6	7	8	9	10	11
SJT=social, juridical, technical		2	0	-4	1	1	0	3	0	0	-2	-1

APPENDIX H: INTERVIEW REPORT LEGAL COUNSELS EIGEN HAARD

Goal: Discuss the (im)possibilities of implementation of the most promising revenue options into the social housing sector.

A semi-structured interview was conducted.

Interviewees:

[M] Martijn Kerkhof, Legal Counsel, Eigen Haard

[D] Danny Koning, Privacy Officer & Legal Counsel IT, Eigen Haard

Date:

9-5-2017

Notes:

Eigen Haard is active in the Amsterdam Metropolitan Region. The statements of both interviewees sometimes deviate from official point of view of Eigen Haard. The interview was conducted in Dutch. For this thesis, statements are translated and paraphrased by the interviewer. The entire transcript is available upon request.

Interview

Introduction

The interviewer introduced the context of the research and explained what the three most promising revenue options are, how the three most promising revenue options were selected, and why the implementation is focused on the social housing sector. The interview started with a general question whether the implementation of such options can fall within the DAEB³ norms. Both M and D acknowledge this, since the options can contribute to the core task of housing associations: providing affordable housing to low-income households. However, they nuance the distinction between DAEB and non-DAEB property, since housing affordability issues also occur within households living in non-DAEB property. Eigen Haard therefore aims to treat DAEB and non-DAEB property in the same manner to avoid arbitrariness. The real legal assessment, however, will take place in practice. If problematic, cooperation with a private partner can always be sought. According to D, legal and/or administrative separation could help in these cases.

M: Sometimes there is only one way to find out whether something new is legally possible. Try it out, and if someone goes to court, check how it is judged. D stated Eigen Haard experimented with income-dependent rent in the past. The official rent was then above the rent threshold for social rent (i.e. non-DAEB), yet the de facto rent was lower than the rent threshold based on one's income. This case was never legally judged, yet it was unknown if it was legally allowed. D emphasized that as long it fits within

³ Activities supporting the core task are called *activities in the service of general economic interest* (Dutch: *Diensten van Algemeen Economisch Belang, [DAEB]*).

the goals of Eigen Haard, they are willing to try it. M&D both acknowledged it is legally easier to give discounts than to increase the rent. Sometimes it is a rather grey area that has to be tested. M: With the introduction of the new Housing Act 2015, we are bound to stricter financial protocols in which accountants compare someone's rent to their income. Then a discussion could arise about the height of the rent: is it the official rent or the de facto rent? This results in discussion about the spirit and aims of legislation. D: Some people are simply not sufficiently supported within the legislation. We feel we have a duty to support those groups.

Option 1: Dwelling as power plant

Both interviewees support the feasibility of a variable energy performance compensation. It is acknowledged that the additional fee, apart from the rent, maintains the incentive for people to live energy efficiently. Administratively, it is also easier to separate this payment from the rent. D: There is a movement towards an integration of housing and energy and we do not have any interest of preventing it from happening. M: Of course, we will cooperate if it really lowers the housing expenses. However, we also have to accept that due to the Housing Act 2015 our possibilities are somewhat limited. As long as housing associations are convinced of the value, they are willing to cooperate.

The risk of a mitigating effect of an increased rent due to more rent points is neglected. It is acknowledged that the maximum theoretical rent can indeed be increased, yet, Eigen Haard almost never rents out dwellings for the maximum rent. This is mainly done for affordability reasons and, in cases such as renovations, to convince tenants to accept the renovation plans.

M&D state a pilot in this field is not bound to DAEB or non-DAEB property, since it concerns an additional fee, and not the rent itself.

Option 2: Subletting every corner of a dwelling

This section was introduced with the question why Eigen Haard does not currently allow subletting. D: Traditionally, subletting is prohibited due to liveability problems. Subtenants are assumed to be less involved in their neighbourhood and, housing associations, have less control of who is staying in their property. This is the case in subrental of the entire dwelling. It is not allowed in both DAEB and non-DAEB property. In DAEB property it is, however, even less desirable since waiting lists are assumed much longer for these kind of houses

A special form of subrental, of which the interviewer was unaware, is mentioned by D. D: We do allow residence stewardship, an arrangement through which one can sublet his dwelling for a period from three months to one to two years. Residence stewardship is subject to several conditions. One of the most important rules is that the arrangement is not profitable for the main tenant.

The distinction between subrental of the entire dwelling and part of the dwelling was emphasized. M: Room subrent (i.e. part of the dwelling) is only allowed with explicit permission of Eigen Haard. Eigen Haard then determines whether there are enough rooms available within the dwelling and what rent is reasonable. Within the determination of the reasonableness of the rent, it is also considered that certain public levies, such as waste fees, increase when an extra person is registered at the address and that furniture depreciates faster.

D: There is a shortage of dwellings in Amsterdam. There is a typical discrepancy between this shortage and the prohibition of subrental.

The aforementioned existing arrangements are only focused on long-term subletting, while platforms as Airbnb provide short-term alternatives. D: It is not necessarily about Airbnb, since we could build our own platform as well. Airbnb is, however, a famous platform that people tend to use and with which you can make agreements. Therefore, it is an opportunity to regulate subletting in a structured way. I do not agree with Eigen Haard's policy that subletting through Airbnb is not allowed. I would allow it in a regulated manner. Airbnb includes many sorts of (sub)rental, from subrental of the entire dwelling to room subrent. In the first case, a social tenant can be evicted, while in the second case a fine is the maximum punishment. Within the current societal debate, all forms are lumped together.

According to D&M, subrental through platforms as Airbnb in the social housing sector has to follow four rules:

1. The dwelling should remain the main residence of the tenant
2. No change of the use of land should occur (i.e. the land use should remain residential)
3. Neighbours have to be informed
4. No profit should be generated. This means that the monthly-generated revenue should not be higher than the rent. Complying with the additional 60-day rule of the Municipality of Amsterdam, this means the dwelling could be sublet for 60 days for the proportional rent or with a maximum revenue of two months' rent.

D: It has never been researched why some people are against Airbnb. It looks to be about one's interpretation and envy that one feels for not being able to use Airbnb. The excesses with drunk foreign tourist do exist. If regulated, we could simply address such issues with our tenant. Within the societal debate, data about Airbnb is often framed in a negative manner. The problem with the proposed pilot of De Key was they did not have a proper motivation why it wanted to start a pilot and how it would arrange it. M: One is afraid that too many people would like to try Airbnb. However, based on small sample, we can say almost 90% of our tenants is not willing to sublet its dwelling through Airbnb. Yet, that fear does still exist.

D: That does not mean that no one would like to try it. The same counted in the case of residence stewardship. Eventually, people started to use it. M: Weekly I have to go to court for causes involving fraud and nuisance. The cases in which Airbnb was involved after 2013 was less than five. We have 60.000 dwellings and more than 200 cases a year.

D: There are two possible explanations. It can be a non-existing problem, or we cannot control it in its current form. Both situations are interesting. Eigen Haard is very sensitive towards political opinions and its reputation on this matter. The juridical department is much more progressive on this subject than the rest of the organisation. Other departments are slowly following. It is time to look at this matter from a different perspective. I see many opportunities. Objectively, there is limited evidence supporting the cons of Airbnb. Yes, foreign investors abusing Airbnb should be dealt with, but that is a complete other use of the platform than we think it should be used for.

M: However, the official statement of Eigen Haard is still not in favour of allowing Airbnb.

D: Juridical there are possibilities. The question is: do housing associations want it? The will is simply lacking. The support is lacking. It is viewed black-and-white and housing associations are too afraid of abuse. The problem it is observed solely from an enforcement perspective.

M: I find it very interesting to sublet part of the dwelling for a different purpose such as for storage space. Of course, officially it is not allowed. Yet, hey, what is the real problem? As long as no profit is made, I do not have anything against it.

M: A woman sublet her dwelling for a few nights when she was away to visit her son in the United Kingdom. On the one hand, I have to say it is not allowed according to the tenancy agreement. On the other hand, do we want to call this fraud? How far do we want to take this? Without the revenue, she would not have been able to visit her son. De facto, it may not necessarily be reducing one's housing expenses but it can contribute to one's overall well-being if one is, for example, able to participate socially.

Option 3: Monetizing in-home generated data

This section was introduced with a short explanation of the idea and it was asked what the most important considerations for this option are. M&D: One's permission is definitely required, but note it can also be revoked at all times. D: The data should be made as anonymous as possible. Make a clear distinction between data related to the home (maintenance-related) and personal data. For personal data, permission is required, while home-related data could probably be collected based on legitimate interest. For example, home-related data could lead to more efficient maintenance plans. In addition, it should be emphasized this data can never be used against the tenant. That definitely creates a trust issue. Privacy is a complicated matter. One is often not aware of the risk of sharing data. When implementing this option one should be very aware of what data is collected and shared, and one should be able to oversee the potential consequences. Otherwise, it could lead to cases of misleading information (Dutch: *dwalig*).

D: It should be prevented that one feels forced to accept sharing its data in return for a lower rent. This rises ethical questions as well. This way privacy would become a privilege for the rich. M: A solution would be never to offer a reduced rent in return for shared data at the beginning of a contract, because one could feel forced to accept the offer. An alternative is to offer it at a later stage.

M&D: Within a pilot, it is essential to select only households that could afford the rent also without the offered discount.

General remark

M concluded the interview with a general potential disadvantage: the envy that people might feel towards others, living in the same houses, for lower housing expenses. Often this can be simply solved by having a good story.

APPENDIX I: FEEDBACK EXPERTS ON MCA RESULTS

The outcome of the ranking based on the averaged ranking per expert was communicated back to all experts. All experts were asked to explain the occurred shift due to the inclusion of the SJT criteria. Douwe van den Wall Bake [DvdWB] and Henry Draijer [HD] responded to this request. The outcomes of this consultation is found in the table below.

TABLE 30: EXPERT EXPLANATION SJT SHIFTS

SJT shift	Explanation DvdWB	Explanation HD
Furniture photoshoot from rank 3 to 5	Photoshoot is passed by Workplace at home. In my opinion, Workplace at home is more desirable from an "S" point of view.	This option like a nice and attractive idea that must be financially feasible. However, when critically observed, the social aspect is, in my opinion, the greatest obstacle.
Workplace at home from 5 to 4	I guess this option is positively judged on the SJT criteria, because of the success of Airbnb. Airbnb has proven this option is feasible from an S, J and T perspective.*	I suspect because of the higher scores on the technical and juridical feasibility.
In-house advertisement from 6 to 8	Probably because of the S. My expectation is that homes without advertisement are highly valued...	I suspect because of the social criterion. Home is a place where one seeks rest. Advertisements disturb simply disturb this rest
Monetizing recyclable household waste	Supposedly, since there is much societal support for waste separation and the circular economy.	I do not have an explanation.
Neighbourhood mail box from 8 to 6	I guess because of the sympathy for the solution (S) and the technological simplicity.	This typically is an idea that people would like, yet where no party (distributors and consumers) would like to invest in. The business case is therefore not solid. There is no issue based on the SJT criteria.

*This option seems misinterpreted by the expert, since the reference to Airbnb is made. The confusion might be caused by the sub(letting) option in which rooms can be (sub)let for other purposes (apart from sleeping) as well.

