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Entrepreneurs in Green Gas stimulating & obstructing factors

Thesis

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1. Introduction

The Netherlands is very dependent on natural gas for its overall energy consumption: 40% of the energy used in the Netherlands is used for the production of heat, which almost fully depends on natural gas (Bekkering, Broekhuis & van Gemert, 2010). This dependency is due to the fact that a dense gas network has been built in the Netherlands upon discovery of natural gas fields in Groningen in the 1960s.This discovery also led to the development of a gas grid and appliances tuned to the composition of this gas (TNO, 2010; Levinsky & Van Rij, 2011). Natural gas is a fossil fuel and contributes to green house gas emissions, which lead to global warming. The Dutch government wants to lower the overall output of green house gas emissions and sees *green gas*, the renewable alternative to natural gas, as an important contributor to their goal of 14% renewable energy in Dutch final consumption (Ministerie van Economische zaken, Landbouw & Innovatie, 2011; Rijksoverheid, 2012). *Green gas* is produced in green gas projects when biogas derived from organic material is upgraded to the same quality as Dutch natural gas, which allows it to be compressed for bio-fuel or to be fed into the gas grid.

There is quite some potential for more green gas production in the Netherlands, concluded CE Delft (2011) after comparing different studies on the potential of biomass for green gas production; they estimate a bandwidth of 1 to 1.5 billion m^3 natural gas equivalent. With an average use of 640 m^3 per person per year (CBS, 2009), this potential corresponds to the gas use of 1,6 to 2,4 million Dutch inhabitants. Local studies for municipalities and network administrators often have even higher estimates of potential biomass for green gas production (e.g. Ecofys, 2011; Jonkman, 2011). Next to the potential, there are green gas success stories in the press such as that of Suikerunie, a producer of sugar and sugar products which intends to produce green gas for 15.000 households (Agentschap NL, 2012) and that of A. van de Groep, a fish trader that produces a green gas amount equivalent to the gas use of 3.500 households (Reformatorisch Dagblad, 2011). However, green gas has thus far contributed very little to the total renewables in end consumption of energy in the Netherlands: a sole 1% (Agentschap NL, 2011).

Thus, the biomass potential is hardly used to produce green gas. Why are there not more entrepreneurs producing green gas? The goal of the proposed research is to describe the stimulating factors for entrepreneurs to engage in a green gas project and the obstructing factors experienced by entrepreneurs leading such a project.

In section 1.1 Biogas to green gas and section 1.2 Government goals & subsidies, the background of the proposed research is provided and the (technological) terms used in this thesis are explained. Section 1.1 and section 1.2 are followed by section 1.3 Research objective & research questions, section 1.4 Working definitions and section 1.5 Social and scientific relevance. The introduction concludes with section 1.6 Thesis outline.

1.1 Biogas to green gas

Biogas is produced from biomass by bacteria in an environment low in oxygen. Biogas can be derived from landfills (landfill gas), waste water or sewage sludge (in a treatment plant referred to as *AWZI* or *RWZI*) and produced from (co)digestion of biomass, including manure. There are different names for digesters based on different biomass streams, also known as *substrates*. A *mono-digester* operates on manure solely. A *co-digester* operates on at least 50% manure and a limited list of approved biomass material. An *all-digester* produces biogas from a much larger set of approved

biomass materials, but this excludes manure. Some all-digesters are known as a *VGI-digester*, which denotes that it runs on biomass streams from the food and beverage industry for consumers. Another type of all-digester is the *GFT-digester*, which runs on kitchen and garden waste and often municipal greens waste.

The composition of the biomass streams, often referred to as *co-streams or substrates*, determines the amount and type of gas output by the bacteria. The composition of co-streams is referred to as *menu*. For co-digestion,this means a mix is made of the most economical input streams to create the best yields in gas, to stabilize the production process and to use the full capacity of the facility (Mata-Alvarez, Macé & Llabrés, 2000). The nature and location of the co-streams lead to the decentralized character of biogas production, as these are often costly to move. What is left of the biomass after (co)digestion is called the *digestate*.

In the early stages of biogas production in the Netherlands, most of the sites were equipped with a *Combined Heat and Power installation* (CHP) to derive value from the produced biogas in the form of electricity and heat (Stichting Groen Gas Nederland, 2013a). These small scale CHPs are referred to as *micro-CHPs*. The energy delivery, the avoided CO_2 emissions and the economic returns per amount of biogas are best for CHPs compared to the other utilization options in a laboratory setting (STOWA, 2011). However, in many cases, not all produced heat from a micro-CHP can be efficiently put to use (year round), which means that heat is disposed of and thus energy is being wasted (Platform Nieuw Gas, 2007).The waste of energy also means an economical loss for the producer. In such cases the production of green gas for the grid or as transport fuel is the most economic and efficient option (De Jong & Heijman, 2011).

However, biogas needs to be upgraded to become green gas. First, the biogas is cleaned from some of the trace components that are *"harmful to the natural gas grid, appliances or end-users"*, because biogas contains *"water vapor, hydrogen sulfide, siloxanes, hydrocarbons, ammonia, oxygen, carbon monoxide and nitrogen*" (Ryckebosch, Drouillon & Vervaeren, 2011, p. 1643). Second, the biogas needs to be upgraded to the required energy calorific value[1] for its end-use. Cleaning and upgrading of biogas to green gas can be achieved with (a combination of) different technologies[2]. Which technology is used for upgrading depends on the composition of the biogas, which depends on the co-streams used to produce the biogas. A venture that aims to produce green gas through one of these technologies can be called a *green gas project*.

1.2 Government goals & subsidies

In most cases, receiving subsidy is necessary to make a green gas project economically feasible, says expert Paulo van Cuijk, green gas developer at Stichting Groen Gas Nederland (telephone inquiry 21-01-2013). According to him there are only a few projects that manage green gas production without subsidy, mainly from biogas derived from landfills and produced by some AWZIs/RWZIs. Furthermore, Van Cuijk indicated that on the market for biomass, projects without subsidy will have to compete with projects with subsidy. An example that an unleveled playing field is a problem for digesters can be illustrated from media reports on the first batch of biogas farmers who receive MEP subsidy (the former subsidy structure of 2003-2006).Of the 25 discussed digesters,

[1] Calorific value is also known as heating value and describes the amount of heat released during combustion of a compound, which is measured in energy per unit of the compound. CO_2 has a lower calorific value than CH_4.

[2]Such as: PSA (Pressure Swing Adsorption), absorption by (water) scrubbers, organic physical scrubbing or chemical scrubbing, and membrane filters.For a clear explanation of each technology read Persson et al. (2006); for a comparison of pros and cons, see Ryckebosch et al. (2011).

five have gone bankrupt and 10 are experiencing extreme difficulties, because the price of biomass has risen and that of electricity has fallen and the farmers cannot compete with the farmers that receive the higher new subsidies (Stichting Groen Gas Nederland, 2012).

To stimulate the development of green gas projects and help them become feasible from a business point of view, the Dutch government has set up a subsidy scheme that compensates renewable energy producers for the price difference between conventional energy and the renewable energy per unit produced (Agentschap NL, 2012a). The current subsidy program is called Stimulation Sustainable Energy (SDE, now known as SDE+[3]) and commenced in 2008. It is renewed and adjusted each year. An entrepreneur who applies for the subsidy can be promised subsidy, which means that once he starts producing green gas, he is compensated to a maximum amount per produced m^3 of gas, which is different for each source of green gas. Also, the entrepreneur has a set period of time to start producing this renewable energy.After this period, usually 4 years, the promised subsidy is withdrawn. The subsidy continues for a maximum of 12 years in SDE+2012/2013.

The current governmental policies seem to achieve a strong development in green gas projects by granting two-thirds of the available subsidy to green gas projects in 2011 (Agentschap NL, 2012b). Yet, a SDE(+) promise is not a guarantee for the realization of a green gas project. Since 2008, 55 green gas projects have been promised SDE(+), of which nine projects have realized the promised capacity by the last measurement date, 01-07-2012 (AgentschapNL, 2012c+d). Inquired by phone, AgentschapNL confirms that the remaining projects might still realize their capacity, but that it is likely that some projects have been cancelled (call with AgentschapNL, 22-01-2013). However, there is no (public) report containing information on the amount of green gas projects that have been withdrawn, nor any report on the reasons why. Thus, subsidy is necessary in most cases but a subsidy promise does not ensure the realization of a green gas project.

1.3 Research objective & questions

The objective of this research is to identify the factors that contribute to the start, the bringing to maturity and the termination of green gas projects. The research objective is formulated as: *"to describe the factors that stimulate or obstruct entrepreneurs leading green gas projects, by providing an overview of the motivations, incentives, barriers and uncertainties experienced by the entrepreneur"*.

The choice for these categories of factors will be further justified in the next section. According to the research objective, the proposed research takes the shape of a problem analysis. This type of analysis serves to indicate that certain variables are problematic (Verschuren & Doorewaard, 2010). The outcome of the research is a problem description from the viewpoint of entrepreneurs in green gas.

[3]The SDE has been adjusted every year since the introduction in 2008. Since 2012 the SDE also contains other aid than monetary compensation and was renamed SDE+. For more: http://www.agentschapnl.nl/programmas-regelingen/stimulering-duurzame-energieproductie-sde

Main research question:

"What are the main stimulating and obstructing factors experienced by entrepreneurs leading green gas projects during different stages of maturity and to what extent do these explain the success of green gas projects?"

Sub-questions:

- *Which stimulating factors in the form of motivation and incentives do green gas entrepreneurs experience in different stages of the project?*
- *Which obstructing factors in the form of barriers and uncertainties do green gas entrepreneurs experience in different stages of the project?*
- *What kind of strategies do entrepreneurs apply when they encounter obstructing factors?*
- *To what extent does the balance between the different factors explain the success of green gas projects?*

1.4 Working definitions

To reach the governmental goals for renewable energy production to lower CO_2 outputs, the potential for green gas can be exploited by market actors starting a new venture, thus by entrepreneurs. There is no set definition of 'entrepreneurship' explains Gartner (1990), who surveyed 44 academic researchers and business leaders. "*Entrepreneurship is a way of thinking, a way of thinking that emphasizes opportunities over threats*" (Krueger, Reilly & Carsrud, 2000, p. 411). McMullen and Shepherd (2006, p. 132) combine different definitions of an entrepreneur to: he who takes action in the form of creating new products or processes, by entering new markets, by creating new ventures, thus to "*act on the possibility that one has identified an opportunity worth pursuing*".

In this research, the working definition of a green gas entrepreneur is: *from those who see an opportunity in green gas and strive to create a new venture from it -which may be part of an existing business-, the entrepreneur is he who leads the project and undergoes risk.*

Meijer et al. (2010) found that the continuation of renewable energy projects was "*toa large extent explained by the strong motivation of the entrepreneur*" and that "*the entrepreneur was willing to take risks in order for the project to proceed according to schedule*" (Meijer et al. 2010, 1228). The motivation of entrepreneurs helps to understand "*what triggers opportunity scanning, the sources of ideas for a business venture, and how the venture ultimately becomes a reality*" (Krueger et al., 2010, p. 412). Krueger et al. (2010) conclude from psychological literature that intentions are the best way to predict planned behavior and they state that starting a venture clearly is planned behavior. Therefore, they continue, intentions are necessary to study how and why ventures come into being. Different types of motivation might be expected from green gas entrepreneurs, who have a 'green' or sustainable business[4], because their activities contribute to decreasing the CO_2 output of energy and therefore contribute to the move towards a sustainable society. By illustration, Walley and Taylor (2002) categorize green entrepreneurs[5] according to their motivation: *ecopreneurs* pursue social and ecological goals by means of profit-oriented businesses and other *green entrepreneurs* pursue profit goals by means of ecological or socially oriented businesses. Yet, motivation is not stable, it can change during the process of initiating, starting and bringing to maturity of a renewable

[4] It is beyond the scope of this thesis to discuss what can be considered 'green' or 'sustainable' business.
[5] Walley & Taylor (2002) include new green start-ups and the greening of existing business, business with sustainability as its goal and product and business that has greened its process, even businesses that are green without intent.

energy project as Meijer et al. (2007) found for entrepreneurs in different stages of biomass gasification (synthetic gas)[6] projects.

The working definition in this research of *motivation* is the personal intention of and main driver for action by the entrepreneur. Next to motivation, incentives are taken into account and together they form the stimulating factors under study. *Incentives* are those factors, which exist outside the entrepreneur and further stimulate the entrepreneur.

After an extensive economic literature review on entrepreneurs, McMullen & Shepherd (2006, p. 139) conclude that uncertainty plays an important and yet different role in each of the main theories regarding entrepreneurs, which they amalgamate to "*uncertainty prevents action by obfuscating (1) the need or possibility for action, (2) the knowledge of what to do and (3) whether the potential reward of action is worth the potential cost.* Previous research into renewable energy projects has shown that uncertainties help to explain the continuation or termination of a project (Jacobsson & Johnson, 2000; Jacobsson & Bergek, 2004; Meijer et al., 2007; Meijer et al., 2010). Meijer et al. (2010) explain that uncertainty is the perceived inability to predict something accurately. Therefore, uncertainties have to do with something that is yet to come. Entrepreneurs need to look ahead if they want to undertake anything. The working definition of the obstructing factor 'uncertainty' in this research is:*a possibility that can stop or delay the project.*

However, next to possibilities in the future that can make an entrepreneur stop or delay his project, an entrepreneur can encounter actual blocks: barriers, which are the second form of obstructing factors. Runhaar, Tigchelaar and Vermeulen (2006) define barriers when researching environmental leadership as "*factors that inhibit companies adopting more environmentally friendly practices or technology*" (Runhaar et al., 2006, p. 162). In this vein, the working definition of barriers is:*factors that inhibit green gas entrepreneurs continuing their project.* As such, a barrier is a *certain block* that stops or delays a project.

Yet, obstructing factors may be overcome. Meijer et al. (2007; 2010) find that uncertainties can be overcome by different strategies; mostly those that increase the knowledge of the entrepreneur. Although they describe strategies applied by entrepreneurs, they do not give a definition apart from "*different approaches to scan potential markets, distinctive levels of R&D/market integration or different learning strategies*" (Meijer et al., 2007, p.5839) between brackets. Therefore the definition of strategies in this research is as follows: "*different approaches to overcome uncertainties or barriers*".

The studies of Meijer et al (2007;2010) find that the motivation and uncertainties change over time. For example, some entrepreneurs in their study were at first motivated by the opportunity provided by a new technology, but later their motivation changed into escalating commitment because of the investments made. Next to this, some obstructing factors are expected by the researcher to only occur at a certain time, for instance problems with physically building an upgrading installation are only expected to occur when the entrepreneur builds the installation. Therefore, the research takes 'different stages of maturity' into account. Based on the website of Foundation Green Gas, which aims to inform the public, the sector and especially those who are interested in producing green gas, four stages have been roughly marked: orientation, feasibility

[6] Biomass gasification, a different technology than the previously discussed anaerobic digestion based technologies, produces synthetic gas by heating biomass to over 700 degrees Celsius without combustion.

&regulation, building phase and management & operation[7]. Iteratively during the research these phases have been developed into stages that accurately describe the experience of the entrepreneur: 1) idea & research, 2) subsidies, contracts & permits, 3) building & testing, 4) up-and-running. A project that has reached the up-and-running phase is considered successful and a project that is stopped or on hold is considered unsuccessful.

1.5 Social & scientific relevance

While green gas has been recognized as an important contributor to the renewable energy goals as set by the Dutch government, not all green gas projects make it to the up-and-running phase. The difference between those that do and those that do not make it may be related to the stimulating and obstructing factors. Governmental support should not be general but should be focused on the specific issues in different sectors (Runhaar et al., 2006) and different renewable energy technologies experience different uncertainties (Meijer et al., 2007; 2010). Thus uncovering the stimulating and obstructing factors experienced by green gas entrepreneurs specifically is socially relevant for governmental intervention such as the SDE(+).

The scientific relevance is related to the lack of literature on green gas specifically. The existing scientific research conducted regarding green gas is focused primarily (solely) on technical barriers for the increase of green gas production on micro and macro level (Bekkering et al., 2009). This means the research examines either the working of the technology on its own and its performance with different substrates and settings –micro- or the working of the technology on the structure of the national gas network and difficulties that stem from this –macro- (Bekkering et al., 2009). Grey literature as issued from research consultancies mostly focuses on technical barriers and possibilities on the meso-level, for instance the availability of biomass, feed-in capacity and consumer demand in a local gas network region (e.g. KEMA and Endinet, 2010; Jonkman, 2011). Thus the viewpoint of entrepreneurs and with that a range of possible other barriers is missing.

1.6 Thesis outline

The next chapter, chapter 2. Research Design, describes and justifies the choices made regarding the research design, which includes case studies and expert interviews. Chapter 3. Theoretical Framework builds the research framework based on a review of literature about renewable energy implementation, resource recovery, green entrepreneurship, implementing change in small and medium sized companies and environmental leadership. The result of this chapter is a list of theoretical stimulating (motivation & incentives) and obstructing (uncertainties & barriers) factors, which can be used for the data collection during the case studies. The research results are presented in chapter 4. Research Results – case studies and chapter 5. Research Results – comparative case study and followed by chapter 6. Conclusion & Discussion.

[7]On the main page of the website groengas.nl under the header “produceren” (producing) Foundation Green Gas divides their information into the subheaders “initiatiefase”, “bouwfase” and “beheer & exploitatie”. The first is twice as long as the other two and again subdivided into “oriëntatie”, “locatie”, “haalbaarheid” and “regelgeving”.

2. Research Design

2.1 Approach

The aim of this research is a problem description, as explained in 1.3 Research objective & questions. The research questions have been formulated in an exploratory way, asking for a descriptive answer. To make the problem description sound, elaborate and with space for complexity Verschuren and Doorewaard (2010) advise to choose depth over breadth. The wish for depth leads to a small-scale qualitative method based approach, namely case studies (see 2.3 Comparative case study). The case studies are executed based on a research framework, which is constructed based on a literature review (see 2.2 Literature review).

2.2 Literature review

A literature review is executed to draw from existing scientific knowledge factors, which might apply to cases of entrepreneurs leading green gas projects. With the gathered data, a theoretical framework is built and a list of possible motivations, incentives, barriers and uncertainties is created. Both help to do systematic and informed research. For example, the total list of factors is condensed into a visual aid as a tool to be used during the data collection. Moreover, the broad range of different factors found in the relevant literature assists in making a more informed decision about the case selection, which is presented at the start of chapter 4. Research Results – case studies.

2.3 Comparative case study

According to Verschuren and Doorewaard (2010), the qualitative research method of a case study allows revealing all the ins and outs of a subject and thus allows space to uncover stimulating and obstructing factors experienced by and strategies applied by entrepreneurs. Gerring (2004, p. 342) defines a case study as "*an intensive study of a single unit for the purpose of understanding a larger class of (similar) units*".

A case study is characterized by a small domain and a small number of research units from a selective and strategic sample, on which intensive data collection is performed (Verschuren & Doorewaard, 2010). The domain about which this research would like to make a statement is that of all green gas projects in the Netherlands, of which there are approximately 63 (combined data from Energy Matters, 2012 and Stichting Groen Gas Nederland, 2013). Verschuren and Doorewaard (2010) advise to look for cases that show a lot of similarities in the case of an exploratory research, because the researcher does not know much about the problem yet.

Gerring (2004) explains that there can be multiple cases in a case study. In a comparative case study each case is studied separately, after which the outcomes of the different cases are compared (Verschuren & Doorewaard, 2010). The choice for multiple cases instead of one case is made because there is a lot of variety between different green gas projects, for instance on variables presented under 1.1 Biogas to green gas, like the use of different substrates and technologies for biogas production. Selecting multiple cases that reflect the variety in the population helps to generalize the outcomes to the population, not just the outcome to the researched cases (Gerring 2004).

Thus, Verschuren and Doorewaard (2010) suggest cases with a lot of similarities and Gerring (2004) suggests cases that strategically represent the variety in the domain. To make an informed

decision on how to make the case selection, the literature review presented in the next chapter will be helpful. Therefore, the justification of the case selection is presented at the start of chapter 4. Research Results – case studies.

2.4 Data collection

Because this research aims to uncover the stimulating and obstructing factors as experienced by entrepreneurs, the entrepreneurs leading green gas projects are the objects of research and with their projects form the cases under study. A case study consists of background research (limited by availability) into the selected case on the Internet and a 1-1.5 hour interview with the entrepreneur at a location chosen by him.

The background research includes the website of the project itself, newspaper articles and at times published decisions on the digester by local government. This information is used by the researcher to approach the interview well informed, which allows the researcher to bring up a topic or ask for explanation of a specific event. Moreover, finding negative articles in newspapers and/or published decisions from local government not in favor of the project helps to confront the interviewee should he answer solely positively and socially desirable.

Interviews, according to Vallerand (1997) are the best way to assess motivation. The “why of behaviour”, the perceived reasons to engage in an activity, can be best approached with this method (Vallerand, 1997). Likewise, Kirkwaard and Walton (2010) explain that interviews allow for the full expression of the many variables that make up the complex decision to start a certain business. Krueger et al. (2010) explain that there is a correlation between intention and behavior and that actual intention is one of the best predictors of behavior. Although at times ‘actions speak louder than words’, the opposite correlation is a lot harder to show, one type of behavior could be produced from many different intentions. Because this research aims to describe the experience of the entrepreneur, direct interviews although with their drawbacks, are considered the best data collection method.

Semi-structured interviews are chosen because albeit the nature of the research is exploratory, the literature review allows collecting of possible stimulating and obstructing factors. It means that although no list of preset questions is used, each interview follows roughly the same structure. The entrepreneur is asked to narrate each phase of the project separately with the help of a visual aid to focus their retrospection. After describing the motivation and barriers in each phase, at times through answering additional clarifying questions, a visual aid with possible categories of stimulating or obstructing factors from the literature is shown, to help the entrepreneurs rank the different motivations, incentives, barriers and uncertainties experienced in each phase. Examples of the visual aids used can be found in Appendix I. The ranking helps to clarify what factors are considered most important and therefore help to bring focus to the research from the large amount of data collected.

The interviews have been audio-recorded to allow the researcher to focus on the interview itself. The audio record was used for a first analysis, in which notes were made per interview of all barriers, uncertainties, motivation and incentives and strategies as mentioned in the interview, ordered by development phase of the green gas project. No full transcriptions of the interviews have been made, but the audio files can be requested. The second analysis compares the outcomes of the different cases. Together, these analyses complete the aim of the research; problem description.

2.5 Triangulation

According to Verschuren and Doorewaard (2010) good research has triangulation of 1) researchers, 2) sources and 3) methods, by which using different sources and techniques compensate for the limitations of the others. In the proposed research, there is only one researcher involved, which does not allow for triangulation (1), however the audio records and notes of the interviews can be requested by future researchers. The collection of different sources and use of methods (2, 3) is limited by time and by availability. There are not many sources available that describe the green gas projects: most often the website of the green gas project, sometimes a newspaper article, in one case online documents on municipal decisions. Therefore, the triangulation is limited to the scarcely available information found during the background research.

2.6 Generalizability

To test the generalizability of the results, two expert interviews have been conducted. The first expert works at a company that helps the entrepreneur develop their green gas project. Biogast is a technology supplier, project developer and advisory company in one. Their aim is to unburden the entrepreneur of the green gas project and be their partner to alleviate the strain of the process by being involved in each step. Biogast develops and has brought green gas projects based on co-digesters, AWZIs, RWZIs and all-digesters to the up-and-running phase and can thus provide insight into the full process.

The second expert works at the Foundation Green Gas Netherlands, which is a public-private collaboration aimed at propelling forward the biogas sector and all its utilizations, including green gas. The foundation provides low and high threshold information (website, database, experts and market developers) and is a network containing all the parties in the biogas chain. Its founders and board include gas grid network operators, municipalities, provinces and energy companies[8].

The results from the interviews with the two experts are presented in chapter 5. Research Results – comparative analysis, which help to reflect on the stimulating and obstructing factors in the comparison between cases presented there. At the end of that chapter, the input of the experts is used to draw a conclusion on the validity and generalizability of the research results of the case studies.

[8] Gemeente Leeuwarden, Eneco, Netbeheer Nederland, E.ON Benelux, provincie Fryslân, Essent, Gasterra, Nederlandse Gasunie, LTO Klimaat & Energie, Agentschap NL, provincie Gelderland and provincie Overijssel.

3. Theoretical Framework

This chapter presents the theoretical framework within which the research has been conducted. Motivations, incentives, barriers and uncertainties have been drawn from scientific literature. Thesefindings might apply to the experience of entrepreneurs in green gas, which facilitates further systematic research. In addition, some strategies to overcome obstructing factors have been identified in the literature.

It has been difficult to find literature that both has the entrepreneur at its core and is performed in a similar sector to green gas. Therefore, a selection has been made from related literature. To what a green gas project can be compared or to which other projects or developments it is considered to be alike is decisive in selecting what is considered relevant literature. To clarify this, the selection of relevant literature is justified first. Second, the gathered data is presented through the research sub-questions and is used for identifying motivations, incentives, barriers, uncertainties and strategies. Third, the conceptual model is presented.

3.1 Relevant literature

Because the production of green gas can be considered a sustainable business, stimulating and obstructing factors found in *literature on green entrepreneurs* could be argued to be applicable. Kirkwood and Walton (2010) examined the motivations of 14 entrepreneurs who started a green business. They limited their research to motivations and did not look into incentives, barriers or uncertainties. Another limitation is that Kirkwood and Walton only examine the reasons to start and not those that explain why the entrepreneur continues. However, their research is the only study in this theoretical framework with such a strong focus on motivations in the meaning of ‘the personal intention of and main driver for the entrepreneur’. The other selected literature mostly focused on incentives, ‘stimulating factors that exist outside the entrepreneur’. Another reason why the study of Kirkwood and Walton (2010) is valuable for this research is that it takes the perspective of the entrepreneur as point of departure.

Because green gas is a renewable energy, stimulating and obstructing factors found in *literature on implementation of other renewable energy technologies* might proof relevant. Meijer et al. (2007; 2010) researched entrepreneurs in biomass combustion and biomass gasification projects with a focus of the interaction between uncertainties and motivation on the start and continuation of the project. These two articles contribute the most to the collection of uncertainties, but some of their uncertainties would be considered barriers in this research. Thus not ‘a possibility that can stop or delay a project’ but a ‘factor that inhibits green gas entrepreneurs continuing their project’, a certain block. Next to those two articles, three case studies on biogas were included: Roose et al. (2012) on the main barriers regarding biogas development in Estonia; Lantz et al. (2007) on the incentives and barriers for expansion of biogas in Sweden; and Brown, Yiridoe and Gordon (2007) on the feasibility of biogas on farms in Nova Scotia. The last article gives an overview of benefits of biogas production but taking some liberty, these can be translated into incentives and barriers for venturing into biogas production. Although these three case studies all take a systems perspective, they could very well provide relevant input as a green gas project necessitates the production of biogas first.

As an entrepreneur changes his business to produce green gas, he can actually be argued to green his existing business and therefore scientific literature that explains the stimulating and obstructing

factors related to *greening business* is relevant. Runhaar et al. (2006) have created an overview of the literature related incentives and barriers regarding environmental leadership. Companies selected as environmental leaders then reflected on the found barriers and incentives. The selection by Runhaar et al. (2006) included large, medium and smaller companies, but most green gas projects are operated by small and rarely by medium sized companies (SMEs). This could mean that the research on incentives and barriers that drive environmental management implementation in SMEs by Perez-Sanchez, Barton and Bower (2003) could contribute relevant incentives and barriers to this research. They put an emphasis on the values and attitudes of managers and manager-owners, because those are assumed to influence the behavior and development of the firm. This perspective is similar to the perspective taken by this research, which puts the entrepreneur as leader at its focus. To these studies on greening an existing business, Matus et al. (2012) add a focus on *successful* greening with their empirical research on incentives and barriers to greening the chemical sector. Although Matus et al. (2012) focuses on 'success factors' to green chemistry as the opposite of barriers, some liberty is taken here to read them as incentives.

The different substrates from which green gas can be produced, are often considered waste streams (e.g. landfills, sewerage, manure, kitchen and garden waste) but energy and possibly other resources can be recovered from these streams. Therefore, it is useful to include stimulating and obstructing factors that are found in *literature on resource recovery*. Iranpour et al. (1999) describe the difficulties in general for environmental engineers in approaching waste as a resource and Desrochers (2002) focuses on the incentives and barriers to reuse of industrial by-products in his argument why industrial ecology is not something new. Two case studies have been added to this: Ammar et al. (2012) discuss the harvesting of coal mine gas, which fits on the recovered product which in both cases is gas and Bibler, Marshall and Pilcher (1998) researched waste heat recovery, each of the articles provide incentives and barriers.

The selected literature is summarized in table 1 on the next page. All motivations, incentives, barriers and uncertainties have been collected by source as they were noted in the source literature in a table, which can be found in Appendix II. In an effort to simplify the data, they have been sorted into categories, grouped and the duplicates removed. Appendix III shows the full table of motivations, incentives, barriers and uncertainties from the literature by category. Because a minority of the literature paid attention to different stages, these are not noted in the tables, but will be represented in the text. In the next sections, the found data is presented in further simplified tables and discussed in relation to the research sub-questions.

3.2 Stimulating factors

RQ1: *Which stimulating factors do green gas entrepreneurs experience in different stages of the project?*
Motivation =*the personal intention of and driver for the entrepreneur.*
Incentives =*stimulating factors that exist outside the entrepreneur.*
(Definitions as presented in ch. 1. Introduction)

Most stimulating factors found in the literature are financial and market related in nature. Second to these are the stakeholder and regulatory stimulating factors. Less often-found are the technological, supply chain, knowledge and organizational stimulating factors. Table 2 summarizes in a simplified way the types of stimulating factors as found in the literature.

Table 1: Summary of sources for literature review

Ref.	Source	Literature	Type of reserach – level of analysis	*Title*/Content
A	Iranpour et al., 1999	Resource recovery	Review – system	*Environmental Engineering: Energy Value of Replacing Waste Disposal with Resource Recovery.* With attention for biodegradation technologies, i.e. waste water treatment and sludge digestion.
B	Desrochers, 2002	Resource recovery	Historical perspective – system	*Industrial ecology and the rediscovery of inter-firm recycling linkages: Historical evidence and policy implications industrial ecology research; reusing industrial by-products*
C	Ammar et al., 2012	Resource recovery	Review - sector	*Low grade thermal energy sources and uses from the process industry in the UK.*
D	Bibler et al., 1998	Resource recovery	Multiple country case studies - sector	*Status of worldwide coal mine methane emissions and use.* About incentives and barriers to increasing harvesting and use of coal mine gas.
E	Runhaar et al., 2008	Greening business	Review & interview testing - company	*Environmental Leaders: Making a Difference. A Typology of Environmental Leaders and Recommendations for a Differentiated Policy Approach* Incentives and barriers to environmental leadership in different sectors in the Netherlands.
F	Perez-Sanchez et al., 2003	Greening business	Review - company	*Implementing environmental management in SMEs.* Barriers and incentives to implement environmental management to green SME and strategies to overcome.
G	Matus et al., 2010	Greening business	Interviews – company / sector	*Barriers to the implementation of green chemistry in the United States.*
H	Roose et al., 2012	Renewable energy projects (biogas)	Case study – country/system	*Underdog or bulldog: Introducing biogas technologies in Estonia* Biogas potential, use, barriers and incentives to implementation in Estonia with reference to success projects other EU countries.
I	Lantz et al., 2007	Renewable energy projects (biogas)	Case study – country/system	*The prospects for an expansion of biogas systems in Sweden—Incentives, barriers and potentials*
J	Brown et al., 2007	Renewable energy projects (biogas)	Case study & test modeling - company	*Impact of single versus multiple policy options on the economic feasibility of biogas energy production: Swine and dairy operations in Nova Scotia*
K	Meijer et al., 2007	Renewable energy projects (biomass gasification)	Review & case studies – company	*The influence of perceived uncertainty on entrepreneurial action in emerging renewable energy technology; biomass gasification projects in the Netherlands*
L	Meijer et al., 2010	Renewable energy projects (biomass combustion)	Review & case studies – company	*The influence of perceived uncertainty on entrepreneurial action in the transition to a low-emission energy infrastructure: The case of biomass combustion in The Netherlands*
M	Kirkwood & Walton, 2010	Green entrepreneurs	Review & case studies - company	*What motivates ecopreneurs to start businesses?* Fourteen in-depth case studies into ecopreneurs that start a for profit business with green products in New Zealand.

Runhaar et al. recognized that some stimulating factors provided reasons to 'go green', while others were incentives to 'stay green', which can be read as recognition of different stages in becoming an environmental leader. Which incentives are incentives to go greenand which incentives are incentives to stay green is not further specified in the article. Likewise, Meijer et al. (2007) find changing motivations and incentives in different stages of biomass gasification (synthetic gas) projects. When the entrepreneurs first considered the project they were motivated because they saw an opportunity to make a profit from an emerging technology (comparable to the idea & research phase), once the entrepreneurs were making steps for the realization of the project (comparable to the permits, subsidies & contracts phase) some were further motivated by hearing from successful examples abroad or by gaining political support. In their following research on biomass combustion projects, Meijer et al. (2010) found additional motivations to continue the project (after the idea & research phase): enthusiasm, feelings of entrapment and the granting of a subsidy. Both articles show that one entrepreneur may have multiple motivations, but in none of the cases an entrepreneur had all the mentioned motivations.

Table 2: Stimulating factors

Financial	**Market**
Motivated to make a profit: - recognition of an opportunity to make a profit **Profit necessary for other motivation:** - making a living/provide for family - opportunity for creating a sustainable product from waste - creating useful and productive objects from something of little value **Financial incentives:** - cash flow available (self, government, capital providers) - the project saves costs - the project generates income - costs in current practice are increasing - high energy prices / fuel - extra benefits, i.e. synergy other processes - higher profit margin eco-product than conventional product	**Motivated by the market:** - identifying a gap in the market **Market incentives:** - keeping up with competition - increasing market opportunities, distinction from competition, location, market edge - near monopoly / niche in market - consumer demand, purchase, financial incentives for consumers - customer pressure - long-term contract signing with customer - green product is cheaper than conventional
Stakeholder	**Regulatory**
Motivated by sustainability: - environment is reason for existence - perception of environmental issues as an opportunity - green values/passion for environment **Stakeholder incentives:** - benefits for the environment/inspired nature/concerned about sustainability - environmental pressure groups - internal and external image/brand improvement - prevent risk on reduced legitimacy & negative publicity in the future - support from media (attention, free publicity) - relations with customers/NGOs/other actors in	**Motivated by regulation:** - wish to comply with regulations **Regulatory incentives:** - helps to comply with traditional regulatory pressure - anticipate future legislation - opportunity arisen from other policies, i.e. landfill ban - clear government stance stimulates - stimulating policies, i.e. subsidies or lowering economic barriers

sectorimproved - support from regional government (not subsidies) / neighbouring households	
Supply chain & Organization	**Knowledge & Technology**
Motivated by organization - being their own boss / being independent, i.e. from national power grid - escalating commitment, feelings of entrapment - passion/enthusiasm, i.e. about own business, products **Organizational & supply chain incentives:** - champions at upper and technical levels - cooperation with complementary partners - improve internal working climate - performance metrics that are integrated into goals and strategy - clear other benefits i.e. for health & safety, reduced odors - supply chain pressure - availability of & access to waste stream - long-term contract signing with resource & tech suppliers	**Motivated for knowledge:** - wish to educate others with business / project **Technological & knowledge incentives:** - availability & provision - promising technology / opportunity new innovation - existing infrastructure available and compatible - positive experiences own/others' projects - view of technology as highly efficient/proven/experiencing difficulties is normal

3.3 Obstructing factors

RQ2: *Which obstructing factors do green gas entrepreneurs experience in different stages of the project?*
Barriers = *factors that inhibit green gas entrepreneurs continuing their project, acertain block.*
Uncertainty = a *possibility that can stop or delay a project.* (see ch.1)

The obstructing factors found in the literature were more evenly spread over the different categories than the stimulating factors as can be seen in table 3 which summarizes in a simplified way the types of obstructing factors as found in the literature. There were also more different factors, which perhaps is due to the fact that the found obstructing factors are more sector/technology/case specific than the stimulating factors (i.e. Bibler et al., 1998 on coal mine gas or Ammar et al., 2012 on thermal heat recovery). For example, in the article on greening chemistry by Matus et al. (2012) some of the found barriers seemed so specific to green chemistry innovations in the United States that they were excluded.

While organization, supply chain and knowledge factors were small categories in stimulating factors and therefore presented together with another factor in table 2, these three categories now present a diverse list of obstructing factors. These categories were especially strongly represented in literature on greening existing business, i.e. on green leadership and on greening SMEs. In many of the articles, regulatory barriers score a top three position forimportance (i.e. Runhaar et al., 2010; Matus et al., 2012; Roose et al., 2012, Brown et al., 2007; Desrochers, 2002).

For obstructing factors, a distinction in different phases is easier to discern from the literature than for the stimulating factors. This can be illustrated with the technological barriers, which at first are uncertainties (comparable to idea & research phase and permits, subsidies & contracts phase), i.e. 'uncertainty about the choice between different alternatives' and which will only in the stage of building and testing cause the barrier 'malfunctioning technology' in Meijer et al. (2007). On a different level is the distinction made between phases in the article on SMEs, where the initial attitude of the manager matters for a project to start (idea & research phase): i.e. the view that the

SMEs make no or low environmental impact and the view that the environment is not a core business issue (Perez-Sanchez et al., 2003). However, if the SMEs reach the stage in which their managers have environmental concerns and decide on implementation, other barriers arise: i.e. a lack of procedures for change and a lack of basic education (Perez-Sanchez et al., 2003). In the phase after implementation of environmental management (comparable to the up-and-running phase) other barriers can be identified, named as *disbenefits*. For instance that there were more resources needed than expected or the developed system was bureaucratic and ineffective (Perez-Sanchez et al., 2003). The development of obstructing factors is most clear in Meijer et al. (2007, 2010), who show that not all uncertainties matter equally and that some uncertainties are more important in different stages of maturity of the project.

Thus, although phases are not a main focus in the selected literature, enough evidence is present that a collection of stimulating and obstructing factors per phase is relevant and will reveal differences between phases.

Table 3: Obstructing factors

Financial	**Market**
Financial uncertainties: - about benefits / cost savings - about financial resources needed - about available financial instruments / resources (unreliability of investors) **Financial barriers:** - high initial investment / running costs - limited support money (subsidy too low) / hesitant capital providers - lack of economical feasibility / profitability - previous investments, reluctance to abandon & costly to remove - lack of surplus capital & resources	**Market uncertainties:** - about the behaviour of competitors - about the customer preferences / demand / compatibility **Market barriers:** - competition is locked-in / cheaper / free-riders strain profit - low - modest consumer demand / not willing to pay - negative image of sustainable products, i.e. more expensive, less effective, too many eco-labels - low or variable product quality - (seasonal) variations in supply and demand - lack of possibility to sell product
Stakeholder	**Regulatory**
Barriers from stakeholders: - lack of social acceptance / willingness to cooperate - objections/resistance because of the environment - community resistance because of non-environmental reasons - skeptical NGOs towards environmental leadership - reticent sector	**Regulatory uncertainties:** - from many changes & unpredictability - about the political behaviour & policies development - about interpretation of current policy and procedure **Regulatory barriers:** - lack of appropriate / harmonious policy framework / legislation / policy - passive/ineffective government - bureaucratic, tedious, too many rules, leading to complexity and more work - rigid rules obstruct innovation / use of resource / emissions - regulation has wrong focus, i.e. favours other tech, or on knowledge instead of production - lack of or inadequate enforcement of regulations - institutional change, i.e. disruptive new law - increased liability
Supply chain	**Technology**

Supplier uncertainties: - about the reliability of technology / resource suppliers - about resources, i.e. amount, availability, price **Supply chain barriers:** - technology supplier cannot resolve tech issues - past negative experiences with supplier - low co-operation in supply chain, difficult to force others i.e. if only one subcontractor - lack of availability / low quality of resources - competing methods that use same resource are locked-in	**Technological uncertainties:** - about the technology itself - about the relation / interaction between the new technology and the technical infrastructure - about the choice between different (future) technological alternatives - diminished faith in technology from negative stories about unsuccessful implementation abroad **Technological barriers:** - a lack of incompatible necessary infrastructure / technology / eco-production methods - scale necessary to efficiently use the technology - difficult to implement complicated tech, every case is unique, dif. requirements for stable functioning - good results competing technologies - geographical distance between recovered source and use - malfunctioning technology / technical difficulties
Organization	**Knowledge**
Organizational uncertainties: - about human resources needed - about how to organize the innovation process - about associated health risks **Organizational barriers:** -'champion' of the greener product/process is not in a position of power - different interests between different divisions within an organization - lack of procedures for change / reluctance to plan - employees / manager not eco-minded - management / company has view that environmental improvements are expensive and not worthwhile / are not a core business issue - manager unwilling to bare perceived uncertainties of project / actions do not reflect personal attitudes - changes in actor constitution, i.e. cooperation fails **Other barrier: uniqueness each project**	**Knowledge uncertainties:** - because product / project / technology seen as 'new', not much known about - about the knowledge required for the project **Knowledge barriers:** - lack of skills, knowledge and expertise in company / employees / owner - lack of awareness / understanding of environmental problems - lack of understanding risks or/and the potential of improvements - large number of involved / necessary disciplines - availability and access to knowledge lacking / not appropriate / data and information gaps - very few experts - lack of knowledge / awareness by customers - communication difficulties between market actors and towards consumers

3.4 Strategies

RQ3: *What kind of strategies do entrepreneurs apply when they encounter obstructing factors?*
Strategies = *different approaches to overcome uncertainties or barriers.* (see Ch.1)

Of the selected literature only the two articles by Meijer et al. (2007; 2010) pay attention to strategies applied by entrepreneurs to handle obstructing factors. Meijer et al. (2007; 2010) state that negative feedbacks such as uncertainties can be mediated by strategies, mostly of the knowledge-gathering-type. Moreover, strategies can become part of positive feedbacks, where the outcome of one strategy is an incentive to continue. In the 2010 article, Meijer et al. define five categories of strategies (2010, p. 1233): studying, experimenting, knowledge acquisitioning, cooperating and

lobbying. In table 4, examples of these strategies found in Meijer et al. (2007; 2010) are shown and examples of barriers and uncertainties they are a strategy for.

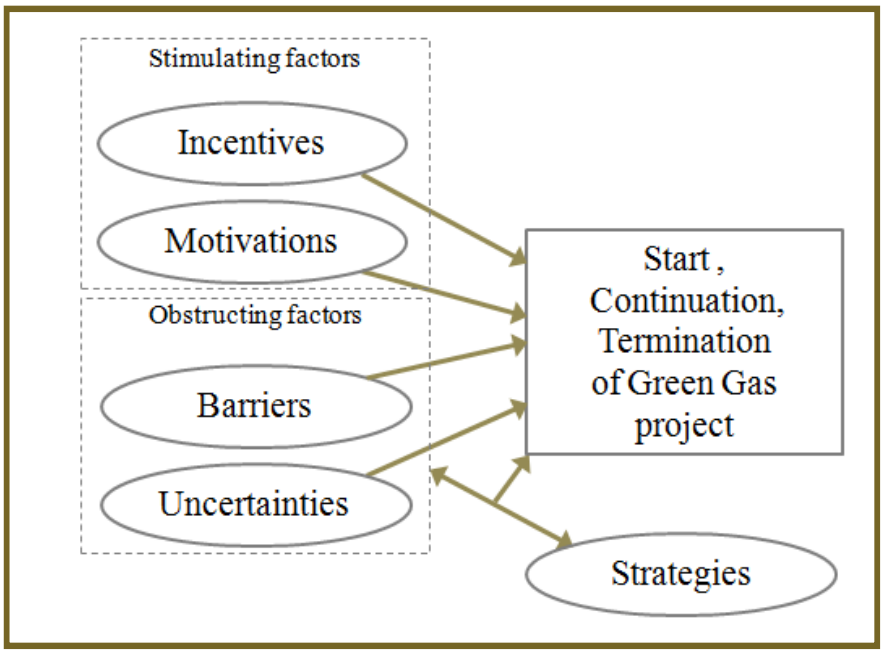
Table 4: Strategies

Category	Strategy example	Obstructing factor example
Study activities mostly idea & research phase	- selecting suppliers by means of an elaborate selection procedure	- uncertainty about the supplier
Experimenting activities mostly implantation stage = building & testing	- keep several options open to manage technological uncertainty - active engagement in technology-development activities to build-up technological know-how	- uncertainty about functioning of technology
Knowledge-acquisition	- contracting technological experts	- uncertainty about resources
Cooperating	- cooperation with biomass suppliers and external investment partners - cooperation with energy companies	- uncertainty about the actions of technology or biomass suppliers - uncertainty about resources / finance - uncertainty about consumer
Lobbying	- organize communication events to discuss issues with opponents - initiate dialogue with the local government authorities	- barrier: lack of support from investors - uncertainty: about the mobilization of financial resources - uncertainty about political support local authorities, possible objections to project

3.5 Conceptual model

Based on the findings from the literature and the concepts presented in 1. Introduction, a conceptual model has been developed. Figure 1 shows that every factor category is expected to have its own influence on the outcome, the start, continuation and/or termination of the green gas project. Figure 2 shows that the outcome of obstructing factors and strategies is expected to influence the start, the continuation and/or the termination of the green gas project.

Figure 1: Conceptual model



4. Research Results – case studies

In this chapter, the research results are presented as case descriptions per entrepreneur, with a table summarizing each case. Each case descriptions presented under 4.2 briefly narrates the phases the project has passed through and the stimulating and obstructing factors encountered in these phases. Because the case selection leans on the presented literature review in the Theoretical Framework chapter, it has been brought into this chapter instead of the Research Design and is presented under 3.1 Case selection.

A difficulty with the research method surfaced during the data collection. First, it was assumed that the visual aids would help the interviewees to rank the different factors as they occurred in each phase. However, the entrepreneurs found it very difficult to comply with the ranking task: either they saw factors as equally important and reinforcing each other, or they ranked the factor importance in order of occurrence. For example: although it was the lack of a permit from the municipality that formed a barrier to continue the project, it was community resistance that had led to this decision, which came forth from negative press. Therefore, the interviewee ranked the negative media attention as the most important barrier. Because there was also a great diversity in amount of factors found in each phase between the different entrepreneurs, the researcher has chosen to only emphasize what the entrepreneur ranked as 'most important', by presenting these factors in bold in the tables that summarize each case.

4.1 Case selection

Within the domain of all green gas projects in the Netherlands, a lot of variation can be found that possibly influences which stimulating and obstructing factors occur. Factors can be expected to be different within categories, relating to these variations, for example: regulatory factors can differ because of the local institutional context of the green gas project, which is dependent ofpermits and support on the province and municipality. Another example: organizational stimulating and obstructing factors can be typically different for consumer-oriented companies (e.g. literature on green leadership and SMEs) than fornon-consumer oriented companies (e.g. harvesting coal mine gas). Likewise, a large or a small production of green gas could foreshadow different obstructing and stimulating factors, for instance related to the public opinion (stakeholder factors) or the investment possibilities which scale offers (financial factors).

One variation that relates to multiple categories of factors is that of the type of biogas production, which is necessary for green gas production (landfill, sewerage, food & beverage industry based, all-digester, co-digester etc.).

1. **Supply chain factors** differ, because the biogas can be produced from different substrates, which are acquired in different ways.
2. **Technological factors** differ because the different substrates are processed with different digester and upgrading installations.
3. **Market factors** differ, because the digestate is a different product, for instance the digestate from co-digestion is considered manure, from all-digesters is considered waste and there is no digestate when landfill gas is subtracted, which means the digestate needs to be offset on different markets.
4. **Organizational factors** differ, because the different type of biogas production types often relate to different company sizes and structures. For example a co-digester is often

operated on a farm and a sewerage gas installation might be operated in a company with more employees and organizational hierarchy.

Thus, to be able to say something about the stimulating and obstructing factors in the domain of green gas projects by examining one unit, the research units are selected in such a way, that they show a lot of similarities as recommended by Verschuren and Doorewaard (2010). This selection is based on the type of biogas production, because this influences supply chain, market, technological and (often) organizational factors. Table 5 shows a summary of the information retrieved in August 2012 and February 2013 from the 'opportunities-map' (Stichting Groen Gas Nederlands, 2013) an online tool to keep track of biogas developments and their status in the Netherlands, combined with information from Energy Matters (2012). The contents of table 5 must be read as estimations of phase and type of digester, not only because the projects in development might have moved to up-and-running or have quit, but also because the projects might have switched to another substrate category in the process of development.

Table 5: Cases in the domain of green gas

Phase	**Substrate category**					
	AWZI/RWZI	VGI	Special digester / other*	All-digester	Co-digester	Unknown
up-and-running	8	4	1	8	4	0
in development	2	1	2	11	12	0
quit / unknown	1	1	2	1	4	2

*Special digester often means that next to green gas or instead of green gas, bio-ethanol is produced.

The co-digesters and the all-digesters form the two largest groups, as can be seen in the table. A limited research into the two categories (by scrutinizing the list of projects provided by Energy Matters, looking up definitions of the different substrate categories and surfing the website of individual projects) reveals a greater diversity between projects that are grouped under all-digester. Furthermore, the boundaries between what is considered a food & beverages industry based, special, other and all-digester are vague and the categories used by Agentschap NL for the provision of subsidies have changed throughout the years as well. In fact, the digesters are at times grouped together as 'industrial digesters', with the common factor that they do not use manure as substrate. The co-digesters form a more homogenous group based on type of organization (mostly family run businesses, farms or agricultural contractors) and substrates used, which allows for the narrow selection advised by Verschuren and Doorewaard (2010).

A consequence of going for depth instead of breadth by choosing a more homogenous group based on 'substrate category' is that the domain this research covers goes from over sixty green gas projects, to the domain of just seventeen green gas projects based on co-digesters. In Appendix IV all co-digesters have been collected[9].

Although the green gas projects based on co-digesters are considered to be more homogenous than those based on all-digesters, these projects also have some points of divergence, which could lead to different outcomes regarding stimulating and obstructing factors. Did they already operate a

[9] There are discrepancies between the numbers found in Table 5 on co-digesters and the table in Appendix III, because during the research some data turned out to be inaccurate. For instance, two co-digesters had been converted were actually all-digester projects and one co-digester that was registered as up and running green gas project, turned out not be feeding in.

co-digester with micro-CHP? In which municipality and province are they located? Is it a farmer or an agricultural contracting business? To be able to say the most about the domain of green gas projects based on co-digesters with the least case studies, the selection has been based on breadth. In table 6 some differences have been collected and numbers are given to count the amount of cases that fit the description. Next to these dichotomously presented differences, there is the size of the (aimed for) green gas production, which ranges in the selected cases from 200 Nm^3/h to 950 Nm^3/h.

Table 6: Differences between cases

Type of difference	Yes	No
Previous activities: Operating a co-digester with micro-CHP before green gas project	4	2
Organization: Farmer, not agricultural service company	4	2
Location in country: Within 100km of other selected case	2	4

Lastly, the research question has the explicit aim to describe different phases. The ideal study would be a longitudinal approach with multiple measure points in time to actually be able to note the stimulating and obstructing factors for each case as they occur and change in time. However, due to the limited time for this research, the temporal dimension is approached through retrospection. It is possible however that the recollection of the facts by the interviewees is different at the end of a project. Therefore, in addition to retrospection, cases are selected that are in different phases. The phases are noted below, with the amount of selected cases in brackets:

1. Idea & research phase
2. Permits, subsidies & contracts phase (3)
3. Building & testing phase
4. Up-and-running (feeding gas into the network) (1)

0. Quit / on hold (2)

It was difficult to selecta case foreach phase, because there is no source that keeps track frequently enough of the phase in which a green gas project is (Foundation Green Gas updates every half year, but not in such detail, they only make a distinction between expected and up-and-running). In the selection of cases, there is no case in the idea & research phase, because cases in the idea & research phaseare not registered anywhere. Furthermore, there is no case included that was building & testing, although one of the cases that was still in the previous phase was at “the verge of construction”. There was only one case in the up-and-running phase, due to one of the selected cases being wrongfully registered as up-and-running by Energy Matters (2012). Accidentally, a case was selected of an all digester, which had been wrongfully registered as co-digester – the results of this 7th case have been kept separate. Lastly, there has been an effort to include terminated projects, which are not just on hold, but the two projects that were known (because of articles online) to have quit did not respond to the researchers attempts for contact. The effects of the case selection on the outcomes of the study have been minimized by including expert interviews.

4.2 Case descriptions

The case descriptions aim to describe the experience of the entrepreneur in each single case, to reveal the stimulating and obstructing factors and the strategies applied per phase. The names of the entrepreneurs have been replaced by fictive names; however the interviewees are aware that anyone familiar with their project could recognize their case. The cases are presented in no particular order.

Entrepreneur 1: Mr. East
Personal communication 23/04/2013

Mr. East runs an agricultural contracting business, specialized in processing and spreading manure and producing silage grass. He started this business 25 years ago from the small family farm business owned by his father. As Mr. East was an early adopter of the digester, his story comprehends all phases for his co-digester. However, he is still in the permits, subsidies & contracts phase with his green gas project. Table 7 summarizes the case.

In the *idea & research phase,* Mr. East was inspiredto look into digesters after he saw digesters pop-up in Germany in 2000. Mr. East was motivated by the possibility to earn more from the manure his company was processing and the possibility to regain nutrients and commercializing those. The entrepreneur recognized that his company had a competitive edge; because of the manure streams his company was processing already, the existing infrastructure for manure storage, the location near a waterway that provided the possibility to ship the manure to and from the digester and the fit with the existing company and activities. According to Mr. East, the availability of the MEP subsidy was a necessary incentive to create a profitable business case with a digester in combination with a micro-CHP. Mr. East explained that even if financial gain is the desired outcome, passion for the project is needed "*an entrepreneur is always occupied with making money*"[…]"*but you need to have a feeling for the project*" (personal communication, 23/04/2013). And, says Mr. East, it is not about the desired outcome of making money; it is more about the 'kick' of how to get to that desired outcome. When prompted, Mr. East says that re-use and recycling loops were appealing to him, yet in a lower importance than his passion for technology and the kick of entrepreneurship.

He did not experience any barriers or uncertainties in this phase: "*In the beginning, you don't see any clouds in the horizon, they only take shape later*"[10]; Mr. East reasons that entrepreneurs would not undertake as much if they were aware of all possible problems in advance.

In the *permits, subsidies & contracts phase,* Mr. East was still motivated by recognizing the opportunity but preferred to have the least risk possible. As a strategy, he attracted a second party of project developers to execute the plan and to be the main shareholders. He now refers to them as 'entrepreneurs from behind their desk and computer screen' and as 'slick ricks'. Because the bank demanded it, Mr. East became a 17% shareholder in the project.

In the *building and testing phase* the difficulties with the digester and micro-CHP started. Mr. East says this was due to a lack of knowledge by the project developers who held the main share: "*These slick ricks had no clue about menu and biology necessary for the operation of the digester*"[11](personal communication, 23/04/2013). After buying out the project developers, Mr. East managed to run the digester and micro-CHP with more success in 2009 and 2010 (*up-and-running phase*). However, there were two developments in the *up-and-running phase* which presented barriers, 1) the price of the main co-streams used in the menu of this digester, glycerin, doubled and 2) the price he was paid for electricity halved.

[10] "*altijd als je ergens aan begint, dan zie je ze nog niet, de beren op de weg komen pas later*".
[11] "*Deze snelle jongens hadden geen benul van menu en biologie en alles wat komt kijken om zo'n vergister te laten werken.*"

Table 7: Case entrepreneur 1 – Mr. East

	Factor			
Phase	Motivation	Incentives	Barriers	Uncertainties
Idea & research	• **recognition of an opportunity to make a profit (D)** • identifying a gap in the market (D) • passion (D) • **entrapment, financially necessary** • to be a link in the regional recycling loop • no more passion / faith in societal role product	• **competitive edge, market opportunity (D)** • information provision & positive experiences others (D) • **unprofitability MEP micro-CHP** • SDE subsidy green gas • existing infrastructure available and compatible • availability of & access to co-streams • experience with renewable energy • fits with existing activities of business • trust in own organization	• no barriers	• **profitability** *- strategy (D): partnering with energy/tech companies* • financial resources *- strategy (D): partnering with energy/tech companies* • co-streams • reliability of co-stream suppliers • granting of permits by government *- strategy: information provision towards parties involved*
Permits, subsidies & contracts	• **entrapment, financially necessary**	• manure processing regulation provides opportunity • incentives from idea & research phase continue to matter	• **rigid rules obstruct project** • lack of economical feasibility • lack of permit • community resistance	• **changing & unpredictable subsidy regime** • profitability • changing (related/manure) regulation
Building & testing			• **difficulties / malfunctioning technology (D)** • negative experiences with tech supplier (D)	
Up-and-running			• **lack of knowledge (D)** • market competition from those with newer/foreign subsidy schemes (D) • increasing costs of resources (D) • middlemen drive up cost resources (D) • lack of (good quality) co-streams (D)	• reliability of co-stream suppliers

(D) Digester specific. Entrepreneur already has an up-and-running co-digester with micro-CHP and factors followed by a (D) relate specifically to those experienced going through the phases before a green gas installation was considered.

Bold: Factor was ranked as most important in this phase.

Regular: Factor was named by the entrepreneur as obstructing/stimulating.

Cursive: Strategy named by entrepreneur to overcome barrier/uncertainty.

The entrepreneur explains that the source of the main problems with rising prices for co-streams for digesters stems from the policies of the government, which by creating a new subsidy scheme every year, creates an unlevelled market playing field where new developments have more resources to spend on co-streams. Mr. East states, that because of the subsidies a market for these co-streams that were previously considered waste has formed, this new-formed marketis exploited by middlemen that drive up the prices.

Mr. East says heentered the *idea & research phase* for a green gas project because of the impossibility to run the existing digester and micro-CHP in a financially viable way with the insufficient MEP subsidy. The availability of the SDE 2010 further incentivized him to explore this possibility. Moreover, the entrepreneur continues that he is convinced by the fit of his current activities and location with his manure processing and co-digester activities, and he even reports he now has additional experience in and knowledge about running such technology. Mr. Eastsees upgrading to green gas as only adding a small step to the existing process.

The project is now on hold, as Mr. East has run into barriers in the *phase of subsidies, permits and contracts*. The main barrier according to Mr. East is institutional: his permit allows him to process a certain tonnage of co-streams in the digester, which was authorized on a digester running mainly on wheat, maize and glycerin. These products, glycerin especially, have a high energy value per weight and are also expensive. Mr. East now runs his co-digester on cheaper fluid 'unpacked mix', waste products from the human food industry. The calorific value of this fluid mix is much lower (but still higher than the 50% of manure that goes into the digester) and more tonnage is needed to be able to run the digester at full potential; however Mr. East is not granted a larger permit by the province, due to an (in Mr. East his opinion unjustified) odour complaint.

Every day the co-digester is running at a loss and the motivation to continue is the entrapment the entrepreneur feels, the passion for the project isgone: "*the digester is like my ball and chain*"[12] (personal communication, 23/04/2013). While initially Mr. East was charmed by the idea of recycling loops and re-using, he now has lost his faith: "*Digesters are terribly inefficient. The supply and discharge of streams, the upkeep.* [...] *Say, I feel that.. That's just impossible* [...] *If financial losses are suffered, then it can't be sustainable, can it?*"[13] (personal communication, 23/04/2013).

As an entrepreneur, Mr. East does recognize possible incentives in the future, "*of course there are rays of hope*"[14] (personal communication, 23/04/2013), for example the possible introduction of a manure processing obligation. The future of his green gas project has two main uncertainties,according tothe entrepreneur: 1) the unreliable government, will it keep changing its subsidy regime and regulations? And 2) the tight financial viability related to the market, how will the markets of co-streams and for digestate develop? Still, the only way to quit would be to let the co-digester branch of his business go bankrupt, whichis not how Mr. East says would like to see it.

According to the definition of success presented in the first chapter of this research (1.4 Working definitions), namely "*a project that has reached the up-and-running phase is considered successful and a project that is stopped or on hold is considered unsuccessful*", the project of Mr. East does not

[12] "*De vergister is een molensteen om mijn nek*".
[13] "*Vergisters zijn ontzettend onefficient, aan-en-afvoer van producten, het onderhoud.* [...] *Voor mijn gevoel zeg maar, ken dat nooit.* [...] "*Als er verlies wordt geleden dan is dat toch niet duurzaam?*"
[14] "*Natuurlijk zijn er wel lichtpuntjes*".

need to go bankrupt to be considered unsuccessful; it is on hold and therefore is considered unsuccessful.

Entrepreneur 2: Mr. South

Personal communication 24/04/2013

Mr. South is co-owner of a large pig farm and additional acres of cropland, which he runs with his brother and wife, next to a 40-hour job. The entrepreneur does not have a co-digester and the green gas project is on hold; the project stranded in the permits, subsidies & contracts phase. The case of entrepreneur 2 is presented in table 8.

After a horticulturist approached Mr. South in 2005, who wanted to buy some land from Mr. Southfor a digester, the entrepreneur became interested to exploit the idea of a digester with micro-CHP himself and entered the *idea and research phase*. He reports to be incentivized by a market for heat, electricity and CO_2, because he is located in an area with many greenhouses. His main motivation to start the project is the stability and continuity of the family business by diversifying its income streams,incentivized by the low prices for agricultural products, says Mr. South. He was further incentivized by his location: easily accessible for the increased transport movements and near the 40-bar gas network and feed-in point. Prompted, Mr. South answered that ideological thoughts were not leading when considering such a big investment. In the idea and research phase he foresaw no barriers or uncertainties, just opportunities. His eyes lit up as he said: *"undertaking, if you want to uptake a business or make something, that's entrepreneurship, that's fun. That's research, that's solving problems, that is plain undertaking*"[15](personal communication, 24/04/2013).

At first, the project ran smoothly. In the *permits, subsidies and contract phase* Mr. South applied a strategy of partnering: by getting partners with a good image on board, he expected that it would be easier to be granted permits and subsidies, lowering uncertainty. He reasoned that this would also help him finance the project, as he negotiated that his partners would pay for a 50% share (lowering uncertainty about financial resources). Moreover, the entrepreneur applied the strategy of information provision towards stakeholders to deal with the uncertainty around permits: he invited the municipal committee for urban planning on a field trip to a university and a well running digester to familiarize them with the type of project he was proposing, after which those on the committee seemed to hold a positive view.

However, in the phase of *permits, subsidies and contracts*, community resistance was formalized by the collection of 400 autographs against the digester and this proved a large barrier according to Mr. South. The committee of the municipality that was at first very willing to grant Mr. South a permit followed the opinion of the public. An additional difficulty was that Mr. South is active in local politics, which meant he could not be present at the municipal meetings to defend or explain his proposal as is conventional in the procedure, because that would be considered a conflict of interests. Thus, he could not apply the strategy of lobbying. Mr. South attributes the community resistance to the barriers of a lack of knowledge amongst the public about digesters and the bad representation in the media, which just focuses on a few bad cases. He holds the government responsible, because the governmentdoes not close the bad cases (barrier of lack of inadequate enforcement regulations). In the Netherlands it is difficult to get a(n environmental) permit, but once a business is in operation regulations are not enforced, according to the entrepreneur.

[15] "*ondernemen, als je zaken wilt oppakken of wilt gaan maken, das ondernemen, das leuk. Das uitzoeken, das problemen oplossen, das gewoon ondernemen*".

Table 8: Case entrepreneur 2 – Mr. South

	Factor			
Phase	Motivation	Incentives	Barriers	Uncertainties about
Idea & research	• **continuity of family business** • less risk, diversifying income streams • identifying a gap in the market • passion for pioneering, innovation, entrepreneurship, technology	• **low prices for agricultural products** • competitive edge, market opportunity • existing infrastructure available and compatible	• no barriers	• (seasonal) consumer demand
Permits, subsidies & contracts	• no more motivation	• manure processing regulation provides opportunity	• **community resistance** • lack of permit *- strategy: information provision to parties involved* • lack of or inadequate enforcement of regulations • lack of knowledge • negative media / image	• changing & unpredictable subsidy regime • changing (related/manure) regulation • financial resources • *- strategy: partnering with energy/tech company*
Building & testing				
Up-and-running				

Bold: Factor was ranked as most important in this phase.

Regular: Factor was named by the entrepreneur as obstructing/stimulating.

Cursive: Strategy named by entrepreneur to overcome barrier/uncertainty.

Second to the main barriers of community resistance and a lack of permit were difficulties that arose in specifying the main customer for the green gas, says Mr. South. Because of daily fluctuating and seasonal demand, neither horticulture nor a residential area seemed to require enough gas for the large development thatMr. South was proposing. He downsized the project, also to decrease the worries of the community about transport movements and odour, but the harm had already been done and the committee will not grant him a permit. Mr. South now has a different location in mind, but has put the project on hold as he awaits local elections and for the public opinion to soften. His main uncertainty for the future is that of the reliability of the government; he said that the SDE subsidy is like a lottery, and you never know what the government will do. He concludes:

"Looking back, yes, whether I regret that the process has stranded there, that's another story. I don't regret it. It has cost me some money, it easily sets you back 20-30.000 euro, but on the other hand, if I had made the investment, I don't know if my business would have survived it"[16] (personal communication, 24/04/2013). The green gas project of Mr. South is considered an unsuccessful project according to the definition in this research.

Entrepreneur 3: Mr. Middle

Personal communication 25/04/2013

Mr. Middle runs a family business with his brother. They own a smaller than average (for Dutch standards)dairy farm and have outsourced the accompanying crop land. The entrepreneur has added wind farming and a co-digester with a micro-CHP to the agricultural activities; the micro-CHP has now been replaced by a green gas upgrading installation. The case of Mr. Middle is the only case with an up-and-running co-digester and upgrading installation. Table 9 gives an overview of the stimulating and obstructing factors encountered by Mr. Middle per phase.

In the *idea & research phase* the main incentive to start with a manure co-digestion was the thin margins for agricultural produce said Mr. Middle. He said that like with the wind farming, he was motivated to expand his business. The entrepreneur reports to have experienced uncertainty because of the complexity of such a project and as a strategy he partnered with a company in renewable energy that could help him set-up a co-digester with micro-CHP.

Mr. Middle did not share any particular obstructing or stimulating factors in the next two phases, which he remembers as going well due to the cooperation with his partner. However, in the *up-and-running phase* he did experience barriers. The production of electricity and heat were not without difficulties: 1) the installation malfunctioned often, 2) a lot of heat was lost and could not be put to use, as, Mr. Middle said with disappointment, neither the nearby camping nor pool wanted to purchase it, and 3) the electricity prices dropped. However, Mr. Middle says he managed to not make a loss on his co-digester with micro-CHP like he saw other entrepreneurs do, because he had added an extra micro-CHP engine at the right time, scaling his business up and preventing the venture frombecoming unprofitable.

[16] "Achteraf gezien, ja of dat ik rouwig ben dat het proces daar gestopt is, dat is een ander verhaal. Ik ben daar niet rouwig om. Het heeft me wel wat geld gekost, je bent toch gauw 20 tot 30.000 euro lichter, maar van de andere kant, als ik de investering had gedaan, dan weet ik niet of ik met mijn bedrijf boven water gezeten had."

Table 9: case entrepreneur 3 – Mr. Middle

	Factor			
Phase	Motivation	Incentives	Barriers	Uncertainties
Idea & research	• **less risk, diversifying income streams** • wish to expand business • to be a link in the regional recycling loop	• information provision & positive experiences others (D) • low prices for agricultural products (D) • trust in & cooperation with complementary partners (D) • availability of capital • experience with renewable energy • **SDE subsidy green gas** • unprofitability MEP micro-CHP • stable/interesting market • availability of capital • experience with renewable energy • trust in & cooperation with complementary partners	• no barriers	• general - complex, long-term *- strategy: research for decision making* • requirements & costs network operator
Permits, subsidies & contracts	• **entrapment, financially necessary**	• **unprofitability MEP micro-CHP** • fits with existing activities of business	• **rigid rules obstruct project** • delays from institutional process, tedious/slow • lack of permit • negative experience with network operator • reticent sector / possible partners (D)	• general - complex, long-term *- strategy: partnering with energy/tech company* • requirements & costs network operator
Building & testing	• **entrapment, financially necessary**	• **unprofitability MEP micro-CHP**	• **negative experience with network operator** • reticent sector / possible partners • rigid rules obstruct project • low / variable product quality (gas)	
Up-and-running	• entrapment, financially necessary	• **positive view of technology** • availability of & access to co-streams • trust in societal role product / sustainability	• **market competition from those with newer/foreign subsidy schemes** • rigid rules obstruct project	

(D) Digester specific. Entrepreneur already has an up-and-running co-digester with micro-CHP and factors followed by a (D) relate specifically to those experienced going through the phases before a green gas installation was considered.

Bold: Factor was ranked as most important in this phase.

Regular: Factor was named by the entrepreneur as obstructing/stimulating.

Cursive: Strategy named by entrepreneur to overcome barrier/uncertainty.

However, Mr. Middle entered the *idea & research phase* for the green gas upgrading installation when the market changed again and he estimated that he could not run the digester with micro-CHP profitably any more. Mr. Middle says that he was incentivized by the knowledge and experience he had gained in the field of producing renewable energy for the green gas project: *"I know exactly how it has to be done and that works just fine*"[17]. In addition, Mr. Middle said that the positive experience with the partnership for the micro-CHP made him apply this same strategy to battle the uncertainty of the overall complexity of the green gas project, this time by partnering with Biogast, which he fully trusted. Another incentive in this phase was that Mr. Middle reported to have more trust in the gas energy market than the electricity market. In this phase Mr. Middle did not foresee any barriers, especially because the bank told him he had the financial possibilities (incentive of available capital) and the partner company would take all difficult issues out of his hands.

In the *permits, subsidies & contract phase*, the project of Mr. Middle was not selected for an SDE subsidy in three consecutive years, yet he sees the SDE 2011 as a good subsidy scheme and an incentive. In this phase Mr. Middle ran into the first barriers regarding the green gas project. The main barrier according to the entrepreneur came from the municipality. It was very strict about the location of the upgrading installation, as it turned out there was a perimeter on the plot, which ran through the location desired by Mr. Middle. Help of the province was necessary to keep the dialogue and permit process going and result in a permit explains Mr. Middle. The second most important barrier came from setting up a contract with the gas grid network operator (from here on: network operator), who offered to build the necessary pipeline for one million euro. Mr. Middle explains that he asked for a quote by the same contractor that would execute the work for the network operator: he could do it for 280.000 euro. Alas, Mr. Middle could not get a permit to build this pipeline under his own management, as the municipality only allows network operators to build pipelines. In the end the network operator built the pipeline for over 400.000 euro, but the barrier had already caused a delay, shares the entrepreneur. Feelings of entrapment, says Mr. Middle, kept him going in this phase after encountering these barriers, but also the incentives of the trust in the cooperation with a complementary partner and the fit of the activity with his organization and current activities. As time went on, electricity prices kept dropping, reconfirming his hunch to invest in the gas market.

The largest barrier Mr. Middle reports to have experienced in *the building & testing phase* again had to do with the network operator. While Mr. Middle had started building and spending large sums on the project, the network operator caused a huge delay by sending a contract with additional requirements for the gas quality claimed the entrepreneur. The requirements were related to new Dutch policy that may come into effect and were different to the current legal requirements which are based on the largest Dutch gas field in Slochteren, he explained. Mr. Middle continued the story with frustration: the negotiations had cost a lot of time and at times the issue almost went to court. Mr. Middle experienced the network operator as very strong in the legal department and felt alone. In the end they managed to settle to requirements the installation of Mr. Middle can achieve. However, he now finds himself in a weak financial position, having made losses between his investment and getting the production going for the return on his investment.

Mr. Middle has one of the few *up and running* green gas installations to upgrade gas from a co-digester. He is pleased with the installation compared to the engines of the micro-CHP; he feels there is less malfunctioning; "it is a breath of fresh air". Moreover, Mr. Middle adds that he is stimulated

[17] "*ik weet precies hoe het moet en dat gaat gewoon goed*"

for his project because he believes the story behind green gas: it works well, is more sustainable than the micro-CHP and helps him to get energy from waste streams that would otherwise be wasted (i.e. incentive of trust in the societal role of the product). The barriers Mr. Middle now experiences are related to the co-streams: 1) many of the good waste streams go to Germany because the entrepreneurs have more to spend due to better stimulation measures, 2) the government restricts what is allowed to be digested in a 'narrow minded way' and lastly 3) the regulations that define the digestate as manure, binds it to stringent rules, which makes the digestate a large continuous expense and difficult to get rid of.

Looking back, Mr. Middle says: *"We have had a lot of problems. I would never do it again, it is just not bestowed on you"*[18](personal communication, 25/04/2013). Akin the definition of success presented in the first chapter, the green gas project of Mr. Middle is considered a successful project.

Entrepreneur 4 – Mr. Border

Personal communication 29/04/2013

Mr. Border is employed in an agricultural contracting company that executes sowing to harvesting and is specialized in soil works and transport. He is head of the digester-branch of the company. It was 14-15 years ago that he and the head of the company, 'Senior', recognized the surplus of manure in the region and decided to do some research in what their role could be, as they were already involved in transporting and spreading manure. The company was one of the first to invest in biogas with a micro-CHP. The stimulating and obstructing factors experienced per phase are summarized in table 10.

In the *idea and research phase* for the co-digester with micro-CHP, Senior and Mr. Border were motivated by a vision of regionalization, where they saw the company as an important link in the regional energy and nutrient recycling loops and a role for the company in creating a more sustainable agricultural region, related Mr. Border. He explains that he envisions that the company can help to realize the full picture of nutrient loops in agriculture. He said: "*We shouldn't just pump feed into cattle to produce liters of milk and meat, but in the future it will also be about the energy that is produced and the minerals that can be collected from the product. Meat will have a smaller negative environmental impact if we can correct the recycling loops*" (personal communication, 29/04/2013).

Their affinity with sustainability was an incentive, but the identification of a gap in the market and the fit with the activities of the company were more important incentives, explained the entrepreneur. As a strategy to gain knowledge before starting the project (and thus inexplicitly deal with knowledge uncertainty) the two went on exploration trips abroad and executed a feasibility study, shares Mr. Border while his eyes light up recalling those trips.

Mr. Border did not discuss any specific stimulating or obstructing factors for the co-digester with micro-CHP in the *permits, subsidies & contracts* phase. However, he did share that the company experienced all possible technical barriers due to malfunctioning of the installation in the *building & testing phase*. Mr. Border showed an old style digester with collapsed roof and explained that when it happened for the first time they had repaired the roof, but later understood that it was due to the chemical processes in the digester that the wooden roof (the standard at the time) would

[18] *"We hebben wel een heleboel problematiek gehad. Ik zou het ook nooit weer doen, het wordt je gewoon niet gegund."*

keep collapsing. The malfunctioning technology made the installation not run optimally, at times running at just 50% capacity. The entrepreneur attributes this to the fact that not all was known about how to construct and run a digester and micro-CHP best, because they were one of the first.

After these first teething problems, Mr. Border and Senior opened their eyes to alternatives. When in the *up-and-running phase* larger technological barriers occurred and at the same time the electricity price dropped, it was clear that they had to change course, recites the entrepreneur. Moreover, continued Mr. Border, they had not been able to fully commercialize the heat from the micro-CHP, making the installation less profitable. The menu is a barrier according to the entrepreneur, as brokers drive up prices of co-streams making the co-digester even less profitable.

The *idea and research phase* for the green gas installation started off with a different plan, as Mr. Border called a meeting with all involved and interested parties and asked their opinion on how the company should move forward. This was a strategy to deal with all the barriers regarding the micro-CHP the company was experiencing. The entrepreneur recalls a clear outcome of this meeting: the company was advised to deliver the biogas in a pipeline straight to the large dairy consumer products company and in this way there would be a constant demand for the gas he produced. Mr. Border remembers that the province and region representatives were pleased, as they had been looking into the option of starting a separate biogas grid next to the existing natural gas grid. Therefore, the entrepreneur expected it would be easy to get the right permits.

Next to the financial necessity due to the investments made in the co-digester and micro-CHP, Mr. Border said that he was incentivized by the total package that this option represented for the company; the value of the product of biogas can be put to much more efficient use than in a micro-CHP, the company already has the resource streams to produce biogas, the activity fits with the company and its ideals, the digestate is a higher quality manure for their manure spreading activities and the necessary infrastructure is present. His previous experience did create uncertainties at the start of the project; he felt like the government cannot be relied upon and uncertain about the technology performance and technology suppliers.

The project entered the *permits, subsidies and contracts* phase and it became a green gas project, instead of a biogas pipeline directly to its customer. Mr. Border explained how this happened: to close the business case, a granted subsidy was still necessary.However, three times the project did not obtain a subsidy in ‘the lottery’ (causing uncertainty about financial resources), but in 2011 the project was granted a SDE promise. However, the granted SDE promise concerned green gas, not biogas for which Mr. Border already had a customer. More delay ensued, Mr. Border revealed with a bit of frustration, as the involved institutions (including Agentschap NL) worked out the possibilities (a barrier from the institutional process). Mr. Border said he was kept dangling until it became clear that because of European agreements, he would not be allowed to build a biogas pipeline (a barrier from rigid rules).

Thus, Mr. Border says he had to let go off the biogas pipeline plan and is now putting all efforts towards a green gas project with a pipeline to a nearby town. He still experiences a barrier of hesitant capital providers, and needs to get the bank to approve on the project. The entrepreneur says that there is a lack of parties willing to provide risk-bearing capital.

Table 10: case entrepreneur 4 – Mr. Border

	Factor			
Phase	Motivation	Incentives	Barriers	Uncertainties
Idea & research	• **to be a link in the regional recycling loop (D)** • wish to make a profit (D) • identifying a gap in the market (D) • passion • **wish to make a profit** • entrapment, financially necessary • passion	• information provision & positive experiences others (D) • fits with existing activities of business (D) • **unprofitability MEP micro-CHP** *- strategy: research for decision makingincluding stakeholders* *- strategy: having a long-term vision* • SDE subsidy green gas • competitive edge, market opportunity • digestate quality better than manure • existing infrastructure available and compatible • availability of & access to co-streams • trust in societal role product / sustainability	• **rigid rules obstruct project** • limited support money	• financial resources *- strategy: partnering with energy/tech companies.* • changing & unpredictable subsidy regime *- strategy: having a long-term vision* • (inexplicit knowledge / feasability uncertainty) *-strategy: exploration trips abroad* *- strategy: execution of feasability study*
Permits, subsidies & contracts	• wish to make a profit • entrapment, financially necessary • passion	• consumers / sector wants to become greener	• hesitant capital providers *- strategy: providing information towards parties involved* • delays from institutional process, tedious/slow *- strategy: involving neighbourhood early* • increasing costs of resources	• changing (related/manure) regulation
Building & testing			• difficulties / malfunctioning technology (D) • lack of knowledge (D)	• technology & different technological alternatives • reliability of technology suppliers
Up-and-running			• **rigid rules obstruct project (D)** • middlemen drive up cost resources (D)	• (seasonal) consumer demand

(D) Digester specific. Entrepreneur already has an up-and-running co-digester with micro-CHP and factors followed by a (D) relate specifically to those experienced going through the phases before a green gas installation was considered.

Bold: Factor was ranked as most important in this phase.

Regular: Factor was named by the entrepreneur as obstructing/stimulating.

Cursive: Strategy named by entrepreneur to overcome barrier/uncertainty.

Additionally, Mr. Border experiences uncertainty over what the regulation regarding digestate will do, because this also determines the menu of co-streams thatthe company will be able to use. The menu also influences the barrier of hesitant capital providers, because the increasing costs for co-streams cause a negative business case. For an instant healthy business case, Mr. Border hopes to sign clients for the CO_2 the installation produces. Because the project is still moving forward and not on hold, but there is no up-and-running upgrading installation, it is not considered unsuccessful, nor successful and could end up either way.

Entrepreneur 5: Mr. North

Personal communication 26/04/2013

Mr. North and his brother co-ownan average sized family dairy company with additional maize cropland. His brother focuses on the cattle and Mr. North focuses on the energy branch of the business, which includes wind turbines and a co-digester with micro-CHP. Table 11 represents the experience of Mr. North schematically.

It was in 2005 that Mr. North entered the *idea and research phase* for a co-digester with micro-CHP, after visiting an 'open house day' at a colleague farmer. Next to this incentive from hearing about a successful project, Mr. North was further incentivized by trust in the electricity market and his experience with renewable energy from wind farming. His main motivation was to diversify the income streams of the family business, the incentive of the added value by this new venture to the existing company contributed to this.

Mr. North did not elaborate on stimulating and obstructing factors regarding the co-digester and micro-CHP in the following two phases apart from one barrier: that of community resistance which occurred in the *permits, subsidies and contract phase*. This main barrier came from inhabitants who were worried about the increased transport movements and possible odour nuisance. A procedure ran at the municipality and the community resistance caused a ten-month delay, recalls Mr. North. As a strategy to deal with the community resistance, Mr. North signed agreements with the municipality that, for instance, stated that he would not use chicken manure as substrate. In the *up-and-running phase* micro-CHP was deemed inefficient to commercialize his biogas according to Mr. North, due to the fact that he could not profit from the production of heat, he did not need all the heat on site and had no customer for the surplus heat he produced.

In 2010 Mr. North started to consider a green gas project, and thus entered the *idea and research phase*. Again, he was motivated by diversifying income streams for the continuity of the company and incentivized by the unprofitability of the micro-CHP. The incentive of what he considered the more stable gas market contributed to the choice for a switch to another technology, explains Mr. North. Mr. North says he has a competitive edge in the market, because he has a broad permit for a wide variety of co-streams (including slaughterhouse waste) and contracts with co-stream suppliers, which together formed the core incentive to find a better way to profit from his co-digester. From an environmental perspective, Mr. North states it is important that gas possesses additional societal value compared to electricity, because gascan be converted on site where the heat can be utilized and is not lost. The possibility to expand the digesting volume in the existing installation and the experience Mr. North had gained, stimulated him further. He foresaw no barriers ahead.

Table 11: case entrepreneur 5 – Mr. North

	Factor			
Phase	Motivation	Incentives	Barriers	Uncertainties
Idea & research	• **diversifying income streams - continuity family business**	• **availability of & access to co-streams** • added value to business • stable/interesting market • having a broad permit • information provision & positive experiences others (D) • experience with renewable energy • fits with existing activities of business • trust in societal role product / sustainability	• no barriers	• no uncertainties
Permits, subsidies & contracts	• **diversifying income streams - continuity family business**	• SDE subsidy green gas • unprofitability MEP micro-CHP *- strategy: securing a broad permit, larger production capacity* • long-term thinking in family business	• **increasing costs of resources** *- strategy: partnering with waste stream suppliers* • lack of (good quality) co-streams *- strategy: securing a very broad permit, larger production capacity* • community resistance (D) *- strategy: create agreement with municipality*	• general - complex, long-term *- strategy: partnering with energy/tech companies* • changing & unpredictable subsidy regime • co-streams *- strategy: partnering with waste stream suppliers*
Building & testing				
Up-and-running				• uncertainty about reliability of resource suppliers (D) *- strategy: staying on top of everything as entrepreneur*

(D) Digester specific. Entrepreneur already has an up-and-running co-digester with micro-CHP and factors followed by a (D) relate specifically to those experienced going through the phases before a green gas installation was considered.

Bold: Factor was ranked as most important in this phase.

Regular: Factor was named by the entrepreneur as obstructing/stimulating.

Cursive: Strategy named by entrepreneur to overcome barrier/uncertainty.

The project is currently in the *permits, subsidies and contracts phase* and Mr. North speaks with trust about the progress of his project. Mr. North argues that he was granted a subsidy easily because of his track record with his current digester, which ran better than other digesters with micro-CHP. Getting most permits has also been easy, explains Mr. North, because he has not built all engines allowed in his broad micro-CHP permit, and therefore the entrepreneur could ask for a revision of his current permit, replacing the fourth micro-CHP engine by an upgrading installation (i.e. incentive from broad permit). While community resistance had formed a barrier in the past, Mr. North now utilizes the odour complaints to justify the upgrading installation; before at warm days with biogas overproduction, the vents of the digester would open en let out gas, but with an additional upgrading installation there never needs to be overproduction, thus no odorous gas will be released.

The main motivation of the entrepreneur continues to be the wish to diversify income streams. This is related to the uncertainty the entrepreneur experiences due to the unpredictability of the government which Mr. North sees as an incentive to diversify the energy branch of the company, in order to be able to fully switch to green gas should that be more profitable. Adding the upgrading installation helps him anticipate the end of the MEP subsidy program in 2016.

There is one main barrier however: Mr. North experiences menu and co-streams as the main barrier. He sees that the prices rise, the quality is not reliable (i.e. unreliable resource suppliers) and there is uncertainty about their continuity. At the same time this also causes his current micro-CHP to become less and less profitable and thus forms his main motivation to continue the green gas project: Mr. North says that there is just more money to be earned with green gas. The strategy Mr. North applies to deal with the uncertainty of co-stream supply is to get the suppliers involved in the project and sign long-term contracts.

Because the project is still moving forward and not on hold, but there is no up-and-running upgrading installation, it is not considered unsuccessful, nor successful and could end up either way.

Entrepreneur 6: Mr. West

Personal communication 19/04/2013

Mr. West is the 4th generation owner of a small dairy farm with small-scalecropland. He wanted to extend his business and started from the viewpoint of his own farm, asking himself "*what is my business suitable for*"[19] (personal communication, 19/04/2013). Mr. West prides himself in 'out of the box'-investing, for instance not in new milk quotas but in properties to rent out. Table 12 summarizes the case of Mr. West.

The provision of knowledge about digesters at the society for young dairy farmers in 2007 and talking with his glass horticulture neighbour, who complained about high gas prices, sparked the idea of investing in renewable energy and thus Mr. West was incentivized to enter the *idea & research phase* for a co-digester project (originally with micro-CHP, later with upgrading installation). He explains with enthusiasm that he was reading more about the topic at his kitchen table, looked out of the window and saw the greenhouses and knew for sure that this would fit his company. His other neighbour processes waste streams into compost, which was the complementing factor.

Asked to rank his motivation for the *idea and research phase*, Mr. West says he was motivated primarily by identifying a gap in the market and incentivized further by the geographical suitability

[19] "*Waar is mijn bedrijf, mijn locatie, nou echt geschikt voor*"

of his own location and access to waste streams through his neighbour. He did not experience any barriers in the idea and research phase, but he did experience an uncertainty about the development of the public opinion, remembers the entrepreneur. Mr. West employed the strategy of informing and involving all 12 surrounding households from the very start with his project, inviting them on a regular basis into his home and explaining them all about the digester and his project, he says: "*Communication in advance is vital - that's sustainable business today,* [as an entrepreneur] *you do not undertake against, next to, but with your neighbors*"[20] (personal communication, 19/04/2013).

Mr. West sees his role as entrepreneur as decisive in each phase, but especially in that of *permits, subsidies and contracts.* He says it was easy to get the right permit in 2008 after which he applied for SDE, which was granted. Recalculating, he found that the granted compensation for the electricity and heat from the desired micro-CHP would not lead to a sustainable business case and thus the entrepreneur declined the subsidy within 6 weeks. In 2009, he did not gain a SDE pledge in the 'subsidy lottery'. He applied for a third time in 2010 and was granted a green gas subsidy, abandoning the plan for a micro-CHP and now aiming for an upgrading installation, narrates Mr. West. The entrepreneur admits that the good subsidy program for green gas was the main incentive for him to run a green gas project and not a micro-CHP. However, the tedious procedure to get subsidized and the delays caused, also formed the main barrier to the project in this phase.

Next to this main barrier, the entrepreneur experienced a barrier and uncertainty related to co-stream supply, as prices sky-rocketed in the process of his project and he had made a conscious decision about getting solely sustainable waste streams to process. Yet, he managed to limit this supply uncertainty by partnering with his co-stream supplying neighbour, becoming the pilot project for a very large dairy consumer product company which would supply his neighbour with additional waste streams and signing a long-term contract of 12 years with Staatsbosbeheer (Forestry Commision), shares the entrepreneur with enthusiasm. Mr. West now feels further stimulated to continue his project by the positive outcomes of his own strategies.

It was difficult to get the capital financing for the project and Mr. West felt uncertainty related to the profitability of the project because of the Rabobank benchmark of digesters, which score low on profitability. He re-assured himself that their scores are low due to the old, unprofitable subsidy schemes (MEP, SDE 2008). To overcome the barrier of hesitant capital providers, Mr. West has applied the strategy of tapping cleverly into funds. With keenness he explains how: First, he has been granted 1,5 million from the MEI-scheme, which stimulates innovation especially in the horticulture industry. Second, because his project will become a showcase project and he is willing to build an educational centre, he was granted 560.000 euro through the DEMO-scheme. Third, he partnered with his co-stream supplying neighbour on the condition of mutual investment. This way, Mr. West does not have to make his family business fully risk bearing, which he says he would be unwilling to do. Mr. West explained that it is exactly family business and the long term vision that keeps him going in the face of barriers and uncertainties and which makes him weary of risk.

[20] "*Communicatie vooraf is van levensbelang – dat is ook duurzaam ondernemen vandaag de dag, ondernemen doe je niet tegen, naast, maar met je buren*".

Table 12: case entrepreneur 6 – Mr. West

	Factor			
Phase	Motivation	Incentives	Barriers	Uncertainties
Idea & research	• **identifying a gap in the market** • wish to make a profit • wish to expand business	• **competitive edge, market opportunity** • existing infrastructure available and compatible • availability of & access to co-streams • information provision & positive experiences others		• profitability *- strategy: having a long term vision* • development public opinion *- strategy: involving neighbourhood early*
Permits, subsidies & contracts	• identifying a gap in the market • wish to make a profit • wish to expand business	• **having long-term contracts with resource suppliers** • information provision & positive experiences others • trust in & cooperation with complementary partners • long-term thinking in family business	• **negative media / image** *- strategy: providing information towards parties involved* • reticent sector / possible partners *- strategy: providing information towards parties involved* • community resistance *- strategy: providing information towards parties involved* *-strategy (to deal with all obstructing factors, also in following phase): having a long-term vision*	• **financial resources** *- strategy: tapping creatively into funds* • technology & different technological alternatives *- strategy: research for decision making* • co-streams *- strategy: partnering with waste stream suppliers*
Building & testing				• **requirements & costs network operator** • reliability of technology suppliers
Up-and-running				• (seasonal) consumer demand

Bold: Factor was ranked as most important in this phase.

Regular: Factor was named by the entrepreneur as obstructing/stimulating.

Cursive: Strategy named by entrepreneur to overcome barrier/uncertainty.

This dedication to eradicating risk is demonstrated by the strategy of Mr. West to overcome the uncertainty of technology and of the technology supplier. The entrepreneur has gained knowledge by visiting 40 to 50 locations with digesters and speakingwith entrepreneurs to find out what would be the best technology supplier for him, one he could trust.

After securing the permits, the subsidy, the further financing and technology supplier for the project, the entrepreneur still experienced a big barrier. Just before the building phase could commence, objections were filed against the green gas project, Mr. West explains. Negative media exposure, a sensational tv program which he says was *"30 minutes of misery"*[21] (personal communication, 19/04/2013), made neighbours concerned about the increased transport movements on the small service road, which had recently become narrower with the construction of a new cycling lane. Mr. West calls it NIMBY (Not In My BackYard) – his neighbours say they think it is a beautiful project, but they just do not want it in their backyards. Kindly, he says, the neighbours did think along for a solution and suggested the digester would be placed on the plot of the co-stream supplying neighbour across the high way. Mr. West could then construct a pipeline to an upgrading plant on his plot, the location to which he had been granted a permit and subsidy, because the last one is not transferable to another location. Again, Mr. West says he has to await the tedious procedure to relocate the digester, but he has faith that it will be done soon: "*we are on the verge of starting construction*"[22] (personal communication, 19/04/2013).

Uncertainties Mr. West experiences for the future are mostly related to the network operator. First, the network operator will start charging for transporting green gas, but how much? Second, the network operator wants a second gas control unit, which will be costly. Third, the network operator is not knowledgeable in the field of green gas. And thus: how will the seasonal demand and grid balance each other out, should another green gas supplier join this part of the grid? Who will pay to facilitate the buffering?

Although on the verge on construction, there is no up-and-running upgrading installation and has to pass through the building and constructing phase first. Therefore the project is considered unsuccessful nor successful.

A case of an all-digester based green gas project: Mr. All

Personal communication 25/04/2013

Mr. All is one of three associates starting a new venture in green gas. All three associates farm crops, not animals. Their first plan with which they started in 2006 was to create a plant based digester (agricultural digester) on farm site.However, the current green gas project is based on a large all-digester (industrial digester). Table 13 summarizes the all-digester case in stimulating and obstructing factors per phase.

The main incentive for the entrepreneurs in the *idea and research phase* to engage in the project was the unprofitable top (i.e. financing gap) in their crop production, says Mr. All. This means that the farmers cannot earn back the investments made in the product with what can be earned with the sales of the product. The associates wanted to cap this unprofitable top by producing energy with their superfluous products with the aid of the MEP subsidy to sell to the surrounding glass horticulture, explains Mr. All. In short this meant that the entrepreneurs were motivated to diversify

[21] "*Een half uur lang één bak ellende*"
[22] "*We staan aan de vooravond van de bouw*"

the income streams of their companies and were incentivized by the available subsidy. While the entrepreneurs were researching and developing their project, Mr. All said, the MEP subsidy ended which caused uncertainty about the reliability of the subsidy scheme. The entrepreneurs had doubts about the economic feasibility of the project and to cope with these doubts, they cooperated with an energy company with a good image, which would help them through the next phase, argued Mr. All.

The project entered the *permits, subsidies & contracts phase*, and because of the help of the local municipality and province it had been fairly easy to get the first permits, says Mr. All. Yet a financial barrier resurfaced as the first subsidy the associates were granted with the SDE in 2008 was too low to run a profitable co-digester project. In 2011 the project was promised SDE subsidy again, however the financial barriers have not ceased to exist: Mr. All explains that the bank is influenced by negative publicity and low benchmarks of current digesters, which means that a loan for the project is not easily provided.

Next to the financial barriers, Mr. All says that community resistance was a main barrier. Mr. All sees that this resistance was due to negative media, an important barrier. The community resistance meant that the original plans had to be adjusted and the desired location was changed. Lastly, the energy company that partnered with them, which helped obtain subsidies and permits, has now withdrawn from the project. Mr. All reasons that this withdrawal is due to the high initial investment, the large riskand the unstable market of co-streams with the stable price paid for the produced gas.

Yet, Mr. All and his associates find continued motivation in the fact that they have already invested in the project (i.e. entrapment). Mr. All is further incentivized by a trust in his own organization; the three companions have been working together for over twenty years and complement each other. But there are more incentives that stimulate Mr. All to continue the project into the future: the entrepreneurs have secured a broad permit and the new location is seen as ideal by Mr. All, with very few surrounding inhabitants, good infrastructure and already many transport movements.

There are uncertainties for the future in the view of Mr. All. Although the broad permit for his all-digester allows him to process many waste streams, there remains an uncertainty about waste stream suppliers and substrate costs. In addition, there is an uncertainty related to the demand for the energy, as the seasons impact the demand for gas by the glass horticulture. Technically, Mr. All sees many options for feeding in, with different grids present near the future upgrading installation, but he is uncertain about where they will feed in and the related costs to connect. The digestate could turn out to be a plus or a minus, depending on related regulations that will be developed, which is another uncertainty.

Because the project is still moving forward and not on hold, but there is no up-and-running upgrading installation, it is not considered unsuccessful, nor successful and could end up either way.

Table 13: case all-digester – Mr. All

	Factor			
Phase	Motivation	Incentives	Barriers	Uncertainties
Idea & research	• diversifying income streams - continuity family business	• **low prices for agricultural products** • competitive edge, market opportunity • consumers / sector wants to become greener • trust in & cooperation with complementary partners	• **limited support money** • lack of economical feasibility *- strategy: partnering with energy/tech companies*	• changing & unpredictable subsidy regime *- strategy: securing a very broad permit, larger prodcution capacity*
Permits, subsidies & contracts	• identifying a gap in the market • entrapment, financially necessary	• having a broad permit • non financial support from regional government • trust in own organization	• **limited support money** • lack of economical feasibility • middlemen drive up cost resources *- strategy: partnering with waste stream suppliers* • cooperation fails • community resistance *- strategy:involving neighbourhood early* • negative media / image	• **profitability** *- strategy: research for decision making* *- strategy: securing a very broad permit, larger prodcution capacity* • (seasonal) consumer demand *- strategy: research for decision making* • changing & unpredictable subsidy regime
Building & testing				• requirements & costs network operator • other
Up-and-running				• co-streams

Bold: Factor was ranked as most important in this phase.

Regular: Factor was named by the entrepreneur as obstructing/stimulating.

Cursive: Strategy named by entrepreneur to overcome barrier/uncertainty.

5. Research Results – comparative analysis

In this chapter, a comparative analysis is executed across the outcomes of the cases. The sections 5.1.1 motivations, 5.1.2 incentives, 5.2.1 barriers and 5.2.2 uncertainties are each discussed separately in relation to the green gas project phases at first. All factors mentioned by more than one entrepreneur or by an expert are presented in simplified tables. For full tables that count whether an entrepreneur mentioned the factor and in which phase, including the full description of the factor, the reader is referred to Appendix V: Stimulating factors and Appendix VI: Obstructing factors.

What can also be read from the tables is the literature in which the factor can be found, which is used to bring out the differences with the literature and to touch upon the uniqueness or sameness of the cases on green gas compared to what can be found in the literature. Meanwhile, the input of the experts is used to reflect on the cases, comparing the cases to the field-experience of the experts. Lastly, a short summarizing conclusion is drawn on each of the types of factors.

The strategies found in the cases are discussed under 5.3 and are discussed in relation to the obstructing factors they help overcome. Section 5.4 discusses to what extent the stimulating and obstructing factors explain the success of the green gas projects. The chapter concludes with 5.5 Generalizability of the results.

5.1 Stimulating factors

5.1.1 Motivation

The motivations mentioned by the entrepreneurs are presented in the table 14. A difficulty with recording the motivation of entrepreneurs to start and continue a green gas project is that the green gas project is not separate from the trajectory leading to it. What was found, for example, was that a person is motivated to look into starting a new venture, then to opt for a biogas digester and then to choose a method to commercialize the biogas such as green gas production. Each of these types of motivation is considered to be a motivation relevant for the green gas project.

Idea & research phase –The most often recorded motivations for entrepreneurs to engage in a green gas project are financial in nature. Half of the entrepreneurs named ‘the wish to make a profit’ as their motivation, which is a common factor found in most literature.However often the profit stands in service of something else: to diversify income streams and limit risks to secure the continuity of the family business. This motivation was ranked most important by two entrepreneurs and also named by the expert of Foundation Green Gas (personal communication, 14/05/2013) as the main motivation for entrepreneurs to start a green gas project. This motivation was only found in the literature on green entrepreneurs. The expert expected that this motivation often occurred with family businesses in relation to a green gas project, because of a gut feeling of the entrepreneur that the gas market is a market with good prospects, which helps to get the family business ready for the future.

The second most important motivation was the identification of a gap in the market which is, like the wish to expand the business, connected to the possibility of making a profit, but also connected to a passion for pioneering, innovation and technology. The passion to pioneer and innovate was also what motivated the founders ofgreen gas services and tech company Biogast (Expert Biogast, personal communication, 29/04/2013). Only one entrepreneur said that "to be a link in the regional recycling loop" was an important motivation, for the others this was a lower ranked motivation.

Table 14: Comparing cases - Motivation

Category	**Motivation**	**Source**	**No. of entrepre-neurs**	**Expert**	**Idea & research**	**Permits, subsidies & contracts**	**Building & testing**	**Up-and-running**
Market	identifying a gap in the market	E(*), M	3+A	B+GG				
Financial	wish to make a profit	B(*), D(*), I(*), J(*), K, L	3	B				
Financial / organizational	diversifying income streams - continuity family business	M	2+A	GG				
	entrapment, financiallynecessary	K, L	3+A	GG				
	wishtoexpand business	K	2					
Organizational	passion	M	3					
	growingenthusiasm	L(*)		GG				
Stakeholder	to be a link in the regional recycling loop	B(*), M(*)	3					

Source – letters reference to in which literature named in table 1 the factor was found, (*)marking indirect mentions.
No. of entrepreneurs – the amount of entrepreneurs who mentioned the factor out of the 6 cases, with A meaning all-digester case.
Expert –B=expert of Biogast, GG=expert of Foundation Green Gas.
Colored phases: the factor was mentioned by an entrepreneur or expert to occur in this phase.

Permits, subsidies & contracts phase – In the interview, most entrepreneurs said the motivation for the project remained the same in the second phase. For others, some motivation seized to exist or faded into the background, such as passion, the identification of a gap in the market, the wish to expand business and the wish to be a link in the regional recycling loop. This can happen because of the negative experiences from obstructing factors in the process of starting a green gas project. One entrepreneur for example was first passionate about technology and undertaking this new venture, but he lost this motivation in a later phase because of all the difficulties he experienced.

A motivation that becomes more important in this phase is entrapment, escalating commitment and financial necessity. For some entrepreneurs this is already present at the start, as they already have an unprofitable micro-CHP and need to change their business around for a healthy business case. For others this has to do with the investment made in time, relationships and research en the green gas project. After being interviewed about obstructing

factors in this phase, the researcher asked: "what kept you motivated to keep going?",entrapment was the answer for half of the entrepreneurs.

Next to entrapment, the expert of Foundation Green Gas sees growing enthusiasm as an important motivation new in this phase. Growing enthusiasm happens when entrepreneurs invest in and engage others in their project. In support of this idea, although no entrepreneurs themselves named this motivation, great enthusiasm about the project was seen in Mr. West, who also had most actively engaged with all stakeholders.

Building & testing – Only one entrepreneur had passed through the building & testing phase with his green gas project. Two financial motivations (recognized by the experts) remained a core driver: the wish to make a profit and entrapment from financial necessity.

Up-and-running – In the table it can be seen that only one motivation was measured in the up-and-running phase: the wish to make a profit. This does not mean that securing the continuity of the family business does not matter anymore or the wish to be a link in the regional recycling loop, but after the large investments made, the focus is on earning those back, explains the expert of Biogast.

Most motivations found in both the literature and in the cases can be found in literature on green entrepreneurs (M) or in literature on renewable energy implementation by entrepreneurs (K & L). This is expected to be due to the fact that the other literature does not take this level of analysis and therefore has its focus on incentives for a company / sector instead of personal drivers. Typical motivations found only in this literature on the level of the entrepreneur but not found in the cases are: 'environment is the reason for existence'/'wish to contribute to more renewable energy'/'being own boss and independent'/'wish to educate others with the project'. All motivations from the literature that were not found in the cases can be found in Appendix VII.

Concluding about motivation, -although none of the motivations were mentioned by more than half of the entrepreneurs-, it can be said by taking them together that all entrepreneurs in the idea and research phase are in some way motivated by the wish to make a profit for the continuity or expansion of their family business by means of identification of a gap in the market and responding to their passion for entrepreneurship. It is the exception to be motivated by sustainability (in wanting to be a link in the regional recycling loop). In the phases that follow, these motivations continue to hold relevance, but are joined by entrapment and financial necessity, which at times when the entrepreneur encounters many obstructing factors form the core motivation to continue.

Reflecting on the applicability of the found motivations to the full domain of green gas projects including projects based on biogas produced through a different method than a co-digester, the expert of Foundation Green Gas said: *"I think partially it is really specific for projects based on a co-digester and agricultural entrepreneurs, because there are also quite some biogas projects that are not family businesses*"[23](personal communication,14/05/2013). According to the expert, it means that the main motivations are not applicable to project

[23] *"ik denk dat het gedeeltelijk wel echt specifiek is voor co-vergistings projecten en agrarische ondernemers omdat je ook best wat biogas projecten hebt die niet perse van een familiebedrijf zijn"*

developers, GFT, RWZI/AWZI and VGI-digester based green gas projects. The expert continues to explain that the entrepreneurs of those projects are mainly motivated by return on investment and by improving the image of the organization, instead of ensuring the continuity of the business by means of a green gas project.

5.1.2 Incentives

Inexplicit in most cases is the fact that the main motivation of the entrepreneurs could have also led to another investment, such as expanding the existing activities by buying more cattle, diversifying with tourism or innovating new livestock feed. Incentives help to explain the decision for green gas instead of another venture; the incentives mentioned by at least two entrepreneurs or by one of the experts are presented in table 15. The incentives that are named the most, ranked most often as important and those occurring just in a certain phase, will be discussed per phase.

Idea & research phase – In the literature different versions of the incentive 'costs in current practice are increasing' were found. Two such financial incentives were found in the cases. 1) Two out of the six entrepreneurs and for the all-digester project, the low prices for agricultural products were an incentive to start the green gas project, which helps to explain why they did not scale up their existing activities. 2) For the four owners of a co-digester with micro-CHP with MEP subsidy, the unprofitability of this set-up was an important motivation to venture into the green gas project. This is due to increasing costs of co-streams, a lack of a customer for the heat produced and decreasing electricity prices. The entrepreneurs that have a micro-CHP see green gas as a solution or an addition to make their biogas business case profitable again. The expert of Biogast agrees, if the farmer cannot capitalize on the heat produced, the MEP subsidy is insufficient. Most early projects that contracted with Biogast were (besides RWZIs) business with an up-and-running digester and micro-CHP. Next to those two negative financial stimulating factors, the availability of a good subsidy for green gas was named by three out of six entrepreneurs as a secondary important factor to start a green gas project.

Three other high ranked and often mentioned incentives are all in some way related to the market/supply chain position of the organization: 1) The competitive edge/market opportunity was named by four out of six entrepreneurs and the all-digester case, which came forth from the certainty the entrepreneurs felt about their locations being unique. Many showed maps and drawings and used terms like: "Superb location", "Unique edge". They demonstrated how they were conveniently located near transport routes for supply of co-streams and discharge of digestate (even alongside a canal), near the market such as horticulture and other gas/CO_2 users and with the right gas grid or feed-in point near to their plot. Likewise, some entrepreneurs saw the 2) availability and access to co-streams, as an incentive in the idea & research phase to start the project, others to continue the project once they had secured co-stream supply in a contract. In total of the two phases, the availability and access to co-streams factor was named by five out of the six entrepreneurs. Complementing these was 3) the fit with the existing activities of the business, named by four out of six entrepreneurs. This relates to the manure streams already being processed in the company such as in the two

agricultural contracting businesses and to the cases that already had an up-and-running co-digester. What is remarkable about these three factors is that the two factors with the strongest focus on the own organization (3) and its uniqueness (1), were not mentioned by the two interviewed experts. However, they both did name the access to co-streams (2) as very important for the success of a green gas project.

Table 15: Comparing cases - Incentives

Category	Incentive	Source	No. of entrepre-neurs	Expert	Idea & research	Permits, subsidies & contracts	Building & testing	Up-and-running
Financial	SDE subsidy green gas	E, G, H, I, J, K, L	3+A	B+GG				
	unprofitability MEP micro-CHP		4	B+GG				
	low prices for agricultural products	I	2+A					
	availability of capital	G	2	B				
Market	competitive edge / market opportunity	F, L(*)	4+A					
	stable/interesting market		2					
	consumers / sector wants to become greener	E, M	1+A					
Regulatory	having a broad permit		1+A					
Technology	existing infrastructure available and compatible	L	4					
Supply chain	availability of & access to co-streams	K, L	5	B+GG				
	having long-term contracts with resource suppliers	L	1	B+GG				
Knowledge	information provision & positive experiences others	K, L	5	GG				
Organizational	fits with existing activities of business	E	4					
	experiencewithrenewable energy		3	B				
	trust in & cooperation with complementary partners	E, K, L	2+A	B+GG				
	trust in ownorganization		1+A	GG				
	long-term thinking in family business	M	2					
	right person w/ right quality in right position	F	1	GG				
	non financial support from regional government	E	1+A					
Stakeholder	trust in societal role product / sustainability	B, D, M	3	B				

Source – letters reference to in which literature named in table 1 the factor was found, (*)marking indirect mentions.
No. of entrepreneurs – the amount of entrepreneurs who mentioned the factor out of the 6 cases, with A meaning all-digester case.
Expert –B=expert of Biogast, GG=expert of Foundation Green Gas.
Colored phases: the factor was mentioned by an entrepreneur or expert to occur in this phase.

A lower ranked, but often occurring (five out of six) factor is information provision and hearing about positive experiences of others. The entrepreneurs could recount when they first

got interested in green gas (or biogas): via the media, saw success stories abroad, invited a speaker to a study group, went to an open house or saw a presentation about it at a networking event. According to the expert of Foundation Green Gas, an average amount of knowledge on the topic is necessary for the entrepreneur to start the project, preferably provided by a neighbor who already has experience with digesters.He explains that too little information means that the option will not occur to the entrepreneur and too much information means that the knowledge about possible difficulties will withhold the entrepreneur from taking the leap into the new venture.

Permits, subsidies & contracts phase – Although not all entrepreneurs stated in the first phase that it was the available subsidy that had incentivized them to start the green gas project,it became clear from the conversations that financial support by the government is an absolute necessity for a healthy business case in biogas. This could be due to the fact that at the start of their project, the entrepreneur might have aimed for biogas production with micro-CHP, which means that the availability of the subsidy for green gas only became important in the permits, subsidies & contracts phase.

Once the research from the first phase was completed, many of the entrepreneurs became more convinced about the fit of their organization with a green gas project. Four out of six entrepreneurs named the availability and compatibility of the existing infrastructure as an extra incentive to keep the project moving forward.

While the entrepreneurs started to encounter barriers and uncertainties in this phase, four organizational factors became important for the continuity of the project. Two of which are focused on the own organization, namely the long-term vision for the family business and the trust in the own organization. And two that are outward focused, namely the trust in and cooperation with complementary partners and non-financial support from regional government.

Building & testing – Only two new incentives were mentioned specifically for this phase, as only one entrepreneur had gone through it with his green gas project: unprofitability of the micro-CHP and experience with renewable energy. The two incentives are related, as the negative and positive lessons learned in the experience with the co-digester with micro-CHP are seen as knowledge and capabilities gained which strengthens the entrepreneur in continuing the green gas project. Next to experiences with a micro-CHP, three out of the six entrepreneurs were also involved in and experienced with wind energy projects.

Up-and-running – In the up-and-running phase no new incentives became important, but three did regain importance, namely, 1) the availability and access to co-streams which for obvious reasons is important for an up-and-running digester; 2) the trust in societal role of the product and 3) the right person with the right qualities in position of power. The second incentive had been important to more entrepreneurs in the idea & research phase, but loses its important in the phases in between, when the entrepreneur encounters barriers and uncertainties and needs to focus on moving his project forward. The third incentive is found in literature concerning larger companies than the family businesses with co-digesters. That the right person is in power might be considered stating the obvious because all interviewees are the (co-)owner of their business or head of the digester-branch, might explain why none of

the entrepreneurs mentioned this as an incentive for the project in another way than trust in their own capabilities (grouped with trust in own organization). However, the expert of Foundation Green Gas mentioned that having an entrepreneur with the right qualities running the project was an important factor.

Looking at the found incentives compared to the literature, incentives from literature on green leadership (E) and again on the level of entrepreneurs (K, L, M) occurred most. Like the financial motivation found in most literature, the financial incentive of the existence of a stimulating subsidy was also found in most literature. One incentive not found in the literature can be explained by saying that it is quite topic specific, namely the unprofitability of the micro-CHP. Otherwise, it was found that the system level literature did not mention incentives related to the own organizations and therefore incentives in this category were not mentioned much in the resources used in the literature review.Illustrative of the difference of the green gas projects with other 'sustainable' ventures are the incentives that were mentioned by multiple articles in the literature review but not mentioned by the entrepreneurs: 'customer pressure', 'improving relations with NGOs/customers', 'traditional regulatory pressure' and 'clear governance stance'. This can be explained by the fact that the product is not sold directly to customers and that the farmers themselves are not (seen as) directly responding to an environmental problem caused by their companies. All incentives from the literature that were not found in the cases can be found in Appendix VII.

Concluding about the incentives, it can be said for those who already owned a micro-CHP, their main incentive to start and continue into other phases the green gas projectwas the unprofitability of the business case supported by the old MEP subsidy. The SDE subsidy for green gas was the incentive that could help create a profitable business case. This main incentive is reflected in related incentives such as fit with the current activities, experience with renewable energy and the availability of and access to co-streams. The expert of Biogast explains that at first the projects his company got involved in all already had a co-digester with micro-CHP, but that the entrepreneurs that Biogast cooperates with now are all starting without a co-digester present.

In general for these projects, it can be said that company specific aspects (location & market related), convince the entrepreneur that his company has a competitive edge in the market or that there is a great market opportunity. In the phases that follow only a few shifts in incentives can be seen, but although encountering obstructing factors, the most important to continue the project become organizational incentives (i.e. trust in own organization), especially those which are the outcome of an applied strategy (i.e. trust in cooperation with complementary partners).

Asked why there are not more entrepreneurs undertaking green gas projects, if there are so many incentives, the expert of Foundation Green Gas answered: "*You need to be prepared to lead the way, explore things and go outside the comfort zone of your normal operations.* […] *You need to trust that things will turn out positively for your business*"[24] (personal

[24] "*je moet bereid zijn om voorop te lopen, dingen uit te zoeken en buiten de comfort zone van je normale bedrijfsvoering te treden* [...] *En er vertrouwen in hebben dat het goed komt en dat het positief uitpakt voor je bedrijf*"

communication,14/05/2013). He explains that although green gas entrepreneurs are entrepreneurs and therefore risk-takers, even compared to other entrepreneurs they have to be prepared to be ahead of the crowd and thus are a special person in the position of power. The expert of Biogast answered in the same vein that the agricultural sector is an aging and reticent sector and therefore especially hesitant to undertake a new venture other than conventional up scaling of the current activities.

5.2 Obstructing factors.

5.2.1 Barriers

The barriers mentioned by the entrepreneurs are presented in the table 16. What can be seen is quite an even spread of 2-3 entrepreneurs that named a barrier (barriers that were named by only one entrepreneur and no expert have been left out of this simplified table and can be found in Appendix VI). The barriers that were ranked as most important and those that are associated together with these will be discussed per phase. Most of the projects found themselves in the *permits, subsidies and contracts phase*, the four entrepreneurs with an up-and-running co-digester with micro-CHP also provided information about the barriers encountered in the *building and testing phase* and *the up-and-running phase.*

Idea & research phase –'Entrepreneurship is seeing opportunities', the entrepreneurs say. Almost all entrepreneurs report to have experienced no barriers in the idea and research phase. "*I wonder*", said the expert of Foundation Green Gas, "*whether all entrepreneurs know that, if they start with a biogas installation that you need to spend, well, around three years*" […] "*Sometimes it's good if you don't know everything beforehand; that it will take a very long time*"[25] (personal communication, 14/05/2013). The negative press is a barrier in the idea and research phase, explained the expert further, because the negative sentiment around co-digesters expressed stops those who are researching the idea of starting a project.The expert of Biogastagrees, and says that negative press is also a reason why many farmers, horticulturists and agricultural contractors do not enter the green gas sector.

A sure barrier that stops a project in this early phase, according to the expert of Foundation Green Gas is the barrier of lack of economic feasibility. If the entrepreneur researching a green gas project cannot calculate a profitable business case, he will not further pursue the project, according to the expert.

If the interviewed entrepreneurs experienced any barriers in the *idea & research phase*, they were related to finance: while calculating the business case it was hard to render it feasible, often related to 'limited support money', which in this phase meant the low MEP and SDE 2008 subsidies.

Permits, subsidies & contracts phase– Most of the barriers were recorded when discussing the permits, subsidies and contract phase, the stage in which most projects found

[25] "*Wat ik me trouwens afvraag of alle ondernemers dat weten, als ze met een biogas installatie beginnen, dat je dan, nouja, wel drie jaar kwijt bent*". [...] "*Soms is het ook handig als je dat van te voren niet allemaal weet, dat het heel lang gaat duren*".

themselves. Looking at table 16, it can be seen that all types of barriers apart from technological barriers occurred in this phase.

A highly ranked and most often named barrieris community resistance. It either causes delay or can cause the barrier of a lack of permit. The interviewees say that neighboring communities worry about an increase in transport movements and odour nuisance. A related barrier is that of negative media / image, named by two out of the six entrepreneurs, the all-digester case and the experts. It can cause community resistance but also influences the financial and permit situation of the project, which are both granted less easily because of the negative atmosphere around co-digesters, argued the entrepreneurs.

The barrier of a lack of a permit caused by community resistance put two of the green gas projects on hold. Next to this institutional barrier, rigid rules related to permits and a tedious and slow institutional process caused actual delays in three out of six projects.

Table 16: Comparing cases - Barriers

Category	**Barrier**	**Source**	**No. of entrepr-eneurs**	**Expert**	**Idea & research**	**Permits, subsidies & contracts**	**Building & testing**	**Up-and-running**
Financial	hesitant capital providers	C, D, F, J, K, L	2+A	B+GG				
	lack of economicalfeasibility	A, E(*), G, H, J, I	2+A	B+GG				
	limited support money	E, H	2+A	B+GG				
Market	market competition from those with newer/foreign subsidy schemes	K(*), I(*)	2	B				
Regulatory	delays from institutional process, tedious/slow	B, E, L	3					
	rigidrulesobstruct project	B, E, G, K	3					
	lack of permit		3	GG				
Technological	difficulties / malfunctioningtechnology	F(*), K, L	2	B+GG				
Supply chain	increasingcosts of resources	J(*)	3	B+GG				
	middlemen drive up cost resources		2+A	GG				
	lack of (good quality) co-streams	E, L	2	B+GG				
	negative experience with network operator	J(*)	1	B+GG				
Knowledge	lack of knowledge	E, , G, H, I	3	B+GG				
Organizational	reticent sector / possible partners	E, G	2	B+GG				
Stakeholder	community resistance	A(*), L, I	4+A	B+GG				
	negative media / image	E	2+A	B+GG				

Source – letters reference to in which literature named in table 1 the factor was found, (*)marking indirect mentions.
No. of entrepreneurs – the amount of entrepreneurs who mentioned the factor out of the 6 cases, with A meaning all-digester case.
Expert –B=expert of Biogast, GG=expert of Foundation Green Gas.
Colored phases: the factor was mentioned by an entrepreneur or expert to occur in this phase.

Most entrepreneurs mentioned some sort of financial barrier, although they did not rank it as the main barrier. But according to the expert of Biogast, securing finance is truly the largest barrier to green gas projects. The banks are making losses on MEP co-digester and micro-CHP projects and are therefore hesitant capital providers that require the own contribution of the applicant to be 35 to 40% explains the expert of Foundation Green Gas. The expert of Biogast argues that it is difficult to secure funding because the bank would like to see a closed business case, which means that the co-stream supplies have been secured in contracts, but many of the interviewees buy their co-streams on the market do not have long term contracts.

The entrepreneurs recognize that co-stream supply is decisive for the (un)profitability of the digester, bluntly said by Mr. North: *"if you don't have* [your co-stream supply] *properly organized, you have nothing"*[26](personal communication, 26/04/2013). Table 16 shows, that half of the entrepreneurs report the barrier of increasing costs of high energy co-streams, next to the barrier that middlemen drive up the costs for resources (two out of six cases and all-digester case) and a lack of availability of good quality co-streams (two out of six). The problem with co-streams is related to the barrier of unequal market competition (two out of six), because digester owners with a newer or foreign subsidy scheme can pay more for the co-streams, which makes the sector cannibalize the older biogas projects, explained Mr. Middle and Mr. East. Moreover, the problem of co-streams is related to the 'rigid rules obstruct project' because entrepreneurs feel that what can be processed in the digester is unnecessarily restricted (two out of six – the third experienced rigid rules related to digestate).

Building & testing – The most important barrier in this phase, through which only one case had passed with its green gas project, was relatedto the network operator. There were two issues. First, actually occurring in the *permits, subsidies & contracts phase* was a barrier related to setting up a contract regarding whom would construct the necessary pipeline for how much. After the building had commenced, the second barrier occurred and caused months of delay, the involved entrepreneur explained: the network operator demanded new requirements regarding the composition of the gas. The expert of Biogast explains that he now has worked with many different network operators, but that he has to start all over again with each operator and that at times they are unknowledgeable or unwilling to cooperate. The attitude and behavior of the network operator causes the main barriers in this phase, according to the expert of Biogast.

Difficulties with the technology and the technology suppliers were experienced by two other entrepreneurs who had gone through this phase with their co-digester and micro-CHP projects. The barriers caused delays and financial losses, because the co-digester had actually broken down or would function sub optimally.

Up-and-running – The menu, the mix of co-streams that are processed in the digester, is important in any phase of the project according to the expert of Biogast. In this phase the increasing costs and lack of good quality co-streams are the most important barriers because they cause a lack of feasibility. However, the only entrepreneur with an up-and-running upgrading installation explained that especially rigid rules of what he could process in his co-digester had been a problem in this phase.

[26] "*als je* [je co-stromen] *niet op orde hebt, heb je niks*".

Next to that, the rigid rules regarding digestate form a barrier. By labeling the whole digestate of a co-digester with only plant based co-streams as 'manure', the treatment of the digestate is bound to the rules of how to process and spread manure, which includes many restrictions in the Netherlands. According to the up-and-running entrepreneur this has been done in many co-digesters. If digestate could be processed to the quality of artificial fertilizer, this would make a waste stream a marketable product, and this could change the whole co-digester market, according to the expert of Biogast. He trusts that a regulation that allows for separation of nitrogen and phosphate from the digestate will come.

Concluding on the main barriers in each phase, it can be said that there are hardly any barriers experienced in the *idea and research phase* and that most barriers occur in the *permits, subsidies & contracts phase*. In this phase, community resistance, hesitant capital providers and a lack of permits form the most important barriers. In the building and testing phase the most important barrier is a negative experience with the network operator, followed by technological malfunctioning. In the last phase, the barriers are related to the in and output of the operation: co-stream supply and digestate. Co-stream supply and its related barriers are important in each phase as they influence the feasibility of the project.

Reflecting on the barriers found both in the literature and in the cases, it seems that the barriers in the literature were much more applicable than those found for the stimulating factors. Remarkably, none of the selected articles mentioned a lack of a permit as a barrier, while this is the main barrier that has put two of the cases on hold. Less remarkable is the fact that the very topic specific 'middlemen drive up costs resources' was not found in the literature. The list of barriers that were found in the literature but not in these cases have a common demeanor. They apply mostly to companies with multiple employees and management and / or have a consumer product. To see all the barriers that were mentioned in the literature but not in the cases, view Appendix VII.

All apart from two barriers were also named by the two experts, who said they recognized the barriers experienced by the entrepreneurs. The two barriers that were not mentioned by the experts are both institutional. The researcher explains the lack of institutional barriers mentioned as such by the expert of Biogast, as the company itself in their projects does not experience these barriers so much as they exist to actually ease the whole institutional process. For the expert of the Foundation Green Gas, the two barriers were not mentioned explicitly, but was implied in the answers of the expert, such as the quote under the idea and research phase which says that a project will take a long time to realize (i.e. barrier of tedious process).

5.2.2 Uncertainties

In table 17, the uncertainties that were named by more than one entrepreneur or by one of the experts have been collected, for the full list see Appendix VI. The uncertainties that are named show quite some similarities to the actual barriers experienced. The uncertainties most often named and ranked most important will be discussed per phase.

Idea & research phase – Many of the entrepreneurs did not report an uncertainty in the idea & research phase, unless they were prompted to think about the phase from the viewpoint

of ‘things you were unsure about, felt uncertain about for the project’. At times, an entrepreneur did discuss a strategy, such as involving the community early on, which was a response to an uncertainty not made explicit, namely the development of the public opinion. Or, the project in general was considered uncertain, because of its complexity. If the entrepreneur named an uncertainty in the first phase, this often related to something he needed to secure himself of in the next phase. The researcher thinks it is possible that with more prompting, the other entrepreneurs would also be able to recall more uncertainties from the first phase, but that they did not see them as relevant to the interview as they had coped with the uncertainty by acting upon it.

The expert of Foundation Green Gas says that many projects stop because of the uncertainties in the first phase. However, projects in such an early phase were not part of the case selection as they are not registered anywhere. He says that especially uncertainties related to the technology, the amount of subsidy and the profitability stop the project.

Table 17:Comparing cases - Uncertainties

Category	**Uncertaintyabout:**	**Source**	**No. of entrepr-eneurs**	**Expert**	**Idea & research**	**Permits, subsidies & contracts**	**Building & testing**	**Up-and-running**
Financial	financial resources	K, L	4	B+GG				
	profitability	F, G, L	2+A	B				
Market	(seasonal) consumerdemand	D, H, I, K, L	3+A	B+GG				
Regulatory	changing&unpredictablesubsidy regime	K, L	4+A	GG				
	changing (related/manure) regulation	B, K, L	3	B				
	granting of permits by government	K, L	1	GG				
Supply chain	co-streams	K, L	3+A	B+GG				
	requirements&costsnetwork operator		2+A	B+GG				
	reliability of technologysuppliers	K	2					
	reliability of co-stream suppliers	K, L	1	GG				
Technology	technology& different technologicalalternatives	C, K, L	2					
Stakeholder	development public opinion		1	B+GG				
Organizational	general - complex, long-term		2	GG				

Source – letters reference to in which literature named in table 1 the factor was found, (*)marking indirect mentions.
No. of entrepreneurs – the amount of entrepreneurs who mentioned the factor out of the 6 cases, with A meaning all-digester case.
Expert –B=expert of Biogast, GG=expert of Foundation Green Gas.
Colored phases: the factor was mentioned by an entrepreneur or expert to occur in this phase.

Permits, subsidies &contracts phase – The most often named uncertainty, by four out of the six entrepreneurs, the all-digester case and the expert of Foundation Green Gas isthe

changing and unpredictable subsidy regime. It isalso ranked as the most important uncertainty by the entrepreneurs, even if the entrepreneur has secured a subsidy promise himself. The subsidy policy development matters, explains the expert of Foundation Green Gas, because installations with newer subsidies in the future might also form an unfair competition to the existing installations and cannibalize the market.

Uncertainty about financial resources is named by four out of six entrepreneurs and this uncertainty is also related to the whether a project will be granted a subsidy next to whether it will be able to secure capital from other sources. Three of the interviewees actually called the SDE 'a lottery', and one named the process arbitrary. Often, entrepreneurs hold back on making investments because they are uncertain whether they will get a subsidy, sayboth the interviewed experts. Multiple of the interviewees have gone through the subsidy process several times and have missed out one or more years before they received a subsidy promise, and thus their uncertainty for the next year was based on an actual encountered barrier. Now that the subsidy is granted in phases, the situation has even become worse, explained the expert of Biogast: "*There certainly will be* [green gas projects] *that won't make it because they have registered in too low a phase because the SDE functions like a lottery*".[27] According to the expert of Foundation Green Gas, "the *subsidy is crucial for your project to proceed*" and "*the certainty of a subsidy is a large barrier with regards to the SDE* [phase]"[28](personal communication,29/04/2013).

Related to the most often named financial and regulatory uncertainty, is the uncertainty about changing (related/manure) regulation, which is named by three out of the six entrepreneurs. These other policies matter because they influence the market of co-streams (i.e. what is allowed to be processed in a co-digester) and the costs related to processing the digestate (i.e. use of which co-streams will classify the digestate as what category of waste, necessitating a more or less costly offset). Uncertainty about these changing regulations is related to the announced revision of for instance the manure regulation, which has been delayed time and again, explains Mr. East.

Not only are the co-streams an important barrier in each phase of the project, the entrepreneurs (3 out of 6 cases and all-digester case) experience uncertainty related to the co-streams supply. This matters in the idea and research phase for calculating the profitability of the business case, it matters in the *permits, subsidies & contracts phase* because of the contracts which the entrepreneur would like to close with co-stream suppliers and securing financing from the bank, and matter in the *up-and-running phase*in which the entrepreneur often still has to buy his streams on the market outside of contracts with suppliers. The uncertainty about co-streams is not solely about costs, but also about the quality and composition of the co-streams, which could mean that the entrepreneur feels uncertain about being able to secure what he considers environmentally sustainable co-streams. Or, explains the expert of Biogast, it can mean that there is a possibility that the co-streams include

[27]"*Er zullen zeker* [groen gas projecten] *zijn die het niet gaan redden door het inschrijven op een te lage fase omdat de SDE als een loterij werkt*".
[28] "*De subsidie is cruciaal voor het doorgaan van je project*" en "*De zekerheid van subsidie is een grote barrière met de SDE* [fase]"

undesired contents which create a lower quality gas and might negatively impact the technology.

One of the last contracts the entrepreneurs need to settle isthat with the gas grid operator. Two of the three cases and the all-digester case feel uncertainty regarding the behavior of the network operator, they name: 1) what will the network operator charge for the transport of the gas? 2) if the network wants a second gas check box, what will it cost? 3) who will pay for investments made to control fluctuations in offer and demand of gas? (who is responsible for this if more producers join the network?).

Building & testing – the uncertainties in this phase are very focused on what needs to be realized in this phase, namely building and testing the technology and are thus uncertainty about the different technological alternatives, technology itself and the technology supplier. Part of the technological uncertainties is already coped with in the previous phase, in which contracts with technology suppliers are signed. However, technology uncertainty can remain also in the *up-and-running phase.*

Up-and-running – Half of the uncertainties from earlier phases return in the up-and-running phase. Although the project is realized by then, the market, regulatory and supply chain circumstances might still change which could influence how well the project runs. An uncertainty not previously discussed but especially relevant for this phase, is the uncertainty about consumer demand for the product, which was named by half of the entrepreneurs and the all-digester case. This uncertainty exists due to the fact that there is a seasonal demand for gas and entrepreneurs are uncertain about whether they will be able to deliver gas to the gas grid year round. According to the expert of Biogast, the location and which grid the project is attached to really matters. A project that is located near industrial consumers can produce well year round, yet one that feeds in on a network that services mostly agricultural consumers can have a hard time in summer, he sees for projects that Biogast partners with.

Concluding, the three most important uncertainties across the different phases are uncertainty about the financial resources, uncertainty about the changing and unpredictable subsidy scheme and uncertainty about the co-streams.

Unsurprisingly, when reflecting on the literature most uncertainties found in the cases are also(and often only) found in the literature on entrepreneurs implementing renewable energy projects (K, L), because the articles of Meijer et al. (2007, 2010) were the only ones that focused on uncertainties. A typical green gas barrier of uncertainty about the requirements and costs related to the network operator was not found in the literature. The list of uncertainties that were found in the literature, but not in these cases are only few and mostly organizational and knowledge based, which can be seen in Appendix VII. That the organizational uncertainties from the literature did not occur in the cases could be related to the organizational motivation and incentives like the trust in their own organization experienced by the entrepreneurs who are mostly the boss of their own family business.

Most uncertainties found were confirmed by either or both of the entrepreneurs; however they did not touch upon technological uncertainties. Possibly, this could be explained by the fact that the experts had focused on barriers when discussing obstructing technological factors

and not on possibilities entrepreneurs might experience in the future. The fact that the researcher has not explored this is a flaw in the interviews.

5.3 Strategies

Strategies as a variable for research have been added later as they were mentioned by the entrepreneurs in each interview. As research is an iterative process, this means that all strategies the entrepreneurs mentioned without being prompted have been tracked by re-listening the audio recordings, but that the entrepreneurs have not been structurally specifically asked for applied strategies. By consequence, the list that can be compiled from the case studies is not exhaustive of the strategies the entrepreneurs might have applied. The strategies presented in table 18 should therefore be read as an incomplete indicative list of possible strategies more entrepreneurs might have applied. What the table shows is that one strategy can be used to cope with multiple different obstructing factors.The five most often mentioned strategies will be further elaborated in this section.

All, apart from one case, mentioned partnering with energy/technological companies.It was mainly used to lower financial uncertainties, but it also helped to battle general uncertainty related to the complexity of the project and ease the process of securing a permit.

Next to this, two entrepreneurs and the all-digester case partnered with, and others tried to partner with co-stream suppliers to battle co-stream supply uncertainty. They aimed at signing long-term contracts regarding co-stream supplies and to get the supplier to also invest in the project, which diminishes his incentive to drive up the prices paid for the co-streams.The entrepreneurs who have achieved this, report that these contracts are an incentive for them to continue the green gas project even though they encounter new barriers.

When a farmer cooperates with Biogast, the tech- and advisory company makes an effort to source as many resources as possible from the farmer himself, explains the expert.The strategy applied to co-stream related barriers can be decisive for a project, elaborates the expert of Foundation Green Gas: "*The good entrepreneurs manage to pull* [biomass supply] *into their project, or they have it themselves, grow biomass themselves or have very good contacts in that world and likewise, those that aren't doing well, those are exactly the ones that do not have good access to biomass, have a worse subsidy and yes, that makes things just really hard*"(personal communication,14/05/2013)[29].

The second most often mentioned strategy was to provide information towards all parties involved (four out of six cases). Entrepreneurs did this by creating a PowerPoint presentation, taking the actors involved on road trips to other co-digesters, by bringing neighbours into their own home et cetera, to battle a range of uncertainties and barriers. This information provision was aimed broadly towards all possible stakeholders. However, there also was a focus on the strategy of involving the neighbourhood early, applied by less than half the entrepreneurs while most of the entrepreneurs did experience the barrier of community resistance.

[29] "*Dus de goede ondernemers trekken* [biomassa toevoer] *zelf in hun project, of die hebben zelf, telen zelf hun biomassa of hebben heel goede contacten in die wereld en ook bij degenen die niet zo goed gaat, dat zijn dus ook degenen die niet zo'n goede toegang hebben tot biomassa, slechtere subsidie, en ja, dan wordt het gewoon heel moeilijk*"

After knowledge provision, knowledge gathering for informed decision making was named the most as strategy applied by the entrepreneurs. However, it is expected that all entrepreneurs have applied this strategy, which is implicit in the name of the first phase 'idea & research'. Therefore perhaps, this strategy was not mentioned without prompting by all entrepreneurs.

Table 18: Comparing cases - Strategies

					Phase			
Strategies	**Source**	**Obstructing factor**	**No. of entrepr-eneurs**	**Expert**	**1**	**2**	**3**	**4**
Securing a broad permit, larger production capacity		- barrier from a lack of good quality co-streams - uncertainty about profitability	1+A	B				
Involvingneighbourhoodearly	L	- barrier from institutional process, tedious/slow - barrier from community resistance - uncertainty about the development of the public opinion	2+A	GG				
Providing information towards parties involved	L	- barrier lack of permit - uncertainty about granting of permits by government - barrier hesitant capital providers - barrier of community resistance - barrier of reticent sector / possible partners - barrier of negative media/image	4	GG				
Partnering with waste stream suppliers	L	- barrier from increasing costs of resources - uncertainty about co-streams	2+A	GG				
Partnering with energy/tech companies	L	- uncertainty about profitability - uncertainty about financial resources - uncertainty in general/complexity project - uncertainty about granting permits	5+A	GG				
Research for decision making (execution of feasability study i.a.)	L	- uncertainty in general/complexity project - uncertainty about feasibility - uncertainty about technology (alternatives)	3+A	GG				
Tapping creatively into funds		- uncertainty about the financial resources	1	GG				
Having a long-term vision		- uncertainty of changing & unpredictable subsidy regime - uncertainty about profitability - to deal with all obstructing factors	2	GG				
Staying on top of everything as entrepreneur		- uncertainty about reliability of resource suppliers	1	GG				

Source – letters reference to in which literature named in table 1 the factor was found.
No. of entrepreneurs – the amount of entrepreneurs who mentioned the factor out of the 6 cases, with A meaning all-digester case.
Expert –B=expert of Biogast, GG=expert of Foundation Green Gas.
Colored phases: the factor was mentioned by an entrepreneur or expert to occur in this phase, 1:.Idea & research, 2: Permits, subsidies & contracts, 3: Building & testing, 4: Up-and-running.

What can be seen in the table with regards to the literature is that strategies were only discussed in one of the articles on entrepreneurs implementing renewable energy projects. This is also the reason that it was not obvious to the researcher at the start of the research that they needed to be included in the interviews. Especially the expert of Foundation Green Gas was very focused on what entrepreneurs could and should to overcome obstructing factors, which meant he mentioned all but one. He explains that if an entrepreneur is capable of influencing an uncertainty [by means of a strategy] that it made the uncertainty bearable for the entrepreneur and would not delay or stop the project.

5.4 Success

What can be said about to what extent all the different factors influence the success of a green gas project?Well, according to the definition of a successful (an up-and-running green gas installation) and unsuccessful project (project stopped/on hold) there was one successful project and two unsuccessful projects in the case selection and the other half of the cases could not yet be determined.

From the diverse range of stimulating factors and the quite even spread of cases across them, it seems that the type of motivation and incentives with which the entrepreneur started does not matter as much for the success of the project. Yet what can be said is that entrapment and financial necessity ensures that the project is continued after obstructing factors are encountered, which was also the situation in the successful green gas project. However, a certain block in the form of a lack of a permit can stop a project, no matter what the motivation of the entrepreneur is, as shown by the two projects on hold.

Although the unprofitable co-digester with micro-CHP in the case of Mr. East added more obstructing factors and decreases the level of motivation of the entrepreneur, having a micro-CHP present often is also the main incentive to engage in a green gas project, which indicates that already having a micro-CHP is not decisive in the success or lack thereof of a project. The unsuccessful project of Mr. South does not have a co-digester and micro-CHP and the successful project of Mr. Middle does, which contributes to the conclusion that the ownership of a micro-CHP is not decisive.

Unfortunately, the other three cases and the all-digester case do not help to make statements about to what extent the stimulating and obstructing factors contribute to the success of the project, as their success is undetermined. However, the experiences of the two experts with more projects can provide more insight.

The expert of Foundation Green Gas explained that most projects quit in the idea phase, due to too many uncertainties or the certain block of a lack of a profitable business case. Both experts explained that before entering this phase, the farmer, horticulturist or agricultural contractor already needs to be an entrepreneur and willing to be ahead of the crowd, while the agricultural sector is a reticent and old sector. This indicates that other than motivation and incentives, a certain attitude is needed, which has not been put under scrutiny in this research.

However, the experts said with certainty that the success of a project is too a large extent dependent on the entrepreneur, his attitude and capabilities, more than incentives and motivation. Part of this attitude is that the entrepreneur needs to be a little bit blind to

uncertainties and barriers, explains the expert of Foundation Green Gas. This is supported by the fact that most entrepreneurs part of the case studies reported to have seen no or very few obstructing factors in the first phase of the project. Part of the capabilities is the ability of the entrepreneur to mobilize the surrounding stakeholders, continued the expert. The importance of capabilities is supported in an indirect way with the many different strategies that the entrepreneurs managed to apply to ensure the continuation of their project in the face of obstructing factors.

5.5 Generalizabilityresults

The input of the two experts is used to reflect on the generalizability of the performed research. The cases were selected from co-digesters that were planning to produce or were producing green gas, but the research questions are formulated to explore obstructing and stimulating factors for cases found in the whole domain of green gas projects.

The expert answered that for the whole domain of green gas projects, the results would be difficult if not impossible to generalize, because so much of the stimulating and obstructing factors are related to the fact that most co-digesters based green gas projects are lead by entrepreneurs who are owners of small family businesses. Moreover, the expert explains, industrial digesters operated by larger companies have very different relationships towards the co-streams market, which is an important obstructing factor for co-digesters in each phase. Industrial digesters differ in two additional ways: 1) they do not need to be located on the farm site and thus can be planned in the most suitable location which also fits the zoning plan of the municipality and 2) the digestate is not marked as manure and is thus processed in a different way in a different market, explains the expert of Foundation Green Gas. The experience of Mr. All who had an all-digester project was in this sense remarkably similar to that of the co-digester entrepreneurs, because he leads this project with two associates and all three of them are small family business owners. What is different between the all-digester case and the co-digester cases was that by changing the plan from an agricultural digester to an industrial all-digester the associates were allowed to relocate the all-digester from their farm site to a site in between glass horticulture, a site closer to the demand

The expert of Foundation Green Gas said that he was relieved to see that the researcher had taken into account so much of the trajectory leading up to the outcome of a green gas project. He elaborated that the Foundation Green Gas had also once started with a focus on green gas, but that they had quickly shifted towards biogas is general, for two reasons: 1) they realized that they should not focus on solving barriers towards green gas, because the entrepreneurs do not get to green gas because of the difficulties they encounter in the biogas trajectory and 2) "*Biogas is actually always in development* […] *there are actually many things which you could to with biogas. And it depends on your location, what is the cleverest thing to do*", plus "*I think there are few people that say "I only want to produce green gas and no electricity* […] *I wouldn't say that that is a heavy weighing motivation*"[30](personal communication,24/05/2013).

[30] "*Biogas is eigenlijk steeds in ontwikkeling* [...] *er zijn dus heel veel mogelijkheden wat je met je biogas kunt doen. En het hangt van je locatie af, wat het slimste is eigenlijk*", plus, "*Ik denk dat er weinig mensen zijn die*

The expert adds that he finds the outcomes coherent with his experience of the complete field of co-digesters that produce biogas; not just with those aiming to produce green gas. Thus, although the study cannot be generalized across all green gas projects, the findings are wider applicable to biogas projects based on co-digesters owned by small family company owners. However, this generalization does not hold for all factors. The obstructing factors that are technology, network operator and product (gas) specific cannot be replicated to non-green gas producing co-digester projects.

Lastly, there is a difficulty to generalize the results across all entrepreneurs of past and present in this field, as the expert of the Foundation Green Gas sees a difference between the entrepreneurs who undertake a green gas project nowadays and those who did it in the early days. He says:

> "*I think that there were some entrepreneurs that started a biogas project* [in the past] *who had the idea that 'I will just do it on the side', while now more and more people realize 'I really do get a whole separate installation in addition, it demands extra skills of me. That means that I cannot just rely on the middleman who comes by and that I will get a good price, but that I have to be smart myself in* [the co-stream] *market'. I think that some sort of realization had dawned upon entrepreneurs, that that is important"*[31](personal communication,24/05/2013).

> *"The new entrepreneurs are confronted everywhere, in the newspaper, at the bank, with critical questions, so they need to be pretty sure of themselves, 'hey do I see this work out?'. So I don't know if this is a characteristic of the entrepreneur, but in any case they have been warned. They have seen the bad examples"*[32](personal communication,24/05/2013).

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zeggen, ik wil alleen groen gas maken en geen elektriciteit,[...] *zou ik niet zeggen dat dat een zware motivatie is."*

[31] *"Ondernemers in groen gas zijn al weer andere ondernemers dan die in het begin met biogas begonnen, maar ik denk dat er ook ondernemers in biogas zijn gestapt met het idee dat doe ik er wel even bij, terwijl nu steeds meer het besef er is ingeland, ik krijg er echt een hele aparte installatie bij, die vraagt ook extra skills van me. Dat betekent dat ik niet alleen maar uit kan gaan van die handelaar die voorbijkomt en dat ik wel een goede prijs krijg, maar dat ik ook zelf slim moet zijn op die markt. Ik denk dat daar ondertussen wel een soort bewustwording van is gekomen bij ondernemers, dat dat belangrijk is".*

[32] *"De nieuwe ondernemers worden overal, in de krant en bij de bank overal met kritische vragen geconfronteerd, dus ze moeten wel heel zeker van zichzelf zijn, hey zie ik dat goedkomen. Dus ik weet niet of dat een karakteristiek van de ondernemer is, maar in ieder geval ze zijn al gewaarschuwd. Ze hebben de slechte voorbeelden al gezien."*

6. Conclusion and Discussion

Summarizing the answer to the research question:

"What are the main stimulating and obstructing factors experienced by entrepreneurs leading green gas projects during different stages of maturity and to what extent do these explain the success of green gas projects?"

Stimulating factors & success

The stimulating factors consist of motivation and incentives. The most often named and rankedmost important motivations for entrepreneurs*to start* a co-digester based green gas project, are diversifying the income streams for less risk and ensuring the continuity of the family business, identifying a gap in the market and the opportunity to make a profit. The most often named and highest ranked motivation to continue the project in the three phases that follow the *idea & research phase* is entrapment and financial necessity.

The incentives in the *idea & research phase* are concerned with the view of the entrepreneur that his company has a competitive edge in the market and that there is a great market opportunity, which is further incentivized by the availability of the SDE subsidy. However, these incentives were not most often and highest ranked; this outcome was influenced by the prehistory of four of the projects, namely their engagement in a biogas project with micro-CHP.

The main incentive for the four cases that already owned a micro-CHP to engage in a green gas project was the unprofitability of the micro-CHP business case supported by the old MEP subsidy, which incentivized them to *start*, but also to continue the project in the next phases. Other related incentives that have often been named and/or high ranked were the fit with the current activities, experience with renewable energy and the availability of and access to co-streams.In the following phases the incentives do not change much but become less often mentioned.The emphasis is shifted somewhat towards organizational incentives (i.e. trust in own organization, cooperation with complementary partners).

Although the previous chapter shows that the assumption of changing stimulating factors in different phases is valid, the change was not the same for each entrepreneur. Some motivations remained; others became less important or were replaced. This means that the motivations and incentives mentioned in a certain phase regularly still hold relevance in later phases.

Yet, there did not seem to be a difference between the successful or unsuccessful performance of a project related to the type of motivation or incentives. Following the expert opinions presented in the previous chapter, it is not so much about which motivation the entrepreneur has, but the fact that he is motivated for the project (attitude). Thus, the main stimulating factors do not explain the success of a green gas project.

Obstructing factors & success

The obstructing factors consist out of barriers and uncertainties. There were hardly any barriers experienced in the earliest phase of *idea & research*. The entrepreneurs experienced

little uncertainty and saw only opportunities, which says something about their attitude. The mentioned types of uncertainties and barriers resembled each other, but uncertainties occurred before an actual barrier was experienced, thus often in an earlier phase.

Community resistance, hesitant capital providers and a lack of permits were the most named and most often ranked as important barriers, where the latter barrier has actually meant that two projects were put on hold and thus rendered them unsuccessful. The barrier is in both cases related to community resistance.Next to this barrier that actually put the project on hold, two barriers related to the network operator caused heavy delays and debtsfor the successful project.

The three main uncertainties experienced were uncertainty about the financial resources, uncertainty about the changing and unpredictable subsidy scheme and uncertainty about the co-streams. The uncertainties did not influence the success or lack of success of the projects, as entrepreneurs could cope with them. The expert did explain that uncertainty about co-streams can create the barrier of hesitant capital providers, who would like to see the uncertainty of co-streams to be resolved before investing in the project.

The extent to which the different obstructing factors explain the success of a green gas project is limited. Strategies mediate the influence of an obstructing factor, because they are an approach with which the entrepreneur can anticipate or respond to an obstructing factor. Yet to apply the diverse range of strategies, a certain level of capability is expected from the entrepreneurs. Regardless of strategies however, one barrier that blocks a necessary step in the process towards an up-and-running green gas upgrading installation is sufficient to put the project on hold.

The limited explanatory value of stimulating and obstructing factors for the (lack of) success for each case could be due to two different factors mentioned by the experts: the attitude and capabilities of the entrepreneur.

Two main remarks regarding the governmental goals for green gas and the related subsidy regime can be made: 1) agricultural entrepreneurs who start green gas projects based on a co-digester say they need the governmental support in the shape of subsidy to make their project profitable and are supported in this by the experts, and 2) the level of the green gas subsidy in comparison to the subsidy for electricity and heat granted for a micro-CHP project, makes in a business specific case green gas the most profitable option. Thus this incentive matters, yet is one sole incentive where many different incentives and entrepreneur related factors need to be in place. Moreover, the incentive does not help to overcome barriers such as community resistance or hesitant capital providers.

Discussion of the results:

There were no big differences or discrepancies between the cases and the expert interviews confirmed the results of the research. Furthermore, many of the found barriers and incentives could also be retrieved from the literature, although an equal amount of the theoretical barriers and incentives proved not to apply. Thus, the researcher feels it is safe to say that the research results accurately describe the experience in the field of co-digester

based green gas projects. However, as explained in 5.5 the generalizability of the results regarding other types of green gas projects is low.

As the study was executed, difficulties from the case selection surfaced. First, because only one of all the cases involved had gone through all the phases, the *building & testing* and the *up-and-running phase* were underrepresented in the recorded factors per phase. This has been compensated by including the experiences of the up-and-running co-digesters with micro-CHP in the process and the experience of the experts. Second, because the case selection included only one successful and two unsuccessful and three undetermined projects, it was difficult to draw any conclusions on determining factors for success or for lack of it. Would the research be done again, the researcher would select more up-and-running projects and via the experts try to reach to projects that were known to them to be on hold or have quit in each phase.

Two weaknesses in the research stem from how the interviews were conducted. The first relates to the semi-structured nature of the interviews, in which the entrepreneurs were given space to narrate the story as they had experienced it, after which they were asked to rank the stimulating and obstructing factors. However, by going through this process more time was spent on narration than was left available to ask verifying questions to check for exhaustiveness of the mentioned factors. By consequence, the researcher feels in hindsight that some factors were implicit in some cases and therefore not counted, but would have been ranked high would the entrepreneur have been prompted about it.

The second weakness relates to the iterative nature of the research, which meant that strategies were added half way through conducting the interviews as a factor that should be recorded. However, the set-up of the interview was not changed to check for strategies and thus these were only noted as the entrepreneur himself decided to share that he had applied a strategy. As aconsequence, the list of found strategies and related obstructing factors is not exhaustive and of weak scientific value.

Recommendations for future research:

1) In this study it is assumed that some of the factors found in the literature do not apply to the cases because the organization is a small family business. Future research could test this assumption by replicating an improved version of this research with green gas projects based on another type of digester. For example by doing the same research for the leaders of green gas project in sewerage gas installations or those based on waste streams from the food and beverage industry.

2) In this study the explanatory value of the stimulating and obstructing factors is found to be limited and capabilities and attitude of the entrepreneur are expected to play a role in this. Future research can focus on the relationship and different weight that can be attributed to the four types of variables for the success or failure of any type of family business sized entrepreneurial undertaking.

3) Scientific research for policy is recommend to focus on the capabilities required to successfully bring a green gas project to maturity and it could make a comparison with

capabilities present in the part of the population that is desired to become entrepreneurs in green gas.

4) In this study, the agricultural sector was referred to as reticent and old by the expert of Biogast. This can be translated into the fact that those in the sector have the wrong attitude for starting a green gas project. Future research for policy could focus on how such a sector can be influenced and which policies would be effective to create the right attitude to want to become an entrepreneur in green gas.

Recommendations for policy makers:

More scientific research is necessary to formulate recommendations on how to increase the amount of entrepreneurs starting and bringing a green gas project to maturity. However, the presented list of obstructing factors can be used as a basis to do research for what policies would help to smooth the experience in the different phases for the entrepreneurs. Policy makers are recommended to focus on the five main themes under which the obstructing factors can be grouped:

1) menu and co-stream supply;

2) government, reliability &flexibility;

3) negative press and community resistance;

4) financing, hesitant capital providers;

5) the network operator.

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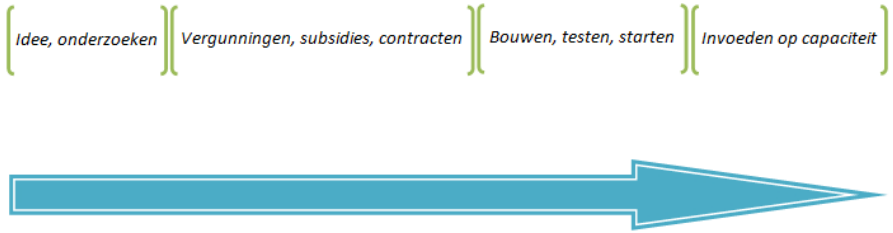
Appendix I: Interview materials

Barrières	Onzekerheden
Wat kom je tegen dat echt een probleem vormt dat het project tegen houdt?	Wat weet je niet zeker en houdt het project tegen? Welke risico's zijn er? Wat kun je niet echt weten maar zorgt wel voor vertraging?
Motivatie	Stimulansen
Waarom wil je het?	Wat van buiten af zorgt dat je het wilt?

Fases – van idee tot invoeding



Fase: Idee - Onderzoeken

Motivatie

Markt	Leveranciers - grondstof	Overheid
gat in de markt meegaan met de concurrentie	mest tot beschikking gemak	helpt om aan regels te houden stimulerende regelingen
Technisch	**Organisatie**	**Belangen van**
bewezen techniek succes van andere co-vergisters bestaande infrastructuur	past in de strategie/visie van bedrijf zelfstandig eigen baas zijn eenmaal begonnen – moet door	duurzaamheid – eigen idealen milieu organisaties sector / steun van andere organisaties
Kennis	**Anders**	**Financieel**
anderen er over willen leren ik weet er veel van bij de overheid	verbeterde kwaliteit mest (digestaat)	valt geld te verdienen economisch – kosten drukken diverse inkomsten stromen

Fase: Vergunningen / subsidies / contracten

Barrières, moeilijkheden, problemen, onzekerheden, drempels

Markt	Technisch	Overheid
concurrentie – conventioneel gas vraag – verkopen aan netwerk	functioneren techniek gebrekkige infrastructuur	regels die belemmeren regelingen – subsidie aanvragen
Leveranciers	**Organisatie**	**Belangen van buitenaf**
techniek - betrouwbaarheid materialen – inkoop co-gewas	hoe het eigen bedrijf in elkaar zit medewerkers die dwarsliggen leidinggevenden	buurt - protest milieu organisaties sector – behoudend
(gebrek aan) kennis	**Anders**	**Financieel**
eigen / in bedrijf markt / sector bij de overheid	geur overlast weinig tijd	investerings kapitaal inkomsten die verdiend gaan worden financiële instrumenten

Appendix II: stimulating & obstructingfactors collected by source

	Source	Obstructing factors (barriers & uncertainties)	Stimulating factors (motivations & incentives)	Theme / industry
A	Iranpour et al., 1999, Environmental Engineering: Energy Value of Replacing Waste Disposal with Resource Recovery.	- every waste stream and its reclamation is really dependent on specific and particular details for that case - efficiency of technology necessitates scale - lack of public willingness to cooperate - geographical distance between recovered source and use - available knowledge & technology determines the reuse potential of a substance - customs and values define what is seen as a resource and what is approached as a waste	- energy saving because reclamation usually consumes less energy than producing new materials - increasing reclamation reduces pollution, which helps to comply with regulation and creates cost savings - available knowledge & technology determines the reuse potential of a substance - customs and values define what is seen as a resource and what is approached as a waste	WASTE Review: environmental engineering for resource recovery, with attention for biodegradation technologies, i.e. waste water treatment and sludge digestion.
B	Desrochers, 2002, Industrial ecology and the rediscovery of inter-firm recycling linkages: Historical evidence and policy implications	- labeling of industrial by-products as hazardous / waste - bureaucratic rules – more administrative work - increased liability (entails costs) - restrictive waste law - ever-changing regulatory framework (*uncertainty*) - transport cost that discriminate against secondary materials - subsidies to the primary material sector - laws for minimum content of virgin material	- market incentive (competition, profit) - creating useful and productive objects from something of little value (converting useless products into ones with economic value) - stiff competition - remanufactured cheaper than virgin materials - residual value close to nothing for producers, but can have value for someone else - lower processing costs because a lot of processing has already been done - lower transport cost because the waste stream is already near the producer & potential buyers - technological innovations: distinct invention, chemical or mechanical - inspired by natures recycling	WASTE A historical perspective on industrial ecology research; reusing industrial by-products
C	Ammar et al., 2012, Low grade thermal energy sources and uses from the process industry in the UK	- a lack of pipe infrastructure - the risk related to how the technology will perform - capital investment cost - awareness of market actors and consumers on existence and benefits - communication difficulties between market actors and towards consumers - location constraints between resource and users - the suitability of the recovered heat for end-users	- higher energy prices - environmental concern (inspired by activists) - government targets to reduce CO2 emission after Kyoto - regulations to monitor and report GHG emissions - increasing costs for raw material shipping and fuel import - fuel scarcity - part of marketing strategy because of media and market pressure	WASTE Review on the recovering of thermal heat by the UK industrial process sector
D	Bibler et al., 1998, Status of worldwide coal	- technical difficulties to recover the methane because of low-permeability coals - hard to put the gas to use because of low or variable gas	- increases mine safety because of less explosions - work can commence earlier when area is effectively drained of gas	WASTE Multiple country case studies about

	mine methane emissions and use	quality - variations in gas supply and demand (seasonal) - lack of infrastructure for gas gathering & pipelines - lack of information on the how of exploitation reaching the sector - seen as 'new', not much known about (*uncertainty*) - lack of surplus capital available to invest in project - lending organizations unfamiliar with concept and therefore hesitant - low natural gas prices and therefore the coal mine gas cannot be sold for a competitive price - environmental objections for drilling coal mine gas gathering holes such as disturbing aquifers - environmental objections for creating multiple surface facilities and pipelines -lack of an appropriate policy framework - foreign investors cannot repatriate profits in joint ventures for production of domestic energy from all countries	- income: can use on site or sell - benefits the environment, because gas is detrimental when vented into the atmosphere	incentives and barriers to increasing harvesting and use of coal mine gas
E	Runhaar et al., 2008, Environmental Leaders: Making a Difference. A Typology of Environmental Leaders and Recommendations for a Differentiated Policy Approach	- Availability of resources for green production - Lack of power in supply chain to force others to co-operate - Low co-operation within supply chain - Lack of good ecological production methods - Ecological product of inferior quality - Only one subcontractor (i.e. market power imbalance) - Rigid rules obstruct innovation - Passive government - Too many rules - Inadequate enforcement of environmental regulations, favours trespassers and disadvantages environmental leaders - Inadequate subsidies (too low or too much focused on knowledge instead of production) - Support by government ineffective due to lack of knowledge of green production/environmental leadership - Modest demand for sustainable products - Increased costs - Customer not willing to pay for sustainability - Limited growth opportunities due to modest demand - Free-riders profit strains - Lack of knowledge by employees - Employees not eco-minded	- Financial support by governments - Savings on energy and - Synergy from co-operation with NGOs - Scrutinizing production processes for environmental improvement results in other (efficiency) gains (side-effect) - Savings because of co-operation - Economies of scope (synergy with other processes) - Synergy from co-operation with other companies (joint purchase, sharing knowledge etc.) - Higher profit margin for green companies - Higher brand consumer awareness - Good contacts with NGOs -Internal and external image improvement -Support from neighbouring households - Environment is reason for existence - Prevent risk on reduced legitimacy in the future - Anticipate future legislation - Prevent negative publicity - Support from media (attention, free publicity) - Support from consultants (knowledge provision) - Incentives of customers (social housing organizations) - Support from regional government (not subsidies, but positive	LEADERSHIP Literature review and case testing: incentives and barriers to environmental leadership in different sectors in the Netherlands, cases based on reputation as green leader

		- Knowledge available is not specific enough for company in question - General overview of opportunities to reduce environmental impact is lacking - Lack of knowledge by customers - Skeptical approach to environmental leadership by NGOs - Negative image of sustainable products - Too many eco-labels - Reticent sector	attention, co-operation, knowledge and the like) - Opportunity for niche market (different customers) - (Near) monopoly in ecological market - To distinguish from competitors in existing markets - Improved working climate (internal and in relations with customers)	
F	Perez-Sanchez et al., 2003, Implementing environmental management in SMEs	(first phase, before starting) - reluctance to plan - lack of capital and general resources - perceived by capital providers as higher risk - lack of (attracting and keeping) technical expertise - lack of skills -relatively low level of research and development - lack of understanding of environmental problems - lack of understanding risks or/and the potential of improvements - lack of access to appropriate information - actions of manager do not reflect personal attitudes - managers have the view that SMEs make no or low environmental impact - the view that the environment is not a core business issue - skepticism about benefits (*uncertainty*) - skepticism about cost savings (*uncertainty*) - skepticism about customer rewards (*uncertainty*) (next phase, when starting to implement) - lack of procedures for change - lack of basic management education (next phase when implemented) - needed more resources than expected - negative experience with consultants because of costs and quality - the developed system is bureaucratic and ineffective	- customer pressure - legislation - cost savings - keeping up with competition - increasing cost of waste disposal en landfill cost - environmental pressure groups - depletion of finite resources - creation of a market for waste - perception of environmental issues as an opportunity (*motivation*)	GREENING SMES Review: Barriers and incentives to implement environmental management in SMEs
G	Matus et al., 2010, Barriers to the implementation of green chemistry in the United States	- changes in the production process of an existing product need to create enough saving to outweigh the upfront costs -exact savings are often hard to make certain or quantify (*uncertainty*) -chemical enterprises reluctant to abandon previous capital	- champions at upper and technical levels - traditional regulatory pressures - availability of capital - clear benefits for health, safety and the environment - energy and material savings	GREENING EXISTING BUSINESS Interviews with leaders (NGOs, industry, science) in green

		intensive investments - old plant removal is costly - regulation favors end-of-pipe technologies - regulation focuses on risk control instead of risk prevention - preferred procurement by government does not favor the future most green product -financial complexities in liability - regulations regarding writing-off old infrastructure - insufficient expertise - large number of involved disciplines - inability of engineers to think on a systems level - data and information gaps - different interests between different divisions within an organization -'champion' of the greener product/process is not in a position of power - lack of awareness in company - the (management/company) view that environmental improvements are expensive and not worthwhile - consumers think that green is more expensive and less effective - conservative sector to green innovation - (most important but specific to the green chemistry sector in the US: barriers regarding the lack of definition and metrics)	- performance measures where green chemistry metrics are integrated into goals and strategy - market demand especially for consumer product firms - supply chain pressure - policies that lower economic barriers such as tax incentives, access to inexpensive capital, technical assistance for implementation	chemistry to identify barriers and incentives to implementation of green chemistry
H	Roose et al., 2012, Underdog or bulldog: Introducing biogas technologies in Estonia	- no harmonious legislation - insufficient provision of target seed funding and subsidies - lack of the possibility to sell bio-methane to natural gas pipelines - not profitable (because low feed-in tariff, because of artificially low non-renewable energy) - support agency money is limited - low market demand - lack of know-how and training - very few experts - lock-in of competing technologies	- clear stance of government of preferred development - financial incentives for market actors and consumers	BIOGAS Case study of biogas potential, use, barriers and incentives to implementation in Estonia with reference to success projects other EU countries
I	Lantz et al., 2007, The prospects for an expansion of biogas systems in Sweden—	**Production stage** - competing treatment methods of biological waste locked-in - gate fees are favorable for other treatment methods, make centralized biogas waste treatment plant unfeasible - additional costs for waste separation at source	**Production stage** - ban on land-filling with organic waste - legislation that 35% of municipal food waste and all uncontaminated food waste from food industries should be treated biologically by the year 2010	BIOGAS Case study of biogas potential, incentives and barriers in Sweden

	Incentives, barriers and potentials	-limited knowledge and practice of using digestate -higher handling costs connected with the digestate compared with commercial fertilizers - limited knowledge among farmers - profitability of ley crop production for biogas production may be lower than the profitability of other alternative energy crops, for heat and power production and for ethanol production - public acceptance -protest from neighbourhood and local authority, scared of odor and increased transport activities - most importantly economical - costs **Utilization stage** - not fully enforced CO2taxes on fossil fuels in all sectors - lock-in effect from established fuels for domestic heat - existing infrastructure, lack of gas infrastructure - storing biogas more expensive compared with liquid and solid fuels - highly seasonal change in demand for heat during the year - higher production costs as a consequence - biogas utilized as CHP is favored by a certificate system based on quotas with the purpose of increasing the amount of renewable electricity used in Sweden - biogas as a vehicle fuel requires adapted vehicles (bi-fuel) which are more expensive than conventional ones - limited number of filling stations in most regions for vehicle fuel - additional cost for ethanol-adapted passenger cars is much lower, than biogas adopted cars - gas grid injection leads to additional costs because of upgrading - limited extension of the natural gas grid in Sweden	- gate fees in future could become favorable to biogas - farm biogas: bi-product of manure into digestate, improved fertilization - decreased cost from the improved quality of the digestate, cheaper than commercial fertilizer - for expanding farms: regulations regarding manure storage capacity, because less storage is needed - reduced odor from spreading digested manure - helps reach requirements environmental quality, e.g. reduces the emissions of GHG and leakage of nitrogen - subsidy for farming ley crops - regulation permitting growing ley crops on set-aside land, increases income - reduced market price of food crops - ley crop helps to restore the productivity of the soil after cereal cropping - agricultural development program supports with subsidy small projects - local investment program supports with subsidy construction of plants, mostly large scale projects **Utilization stage** - exemption from Swedish energy- and CO2taxes on fossil fuels - infrastructure for as cheaper and easier to establish than district heating - biogas utilized as a vehicle fuel is, with present policy instruments, the most favored utilization alternative - for vehicle fuel: price of upgraded biogas differs locally, but the current market price is approximately 20–30% lower than petrol on energy basis - cheaper than other biofuels - local initiatives to promote the use of biogas as a vehicle fuel exist - the view of natural gas actors as allies for expansion of biogas, because of expanding market	
J	Brown et al., 2007, Impact of single versus multiple policy options on the economic	- (most important barrier) not economically feasible unless large scale farm - not economically feasible unless a combination of 2 favorable stimulation schemes (and then still not for small farms) - upfront fixed costs digester (engine/generator, storage tanks, mix tank)	- monetary benefits from electricity production - monetary benefits from heat and hot water production - cost saving by use on site of electricity & heat - by-product of recycled water - various waste water uses (such as flushing barns) - increased farm value from added amenities	BIOGAS Case study and large number test modeling for policy impact on economic feasibility or biogas production in

	feasibility of biogas energy production: Swine and dairy operations in Nova Scotia	- infrastructure costs (piping to and from digester, grid hook-up) - implementation costs (engineering, construction labor) - Financing costs (interest, tax) - Running costs (acquisition of substrate and other raw materials, water for mixing the materials, energy to run the digester, plant operation, plant maintenance, storage of slurry, disposal of slurry, biogas distribution, biogas utilization) - ammonium lost through volatilization - sulfur dioxide and nitrogen oxide emissions - health risks associated with exposure to the biogas (*uncertainty*)	- improved fertilization properties digestate - lower water content of waste water - reduced weed seed germination - reduced pathogenic organisms - reduced odors - reduction greenhouse gas emission reduction - decreased risk potential for water contamination - reduced legal considerations - policy incentives that encourage green or renewable energy production - consumers' voluntary purchase of renewable energy at premium prices	Nova Scotia, Canada
K	Meijer et al., 2007, The influence of perceived uncertainty on entrepreneurial action in emerging renewable energy technology; biomass gasification projects in the Netherlands	- *uncertainty* about the technology itself, reg costs and performance and how is will operate in the existing technological infrastructure - barrier from complicated operation technology and related stable operation difficulties - *uncertainty* about the choice between different technological alternatives - political *uncertainty* about the licensing procedure and emission regulation - barrier of institutional change - *uncertainty* about reliability of governmental instruments as they often change - *uncertainty* about financial instruments - *uncertainty* about biomass resources - *uncertainty* about financial resources, unreliability of investors - *uncertainty* about the reliability of technology suppliers, reg. timing, pricing and quality - *uncertainty* about the reliability of biomass suppliers - *uncertainty* about the consumer preferences and demand of the produced electricity - barrier of a disruptive new law - barrier disruptive changes in actor constitution - barrier from managers declining project, they were unwilling to bare perceived uncertainties - barrier from limited time window (for instance set by government law exemption) to realize project - technological barrier of getting a successful running plant set	- recognition of an opportunity to make a profit (*motivation*) - financial subsidy for the production of renewable electricity - high costs for manure disposal - wish to create an affordable, reliable and sustainable energy supply (*motivation*) - positive outcomes EU sponsored R&D project - access to wood residue waste stream - view of technology as highly efficient (*motivation*) - availability of built and tested technology, gasifier units - cooperation with complementary partners - entrapment, escalating commitment (*motivation*) - scaling up opportunities	RENEWABLE ENERGY PROJECT Literature review and case study research into uncertainties and motivation regarding biomass gasification

		up - good results competing technologies - barrier from influenza outbreak - diminished faith in technology from negative stories about unsuccessful implementation abroad - unwillingness of banks to lend to project as is seen as high risk - strict emission rules for waste disposal companies and technology marked as waste treatment plant		
L	Meijer et al., 2010, The influence of perceived uncertainty on entrepreneurial action in the transition to a low-emission energy infrastructure: The case of biomass combustion in The Netherlands	- *uncertainty* about the cost of the new technology - *uncertainty* about the performance of the new technology - *uncertainty* about the relation between the new technology and the technical infrastructure in which the technology is embedded - *uncertainty* about future technological options - *uncertainty* about the knowledge required for the project - *uncertainty* about the amount and availability of raw material (increasing price of biomass) - *uncertainty* about human and financial resources needed for the innovation - *uncertainty* about how to organize the innovation process - *uncertainty* about the behavior of (potential or actual) competitors - *uncertainty* about the reliability of suppliers - *uncertainty* about consumers' preferences - *uncertainty* about compatibility of the new technology with consumers' characteristics, - *uncertainty* about demand (i.e. for heat) over time - *uncertainty* about governmental behavior and policies - *uncertainty* about interpretation of current policy - barrier from lack of policy - unpredictability of governmental behavior (*uncertainty*) - technical barriers such as malfunctioning technology (oven melted leading to insufficient production and excessive emissions) - barrier from supplier who was unable to help resolve technical issues - technology supplier went bankrupt - in exploitation phase: barrier from problems with biomass quality	- availability of wood residue/surplus waste stream - expensive disposal of waste/manure stream - motivated by opportunity for creating a sustainable product from waste, with hopefully some financial gain (*motivation*) - opportunity to sell renewable energy on the market - positive experiences from other installations - convinced of economic feasibility (*motivation*) - convinced that there is a large availability of input resource (manure) - feelings of entrapment (*motivation*) - favorable institutional change, such as introduction of MEP-subsidy - successful technological developments - governmental policies to reduce CO2 - cooperation with a complementary party - the view that (tech) difficulties in different phases are normal 'teething problems' - want to expand sustainable energy production (*motivation*) - existing infrastructure (district heating system) - long-term contract signing (for resources/consumers /suppliers) - governmental policy which stimulated energy production out of non-reusable waste - technology considered to be 'proven' - support from environmental organizations by not filing objections if party agrees to meet higher than by law requirements	RENEWABLE ENERGY PROJECT Literature review and case study research into the dynamics between uncertainties and motivation regarding biomass combustion

		- barriers from change in actor constitution - barrier from tedious licensing procedure - barrier from banks that perceive uncertainty and therefore do not want to hand out loans - *uncertainty* about the subsidy application due to many changes in policy & procedure - difficulties from the uniqueness of each project - barrier from objections/resistance by environmental organizations and neighbours (lack of social acceptance) - cooperation with partner fails		
M	Kirkwood & Walton, 2010, What motivates ecopreneurs to start businesses?		- green values/passion for environment (*motivation*) - identifying a gap in the market (*motivation*) - making a living/provide for family – explicitly different from profit-driven (*motivation*) - being their own boss (*motivation*) - passion – about their business of products (*motivation*) - increasing market opportunities for sustainable products and services - consumer demand and purchase environmentally friendly products - consumer environmental awareness - educating others (*motivation*) - trend towards value-driven environmentalism - compliance with regulations - desire to make the world a better place to live (*motivation*) - *motivation* to be independent (e.g. from the National Grid) - motivated by sustainability - lifestyle of sustainable entrepreneurship	GREEN ENTREPRENEURS Literature review and 14 in depth case studies into ecopreneurs that start a for profit business with green products in New Zealand (where there are many SMEs)

Appendix III: stimulating & obstructing factorscategorized

Financial			
Barriers	**Uncertainties**	**Incentives**	**Motivation**
Financial barriers to do with starting a new venture/procedure: - high initial investment - running costs - previous investments, reluctance to abandon & costly to remove - increased costs - lack of economical feasibility / profitability **Financial barriers to do with resourcing cashflow:** - limited support money - hesitant capital providers - lack of surplus capital & resources	**Financial uncertainties to with starting a new venture / procedure:** - uncertainty about benefits - uncertainty about cost savings - uncertainty about human and financial resources needed for the innovation **Financial uncertainties to do with resourcing cashflow:** - uncertainty about financial instruments - uncertainty about financial resources (inc. unreliability of investors)	**Financial incentives from cashflow:** - financial support by governments - availability of capital - convinced of economic feasibility **Financial incentives because savings from:** - reduced demand for energy & resources - dealing with less pollution - use on site: electricity, heat, gas, reclaimed waste water - improved quality in process, i.e. digestate cheaper than commercial fertilizer, improved soil productivity, less seed germination - remanufactured material cheaper than virgin materials - exemption from taxes: energy- and CO2 taxes on fossil fuels **Financial incentives from income generation:** - sale of product/residue: heat, electricity, gas, hot water, chemical by-product - higher profit margin on product - increased farm value from added amenities **Financial incentives from increasing costs:** - energy/resource prices - manure/waste disposal - in producing alternative product (i.e. food crops instead of energy crops) **Financial incentives from extra benefits** - scaling opportunities, economies of scope (synergy with other processes) - work can commence earlier - synergy from co-operation with NGOs and/or other companies	**Financial motivation from profit:** - motivation from recognition of an opportunity to make a profit **Financial motivation with profit as support:** - motivation from making a living/provide for family - motivated by opportunity for creating a sustainable product from waste, with hopefully some financial gain - creating useful and productive objects from something of little value

Market			
Barriers	**Uncertainties**	**Incentives**	**Motivation**

Market barriers from competition: - lock-in of competing technologies - conventional is cheaper - competition is cheaper because of additional costs for consumer to put product to use **Market barriers from consumers:** - low - modest demand - customer not willing to pay for sustainability - negative image of sustainable products, i.e. more expensive, less effective **Market barriers from product characteristics:** - low or variable product quality - variations in gas supply and demand (seasonal) - lack of possibility to sell bio-methane to gas network **Other:** - Free-riders profit strains - Too many eco-labels	**Market uncertainties from competition:** - uncertainty about the behavior of (potential or actual) competitors **Market uncertainties from consumers:** - uncertainty about the consumer preferences and demand for the product - uncertainty about compatibility of the new technology with consumers' characteristics	**Market incentives from competition:** - keeping up with competition - increasing market opportunities, i.e. monopoly in market, entering niche market, distinction from competition - cheaper to establish than alternative in new market **Market incentives from consumers:** - consumer pressure, demand, purchase – especially for consumer products - long-term contract signing - incentives by customers, i.e. social housing organizations, local initiatives - trend towards value-driven environmentalism, increasing consumer awareness **Market incentives through incentives for consumers:** - financial incentives for consumers - product is cheaper than conventional, i.e. upgraded biogas utilized as a vehicle fuel	**Market motivation:** - motivated by identifying a gap in the market

Regulatory			
Barriers	**Uncertainties**	**Incentives**	**Motivation**
Regulatory barriers from lack of coherent framework: - lack of appropriate / harmonious policy framework / legislation / policy - passive/ineffective government, i.e. lack of knowledge of green production **Regulatory barriers from rigidness:** - bureaucratic, tedious, too many rules, leading to complexity and more work - rigid rules obstruct innovation / use of resource / emissions - increased liability **Regulatory barriers from wrong focus:**	**Regulatory uncertainties related to policy change:** - uncertainty from many changes & unpredictability **Regulatory uncertainties related to clarity:** - uncertainty about the licensing procedure, political behavior & policies - uncertainty about interpretation of current policy	**Regulatory incentives from constraining legislation:** - complying with traditional regulatory pressure - anticipate future legislation - helps to comply with indirectly related regulation - opportunity arisen from other policies, i.e. landfill ban **Regulatory incentives from stimulating policies:** - policies that encourage green or renewable energy production, i.e. subsidies - policies that lower economic barriers, i.e. tax incentives	**Regulatory motivation:** - wish to comply with regulations

- regulation favors conventional tech/resource use - regulation focuses on risk control instead of risk prevention - inadequate subsidies, i.e. too low, focused on knowledge instead of production - preferred procurement / policy by government favors another product / tech **Other** - regulation influences finance negatively, i.e. foreign investors cannot repatriate profits, writing-off old infrastructure - lack of or inadequate enforcement of regulations - institutional change, i.e. disruptive new law		**Regulatory incentives from government stance:** - clear stance of government of preferred development technology/sector - government targets and policies to reduce CO2 emissions, inc. monitoring & reporting regulations	

Technological			
Barriers	**Uncertainties**	**Incentives**	**Motivation**
Technological barriers general: - available technology limits what can be done - scale necessary to efficiently use the technology - difficult to implement complicated tech, every case is unique, dif. requirements for stable functioning - good results competing technologies **Technological barriers from infrastructure & distance:** - a lack of or limited necessary infrastructure - geographical distance between recovered source and use - existing infrastructure not compatible **Technological barriers from technical difficulties:** - technical difficulties for recovering resource - malfunctioning technology, i.e. melting oven, ineffective management system - difficulties getting a successfully running plant set up	**Technological uncertainties general:** - uncertainty about the technology itself, regarding costs and performance - uncertainty about the relation / interaction between the new technology and the technical infrastructure - diminished faith in technology from negative stories about unsuccessful implementation abroad **Technological uncertainties from choice:** - uncertainty about the choice between different (future) technological alternatives	**Technological incentives from availability:** - technology available - existing infrastructure available and compatible **Technological motivation from perception:** - view of technology as highly efficient - technology considered to be 'proven' - the view that (tech) difficulties in different phases are normal 'teething problems' - other successful technological developments	

Supply chain			
Barriers	**Uncertainties**	**Incentives**	**Motivation**
Supply chain barriers related to tech/infrastructure: - technology supplier cannot resolve tech issues, i.e. goes	**Uncertainties from tech suppliers:** - uncertainty about the reliability of technology suppliers,	**Supply chain incentives:** - supply chain pressure	

bankrupt - lack of good ecological production methods - low co-operation in supply chain, difficult to force others i.e. if only one subcontractor - past negative experiences with supplier, i.e. costs & quality of consultants **Supply chain barriers related to resources:** - lack of availability of resources - competing methods that use same resource are locked-in - low quality of resource / products - additional costs for obtaining resource	reg. timing, pricing and quality **Uncertainty about resources:** - uncertainty about resources, i.e. amount, availability, price - uncertainty about the reliability of resource suppliers	- availability of & access to waste stream - convinced that there is a large availability of input resource, i.e. manure - long-term contract signing with resource & tech suppliers	

Knowledge			
Barriers	**Uncertainties**	**Incentives**	**Motivation**
Lack of knowledge in company: - Lack of skills, knowledge and expertise in company related to employees - Lack of know-how owner and training owner - low level of R&D - lack of awareness / understanding of environmental problems - lack of understanding risks or/and the potential of improvements - knowledge barriers because of large number of involved disciplines **Lack of knowledge in field:** - availability and access to knowledge lacking / not appropriate - data and information gaps - very few experts **Lack of knowledge in market:** - lack of knowledge / awareness by customers - communication difficulties between market actors and towards consumers	**Knowledge uncertainties:** - product / project / technology seen as 'new', not much known about - uncertainty about the knowledge required for the project	**Knowledge incentives:** - knowledge available to create possibilities - knowledge provision, i.e. support from consultants - positive outcomes sponsored R&D project - positive experiences from other projects	**Knowledge motivation:** - motivated to educate others with business / project

Organizational			
Barriers	**Uncertainties**	**Incentives**	**Motivation**

Organizational barriers from structure of company: -'champion' of the greener product/process is not in a position of power - different interests between different divisions within an organization - lack of procedures for change **Organizational barriers from attitudes in company:** - employees not eco-minded - manager has view that SMEs make no or low environmental impact - management / company has view that environmental improvements are expensive and not worthwhile / are not a core business issue - manager unwilling to bare perceived uncertainties of project - actions of manager do not reflect personal attitudes - reluctance to plan in company **Organizational barriers from actors involved:** - changes in actor constitution, i.e. cooperation fails	**Organizational uncertainties:** - uncertainty about human resources needed - uncertainty about how to organize the innovation process	**Organizational incentives:** - champions at upper and technical levels - cooperation with complementary partners - improve internal working climate - performance metrics that are integrated into goals and strategy	**Organizational motivation:** - motivated by being their own boss - motivated by escalating commitment, feelings of entrapment

Stakeholders (inc environment)			
Barriers	**Uncertainties**	**Incentives**	**Motivation**
Barriers from stakeholder actions: - lack of social acceptance / willingness to cooperate - objections/resistance because of the environment **Barriers from stakeholder attitudes:** - skeptical NGOs towards environmental leadership - reticent sector		**Stakeholder incentives from the environment:** - clear benefits for the environment - inspiration from nature - environmental concern inspired by environmental pressure groups - motivated by sustainability **Stakeholder incentives through image & legitimacy**: - higher brand consumer awareness - internal and external image improvement - prevent risk on reduced legitimacy & negative publicity in the future - support from media (attention, free publicity) **Stakeholder incentives other:** - relations with customers improved, better working climate - support from regional government (not subsidies, but positive attention, co-operation, knowledge and the like) - good contacts with NGOs, i.e. will not fill objections to project if meets higher than by law environmental requirements	**Motivation from the environment / sustainability:** - environment is reason for existence - perception of environmental issues as an opportunity - desire to make the world a better place to live - green values/passion for environment - wish to create/expand an affordable, reliable and sustainable energy supply

		- support from neighbouring households - view of competitors in sector as allies, i.e. natural gas actors want to expand the market as well	

Other			
Barriers	**Uncertainty**	**Incentives**	**Motivation**
- limited time window to realize project - barrier from external event, i.e. as influenza outbreak - customs and values define that possible resource is approached as a waste	- associated health risks	- clear benefits for health & safety, i.e. decreased risk potentional for water contamination, less explosions in mine - reduced odors - customs and values define that a resource is not seen as a waste	- part of lifestyle of sustainable entrepreneurship - independency, i.e. from National Grid - passion, i.e. about own business, products

Appendix IV: Domain of green gas projects based on co-digesters

Who, where	Stage	Cap.Nm3/hr
Groot Zevert Vergisting BV , Beltrum	expected	625
Van Genugten V.O.F., Sint-Oedenrode	expected	450
Mts. P.J. en M.C. Pronk, Warmenhuizen	expected	?
VOF Bioenergie Veendam, H van Oosten, Meeden	expected	?
Mts Leenders, Asten Heusden	expected	900 / 350
Bio energie Coevorden, Coevorden	expected	803
Kuijsten Montfort B.V., Biogast, Montfort	expected	180
Biogas Nistelrode BV, Nistelrode	expected	500
Mts H. B. en S. Lawerman-Dijkstra, Hiaure	expected	?
BMEC salland bv, Amersfoort	quit/unknown	?
? , Zwartebroek	quit/unknown	15
? , Sevenum	quit/unknown	13
Maatschap B en A.A.M. van Noord-Goes, Wijster	quit/unknown	?
MTS. Hotsma, Biddinghuizen	up-and-running	220
Bouwhuis Biovergisting, Witteveen	up-and-running	220
Schaap bio energie, Tirns	up-and-running	206
Broekland B.V, Lierop	up-and-running	250

Appendix V: Stimulating factors counted

Legend
Compiled – the description of the factor compiled from the literature sources and the entrepreneurs, to simplify very similar factors into one.
Motivation – the stimulating factors was recorded as a motivation, without this word, the stimulating factor was recorded as an incentive.
Short – the description of the factor as shortened for use in the tables presented in the thesis.
Source – letter pointing to the literature from which the factor is derived.
(*) Indirectly mentioned factor.
Entrepreneur – the number points to the case of the entrepreneur as found in the case descriptions.
A – All-all digester case
B – Expert from Biogast
GG – Expert from Foundation Green Gas
Numbers – phase in which the factor was said to matter 1. Idea & research, 2. Permits, subsidies & contracts, 3. Building & testing, 4. Up-and-running.
Bold – factor was said to be most important in this phase.
Red – the factor is co-digester specific (before green gas was considered).

Stimulating factors: motivation & incentives		**Source**	**Entrepreneur**							**Expert**	
Compiled	**Short**		**1**	**2**	**3**	**4**	**5**	**6**	**A**	**B**	**GG**
Financial											
Motivation: recognition of an opportunity to make a profit (i.e. use biotickets additionally)	wish to make a profit	B(*), D(*), I(*), J(*), K,L	**1**			1, **1**		1		1, 2, 3, 4	
Motivation: less risk, diversifying income streams - continuity family business	diversifying income streams - continuity family business	M		1	**1**		**1**		1		**1**
financial support by governments	SDE subsidy green gas	E, G, H, I, J, K, L	1		**1**	1	2	2	1	**2**	2
availability of (own / partner / special fund) capital	availability of capital	G			1			1		2	
added value to business from added amenities	added value to business	J					1				
unprofitability MEP micro-CHP due to increasing co-stream prices, decreasing electricity prices, no market for heat, low subsidy.	unprofitability MEP micro-CHP		**1**		1, **2, 3**	**1**	2			1	2
low prices for agricultural products	low prices for agricultural products	I		1	1				**1**		
Market											
Motivation: identifying a gap in the market	identifying a gap in the market	E(*), M	1	1		1		**1**	2	**1**	1
increasing market opportunities, i.e. unique location, competitive edge	competitive edge, market opportunity	F, L(*)	**1**	1		1		**1**	1		
stable/interesting market	stable/interesting market				1		1				

trend towards value-driven environmentalism, increasing consumer awareness (glastuinbouw wil toch vergroenen – Friesland Campina wil ook groen)	consumers / sector wants to become greener	E, M				2			1		
improve quality product, i.e. digestate better than manure	digestate quality better than manure	I, J				1					
Regulatory											
opportunity arisen from other policies, i.e. manure processing	manure processing regulation provides opportunity	A(*), F, M(*)	2								
having a broad permit	having a broad permit						1		2		
Technology & knowledge											
existing infrastructure available and compatible	existing infrastructure available and compatible	L	1, 1	1		1		1			
view of technology as proven / highly efficient / tech problems as normal teething problems	positive view of technology	K, L			**4**						
information provision & hearing about positive experiences others	information provision & positive experiences others	K, L	1		1	1	1	1, 2			**1**
previous experience, i.e. wind energy, biogas	experience with renewable energy		1		**1**		1			3	
Supply chain											
availability of & access to waste stream	availability of & access to co-streams	K, L	1		4	1	**1**	1		2, 4	2
having long-term contracts with resource suppliers	having long-term contracts with resource suppliers	L						2		2	2
Organizational											
motivation: escalating commitment, feelings of entrapment, financially necessary – investments done	entrapment, financially necessary	K, L	**1**		2	1			2		2, **3**
motivation: growing enthusiasm	growing enthusiasm	L(*)									**2**
motivation: wish to expand business	wish to expand business	K			1			1			
motivation: passion for pioneering, innovation, entrepreneurship, technology	passion	M	1, -2	1		1, 1				1	
fits with existing activities of business	fits with existing activities of business	E	1, 1		2	1, 1	1				
trust in & cooperation with complementary partners	trust in & cooperation with complementary partners	E, K, L			1			2	1	2	2
trust in own organization	trust in own organization		1						**2**		1
long-term thinking in family business	long-term thinking in family business	M					2	2			1
right person in right position / dependent on quality entrepreneur	quality entrepreneur in power	G									1

Stakeholder											
motivation: to be a link in the regional recycling loop	to be a link in the regional recycling loop	B(*), M(*)	1		1	**1**					
non financial support from regional government, i.e. aid of province in negotiations	non financial support from regional government	E							2		
trust in societal role product, passion for sustainability / green values, fits with ideals	trust in societal role product / sustainability	B, D, M			4	1	1			1	

Appendix VI: Obstructing factors counted

Legend
Compiled – the description of the factor compiled from the literature sources and the entrepreneurs, to simplify very similar factors into one.
Uncertainty– the obstructing factors was recorded as an uncertainty, without this word, the obstructing factor was recorded as a barrier.
Short – the description of the factor as shortened for use in the tables presented in the thesis.
Source – letter pointing to the literature from which the factor is derived.
(*) Indirectly mentioned factor.
Entrepreneur – the number points to the case of the entrepreneur as found in the case descriptions.
A – All-all digester case
B – Expert from Biogast
GG – Expert from Foundation Green Gas
Number – phase in which the factor was said to matter or occur 1. Idea & research, 2. Permits, subsidies & contracts, 3. Building & testing, 4. Up-and-running.
Bold – factor was said to be most important in this phase.
Red – the factor is co-digester specific (before green gas was considered).

Obstructing factors: barriers & uncertainties		**Source**	**Entrepreneur**							**Expert**	
Compiled	**Short**		**1**	**2**	**3**	**4**	**5**	**6**	**A**	**B**	**GG**
Financial											
high initial investment / hesitant capital providers (crisis, low benchmark)	hesitant capital providers	C, D, F, J, K, L				2		2	2	**1, 2**	1, 2, 3
lack of economical feasibility / profitability, high running costs, scale necessary	lack of economical feasibility	A, E(*), G, H, J, I	2						1, **2**	1	4
limited support money, i.e. subsidies too low, SDE 2008, early phase, not for biogas only for green gas	limited support money	E, H				1		2	1	2	2
uncertainty about financial resources (inc. unreliability of investors, SDE lottery)	financial resources	K, L	1	2		**1**		**2**		**2**	**1, 2**
uncertainty about profitability (due to changing costs resources, competing subsidies, regulations manure)	profitability	F, G, L	**1**, 2					1	2	1, 2	
Market											
market competition from those with newer/foreign subsidy schemes	market competition from those with newer/foreign subsidy schemes	K(*), I(*)	4		**4**					2, 4	
low or variable product quality (gas)	low / variable product quality (gas)	C(*)			3						
uncertainty about the consumer demand for the product, i.e. CO2, seasonal variation gas	(seasonal) consumer demand	D, H, I, K, L		1		4		4	2	1, 4	2

Regulatory											
institutional process bureaucratic, tedious, too many rules, leading to complexity, more work, delays	delays from institutional process, tedious/slow	B, E, L			2	**2**		**2**			
rigid rules obstruct innovation/project, i.e. what and amount of co-streams can be used, can build where	rigid rules obstruct project	B, E, G, K	**2**		**2**, 3, 4	**1,** 4					
lack of permit, i.e. for construction digester / pipeline etc.	lack of permit		2	2	2						2
lack of or inadequate enforcement of regulations	lack of or inadequate enforcement of regulations	E, I		2							
uncertainty from changing & unpredictable subsidy regime	changing & unpredictable subsidy regime	K, L	2	2		1	2		1		2
uncertainty from changing (related/manure) regulation, i.e. influence EU, differences between municipalities, between countries	changing (related/manure) regulation	B, K, L	2	2		2				4	
uncertainty about granting of permits by government	granting of permits by government	K, L	1								2
Technology & knowledge											
malfunctioning technology / difficulties to get menu/biology right, i.e. collapsing roofs, H2S	difficulties / malfunctioning technology	F(*), K, L	**3**			3				3	4
uncertainty about the technology itself & different technological alternatives	technology & different technological alternatives	C, K, L				3		2			
lack of knowledge, i.e. partners, public, entrepreneur/owner, network operator	lack of knowledge	E, G, H, I	**4**	2		3				2, 3	1
Other *uncertainty*: i.e. possibility of archeological finds at building site	other								3		
Supply chain											
negative experiences with tech supplier	negative experiences with tech supplier	F, L	3								
uncertainty regarding reliability of technology suppliers, i.e. timing, pricing and quality	reliability of technology suppliers	K				3		3			
negative experience with network operator, i.e. delays, changing contracts	negative experience with network operator	J(*)			2, **3**					**2, 3**	**3**
uncertainty about additional requirements & costs network operator, i.e. gas composition, second check box, transport costs, pipeline, stability capacity	requirements & costs network operator				1, 2			**3**	3	**3**	3
increasing costs of resources	increasing costs of resources	J(*)	4			2	**2**			**1,** 2, 4	**2, 4**

middlemen drive up cost resources	middlemen drive up cost resources		4			4			2		4
lack of availability of resources / good quality resources	lack of (good quality) co-streams	E, L	4				2			3, 4	2
uncertainty about resources, i.e. amount, availability, price	co-streams	K, L	1				**2**	2	4	**1,2,4**	2, 4
uncertainty about reliability of resource suppliers	reliability of co-stream suppliers	K, L	1,**4**								2
Organizational											
cooperation fails	cooperation fails	K, L							2		
uncertainty about the complexity /long term of the project ("complicated matter", "you dive in the deep end")	general - complex, long-term				**1**		2				1
Stakeholder											
reticent, old owners, sector / reticent possible partners	reticent sector / possible partners	E, G			2, 3			2		**1**	**1**
lack of social acceptance- community resistance: transport movements, odor	community resistance	A(*), L, I	2	2			2	2	2	2	2, 4
negative media + bad image digesters, i.e. KRO reporter	negative media / image	E		2				2	2	1	1
uncertainty about the development public opinion	development public opinion							**1**		2	2

Appendix VII: Stimulating & obstructing factors from literature - Not occurring in cases

Stimulating factors

Category – incentive / motivation	**Simplified factor**	**Source**
Financial incentive	the project saves costs	A, B, E, F, G, I, J
Financial incentive	high energy prices / fuel	A, C, F, L
Financial incentive	higher profit margin eco-product than conventional product	E
Market incentive	keeping up with competition	B, F
Market incentive	near monopoly / niche	E
Market incentive	green product is cheaper than conventional	I
Market incentive	customer pressure	C, F, G, M
Motivated by sustainability	environment is reason for existence	E, M
Motivated by sustainability	wish to contribute to more renewable energy	K, L
Stakeholder incentive	environmental pressure groups	F
Stakeholder incentive	internal and external image/brand improvement	C, E
Stakeholder incentive	prevent risk on reduced legitimacy & negative publicity in the future	E
Stakeholder incentive	support from media (attention, free publicity)	E
Stakeholder incentive	relations with customers/NGOs/other actors in sector improved	E, F, L
Motivated by regulation	wish to comply with regulations	I
Regulatory incentive	helps to comply with traditional regulatory pressure / anticipate future legislation	A, C, E, G, I, M
Regulatory incentive	clear government stance stimulates	C, H, I, L
Motivated by organization	being their own boss / being independent, i.e. from national power grid	M
Organizational incentive	improve internal working climate	E
Organizational incentive	performance metrics that are integrated into goals and strategy	G
Organizational incentive	clear other benefits i.e. for health & safety, reduced odors	D, G, I, J
Supply chain incentive	supply chain pressure	G
Motivated for knowledge	wish to educate others with business / project	M
Technological incentive	promising technology / opportunity new innovation	A, B

Obstructing factors

Category –uncertainty / barrier	**Simplified factor**	**Source**
Financial barrier	- previous investments, reluctance to abandon & costly to remove	G
Market uncertainty	about the behavior of competitors	L
Market barrier	competition is locked-in / cheaper / free-riders strain profit	D, H, I, K
Market barrier	low - modest consumer demand / not willing to pay	E, H
Market barrier	negative image of sustainable products, i.e. more expensive, less effective, too many eco-labels	E, G, I
Barrier from stakeholders	objections/resistance because of the environment	D
Barrier from stakeholders	skeptical NGOs towards environmental leadership	E
Regulatory barrier	lack of appropriate / harmonious policy framework / legislation / policy	H, L
Regulatory barrier	passive/ineffective government	E
Regulatory barrier	increased liability	B
Regulatory barrier	regulation has wrong focus, i.e. favors other tech, or on knowledge instead of production	B, G, I
Supply chain barrier	low co-operation in supply chain, difficult to force others i.e. if only one	E

	subcontractor	
Technological uncertainty	diminished faith in technology from negative stories about unsuccessful implementation abroad	K
Technological barrier	a lack of incompatible necessary infrastructure / technology / eco-production methods	A, C, D, E
Organizational uncertainty	about human resources needed	L
Organizational uncertainty	about how to organize the innovation process	L
Organizational uncertainty	about associated health risks	J
Organizational barrier	'champion' of the greener product/process is not in a position of power	G
Organizational barrier	different interests between different divisions within an organization	G
Organizational barrier	lack of procedures for change / reluctance to plan	F
Organizational barrier	employees / manager not eco-minded	E, F
Organizational barrier	management / company has view that environmental improvements are expensive and not worthwhile / are not a core business issue	F, G
Organizational barrier	manager unwilling to bare perceived uncertainties of project / actions do not reflect personal attitudes	F, K
Knowledge uncertainty	because product / project / technology seen as 'new', not much known about	D
Knowledge uncertainty	about the knowledge required for the project	L
Knowledge barrier	lack of awareness / understanding of environmental problems	C, E, F, G
Knowledge barrier	lack of understanding risks or/and the potential of improvements	F, G, I
Knowledge barrier	large number of involved / necessary disciplines	G
Knowledge barrier	availability and access to knowledge lacking / not appropriate / data and information gaps	D, E, F
Knowledge barrier	very few experts	F, H
Knowledge barrier	communication difficulties between market actors and towards consumers	C
Other barrier	uniqueness each project	A, L