

Increasing the attractiveness of district heating networks to consumers

An exploration

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Preface

This report has been established within the Flexiheat project. Flexiheat has focused on increasing flexibility in district heating systems. The intelligent district heating network is a dynamic network: an open network where different waste heat and renewable energy sources are connected, that has multiple producers and groups of consumers and facilitates the connection between different energy infrastructures (gas, heat and electricity). Eventually this will lead to an optimal deployment of the available heat sources and an increased cost-efficiency of district heating. Flexiheat aims to develop new concepts for these intelligent, flexible district heating networks. One of the strategies is to allow third party access to the network. A smart control system is developed to manage the heat flows across the network. This system makes use of dynamic pricing. In this exploration the concept of third party access in relation to the Flexiheat project will be discussed. The development of new business and price models based on the Flexiheat approach has led to an analysis of possible alternative price models for consumers.

The research topics of Flexiheat are applied to several practical cases to show the possible impact of the new developments on those situations. One of the cases was the city of Groningen, where a geothermal heating grid is under construction. With this exploration, we would like to advice Warmtestad, the organization developing the network in Groningen, on possible measures to increase the attractiveness of the new district heating networks to consumers.

Introduction

District heating networks (DHN) are recently gaining attention as a strategy to achieve CO₂ emission reductions in the built environment, especially among (local) governments and other public parties. District heating networks are often developed from a public interest point of view rather than from a commercial point of view, in which a firm aims to gain revenue by creating value to customers. A major issue in the development of district heating networks is the lack of attention for creating a product that customers value and are willing to pay for. This will be key in designing robust business models that better comply with customer needs and expectations.

This document is an exploration to customers' attitude towards district heating and possible solutions for increasing the attractiveness of district heating technology. The insights of this exploration can be used to develop new business and price models for the district heating sector. Ultimately, this will lead to higher customer satisfaction and a strengthened district heating sector. The focus is on the products and price options that are offered to consumers in order to make district heating networks an attractive alternative for gas heating.

An short analysis of market failures shows how consumer issues can be explained from an economic point of view (chapter 1). International experiences of existing and developing district heating networks are used in a literature review in order to gain understanding of the needs and expectations of customers (chapter 2). Using these insights, two strategies will be presented that deal with some the most important barriers for district heating, which are trust towards a monopolistic district heating company, a lack of consumer choice and high district heating prices. One strategy is to allow third party access to the network (chapter 3), the other strategy is the development of alternative price models (chapter 4). Finally, some recommendations will be given for further researching the possibilities of increasing attractiveness of district heating networks to consumers.

1. Identification of market failures

In this first section, the current difficulties in the heat market will be mapped in a quick scan of market failures, with the goal of identifying possible strategies for the issues that need to be solved to design attractive business models for district heating networks. For each problem, the issues will be described and possible causes and solutions will be indicated.

1.1 Problem 1: Consumer choice

Issues: In district heating networks, there is one vertically integrated district heating company. This means that consumers generally have no opportunity to switch to another retailer once connected to a heat network. There are also limited possibilities to redress when the service or billing falls short (Which?, 2015). Consumers cannot profit from switching to the cheapest energy retailer yearly and profit from this price advantage, as is the case in gas and electricity networks. In a time where consumers increasingly want to be in charge of their own energy supply and developments such as citizen participation and 'prosumers' are gaining popularity, obliged connection is hard to sell. How can this issue be addressed in a way that the development of heat networks will be strengthened?

Possible causes: market power (natural monopoly), network externalities

Possible solutions: more flexible contracts, product and price differentiation, increasing choice between heating alternatives (instead of obliged connection), more choice in suppliers through TPA.

1.2 Problem 2: Monopoly pricing

Issues: Heat networks are natural monopolies and without regulation, the situation could lead to monopoly pricing. In the Netherlands we have a regulated market, based on price cap regulation. Regulated markets based on cost-plus pricing or marginal cost-pricing are also possible. Various countries know a deregulated market. Both fully regulated markets and fully deregulated markets have their advantages and disadvantages in terms of balancing the interests of producers and consumers. However, there is a consensus that an efficient DH market must operate on a free competition basis, under regulatory control" (Li et al, 2015).

Consumers complain about too high prices and being worse off than with gas fired boilers. Regulation is currently failing to sufficiently protect consumers against monopoly pricing. The Dutch district heating act is considered to be not trustworthy and effective in protecting consumers. Consumers are 'suspicious'. They are also not protected against sudden price increases (price increase up to price cap after introduction of the heat law). Many consumer complaints concern price, in particular a lack of transparency and clarity in pricing (FEI, 2013; Which?, 2015). "*Many consumers lacked confidence that they were paying a fair and accurate price for their heating*" (Which?, 2015, p 10).

Information asymmetry could decrease the effectiveness of regulation. The DH companies tend to have a knowledge advantage over to the supervisory body and the government, who still need to build expertise on the heat market (Jansen, 2014).

Possible causes: market power, information asymmetry, incompleteness of regulation

Possible solutions: split-up in infrastructure and supply (like electricity and gas) as an independent and transparent grid operator advocates the public interest, standardized bills to improve clarity, independent benchmark on all heating alternatives, (additional) regulation, central service/complaint organization and access to ombudsman services, price responsiveness (dynamic pricing), making other heating alternative more available as an alternative (e.g. heat pumps).

Note: price elasticity

Market power can be reduced by a high price elasticity and availability of alternatives. Price elasticity shows the responsiveness of a consumers to the change in price of the product. A study of Li et al (2015) has shown that the demand for DH shows a relatively low price elasticity. Cross-price elasticity of DH shows the responsiveness of demand for DH to the change in the price of a heating alternative. The cross-price elasticity of DH is influenced by “*the availability of alternative heating systems and the switching costs between different systems*” (Li et al, 2015). Availability of alternative heating systems can thus decrease market power.

1.3 Problem 3: Long-term contracts

Issues: District heating networks are capital intensive and often have long pay-back times. This requires long-term commitment of all parties involved: the network owner, the heat supplying firm and the consumers. This commitment contradicts interests of the stakeholders in many cases. Potential heat supplying firms, in particular waste heat, are reluctant to commit to long-term contracts as their operation processes do not have such a long time horizon. For consumers, being bound to only one heating solution for many years without the possibility of switching to other heating alternatives, is considered a large disadvantage.

Possible causes: locality of heat.

Possible solutions: allowing competition (open networks), flexible contracts.

1.4 Problem 4: Lock-in of gas

Issues: Almost every household in the Netherlands is connected to gas infrastructure. Gas heating provides a cheap and comfortable form of heating. Incentives are lacking for consumers to switch to alternative heating systems, such as district heating.

On the network side, district heating needs to compete with gas infrastructure. Triple infrastructure (electricity, gas, heat) is expensive. It is hard to break the lock-in of gas infrastructure, especially in the existing built environment. Costs for the construction of a district heating network could be ‘socialized’ in which costs are divided among all users, instead of only the local users. This is also the case with gas and electricity and creates a more equal level of competition.

Possible causes: power of the incumbents, network externalities.

Possible solutions: A better chain integration of energy infrastructures would allow grid operators for instance to decide between renovating gas networks or replacing it by a heat network (Connecting different energy infrastructures (hybrid energy networks) to utilize each commodity best at each location could also be a strategy to break lock-in), socializing district heating networks.

1.5 Problem 5: Investments in the network

Issues: District heating networks are associated with high investments costs and long payback times. Currently, most district heating networks are owned and operated by commercial parties. Relatively high rate of returns of commercial parties may increase district heating costs and create an unequal comparison with gas infrastructure which is owned by semi-commercial organizations under government regulation. New actors such as grid operators water companies may act as (independent) network operators. Direct interference of a local governments would also be effective to keep network costs low.

Possible causes: Insufficient feasibility of heat networks (no market failure), government failure to ensure sufficient energy infrastructure.

Possible solutions: improvement of the investment environment (cost reductions) and firm's competitive advantage, strengthening of formation of clusters and cascading (Kamp, 2015) (In the industrial context a community infrastructure and with central control could be a good business model); open networks with multiple producers to eliminate the issue of long-term guarantees.

1.6 Problem 6: Value of heat

Issues: In the Netherlands, the heat price is related to the gas price instead of real costs due to a price cap based on the gas price (NMDA tariff). The foundation of the heat price in the gas price means that there is also an energy tax component included, which is not justified for district heating based on energy efficient production and sustainable sources (Kamp, 2015). Also, the benchmark for the SDE+ subsidy and the feasibility of the energy savings and investments are based on gas. The costs of the purchase and maintenance of a gas fired boiler are usually not taken into account in the comparison between heat and gas. In conclusion, the social costs and benefits in the heat chain can insufficiently be expressed in the heat price. Policy instruments should be used to internalize these impacts in the heat price. The implementation of such policy instruments would motivate DH companies to switch to "Green Heat" (Li et al, 2015).

Possible causes: externalities, regulation fails/is insufficient, price model not suitable.

Possible solutions: Internalizing externalities: alternative policy instruments for valuing CO₂ emission reductions (other than the EU ETS system), valuing avoided gas infrastructure investments, transparent comparison between real cost of gas and heat, increasing the tax on CO₂ emission.

2. Identification of customer satisfaction and needs

In this section, international experiences of existing and developing DHN are used in order to gain understanding in the needs and expectations of customers. This will eventually enable the development of new business model concepts that better comply with customer needs and expectations. In Scandinavia, where the district heating sector is much larger than in the Netherlands, a number of researches have been conducted on customer satisfaction. In growing district heating countries, like United Kingdom and the Netherlands, these type of studies are also available. In this section the results of these studies will be summarized and their parallels will be found. Some studies that will be used:

- Finland: Finish Energy Industries, 2013. Strategy for the district heating sector. Sector Study on strategies for DHN. Report is based on interviews with the sector's interest groups, a member survey, recent analyses concerning and surveys charting customer satisfaction and customer orientation.
- UK: Which?, 2015. Turning up the heat: getting a fair deal for district heating users. Study from a consumer organization based on customer surveys and interviews.
- Finland: Ahvenniemi, H. and Klobut, K., 2014. Future Services for District Heating Solutions in Residential Districts. Academic paper on customer preferences.
- NL: Van Lidth de Jeude & Midden, 2014. Veronderstellingen eindgebruikers collectieve warmtelevering Rotterdam. Consultancy study on customer preferences;
- NL: Janssen, B., 2015. De consument en de collectieve warmtevoorziening. Thesis on customer satisfaction based on surveys and data from various consumer organizations.

In Scandinavia, where district heating covers a much larger share of heat supply, there is a growing awareness for the role of the customer in new business development. A lack of flexibility and clarity in pricing weakens the image of district heating and leads to poorer customer satisfaction (FEI, 2013). Studies have been conducted on customer satisfaction in existing district heating networks and the needs and expectations in future district heating networks (FEI, 2013; Ahvenniemi & Klobut, 2014). Those studies found that in order to stay competitive with other heating alternatives, district heating companies need to find new ways of utilizing heat and new applications. *“Companies need the ability and will to find applications on their customers' behalf and ways in which they can save energy or improve the prospects of increasing the value of their business activities”* (FEI, 2013). In order to retain competitiveness, district heating companies need to develop new business and service models (Ahvenniemi & Klobut, 2014). An approach in which all customers get the same product no longer suffices. Traditional district heating does not sufficiently take into account preferences and needs of different customers. The literature review will reveal the values that customer that are considered as important or that are considered as key in the development of DHN by the DH sector. This will provide us with a 'checklist of values'.

2.1 Price

The customer satisfaction surveys studied in the context of this report indicate that consumers of DH networks are highly sensitive to price. The report of the Finish Energy Industries (2013) mentions unclear pricing as one of the main reasons for a weakened image and poorer customer satisfaction: *“Practices related to pricing and its transparency are criticized”*. The study of Ecofy (2014) on

assumptions of consumers of DH systems concludes that the attitude of non-users is to a great extent determined by the assumptions on the price and control on the price. Among consumers of DH networks included in the study no one assumes that he or she profits financially. Rather, the majority believes that district heating is more expensive than a gas-fired heating system. Also the study of Janssen (2015) concludes that consumers believe that district heating is more expensive than gas. Most complaints reported in this study are on the height of tariffs.

Also the British consumer body Which? (2015) points out that in various DH networks price was the overriding issue in consumer satisfaction surveys. As a result of a lack of transparency in how prices are derived and clarity of the billing (see 2.4) consumers lack confidence that they were paying a fair and accurate price (Which?, 2015). Obviously, without the right information it is difficult to make informed decisions on whether pricing is fair (Which?, 2015).

In customer satisfaction surveys (Which, 2015; Van Lidth de Jeude & Midden, 2014; Janssen, 2015) customers repeatedly mention the monopolistic position of the DH company as the source of suspicion that the price they pay for the heat is too much. It is striking that many consumers indicate a too high price whereas they are not actually able to check the bill and compare this with other heating alternatives. This presumes that there is a relation between the perception of fair prices on the one hand and trust and transparency on the other hand.

The price structure is also a point of debate. High standing charges easily gives consumers the idea that they are paying too much (Van Lidth de Jeude & Midden, 2014). In schemes with considerable standing charges¹, consumers with low usage consider price as unfair as standing charges even exceed the users unit rate (Which?, 2015). Consumers sometimes also consider district heating as not sustainable because high fixed rate compared to the relatively small users rate does not stimulate energy efficiency (Janssen, 2015).

2.2 Comfort

Comfort is generally seen as an advantage of district heating networks. It is considered to be a reliable, safe and low maintenance technology (Van Lidth de Jeude & Midden, 2014; Ahvenniemi & Klobut, 2014). In an overview notifications to the Dutch association of homeowners (Vereniging Eigen Huis) consumers of DH systems report positively about comfort among the many complaints in the other areas (including price and trust). Apart from a lack of performance in old systems most dissatisfaction is caused by a lack of control over the temperature in the house which leads to discomfort. Which? (2015) reports a lack of control in both old and new systems.

For existing houses connected to a new DH network, the level of comfort is not necessarily improved. When central heating in housing blocks or flats is replaced with district heating, the physical layout of the building is not changed. Complaints on the current system may affect the attitude of tenants towards the DH networks. The attitude towards comfort seems to be related to the quality of the installation and the housing situation in combination with the need for comfort (Van Lidth de Jeude & Midden, 2014). Poor insulation levels, low radiator capacity and overdue maintenance are all

¹ In the Dutch social housing sector a ratio of 35% fixed component and 65% users component in central heating systems is common. The heat law prescribes a maximum fixed standing charge.

issues that influence the perception of comfort with the new district heating system. Not taking these issues in account when developing the district heating system may cause dissatisfaction in the future.

2.3 Transparency

The customer satisfaction survey executed by the British consumer body Which? (2015) identified the lack of transparency on pricing as one of the most important factors of dissatisfaction among DH consumers. It is often not clear to consumers how the price of heating is constructed and it cannot be checked whether the calculated price is correct. *“Suppliers should provide transparent and standardized bills with a full breakdown of costs, and an easy-to-use and reliable heat price comparator to allow customers to compare their bills with alternative heating systems”* (Which?, 2015: p3). Metering systems can be a reason for a lack of transparency in many schemes. People for example don't understand the evaporation meters on radiators and the distribution of costs in unmetred schemes. Many consumers are unable to check and understand the quantity of heat that is billed.

Another drawback is the fact that it is not easy for consumers to compare the DH system with other heating alternatives. Many are feeling worse off than with a gas-fired heating system or other heating alternatives (Van Lidth de Jeude & Midden, 2014; Janssen, 2015). Even though the heat law that was recently introduced in the Netherlands, which should ensure that customers do not pay more than with conventional gas-fired heating, it seems not to increase trust. Janssen (2015) shows that the majority of the respondents (Dutch consumers of DH systems) included in this survey do not feel protected by this law. Rather, the majority of the respondents indicate to have little faith in the energy supplier/DH company and more than half of the respondents prefer to switch to other heating alternatives.

The DH companies are accused of giving evasive and contradictory information (Janssen, 2015; Which?, 2015). Eventually a lack of transparent information can lead to mistrust towards the DH company. In some cases it puts DH companies in such a bad light that consumers feel forced to seek legal redress.

A lack of transparent information in some cases leads to unjustified assumptions regarding the district heating company. Some consumers seem to think that DH companies make substantial profits, whereas the sector itself claims to struggle with profitability (Janssen, 2015). For consumers it is not understandable that the heat price in DH networks with 'cheap' waste heat is so high. Consumers have also mentioned the suspicion that houses connected to district heating are deliberately and without knowledge of consumers less well insulated, bringing heating costs up. Those assumptions shed a bad light over the district heating sector. Transparency goes hand in hand with the feeling of control and trust. The rigid and inflexible image of district heating is likely to be improved by increased openness and transparency on how prices are established and how bills are constructed.

2.4 Sustainability

DH networks can be a cost-efficient measure to achieve CO₂ emission reduction in the built environment. Whereas municipalities, housing corporations and other parties with public interest consider the possibility of DH networks because of the sustainability in terms of CO₂ emission

reductions, building- or home-owners often have many different considerations when considering a heating system. Studies show that environmental considerations are generally the least decisive factors (Ahvenniemi & Klobut, 2014; Mahapatra & Gustavsson, 2009). *“As several earlier studies have pointed out it seems that even if the environmental awareness is increasing it still does not play a remarkable role in households’ decision making”* (Ahvenniemi & Klobut, 2014, p136). Factors that are weighed more heavily are reliability, safety, comfort, heating costs and easiness of the installation.

Sustainability is not experienced in the same way and consumers do not always consider the DH network to be sustainable. The utilization of industrial waste heat is, despite of the environmental benefits, considered not sustainable as it is still based on fossil resources (Janssen, 2015; Van Lidth de Jeude & Midden, 2014). The environmental underpinning seems hard to explain and ‘sell’ to consumers. Even if environmental benefits are clear to consumers, it is not necessarily contributing to the attractiveness of district heating as a heating alternative. Some people are aware that the costs of the environmental benefits are brought up by only a small group of users, while the environmental benefits stretch much wider. This is considered as unfair. In the communication with the customer, the environmental consequences of district heating operations are given a lot of space, while the financial aspects and the direct customer benefit of district heating are not emphasized to any particularly great degree (Felleesson & Johnson, 2009).

District heating pipes are constantly loaded with hot water. This is also the case in summer when heat demand is centered around morning and evening peak for sanitary purposes or when only one user in a flat consumes hot water. This is a visible effect for consumer that they often consider as not efficient or sustainable (Van Lidth de Jeude & Midden, 2014).

2.5 Flexibility and consumer choice

The various customer satisfaction researches report a distrust of consumers towards the district heating company. This is partly powered by the fact that the consumers does not have free choice and cannot change suppliers (Janssen, 2015). Consumers of a DH system cannot switch suppliers for two reasons 1) the DH network is often a natural monopoly, meaning that there is only one supplier of district heat, and 2) alternative heating technologies are often out of league because costs are significantly higher (such as electrical heating) or technically not a possibility because the (gas) infrastructure is absent in district heated areas. Even if the consumer chooses not to use the DH system, the standing charge for the district heating still needs to be paid.

One of the consequences of not being able to switch suppliers is that consumers do not have the possibility to choose for the supplier that offers the best deal or profit from regular client discount. Although consumers of DH networks are also regular customers, they do not profit from it, neither do they have the advantages of non-regular customers. They can also not take part in promotions or collective purchase programs (Janssen, 2015). On the contrary, the district heating company may even take advantage of their guaranteed customer base and won’t deliver good service or reduce bills through efficiency improvements (Which?, 2015).

In addition, consumers have little influence on the cost. The lack of flexibility is inherent to DH networks, but the extent to which it leads to distrust and dissatisfaction vary highly among different DH networks.

To sum up, the factors related to flexibility that contribute to a feeling of distrust and dissatisfaction are:

1. Not being able to switch suppliers
2. Not having influence on the price

The strength of district heating has been a reliable, robust product that is cost-efficient at the same time. Across Europe, this is still the main driver for its success. But it is also applied to all customers in the same way, something that no longer suffices to keep up with the competition of other heating alternatives: *“The majority of customers are satisfied with the basic product but, on the other hand, the same kind of product is no longer sufficient for the needs of all customers”* (FEI, 2013). Adaptation of features to customer requirements is suggested to adapt to changing needs. To improve the image of inflexibility and stand out from the competition, district heating companies should make changes in their practice that are visible to customers, including more openness.

2.6 Consumer protection

Which? (2015) has identified a poor customer service and complaints handling procedures as important factors for customer dissatisfaction. Customers are not sufficiently heard and helped when there is a complaint. Not only do they receive poor customer service, there is no central point of contact with whom they can take their complaint forward (Which? 2015). There is often no organization taking responsibility nor is there a central ombudsman to resolve complaints. Consumers feel trapped because no matter how dissatisfied they are, they cannot switch. Resistance can be fierce: conflicts between the district heating company and the consumer have in some cases resulted in legal procedures in the Netherlands and even the establishment an action group in a specific situation (Tilburg Reeshof).

Considering the monopolistic position of the district heating company, customer protection is especially important. In the Netherlands a main form of customer protection is through the heat law that should protect the customer from monopoly pricing and should guarantee reasonable practice for the technical performance of the system. Janssen (2015) has in his study concluded that heat consumers feel not sufficiently protected by the heat law. The heat law does not sufficiently provide minimal quality standards that are legally enforced and controlled. Overall, there has been criticism to the functioning of this law ever since its introduction in 2014. However, a discussion of the heat law goes beyond the scope of this research note. Next to protection by the heat law, guaranteed performance standards and access to independent and binding redress are fundamental bedrocks for a credible customer protection framework (Which?, 2015). A lack such protection leaves many consumers with district heating feeling vulnerable and powerless.

2.7 Service products

It is common for district heating companies to offer normal maintenance services, but little do offer additional services. In order to stay competitive, researchers have suggested that district heating companies should develop new heating related services (Ahvenniemi & Klobut, 2014). The district heating company can offer a wider range of products which will strengthen the competitiveness of the core product and increase customer satisfaction. This diversification can be seen as a more customer oriented approach and is a basis for strengthening the long-term relation with the

customer. *“External research on customer satisfaction clearly demonstrates that customers are more satisfied when energy companies provide additional services”* (Euroheat&Power, 2011). In business in general, economic value creation through services linked to physical products is an ongoing trend (FEI, 2013).

The new products offered are typically services related to management of energy use at different stages of the customer lifecycle, or technical add-on devices to be linked to the heating system (FEI, 2013). Also flexible services and solutions are seen as a new opportunity for district heating companies. The study of Ahvenniemi & Klobut (2014) identified interest among consumers for the following service products:

- Energy consumption monitoring service;
- Internet service enabling comparison of different heating methods scored;
- Heating system as a "keys-in-the-hand service".

Service products are not essential customer needs but can be used to increase the attractiveness of the DH system. Offering information sharing services such as the first two options can be a way of increasing transparency and customer trust. All inclusive “keys-in-the-hand service” can be an effective way of lowering the barrier for home-owners to adopt the DH system. In more technical terms one can think of offering cold next to heat, all energy commodities in one contract (Euroheat&Power, 2011) or to offer solar heating connected to the primary DH system (Ahvenniemi & Klobut, 2014). There are many more opportunities for creating service products that lower the barriers to adopting DH systems and increase customer satisfaction.

2.8 Conclusions/instruments

In the Netherlands, district heating suffers from a bad image of old block heating systems. Both Dutch and UK studies report complaints on the technical performance of the DH system, both in old and new systems. This is remarkable as in Scandinavia high technical performance (comfort, reliability, etc.) has led to a wide acceptance of the technology and to its success. Multiple studies have identified district heating as a technology with relatively high attractiveness (only heat pumps score better). The Scandinavian studies do not (strongly) report complaints on technical performance. It can be concluded that traditional strengths of district heating such as easiness, comfort, good operation reliability and stability of costs should be highlighted when marketing district heating to potential customers (Ahvenniemi & Klobut, 2014). A good deal highlights these strengths and makes sure that there are instruments in place to monitor and guarantee these strengths.

A lack of trust, mainly caused by a lack of transparency, is a large issue for district heating companies across Europe. This is related to the monopolistic position of the DH company. Many consumers are feeling worse off than with gas heating. This might be merely a trust issue rather than rational proof that DH is more expensive or a consumer pays indeed more compared to gas heating. First of all, customers of a DH system must actually get a fair deal, and the information concerning prices must be understandable and communicated clearly. Customers must be provided with information to make informed decision on whether pricing is fair. Monitoring prices and a benchmark tool for comparing between different heating alternatives are suggested (*“An independent, tailored and easy-to-use heat price comparator should be developed for all home owners and tenants connected*

to a district heat network” (FEI, 2013)). Secondly, the solution must be focused on building trust. District heating companies across Europe are seen as inflexible and defensive. The weakening of the image can be remedied through better customer communications and PR (FEI, 2013). The position of district heating must be strengthened through openness and a more customer-oriented way of doing business. Informative events such as excursions to the heat production facility are organized by district heating companies to contribute to the process of building customer relations (for example NUON and Natuurlijk IJburg).

In summary:

1. Emphasize the strengths of district heating
2. Make sure customers really get a good deal
3. Provide the information to prove it
4. Build a strong relationship with the customer by openness and good customer service
5. Use service products to create a more customer-oriented business

A preliminary checklist contains the following values and hypothesis:

Value	Non-users Expected outcome (hypothesis)	Users Expected outcome (hypothesis)
Heat price	Sensitivity high to very high, behavioral expectations medium	Sensitivity high, behavioral expectations low
Level of comfort of the indoor climate	Sensitivity relatively low, relevance in modern DH systems lower	
Service products offered linked to the physical products	Sensitivity low	Sensitivity medium
Transparency in pricing	Sensitivity medium	Sensitivity high
Sustainability	Sensitivity low	Sensitivity low
Flexibility (switch suppliers or other heating alternatives)	Sensitivity high	Sensitivity high
Consumer choice (different products)	Sensitivity medium	Sensitivity medium
Independent platform/consumer association	Sensitivity medium	Sensitivity medium

Table 1. Set of values of consumers towards district heating networks

3. Strategy 1: Increasing competition by third party access

Open networks are gaining attention as a way to increase the attractiveness of district heating to consumers. Open networks allow for more competition on the networks, which are expected to lead to increased cost efficiency, transparency and consumer choice and eventually higher customer satisfaction. There have been several studies on the concept of open networks and third party access. First, we will zoom in on this concept and expound the possible market models and expected benefits from those models. Next, we will elaborate on the concept of dynamic pricing which is introduced in the Flexiheat project, as a specific solution for an open network with higher cost efficiency.

3.1 Third party access: disconnecting the value chain

As explained in section 1.2, district heating networks are natural monopolies that have a very local and integrated nature. Production and distribution of the network is traditionally vertically integrated, with one district heating company responsible operating the entire chain including production, supply and distribution (Söderholm & Warell, 2011; PWC, 2015). This can lead to monopoly pricing. Third Party Access (TPA) refers to the regulation of access of parties not being the network operator to the network, either as supplier or producer. TPA can be used as a policy tool to address the market failure of imperfect competition. TPA potentially leads to two main advantages for consumers: 1) choice of retailer or producer and 2) lowering of costs. To allow third parties to enter the network, different market models need to be considered in which production and distribution are disconnected to enable competition. By this disconnection, district heating networks will show more resemblance with gas and electricity networks after the liberalization of those markets. Many different models have been studied by various authors (Söderholm & Warell, 2011; PWC, 2015; Dervis & Nierop, 2015; Ouden, Hoeksema & Graafland, 2015). We will now explain the different possible conceptual models studied by the aforementioned authors.

3.2 TPA models

Regulated TPA

Regulated TPA is meant to ensure unlimited access of third parties to the network in a non-discriminatory way. The model requires a full vertical separation of distribution and production in order to create fair competition between different producers and retailers. The conditions for access to the network are determined ex ante. In theory, regulated TPA would stimulate competition on production and supply and thus lead to a more efficient operation. More production sources could lead to flexibility to deploy production sources at the right time, which is expected to increase the efficiency of production (PWC, 2015). However, the efficiency increase depends on the size of the market and the number of competing firms (Söderholm & Warell, 2011).

On the downside, extensive regulation will be needed to allow competition. The separation of distribution and supply creates competition on the production and supply side, but the distribution remains a natural monopoly and price regulation will be needed to address the network operations. As a result of the separation the tariff will have to be split between a fixed tariff for the network and a variable tariff for the consumption of heat. District heating costs will increase for users with low use

as the fixed tariff will increase because part of the network costs are currently incorporated in the variable tariff.

In the most radical form of regulated TPA there is an independent grid operator which allows independent investment decisions on the network as well as equal competition between producers and suppliers because there is no longer an integrated district heating company with a stronger competitive position compared to third parties. Producers and suppliers can make bilateral agreements on the price and volume of heat to be delivered. Under attention is also an independent trade platform similar to the APX/ENDEX for electricity (Dervis & Nierop, 2015). Such a platform will allow an optimal dispatch of the available production capacity. However, it can be questioned to what extent to functioning of such as market is realistic for district heating due to the locality of production units. As a result of this free market, the grid operator needs to be responsible for security of supply, i.e. contracting back-up capacity.

Box 1. Dynamic pricing

Regulated TPA using an independent network operator and a market place offers the possibility of dynamic pricing. The concept of dynamic pricing has been studied in the Flexiheat project. The aim of dynamic pricing is to find the optimum dispatch of different production units in the network while satisfying consumer needs. It requires a control of the network through 'distributed controllers' that use producers' cost curves and consumers' utility functions to calculate the optimal operation. Buffers are used to increase the optimization possibilities by shifting loads in time. The algorithm developed in Flexiheat allows the modelling of different levels of price sensitiveness of consumers and producers: fixed (price inelastic) users, price driven users and controllable users.

Dynamic pricing offers several advantages over standard regulated TPA. First of all, it allows overall optimization of the network. Dynamic pricing can also help in terms of security of supply since there is an incentive for multiple producers to compensate for shortages in supply. However, there might be situations in which the maximum heat price is reached while not satisfying the total demand. In these cases a responsible party is still necessary to balance demand and supply.

For more information see (Scholten, De Persis and Tesi, 2015)

Negotiated TPA

In a negotiated TPA model, the access of third parties to the network is negotiated between the new producer and the existing district heating company (also being the network operator). The conditions for access to the network are set ex post. These negotiations can be mandatory or voluntary (Dervis & Nierop, 2015). The established company has a stronger position in the negotiations than the new producer compared to regulated TPA (Söderholm & Warell, 2011; PWC, 2015). One of the advantages of negotiated TPA is that local conditions can be taken into account, it is still possible to accomplish system optimization by the integrated producer/supplies/distributor.

Single buyer model

An alternative for negotiated and regulated TPA with a less open market, yet allowing production competition on the network, is the single buyer model. This is also the dominant model in district heating networks. The single buyer model allows competition of production. However, there is still one integrated distributor/supplier (the single buyer) and consumers have no free choice of retailer (Dervis & Nierop, 2015). In this model, the new producers cannot sell directly to the consumers whereas the single buyer purchases contracted volumes of heat from the producers and sells it to the consumers. Like in negotiated TPA, the transportation and system costs are negotiated separately (Söderholm & Warell, 2011). This could lead to a situation of information asymmetry as the established district heating company has the information on systems costs that the third parties do not.

Extended producer market

Söderholm & Warell (2011) describe a TPA model that has an extended producer market. Heat is bought and sold between the network operator and different production units, but there remains to be one district heating company for the supply and distribution. The value chain is vertically separated to the extent of splitting the activities of one integrated company in distribution and supply activities. This will lead to increased transparency about the prices charged. The aim of the model is to create market incentives by making information on costs and risks in each part of the value chain visible (PWC, 2015). This will stimulate benchmark competition among different networks.

TPA for retailers

In fact, regulated and negotiated TPA allow third parties to not only have access to the network, but also to sell directly to the final consumers. Yet, a form of TPA focused on opening the retail side of the value chain can be discussed as a separate model (Darvis & Nierop, 2015; Ouden, Hoeksema & Graafland, 2015). An integrated producer/distributor gives third parties access to the network, but does not function as a single buyer as there is now retail competition. As a result, consumers can now choose their own retailer. This model is common in the telecom sector. However, retail competition will only lead to lower district heat prices with sufficient retailers. Also, there is not necessarily competition of production as well. As long as there is not also competition of production, the effect on prices will be limited. Darvis & Nierop (2015) conclude that TPA for retailers probably has only small positive effects on district heating prices, partly because of limited competition of production. The prices may even lead to higher costs due to efficiency losses in case each retailer has an individual supply obligation to the consumers and should therefore provide back-up capacity each individually.

3.3 District heating characteristics limiting the prospects of TPA

Inefficiencies in a separated value chain

TPA has already been successfully introduced in gas and electricity networks. When assessing the prospects of introducing TPA in district heating networks, one should take into account the specific characteristics of district heating networks. Unlike gas and electricity, district heating networks are

closed systems in which the return temperature affects the performance of the production units and the efficiency of the supply chain as a whole. However, it is unknown which consumers affect which production units in a TPA network and what incentives there are to lower the temperatures (Söderholm & Warell, 2011). This could lead to problems with the system optimization and a loss of synergy (PWC, 2015). Additionally, parameters such as the pressure, flow and temperature vary over the network. This variation increases difficulties of connecting a new production unit at an optimal efficiency level (Darvis & Nierop, 2015). These technical issues with supply chain optimization and economic inefficiencies are a result of externalities, a market failure in which negative side effects of production are insufficiently incorporated in the price of the product (Söderholm & Warell, 2011). Those can be internalized by means of contracts between the network operator and the producers. In conclusion, TPA could lead to increased costs for operating the system as a result of dependencies in the supply chain. Separation could lead to technical difficulties, inefficiencies and thus higher costs.

Locality of heat sources

Even though multiple producers are desired in the district heating network as competition will be increased, it is still the question to what extent there will indeed be sufficient production units available and able to operate efficiently. District heating networks are, unlike gas and electricity, highly local in nature. Heat cannot be transported over large distances because heat losses during the distribution will lead to high efficiency losses. Therefore, only potential production units that are close to the end consumers will be feasible. This highly limits the availability of additional production sources and thus limits the possibilities for production competition. It must be noted that TPA may offer good possibilities for small waste heat sources and renewable energy sources to enter the network.

Natural monopolies

Even though TPA should lead to more competition and therefore to less market power of the monopolist, the position of established district heating companies forms a barrier to TPA at the same time. In many TPA models, the access of third parties is to some extent voluntarily. The vertically integrated district heating company often lacks financial incentives to allow other heat suppliers. In practice this leads to very limited access of third parties despite of the policies in place.

Due to the characteristics of district heating networks, a monopolistic, vertically integrated district heating company is not necessarily less efficient than a network operated with TPA, especially when it is operated by a local government on a cost-covering basis. The risk exists that a cost-covering monopolist might be replaced by a profit-maximizing monopolist when TPA is introduced.

International examples

A study of PWC (2015) compared international examples of district heating networks that allow some form of TPA. Included are the district heating networks of Copenhagen, München, Stockholm and Warschau. The study concludes that there are no real examples of functioning TPA on district heating networks. Only the networks in Copenhagen and Warschau have multiple active producers on the basis of regulated TPA, but a completely free network access does not really occur. There has been an extensive discussion on market opening in Sweden from mandatory negotiated TPA to regulated

TPA. Two governmental investigations have led to the conclusions that the introduced negotiated TPA has not have the desired effect and that the costs of a separation of production and distribution necessary for regulated TPA exceeds the benefits (Darvis & Nierop, 2015).

3.4 Conclusions

From the studied literature it becomes evident that there are many concerns around introducing TPA in district heating networks. One of the main issues is the fact that increased competition does not necessarily lead to lower prices. Instead, TPA may even lead to higher consumer prices. *“Although there may only be some small positive effects on the competition may have a significant impact on the possibility to run the system in a cost-effective manner”* (Söderholm & Warell, 2011). This mainly has to do with inefficiencies in the operation of the system as a result of the locality of the network and the interdependency of production and distribution. Another important point is that natural monopolies are not easily changed into competitive markets, for the reasons mentioned above. This has also become clear from the fact that there are limited international examples. TPA requires extensive regulation and monitoring. The costs associated with this will need to be outweighed by the positive effects.

Multiple the studies conclude that the effectiveness of TPA depends on the size and location of the network and are therefore expected to have the best prospects for large-scale district heating systems (Söderholm & Warell, 2011; PWC, 2015).

Even though regulation may in theory be softened or even abandoned in case of more market competition, most studies conclude that price regulation will still be needed because of the expected limited availability of third parties. When there is one or more market failures associated with the network, which is the case in a natural monopoly, opening of the market through TPA may not be desirable. Instead, price regulation may be more effective to lower district heating prices. Söderholm & Warell (2011) conclude that in case of natural monopolies *“a price regulation may be the only option to protect consumers from being charged monopoly prices”*.

Free choice of a retailer does not seem realistic considering the characteristics of district heating networks (Darvis & Nierop, 2015). Retail competition does not easily lead to lower costs, as most costs are determined by the (limited variety in) production capacity and network costs.

The following policy suggestions follow from the studied literature:

- One uniform TPA solution could easily lead to inefficiencies in many networks considering the large variation of networks. Setting minimum conditions for access to the network would however be a good suggestion.
- When introducing a form of TPA, the technical criteria, economic feasibility and process need to be become clear.
- As an alternative to the aforementioned TPA models, an administrative separation of production and distribution would already lead to more transparency and a better competitive position of third parties (producers), as is for example the case in an extended producer market.

4. Strategy 2: More consumer choice by introducing price models

Lack of choice and high district heating prices have been identified as one of the most important reasons for customer dissatisfaction. These are direct results of the fact that district heating networks are natural monopolies. In the previous section we have looked into the possibility of abolishing the monopolistic position of the integrated district heating company by introducing TPA. Another approach to increasing choice and lowering costs can be sought in the introduction of alternative price models.

4.1 Pricing models

A pricing model is structure of how the price the district heating company charges the consumers is structured. There is a strong need to develop a new pricing mechanisms in order to strengthen the competitive position and promote sustainable development of DH systems (Li et al, 2015).

Price components

In the Dutch system there are three components: connection fee (in Dutch: bijdrage aansluitingskosten), standing charge (in Dutch: vastrecht) and variable energy costs (GJ price). The main reason there is a preference for a fixed charge is that heat demand is greatly variable over a year, and a high proportion of the operating costs of a DH system don't change in a short run (Larsson, 2011). A high fixed component can reduce the risk for the producer that is caused by fluctuations in consumption. As total costs remain the same in different fixed-variable fee compositions, the higher the fixed charge is, the lower the unit cost of heat consumption becomes.

There is recently more attention for a price model with only a variable fee to support energy efficiency measure and to make consumers feel more in control about the heat price. Larsson (2011) shows the effect of different compositions of price models on the impact of energy efficiency measures. Apart from the three components mentioned, the study includes several other price components (table). Obviously, high fixed costs leads to lower incentives for energy efficiency measures. A solution could be to set multiple variable unit costs for consumers to choose from.

Price component	Description
Fix	A fully fixed cost, independent of energy use, price/year
Fix (prev)	A cost which is fixed for the current year but is based on previous years' consumption and therefore ultimately variable, price/MWh
Energy	The energy cost in price/MWh
Category	Capacity cost based on category number, a number of hours determining the subscribed capacity of a certain type of customer. In most cases the total annual consumption is used, but there are also cases where the winter consumption determines the subscribed capacity, price/kW
Measured	Capacity cost based on measurement, price/kW
Flow	Flow cost, price/m ³

Table 2. Price components (Larsson, 2011)

Prices models with high variable cost stimulate an overall lower energy consumption, but do not form an incentive to reduce peak loads. The study also concludes that pricing models including seasonal pricing, measured capacity or capacity based on winter consumption provide increased incentive for peak load reduction. The extent to which the incentive actually leads to increased energy efficiency is however another field of study.

Cost methods

Different methods exist to determine district heating prices, mainly categorized in Cost based pricing and alternative pricing. Marginal pricing – deregulated market – fuel costs (and thus marginal costs) vary through seasons: variations in the tariffs of DH reflect the fluctuations in energy cost. A full explanation of marginal cost pricing method falls beyond the scope of this research note. Interested readers are referred to (Li et al., 2015).

4.2 Flexible pricing options for consumer choice

Heat is seen as a homogenous product with limited prospects for differentiation. However, differentiating a commodity offers the prospect of increased profitability by designing variations of the commodity that meet the specific needs of different customer segments (Martensson & Frederiksen, 2006). As district heating has a high degree of local market penetration, the commodity should be offered in a wide range of variants to attract all those different customers by meeting their specific needs and preferences. Heterogeneous customer segment...

Several options for differentiating can be identified:

1. Cost structure: different weighting of connection fee, fixed and variable costs;
2. Different price structure for different buildings;
3. Differentiating in price to capacity;
4. Different prices according to sustainability of the product;
5. Differentiating through extended service offers.

4.2.1 Cost structure

Weighting fixed and variable cost

Traditionally the price structure of district heating companies consisted of a significant fixed tariff and variable energy costs. There is increasing attention for price structure with a large or full variable tariff. This has two main advantages: 1) there is an incentive for energy efficiency measures and 2) it gives consumers a higher feeling of control of the heat price. Disadvantageous are mainly for the district heating company as the fixed part is a way of securing that operating and maintenance costs are covered although the heat load is variable. *“The main reason there is a preference for a fixed charge is that heat demand is greatly variable over a year, and a high proportion of the operating costs of a DH system don't change in a short run. Therefore, a fixed charge can streamline the cash flow of producers”* (Li et al, 2014).

Weighting investment cost

For home-owners the district heating company can offer choice in how much investment costs are charged in relation to the fixed costs and variable energy price. The higher the investment costs, the lower the fixed and variable energy costs become. By weighting investment cost differently, home-owners are given the opportunity to invest in the installation. Martensson & Frederiksen (2006) propose such a strategy for Swedish home-owners. They mention several advantages for home-owners: 1) the price structure allows a better comparison with the fiercest competitor of DH in Sweden: the ground-source heat pump as heat pumps have similar large investment costs; 2) the price structure offers possibilities for a different ownership structure in which the local DH network will initially be owned by the district heating company and home-owners can obtain shares of a local energy company and become owners of the heating system.

4.2.2 Differentiating to building type

When differentiating to building type, the DH company sets prices according to different consumer types. This system exists in Finland, where the price differs between small private houses, apartments and industrial buildings based on tax rules and amount of consumption (Li et al., 2011). In this pricing system, the opportunity to switch to other heating alternatives is also taken into account. Owners of small houses have to pay higher prices than other types of buildings as it is easier for those home-owners to switch to other heating alternatives, such as electrical heaters or heat pumps.

4.2.3 Price to capacity

An alternative for a uniform price for all consumers is a differentiation in capacity. This is similar to electricity and gas suppliers, who also use different tariffs depending on the connection size. A large businesses pay more than small home-owners. In the telecom sector this principle is even further applied by offering consumers different products (phone and data plans) based on the expected used volume. A consumer with limited use of a mobile phone will choose a plan with a smaller volume than a consumer with a high use. The advantages for the consumer are that a phone plan is cheaper than paying prepaid and that total costs are better controlled. A similar principle could be applied in district heating networks by offering consumers different 'heat plans' based on a maximum of GJ used. This is a very different method of pricing in which the consumer is not charged the actual volume consumed (but sometimes a bit less). This option is more focused on increasing consumer choice and does not necessarily lead to lower costs.

4.2.4 Variable tariffs

Tariffs may also be differentiated between variability of price. Production and distribution costs of district heating will develop over time, depending on changes within the network, such as expansion of the network, construction of new production capacity, price changes in other fuels such as electricity needed to operate the network etc. Consumers can be offered choice to what extent they wish to be exposed to (and potentially profit from) price development. The district heating system of

Fortum in Stockholm for example offers its clients choice between half yearly changing prices, yearly changing prices with a summer and winter price and a fixed price (Harting, 2015).

4.2.5 Real time heat load

District heating load varies according to daily and seasonal patterns. Real costs of producing the heat vary accordingly, mainly caused by the fact that more expensive back-up plants are used to supply the peak load. To reflect real costs in the heating prices and form an incentive to consumers to decrease peaks and save energy costs, a pricing system based on real time costs can be proposed. The heat price will be higher during peak hours and lower for base-load consumption.

Deventer, Gustafsson & Delsing (2011) propose a strategy for controlling the district heating load through real time pricing. In their model, the home substation receives price information from the heat supplier. The user's wishes are communicated through the substation: a price is indicated for low prices, a tolerable temperature is indicated for high prices and the target indoor temperature is interpolated when the price is within a those two points. The substation adjusts the heat consumption accordingly. Such a pricing model lowers energy consumption and saves energy costs for consumers without compromising indoor comfort. Indirectly, this can make the DH network cheaper as pipes can have smaller dimensions when the peak load decreases. A variation to this model is a real time pricing model in which multiple buildings cooperate together and place bids for the potential to reduce heat consumption to an auction (Deventer, Gustafsson & Delsing, 2011).

4.2.6 Differentiation between levels of sustainability

In an open network, that allows the connection of many different sources of heat, there will also be a large variation in costs of different sources. Deploying the different sources in a cost-efficient way, for example in a base-peak-load or dynamic pricing system, will not necessarily be the most sustainable way. Customers could be offered a 'green heat' product next to the standard heat product in which they pay a bit more for heat from sustainable sources. Harting (2015) distinguishes three different ways to offer consumers the choice of 'green heat' versus the standard 'grey' heat:

- 1) Offering 'green heat' as a new product in an existing network when new green production capacity are added to the system. Consumers could potentially stimulate investment decisions for green production capacity by demand for such a product and the willingness to pay a higher tariff.
- 2) Enabling consumers to invest in new green production capacity by crowdfunding. Consumers will be offered a financial advantage in return.
- 3) Choice of either 'green heat' or 'grey heat' for new connections to a district heating network. The choice for 'green heat' will affect the Energy Performance Coefficient of a building positively.

4.2.7 Extended service offers

In an extended service offer, the product is combined with a service related to the supply of heat. The possibilities are of course numerous. For example: combining the DH connection with a discount on glass fiber or a free energy coach that advises on energy saving measures.

4.3 Examples from practice

We will now illustrate some approaches from practice:

Den Haag De Oorden (social housing)

The offer of the initiative “Energie van de buurt” consists of a fixed discount of 10 percent on the gas price. The price is guaranteed for the long term, which includes a yearly price indexation with CPI (consumer price index) of the ACM (Autoriteit Consument en Markt) (Zwieterink, 2015). The energy bill consist of only a variable fee. Consumers only pay for what they use, which is also an incentive for insulation and other energy saving measures. Fixed costs are incorporated in the variable fee (GJ price). Connection the DH network is cost neutral for the owners. The owners do not pay a connection fee (related to investment costs of the DH network) but a yearly fee for avoided boiler costs (related to the current heating system). This is expected to lower the barrier for real estate owners switch to the DH network. Concerning services provided, the district heating provides the installation and if needed the technical home adjustments.

Buurtwarmte Amsterdam (home-owners)

Grid operator Alliander wants to support home-owners in Amsterdam to increase energy-efficiency by a neighborhood DH network. The approach that is chosen here is to get in close contact and cooperation with the future end-users from very early on in the process. The key to success is here seen as understanding the motivations of the people involved. Alliander responds to the already existing wish of home-owners in the neighborhood to become more sustainable in energy use. Unlike the core values as identified in section 2, sustainability is key in the value proposition. Before making the business case, the local grid operator talks to the people to poll the interest for neighborhood heating and comes with an tailor-made offer accordingly. Home-owners get the opportunity to become co-owners of the DH network, for example in the form of an energy cooperative, instead of being just a consumer. This mutual process is a promising step towards local sustainable energy initiatives for heating.

Jämtkraft (home-owners)

Jämtkraft (Sweden) made a package offer, consisting of a fixed district heat price for five years, long-term (30 years) loans at a low interest rate and a guarantee on the installation (Mahapatra & Gustavsson, 2009). The offer also involved a discount for connection to the fibre optic broadband network (Tommerup, H. M, 2010). This is a good example of offering an additional product linked to the core product (section 2.7).

4.4 Conclusions

There are many solutions to increase consumer choice by using different price models. Many of them are not implemented in existing district heating networks but are currently subject of the debate around district heating and consumer choice. Some of the price models discussed are inspired by examples of Nordic district heating networks. Apart from the possibilities that are discussed above, there are many other instruments that may be used to create a good deal for consumers such as offering a discount to competitive alternatives, long term price guarantees, investment support to allow consumers participate and invest, technical guarantees etc.

Although there might be specific conditions to a (successful) implementation of these price models, there are two important general conditions:

1. There should be legal support for implementing these solutions. The Dutch district heating act (Warmtewet) is highly limiting in introducing either one of these options. One solution would be to allow experiments with some of these options on a small scale.
2. There should be sufficient financial possibilities for the district heating company to apply alternative price models. The introduction of some price models involves a higher risk for the district heating company, for example when applying variable tariffs. The goal of many alternative price models is to lower the costs of district heating for the consumer, which also decreases income for the district heating company. As a result, a cost reduction needs to be accomplished in another way.

Recommendations

The literature review of customer satisfaction and needs has resulted in a set of values (checklist). However, peoples' attitude and motivations differ from case to case. To develop new business models that better comply with customer needs, the specific attitudes of the potential new customers need to be mapped, for example by conducting questionnaires and interviews². The attitudes should be tested not only quantitatively (how many consumers are sensitive to price) but also qualitatively (to what extent are consumers sensitive to price and is their behavior adaptable?). The results will give insight in how potential customers should be approached and how they can be persuaded to be connected to the district heating network. The 'positive expected values' of consumer satisfaction can be identified with these insights.

To attract new customers and keep current customers satisfied, district heating companies need to convincingly offer consumers a good deal. New consumers need to decide whether to switch from the current heating system to a district heating connection or not. Customers of existing networks can act as ambassadors for new customers when they are satisfied about the products and services delivered. This exploration has proposed some approaches to make a good deal for consumers by looking at factors that influence consumer satisfaction. A good deal for consumers is strongly linked to customer needs.

TPA could be a good measure to stimulate the use of small-scale waste heat and renewable heat. However, positive effects on district heating prices are expected to be low and consumer choice will not increase much. Alternative price models could be a more effective measure to increase consumer choice (and possibly other values as well). In this exploration some possibilities are mentioned, but those concepts need to be further developed and researched. An important aspect is the legal possibilities for product differentiation.

² The starting situation of the potential customers of Warmtestad have been studied by a group of communication students of the Hanze University of Applied Sciences in collaboration with Warmtestad. We refer to the report "Aardwarmte: Ook een oplossing voor Groningen Noordwest?"

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