Thesis: Support base for hydrogen economy Groningen-Assen

Motives and regional impact of firms implementation of the hydrogen economy

Master thesis: Economic Geography

Vincent Popma
S3171337

Rijksuniversiteit Groningen

Supervisor: Prof. Dr. Jouke van Dijk
Second assessor: Dr. Sierdjan Koster

Abstract

During the past years hydrogen has become a more relevant option to support the transition towards a sustainable energy usage. In order to fill the economic gap that could fall when the fossil-fuel industry would be cancelled, hydrogen is seen as promising substitute, especially by governmental institutions in the region of Groningen-Assen. So far, there has been a lack of research on the support base of the hydrogen economy for firms. This thesis will answer the research question: Is there a threshold for firms to implement a hydrogen economy in the region Groningen-Assen for their business? This will be done by analysing survey data with regression analysis and comparing sustainability motives in the region against the literature. Outcomes suggest no clear threshold for firms, however if firms see the major advantage of hydrogen to improve their competitive advantage and the major constraints for implementing hydrogen are costs, firms could be more likely to implement the hydrogen economy into their business. Further trends suggest there is need for more clear law and regulation and improved accessibility of green hydrogen. Firms are expecting a knowledge gap in the region as they expect a lack of qualified personnel in the region. Firms still require more financial aid in order to embrace the transition towards hydrogen economy Groningen-Assen.

Table of contents

1 Introduction

1.1 Background

Over the past years hydrogen has become a more relevant option for governments and firms to support the transition towards a sustainable and renewable energy usage. With climate change and an ever more energy-consuming society the importance of renewable energy sources is greatly increased. Hydrogen is an energy carrier that can be used widely in industry, mobility and other sectors requiring large amounts of energy (Gigler & Weeda, 2018).

In the Netherlands, a large share of the energy consumption is based on natural gas. After 20 years of exploitation of the Groningen gas fields earthquakes started to appear, caused by the gas extraction. In 2018 more than 85.000 damage claims had been made with regards to earthquakes and societal pressure to stop gas extraction started to rise. Due to increasing social resistance towards the gas extraction and fossil based economy in Groningen, the Dutch government decided to heavily decrease the gas extraction by 2020 and completely shut down the Groningen gas fields by 2022. (Ministerie van Economische Zaken en Klimaat, 2020; Correljé, Van der Linde & Westerwoudt, 2003). In order to fill the economic gap that could fall when this fossil industry would be cancelled, hydrogen is seen as the substitute especially by governmental institutions in the region (Regio Groningen-Assen, 2021; Provincie Groningen, 2019).

Groningen is an interesting region to develop a change in energy use and renewable sources, because its citizens seem to be very concerned about fossil fuel use and extraction, while the industry sector in the region is used to working with energy supply (e.g. powerplants in Eemshaven) and recycling of rest products into renewable energy. Sustainability projects already planned investment of 438 million euro's into the three northern provinces. Therefore the primary conditions for infrastructure and a so-called hydrogen economy, are already in place (Provincie Groningen, 2019).

Further development of the hydrogen economy has been planned in the NortH2 project. The first stages of this project are developing a 4 GW wind farm and further on- and offshore power infrastructure, setting the stage for turning the northern Netherlands into a highly modern renewable hydrogen economy. Substantial parts of the project will be located in the provinces of Groningen and Drenthe. The network of Groningen and Assen, working together in the Regio Groningen-Assen (Figure 1), has decided to start a joint economic agenda as the area has experienced economic decline over the years. With the exception of their capital cities, the provinces are among the economically weakest regions within The Netherlands, with relatively low household incomes and relatively high unemployment rates. Hence, NortH2 could provide a welcome economic boost to the region (Los & Van Dijk, 2020; Regio Groningen Assen, 2021).

Figure 1: Joint economic region of Groningen-Assen (Regio Groningen-Assen, 2021)

The scientific relevance of the implementation of a hydrogen economy lies especially in case studies for this specific region. The Future Markets CERRE report (Moraga González,, Mulder, & Perey, 2019) explored the future potential of a hydrogen and biogas market. They have provided a regulatory-distribution framework that could be applied in the Groningen-Assen region. Stadtler & Lin (2017) have provided the AMC factor-framework which explains factors impacting on firm behaviour towards an environmental transition, which could be interesting for firms transition towards hydrogen economy Groningen-Assen. Earlier studies on the potential use of hydrogen in regions were mostly undertaken in the context of governmental plans and promises of investments in the region (OECD, 2020). So far, there has been a lack of research on firms' attitudes and future prospects towards the hydrogen economy. This perspective is termed the support base for the hydrogen economy for firms in this thesis. This thesis will analyse the support base of firms for the hydrogen economy in the region Groningen-Assen, based on (regulatory) driver factors (Stadtler & Lin, 2017) constraints and the opportunities for firms in different sectors.

1.2 Research problem

This research will explore the support and opportunities for the hydrogen economy among firms, which could be important for policy makers and investors towards further implementation of hydrogen. It will include empirical research on the type of firms that could be affected.

In order to explore more of the potential hydrogen economy of Groningen-Assen the following research question will be analysed:

1. What are the constraints and opportunities for firms in the region to implement the hydrogen economy Groningen-Assen for their business?

In order to answer the main question, the following secondary questions have been formulated:

Context

2. What are businesses and sectors that may benefit from a hydrogen economy in Groningen-Assen?
3. What could be the role of these firms?
4. What are main motives for these firms to adapt to a hydrogen economy?

Constraints

5. What are disadvantages for firms to adept to a hydrogen economy
6. Is it possible for these firms to adapt to a hydrogen economy?
7. Is it desirable for these firms to adapt to a hydrogen economy?

Opportunities

8. What are gains for firms to adept to a hydrogen economy
9. What are the uncertainties in (dis)advantages for firms to adept to a hydrogen economy

Regional impact

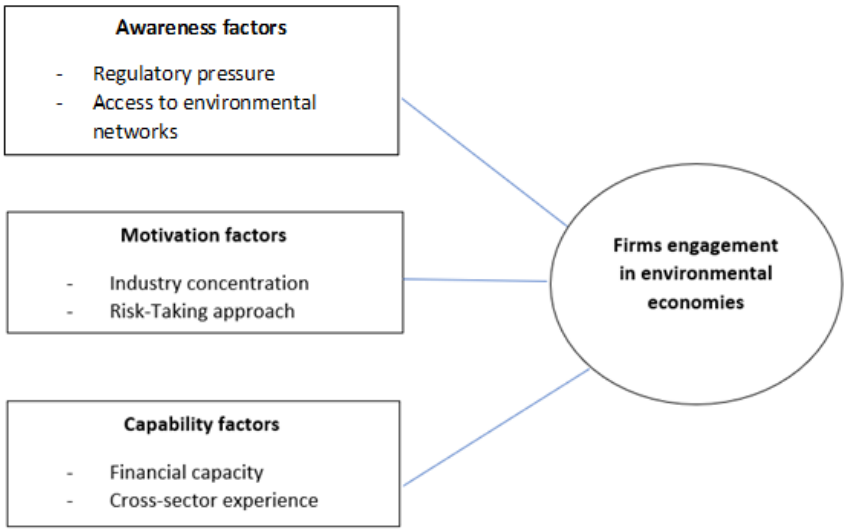
10. What is the contribution to the region of firms when joining the hydrogen economy
11. What (commercial) roles are missing from the region when building the hydrogen economy?

2 Conceptual model and theoretic framework for the hydrogen economy support base

2.1 Literature and theory

There has been previous research on the shift of firms towards more environmental procedures and environmental alliances. Stadtler and Lin (2017) have defined an AMC (Awareness, Motivation & Capability) framework which explains the drivers firms generally experience when considering adaptation towards an environmental economy like the hydrogen economy. Figure 2 illustrates these drivers and their relationship towards engagement into a new and environmental economy.

Figure 2: **AMC factors for firms moving into environmental economies (Based on Stadtler & Lin, 2017)**



The model focuses on a firm's strategy and allows the joint consideration of three interdependent, but conceptually different drivers. This model captures and acknowledges firm decisions in their greater complexity (Stadtler & Lin, 2017). This theory emphasizes firm decision making and can be applied in the current case study.

2.2 Awareness

2.2.1 Regulation

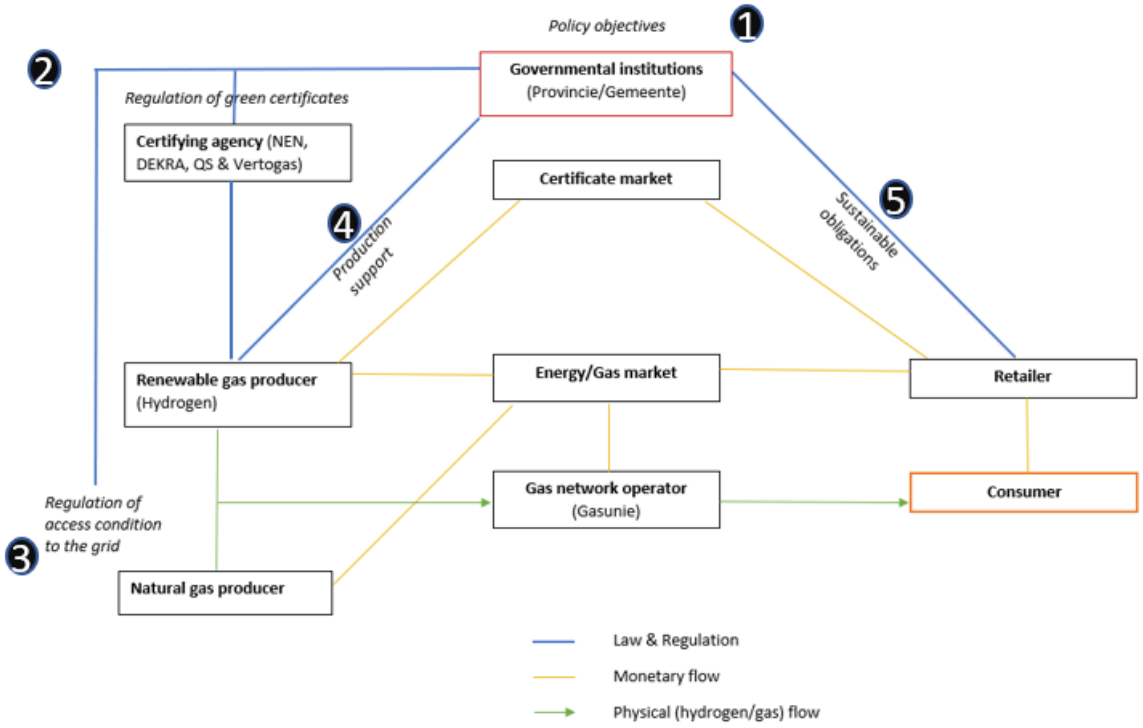
Regulation and regulatory pressure is inevitable for markets. Economic regulation refers to government-imposed restrictions on firm and/or consumer decisions over price, quantity, and entry and exit (Viscussi et al., 2005). Not only may regulation hinder firms, in contrast and especially in the market for hydrogen as energy carrier, regulation may well promote the product and make it a more competitive alternative to fossil fuels (Moraga González, Mulder, & Perey, 2019). Figure 3 describes 5 different aspects within regulation for hydrogen.

The first (1) aspect describes government policy strategies and goals they want to achieve. The second (2) aspect refers to a basic premises for any further regulation, which is controlling the supply of a renewable gas by the creation of schemes for guarantees of quality and origin. Another key condition for a renewable gas is that producers need access to the gas infrastructure. The third (3) aspect, therefore, refers to the regulation of the conditions for this access. To promote use of a

product like hydrogen for producers is to give them favourable conditions for getting access to the gas network, which will also reduce their costs or increase their ability to inject the gas into the network.

Even if hydrogen is traceable and can be injected into the grid, because of its relatively high costs, the producers may still find it difficult to operate in a market in which the price of non-renewable gas is low. Therefore, the fourth (4) aspect of regulation consists of the introduction of production support schemes meant to reduce the costs of producers of hydrogen in order to enable them to compete with natural gas. The final (5) aspect in Figure 3 are regulatory measures to foster demand for hydrogen, for instance, by imposing renewable energy obligations on retailers. Such regulatory measures can for example oblige gas retailers who would sell natural gas, to make use of the renewable alternative.

Figure 3: Analytical framework economic regulation of hydrogen in Groningen-Assen region (after Moraga González, Mulder, & Perey (2019).



For explanation of numbers, see text.

Currently, laws on hydrogen use in firms have not been implemented yet, apart from those for regulating production. The importance for policymakers therefore increases to establish a structured legal framework.

It is expected that national law “Stimulering Duurzame Energieproductie (SDE)” or the European “Renewable Energy Directive (RED II)”, which are both laws on promoting sustainable development in terms of subsidies, will foster the initiative for companies to become involved in producing and supplying hydrogen to the masses and for consumers to have access to a competitively priced product (Godula-Jopek, Jehle and Wellnitz, 2012; Provincie Groningen, 2019).

Adaptation of the existing infrastructure is a technical possibility for transporting hydrogen, nevertheless must be in line with infrastructural laws and regulation.

An important factor in the implementation of hydrogen by firms is that a new socio-economic structure will be created. Over the past years the energy carrier hydrogen has been sold from business to business where information would be more symmetric in terms of product application and quality knowledge, compared to selling to the public. Both firms would understand what the product is and what the purpose of the product would be.

It is expected that as investments are raising, the business case and employment opportunities will increase due to a rise in demand. However, this will also lead to higher dynamics in supply of the product making it will be more difficult to control for quality, quantity and safety. Thus, , future users could be more frequently civilian-consumers without proper safety knowledge, instead of professionals (Godula-Jopek et al., 2012).

2.2.2 Networks

According to Stadtler & Lin (2017) the existence of firms networks highlights that the surroundings and connection of an organisation influences its awareness of strategy-related patterns. Entry into diverse networks impacts the type of information that is obtained . For firms involved with hydrogen this sets their experience with sustainable involvements' distinctive symptoms, opportunities and stakeholder perspectives. Consequently, firms' connections with external organizations working on sustainable (energy) programs seems critical for the shift from polluting industry to sustainable development projects, like implementing hydrogen. Primarily, engagement and knowledge exchange with networks who may provide complementary sustainable visions and adopting different perspectives will enrich and develop a firm's knowledge base on new environmental options like renewable energy. Further, firms' environmental networks improve close connections with key pioneers in the environmental field (Chen & Miller, 2015). Overall, these connections help sharpen firms' awareness of emerging trends, challenges and the important needs and opportunities related to sustainable development (Lin, 2012).

2.3 Motivation

2.3.1 Industry concentration

Industry concentration is expected to add to a larger cohesion in terms of the organisational field of firms. There has been a relation between environmental behaviour and industry concentration in terms of firms' strategy, due to this greater cohesion (Aigbedo, 2021). However the AMC framework (Stadtler & Lin, 2017) originally suggests this to be a negative relationship, since implementation of multiple (therefore diverging) environmental practices will realize a lower competitive advantage due to the possibility of competitors replicating.

On the one hand, for oligopoly markets there is less incentive for firms to implement transformational environmental projects, as these are often more risk-averse firms that want to defend their market share. To make such a radical technological transition to implement hydrogen in the firms' business plans, it can be expected that their behaviour is more in line with the findings of Stadtler & Lin (2017). On the other hand, in markets where there is a lot of competition in a more dynamic industry it might be that (technological) shifts are actually beneficial to their market share. These firms might examine transformative shifts in renewable strategies as a decent differentiation opportunity to craft a competitive niche. Firms taking this approach could therefore accept possible short-term losses involved and focus on strategy and profit long term, for example by improved corporate image or entry in other markets (Carballo-Penela and Castromán-Diz, 2015; Stadtler & Lin, 2017).

In addition, complementing and/or competing firms concentrated in a relatively close spatial proximity could motivate each other to invest into renewables. Most renewable technologies, such as hydrogen, show economies of scale: an increase in capacity lowers the unit cost since significant investment expenditures can be divided over more units of output. This could also increase the likelihood of concentrated firms transitioning to the hydrogen economy (Moraga González, Mulder, & Perey, 2019).

2.3.2 Risk taking approach

Technological difficulties and process unpredictability add to risks of sustainability transitions. Firms implementing the renewable energy grid into their business plan often experience large complications. Socio-economic and technological challenges increase the risk of such transitions, as knowledge gaps for employees could be created moving towards these new technological innovations. Implementation of innovations as the hydrogen economy causes interaction for firms with different and new stakeholders, like governments or new markets and competition (Stadtler & Lin, 2017).

While the transition mainly comes from economic interest, moving towards renewable energy and the hydrogen economy will cause positive side-effects for environmental issues. However, the fundamental aspiration of firms is risk-and cost reduction, increasing prominence to attract talent and improve market position, shareholder value and competitiveness. Shareholder value could especially pay off by meeting governmental objectives, earning benefits and other support. Long term these factors might promote more risk-taking approaches by firms. This accounts especially for high-polluting firms, that will eventually face risks in the long term, as they could lose key customers, greater costs and sanctions over time. Risk-taking approach is expected to come from a purely economic view and remains focused on serving the business itself and its economic goals (Kassinis and Vafeas, 2009; Dyllick and Muff, 2016).

2.4 Capability

2.4.1 Financial capacity

Logically, firms with a lesser cash-position and lower financial resources are less eager to consider investments for the long term, as are required to implement a hydrogen system into their business. It can be expected that these firms are less interested towards environmental investments, as they would not directly show results in terms of profitability (Berrone et al., 2013). Firms with greater financial resources are able to make more diverse investments, either to benefit short term (for example an increase in market share) or more radical investments for the long term. These long term investments could potentially be the change towards the hydrogen grid. Such considerably larger investments often require taking over existing operations such as infrastructure, and restructuring processes within the firm. This often involves greater costs than traditional technology would. Even though the principle of economies of scale holds, (early) investment for the hydrogen economy will require relatively large costs. Pollution declining approaches, like carbon capture storage (CCS) will cost less, not considering governmental sanctions long term. Especially in that situation, having larger financial resources would allow firms to opt for a more long-term strategy in their sustainability procedures, opening towards more costly options short term, and undergo the lean time until the investment brings success. This means that transition will not be possible without enough (governmental) funding (Marin-Vinuesa et al., 2020).

2.4.2 Cross-sector experience

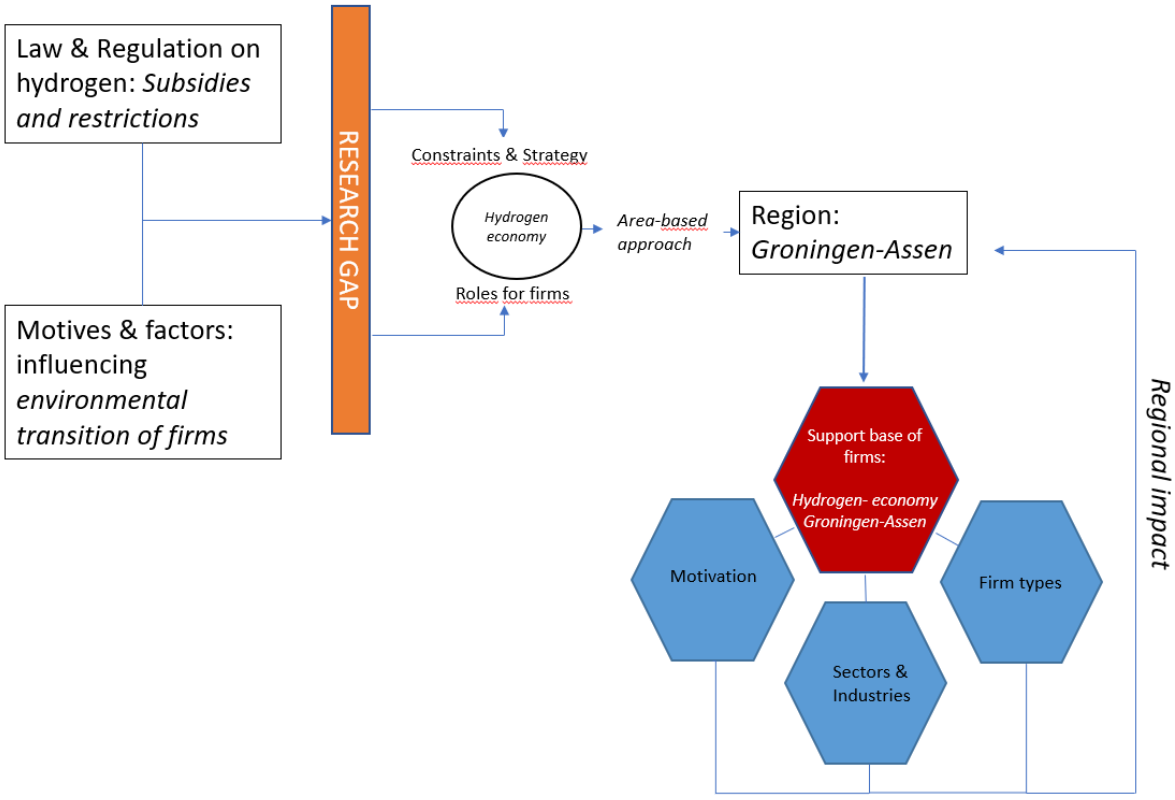
Investments and developments on renewable energy extend beyond firms and includes interaction between a varied amount of stakeholders, in order to establish significant changes in business models and technologies (Stadtler & Lin, 2017).

This creates complexity from considering multiple stakeholders and different forms of value creation simultaneously is an important stepping stone toward collaborative approaches to developing and managing organizations around shared purposes, like the hydrogen economy. The literature states it is well known that short-termism can be adverse for sustainability efforts within and between organisations (Colaner et al., 2018; Slawinski et al., 2017; Slawinski & Bansal, 2015). Therefore, the need to adopt a long-term perspective is sometimes discussed as a unified part in the business model. Business models for sustainability aim at solutions for sustainable development by creating supplementary monetary and non-monetary value through pro-active management of multiple stakeholders and incorporation of long-term perspectives (Geissdoerfer et al., 2018). It follows that multi-stakeholder, cross-sector collaborative business models aiming at sustainable value creation face the challenge of aligning altering and multiple perceptions over time. So-called temporal tensions that occur between stakeholders must be considered and managed (Pedersen et al., 2021).

2.5 Conceptual framework

From the existing literature on hydrogen law and regulation and internal motivation of firms, the following conceptual model has been developed for this thesis (Figure 4).

Figure 4: Conceptual framework on the support base of firms' implementation of hydrogen economy Groningen-Assen



To explore the threshold and type of firms implementing the hydrogen economy Groningen-Assen into their business plan, it is important to understand the regulative possibilities and limitations for hydrogen. To further understand what happens to these firms, when the possibility of implementing a hydrogen economy into their business becomes a reality, it is important to understand motives and drivers. Since the hydrogen economy is a relatively new concept and it is not yet explored what factors drive firms to this transition, more general literature on firms environmental transitions has been used for building this framework (Stadtler & Lin, 2017). From this framework a hypothesis can be formulated, for the constraints and opportunities of firms implementing the hydrogen economy Groningen-Assen into their business plans. Accordingly, the following hypothesis has been formulated: ***Factors that influence firms' decision to implement hydrogen into their business mostly concern constraints in regulation and financial capability, while possible opportunities involve firms to be part of a competitive niche market and to effectively reduce their emission output.***

3 Methodology

3.1 Research type

The approach to the research question is based on empirical research in the field of spatial economics. Based on the literature research into scientific evidence in the field of firms and the hydrogen economy (see chapter 2), questions and hypotheses about firms in the region Groningen-Assen were formulated to guide further analysis on the support base for firms towards a hydrogen economy. The factors driving firms and their relative importance were explored in a survey among firms and analysed by regression modelling.

The literature and the SBI selection identified specific topics regarding firms and the hydrogen economy in the region Groningen-Assen. The choice for quantitative research by making a questionnaire in this case seemed most sensible, because this method allows for a large amount of firms to be analysed (Clifford et al., 2016). While (in-depth) interviews would potentially find more specific motives for firms to engage in a hydrogen economy, conducting a survey allows for a larger sample and a more direct and clear depiction of motives and factors that firms may see as most important in general. This generalisation of factors could be interesting for governments, as this gives more direction to what firms need.

3.2 Data collection

3.2.1 Selection of the sample firms

The firms included based on the conceptual model, were mainly firms in sectors that are involved in producing, distributing and/or consuming of hydrogen. These sectors are defined by SBI codes. The SBI codes identify the firms' major sector of business as indicated by the firm. For the firm selection the SBI-Hierarchy Navigation Tool (CBS, 2021) was used. This tool requires the user to fill in a key concept, in this case "hydrogen" and then gives all possible sectors (as SBI codes) that may include this key concept.

Sectors concerning production and distribution of hydrogen were selected primarily as these sectors are identified in the NorthH2 report (Moraga González, Mulder, & Perey, 2019). According to the Hierarchy Navigation Tool sector D: Production, distribution and trade of electricity, natural gas, steam and cooled air (SBI codes 3511 to 3514) were most important. These sectors were therefore selected. Other important sectors were: 3530 (Production and distribution of steam and cooled air by solar power for heating and energy supply), 2011 (Manufacturing of industrial gasses) and 46751 (Wholesale in chemical products for industrial application). Respondents with a different SBI-code were also invited to answer; these respondents were asked to fill in their SBI-code, instead of picking from one of the given options (CBS, 2021; Moraga González, Mulder, & Perey, 2019).

3.2.2 Approach of respondents

The main selection of firms has been made following expectations from the literature as to which sectors are expected to have interest in hydrogen and by using the hierarchy navigation tool (CBS,2021). From this tool, the main sectors, based on SBI codes, that would potentially implement hydrogen into their business were selected, as mentioned in 3.2.1. Firms were selected based on the free online Bedrijvenregister (Drimble.nl,2021) and employees of firms within the relevant sectors were approach through the platform of Linkedin. Also experts were approached to ask for help with distribution of the survey in their networks.

3.2.3 Survey and analysis

The type of survey that has been developed is an internet survey (Clifford et al., 2016). This is more time-efficient compared to physically visiting the selected firms, however could be less effective in terms of respond-rate. To limit this downside, a reminder email was sent and later on the targeted firms that did not answer the survey were given a phone call as a third reminder to completing the survey.

The questions asked in the questionnaire were based on the research questions mentioned in chapter 1.2 and derived from the conceptual framework. From this conceptual framework (section 2.5) known factors of firms environmental transitions are derived, which resulted in questions concerning the hydrogen transition. With questions based on the AMC framework (Stadtler & Lin, 2019) firms' motives for transition to the hydrogen economy were measured.

3.2.4 Content of questions

The survey consisted of 21 questions (Q). Most of these were multiple answer type, most notably those considering factors in transition for firms, as these would show most clearly what firms would consider most important.

The first question was about the name of the firm. This is interesting as this will give the data more of a character and will help the analysis in terms of what types of firms will be interested in the hydrogen economy is this specific region. The responses to this question will not be shared due to commercial confidentiality issues.

The next questions 2 and 3 are about the knowledge on hydrogen of the personnel and how hydrogen may be applied within the firm. Q4 and 5 were Likert scale questions (Clifford et al., 2016) rating to what extent firms think there is clear regulation on hydrogen and to what extent firms think hydrogen is safe to use within the firm. Q6 considers the role firms will take in the hydrogen economy. Q7 and 8 address to what extent firms benefit from the transition and why the hydrogen economy might benefit them. Q9 to 12 evaluate restrictions and alternatives. Q13, 14 and 15 ask about firms' transition strategy considering hydrogen and about their current engagement in the energy transition with(out) hydrogen. Q16 to 18 consider the regional impact of the transition to a hydrogen economy and also ask if firms are able to achieve this themselves or to what extent they need (financial) support to successfully transition. Q19 to 21 again were more pragmatic to understand the firm in terms of sector/SBI-code, postal code and the amount of employees, to support further analysis of the survey results in terms of regional impact.

3.3 Data analysis

3.3.1 Coding of variables

The respondents were coded into applicable classes from the sample and their responses were coded into corresponding variables (Table 1).

Table 1: Coding of variables

Question	Label	Type	Coding
1	n.a. (Firm name)	open	n.a
2	Knowledge	interval	1 to 5
3	Application	interval	1 to 4
4	Law	interval	1 to 5
5	Safety	interval	1 to 5
6	Role	nominal	encode
7	Benefit	interval	(erg weinig) 1 to 5 (erg veel)
8	Reason	nominal	encode
9	Disadv	nominal	encode
10	Option	nominal	encode
11	Achievable	interval/binary	1 to 5/0=No, 1=Yes
12	Support	interval	1 to 4
13	Grnenerg	binary	1= Yes, 0 = No
14	InvestH2	binary	1= Yes, 0 = No
15	Advantage	nominal	encode
16	Regional	nominal	encode
17	Lacking	nominal	encode
18	Governm	nominal	encode
19	n.a. (Zip code)	fixed	
20	Employees	interval	open
21	n.a. (SBI code)	fixed	options + Anders

The first question is irrelevant to coding as it is just used for indication of which firm corresponds to which case. Q2, however starts the survey data in terms of results. This question, being on Likert scale, is coded into the variable *Knowledge* with range 1-5 (erg weinig – erg veel). Q3 allows the respondent to pick multiple options for the application of hydrogen for their firm. This variable was named *Application* and is a interval variable. Q4 consists of a fixed rating between 1 – 5 (5 meaning absolutely clear regulation) and therefore becomes an interval variable named *Law*. Question 5 is similar to Q4, but is rating safety of hydrogen within a firm. Therefore this is also an interval variable coded into *Safety*. Q6 is considered similar to Q3, also as a nominal variable named *Role*. Question 7 is on Likert scale again named *Benefit*. Q8 (*Reason*) features multiple nominal options. The options for this categorical variable were encoded and the option not applicable ('n.v.t.') was dropped. For Q9 (*Disadv*) and Q10 (*Option*) the approach is similar, options were encoded in Stata. Q11, dependent variable *Achievable*, was again on Likert scale. As there is no clear value between the options, this variable is considered an interval variable and also coded 1-5 with 5 meaning firms see the hydrogen economy as highly achievable and answered with "Ja, waterstof zit absoluut in het toekomstbeeld van het bedrijf". Q12 (*Support*) is similar, but consists of 4 categories. Q13 has two options (either yes or no) and was therefore coded into a binary variable named *Grnenerg* (no= 0, yes = 1). Relative to Q13, Q14 adds another option for firms that are interested in implementing hydrogen into their business. Coding for Q14 therefore includes no=0, yes=1, interested=2 and was named *investH2*. Q15 to 18 are all nominal variables, without a clear order, and will be coded 1 – 5. The names of these variables will be *Advantage*, *Regional*, *Lacking* & *Governm.* The final codable question is number 20, and showing the amount of employees of a firm. This will be an interval variable named *Employees.*

In order to answer the research questions with the data from the survey, some results have been adapted to one of the options given. For example in Question 11, when firms answered whether or not they are interested in joining the hydrogen economy, answers that stressed the dislike of a firm towards the hydrogen economy were moved to the option " Nee, de waterstofeconomie is niet interessant voor het bedrijf". Firms that acknowledge future projects or pilots with hydrogen were changed to "Ja, er wordt gekeken naar opties voor de waterstofeconomie in het bedrijf". Such changes have to be kept in mind when interpreting and analysing the results. Therefore both the original and adapted data have been included in the Appendix.

3.3.2 Statistical model

In this research, two models have been used to test what factors could influence a firms decision in whether or not they would implement the hydrogen economy into their business.

In the first model, the dependent variable *Achievable (Achievable)* is a categorical variable (Category 1 (Nee, absoluut niet interessant…), 2 (Nee gekeken, maar niet haalbaar 3 (Anders…), Cat. 4 (Ja, er wordt gekeken naar…), and Cat.5 (Ja, absoluut in toekomstbeeld…)), and it is sought to compare the motivating factors that influence firms' threshold on implementing the hydrogen economy into their business strategy. It has to be noted that cases in category 3 (Anders…) were divided into either of the other category as the firms who chose this option solely explained their choice. Ordered logistic regression models (hereafter "ologit" models) for empirical testing were chosen, since these models are considered to be well suited for the study of ordered categorical outcome variables, especially when comparing across categories without clear differences in size between them. For this research it was expected to be especially interesting to check the factors that influence the decision for firms to implement the hydrogen economy into their business plan. Data on factors for the potential use of hydrogen, firms opinion on the clarity of law & regulation, safety and the number of employees were also collected.

A second model has been used as well in this research, to test whether a firm will achieve to implement hydrogen into their business plan, or not. This has been done to reduce the spread in categories, as the limited amount of data is then concentrated between only 2 categories to potentially strengthen the statistics. The dependent variable Achievable is therefore transformed into a dummy, where categories 1 and 2, as well as 4 and 5 were combined into no (0) and yes (1). Category 3 (Anders) was dropped for this test as most of the answers only explained why they would choose one of the other options. For this dependent variable a logistic regression has been used, tested against the same independent variables as described in the first model.

3.4 Tools

The regression and analyses were done in Stata (16). This program has been used in the Masters' course Advanced Statistical Analysis (ASA) and therefore has been picked to use for analysis as the author had previous experience using this tool. The corresponding do file of the regression is provided in Appendix 9.2.

The questionnaire is made in the online tool of Survio.com (2021). This tool already creates clear data-output which can be exported to Stata. It is also very user friendly to both the researcher and to the respondents.

To picturize the respondents by ZIPcode, Arcgis Online has been used to create a map.

The Hierarchy Navigation Tool of the CBS (2021) has been used to identify sectors that work with hydrogen.

To approach firms, first Drimble.nl (2021) was used. This is a website that provides lists of firms per region and sector (Bedrijvenregister). Later on the social media platform of LinkedIn was used to reach out to firms that could potentially implement hydrogen into their business plans.

The complete survey and data have been put into the supporting documents section as Appendix 9.1.

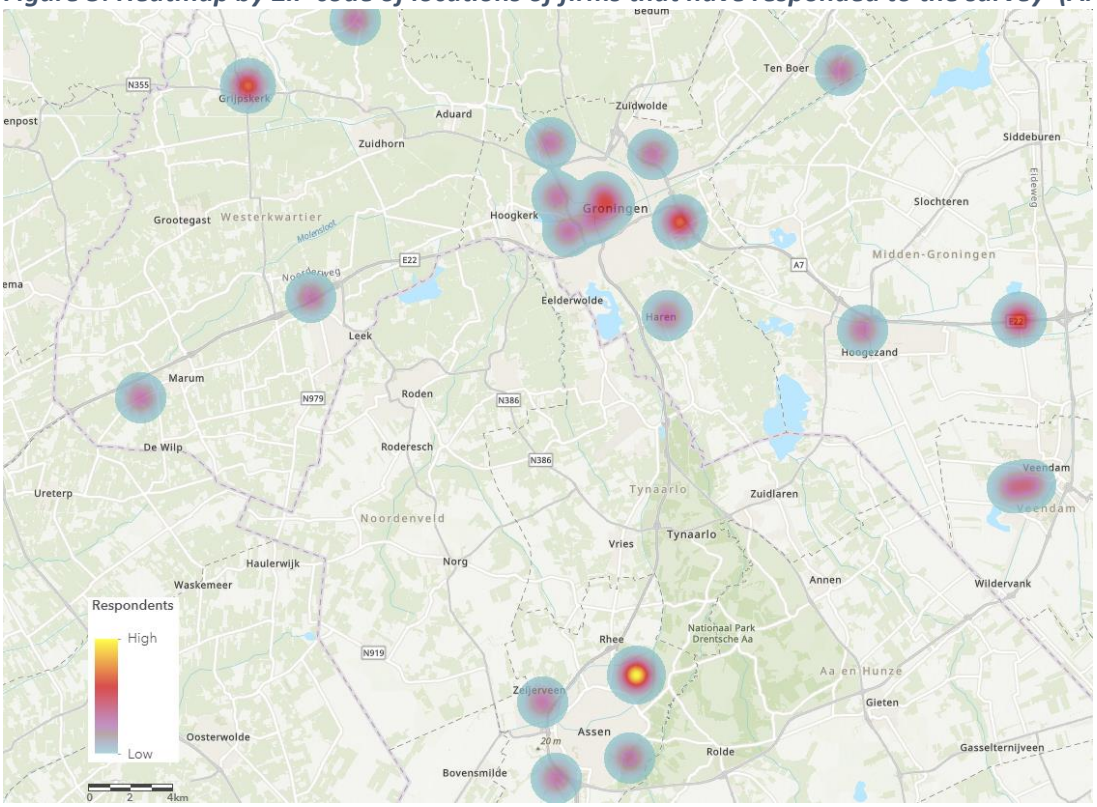
4 Results

4.1 Survey demographics

The survey page was visited by 168 people between 28-05-2021 and 13-07-2021. In total, employees from 41 different companies have completed the survey. In terms of firm attributes, 17 out of these 41 companies have more than 50 employees (41%).The most frequently mentioned sectors in which the companies are active were:

- Trading of electricity and gas through pipes (12.2%),
- Production of electricity; transmission and distribution of electricity and natural gas (7.3%) and
- Management and operation of transport networks for electricity, natural gas and hot water (7.3%).

Figure 5: Heatmap by ZIP code of locations of firms that have responded to the survey (ArcGIS)



The map on Figure 5 shows the concentration of firms that responded to the survey. While most of the firms responded from the region of Groningen, the largest concentration of respondents came from the north-eastern part of Assen (7%).

In Table 2 and Table 3, respectively, the descriptive statistics and correlation of the major variables are shown. For 2 variables in the sample, not all firms found the ability to respond. For the variable Governmental needs *(Governm)* 37 respondents identified what they need most from governments towards implementing hydrogen into their business. The question on what (coded) sector firms operate in (*SBIcode*) was answered by only 32 out of 41 respondents.

Table 2: Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Knowledge	41	2.951	1.283	1	5
Benefit	41	3.731	1.183	1	5
Achievable	41	3.717	1.413	1	5
Support	41	2.073	.607	1	3
InvestH2	41	1	.806	0	2
Application	41	1.780	.690	1	3
Role	41	3.585	1.071	1	5
Reason	41	3.317	1.603	1	6
Disadv	41	2.658	1.493	1	5
Option	41	3.731	1.140	1	5
Advantage	41	3.243	1.545	1	6
Regional	41	3.170	1.321	1	5
Lacking	41	3.195	1.749	1	5
Governm	37	3.702	1.127	1	5
Law	41	2.463	1.163	1	5
Safety	41	3.804	1.122	1	5
Grnenerg	41	1.097	.300	1	2
Employees	41	445.58	.911	1	8000
SBIcode	32	X	X	0	X

Table 3: Correlation table

	Achiev~e	Benefit	Knowle~e	Support	InvestH2	Applic~n	Role	Reason	Disadv	Option	Advant~e	Regional	Lacking	Governm	Law	Safety
Achievable	1.000															
Benefit	0.4963	1.000														
Knowledge	0.3504	0.5657	1.000													
Support	0.4559	0.4088	0.3127	1.000												
InvestH2	0.3050	0.4960	0.7114	0.2486	1.000											
Application	-0.0581	-0.1576	-0.1377	0.0444	-0.0826	1.000										
Role	0.1002	0.4629	0.4481	0.1836	0.4739	0.0045	1.000									
Reason	-0.1211	-0.2405	-0.1047	0.0232	-0.1306	0.2320	-0.1510	1.000								
Disadv	0.0495	0.1204	0.1429	0.2202	0.0557	0.1105	0.1331	0.0700	1.000							
Option	0.1527	-0.0651	-0.0453	-0.1168	0.0078	0.2476	0.0146	0.0411	-0.1598	1.000						
Advantage	0.1421	-0.0063	-0.1123	-0.0714	-0.0700	-0.0191	-0.0483	0.4116	-0.1843	0.0881	1.000					
Regional	0.1581	0.1250	0.3061	0.3234	0.2719	0.0381	0.1573	0.1983	0.3149	0.0350	0.0186	1.000				
Lacking	0.0306	0.1899	0.3911	-0.1532	0.3277	0.0028	0.2613	0.2426	0.1377	0.0913	-0.0214	0.2995	1.000			
Governm	-0.2116	-0.4018	-0.3136	-0.1295	-0.2041	0.0125	-0.4222	0.3251	0.0230	-0.0082	0.3313	-0.3397	-0.2480	1.000		
Law	0.2626	0.4245	0.5115	0.3156	0.3732	-0.2610	0.4721	-0.1499	0.0693	0.0058	0.1607	0.1376	0.0520	-0.2256	1.000	
Safety	0.4258	0.1958	0.5072	0.1792	0.5232	-0.0528	0.1868	0.0814	-0.2619	0.1673	0.2098	0.2736	0.1998	-0.2975	0.1272	1.000

4.2 Context

In the sample of firms in region of Groningen-Assen, most of the firms answered 'Ja …..' (Yes) on the question about whether they think the hydrogen economy is interesting for their business (dependent variable *Achievable*). When making a cross table (Table 4) for *SBIcode* against *Achievable* 24 out of 31 (77%) that filled in their SBI code answered that they are planning to (14), or already implementing (10), hydrogen into their business. Table 4 shows the main sector per SBI code for clarification.

Out of these 24, 10 are in one of the sectors with SBI code 351, *Energiebeheer* in Table 4 (Productie van elektriciteit; transmissie en distributie van elektriciteit en aardgas). This means most of these firms are in the electricity or gas business, either in producing, or distribution of electricity and gas. Second highest scoring sector is 421 (Bouw van wegen, spoorwegen en kunstwerken) building and road construction firms. Of the 24 that answered yes, 10 answered "Ja, een waterstofeconomie zit absoluut in het toekomstbeeld van het bedrijf" (41,7%) and 14 said "Ja, er wordt gekeken naar opties voor de waterstofeconomie in het bedrijf"(58,3%).

Table 4: Achievability of a hydrogen economy and the sector of firms

	Achievable				
SBIcode	Nee, niet interessant	Nee, gekeken	Ja, opties	Ja, absoluut	*Total*
Delfstofwinning					
0:	0	0	1	0	**1**
06:	0	0	1	0	**1**
Industrie					
1:	0	1	0	0	**1**
273128:	0	0	1	0	**1**
Energiebeheer					
3512:	0	0	2	1	**3**
3513:	0	0	2	0	**2**
3514:	0	0	1	3	**4**
351:	0	2	0	1	**3**
Sanering					
3700:	0	0	1	0	**1**
3821:	1	0	0	0	**1**
3900:	0	0	1	0	**1**
Bouw					
42:	0	0	1	0	**1**
421:	0	0	1	0	**1**
4211:	0	0	1	3	**4**
Groothandel					
4675:	1	0	0	0	**1**
Advisering					
70221:	1	0	0	0	**1**
7112:	0	0	0	2	**2**
721:	0	0	1	0	**1**
N.a.					
X	0	1	0	0	**1**
Total	***3***	***4***	***14***	***10***	***31***

Table 5: The role and sector of firms

	Role					
SBIcode	Anders	Consumerend	Geen	Ondersteunend	Producerend	***Total***
Delfstofwinning						
0:	0	0	0	1	0	**1**
06:	0	0	0	1	0	**1**
Industrie						
1:	0	0	0	1	0	**1**
273128:	0	0	0	0	1	**1**
Energiebeheer						
3512:	0	0	0	3	0	**3**
3513:	0	1	0	1	0	**2**
3514:	0	0	0	4	1	**5**
351:	0	0	1	0	2	**3**
Sanering						
3700:	0	0	0	1	0	**1**
3821:	1	0	0	0	0	**1**
3900:	0	0	0	1	0	**1**
Bouw						
42:	0	0	0	0	1	**1**
421:	0	1	0	0	0	**1**
4211:	0	4	0	0	0	**4**
Groothandel						
4675:	0	0	1	0	0	**1**
Advisering						
70221:	0	1	0	0	0	**1**
7112:	0	0	0	2	0	**2**
721:	0	0	0	1	0	**1**
N.a.						
X	0	0	0	1	0	**1**
Total	**1**	**7**	**2**	**17**	**5**	**32**

In Table 5 the role (*Role*) of firms is put against the sectors (*SBIcode*). In this case 32 of the 41 firms in the Groningen-Assen sample filled in the sector combined with their potential role. From the table it can be seen that most of these firms (17) expect to have a supportive (Ondersteunend) role in the hydrogen economy. In contrast, the second largest sector that is planning to use hydrogen, the (road)construction sector (421) is planning to consume hydrogen, which is expected for their heavy industry, as they provided as main reason in comments.

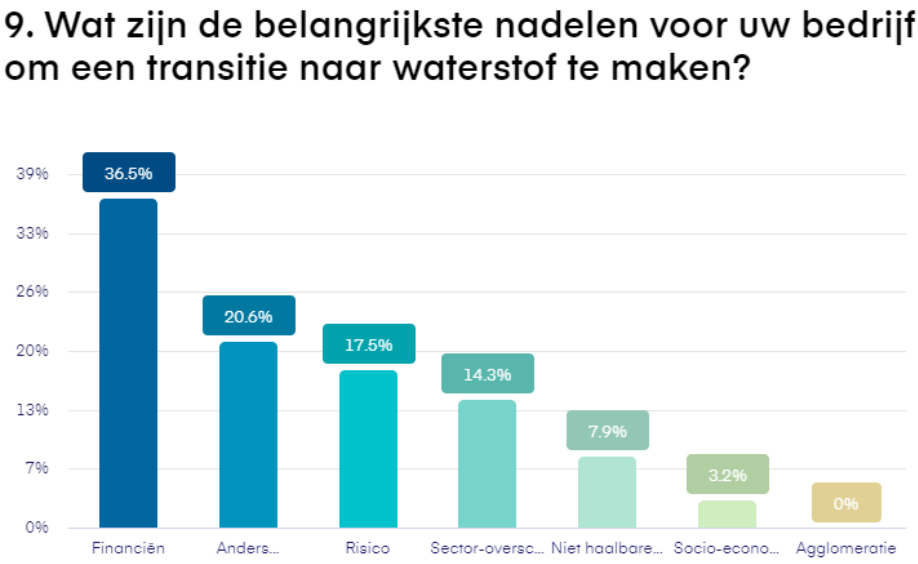
The main motives for firms to engage in a hydrogen economy were asked in Question 8, *Reason* (Figure 6). In terms of main drivers the majority answered that it would be an opportunity for the firm to enter a potential new market (almost 30%). The second driver was mentioned to be for the benefit of the firms' energy transition. It is noted that the majority of firms that opted for "Anders" mentioned specific sustainability measures that the firm conducted or remarked that sectors (351) need hydrogen to stay relevant. Other contextual factors of firms, like firm-size did not seem to add much to the analysis

Figure 6: Advantages for firms to implement hydrogen into their business, answers in percentage of respondents (Q8, survey)

4.3 Constraints

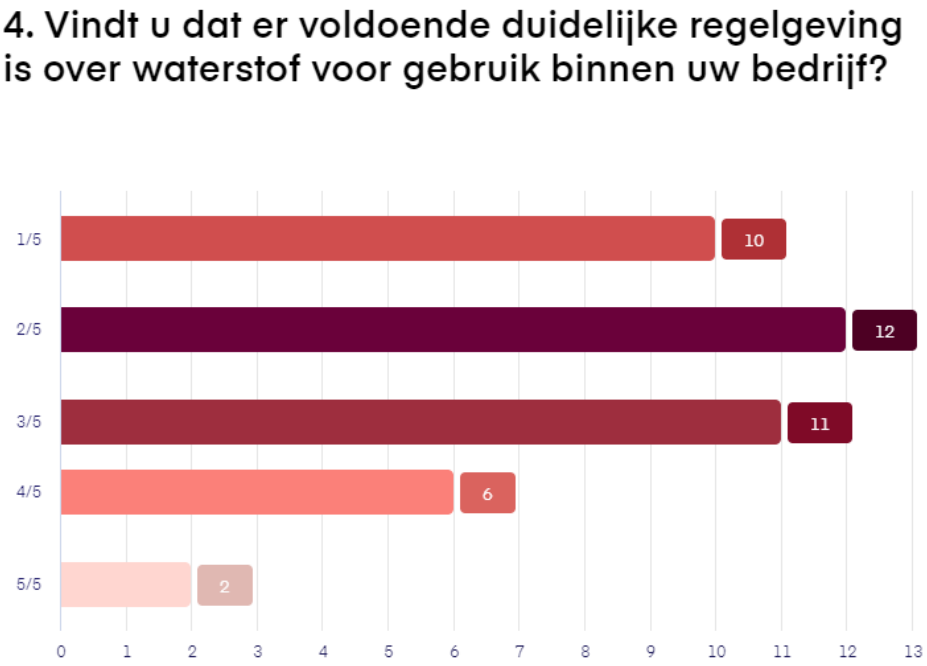
In the questionnaire firms were also asked for the biggest constraints they expect to run into when adapting to a hydrogen economy (Figure 7). This was Question 9 (*Disadv*). In the sample, firms answered that Financial reasons are the primary concern (36%). , followed by individual reasons for firms in "Anders". Within the "Anders" category, the majority, again, acknowledged financial issues; a lack of shareholder support, yield and unclear pricing.

Figure 7: Disadvantages to implement hydrogen, answers in percentage of respondents (Q9, survey)



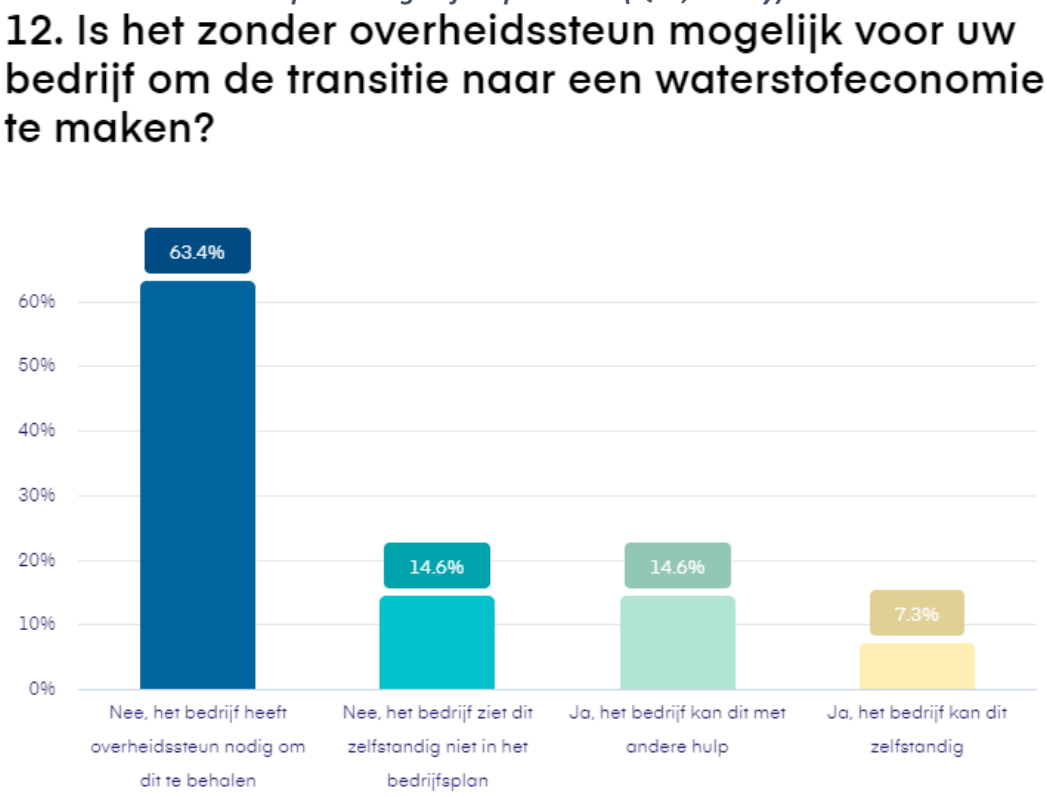
Other firms mentioned a lack of clear law and regulation. This result was supported in Question 4 (*Law*) on rules, law and regulation (Figure 8), where most firms answered the clarity of rules and regulation to be 2/5, with 1/5 being completely unclear and 5/5 being absolutely clear. Of firms in the sample, 53% scored the clarity of law and regulation to be 2/5 or even lower. When including neutral (3/5), 33 out of 41 in the sample scored the rules and regulation to be unclear.

Figure 8: Rating of firms on clarity of rules & regulation, in number of respondents (Q4, survey)



The survey data suggest large difficulties for firms to adapt to a hydrogen economy, especially by themselves (Figure 9). Of the firms in the sample, 63% state they need governmental support for making the transition towards a hydrogen economy. Nearly 15% of the firms find it impossible to make the transition towards hydrogen. The remainder of firms (22%) in the sample are, or expect to be able to make the transition to a hydrogen economy by their own means, without governmental aid. Either by themselves or with help from other parties or institutes.

Figure 9: The possibility for firms to make the transition to a hydrogen economy, answers in percentage of respondents (Q12, survey)



4.4 Opportunities

The main advantage as identified by firms was to strengthen their competitive advantage (Concurrentiepositie). In line with the literature firms see the transition to be a more complicated engagement into the energy transition, than simply using hydrogen to increase a firms' sustainable operations (Pedersen et al., 2021). This is observed for both the total sample (Table Table 3) and especially for the largest sector 351 (Energiebeheer). The second driver that was deemed important was sustainability (Verduurzamen), which firms across all sectors within the sample picked, however this factor was not significant in the regression analysis.

Table 6 : Firms drivers as advantages of hydrogen for their business per sector

	Advantages					
SBIcode	Anders	Concposit	VerbMarkt	Verduurza	WeiVerand	**Total**
Delfstofwinning						
0:	0	0	0	1	0	**1**
06:	0	0	0	1	0	**1**
Industrie						
1:	0	1	0	0	0	**1**
273128:	0	1	0	0	0	**1**
Energiebeheer						
3512:	0	0	2	1	0	**3**
3513:	0	0	1	0	1	**2**
3514:	0	4	0	1	0	**5**
351:	0	1	1	1	0	**3**
Sanering						
3700:	0	0	0	1	0	**1**
3821:	1	0	0	0	0	**1**
3900:	0	1	0	0	0	**1**
Bouw						
42:	0	1	0	0	0	**1**
421:	0	0	0	1	0	**1**
4211:	1	2	0	1	0	**4**
Groothandel						
4675:	1	0	0	0	0	**1**
Advisering						
70221:	1	0	0	0	0	**1**
7112:	0	0	1	1	0	**2**
721:	0	1	0	0	0	**1**
N.a.						
X	0	0	1	0	0	**1**
Total	**4**	**12**	**6**	**9**	**1**	**32**

4.5 Uncertainties

Uncertainties for firms were mentioned in the “Anders” answers across multiple questions, especially in the disadvantages. As mentioned before most uncertainties come from financial situations and include lack of support from shareholders and the lack of mass implementation. This makes hydrogen expensive, as firms need to establish networks themselves.

There are also uncertainties in the advantages, according to the sample. Firms in the region Groningen-Assen consider the competitive advantage of pioneering in hydrogen to be of short-term value only, as competition may implement hydrogen in a later phase much cheaper. That would create a level playing field in the market again. Other uncertainties, as will be elaborated in 4.6, were firms contributions to the region.

4.6 Regional impact

In the survey Question 16 (*Region*) asked the firms to highlight the contributions they expect to make towards the region. The firms answered mainly that they expect to increase knowledge in the region (Figure 10). Only 14% of firms expect to attract additional economic activities to the region by

implementing the hydrogen economy into their business plan. However, it should be noted that firms are not exactly sure if they accomplish these contributions to the region, as they acknowledged with notes in the answer “Anders”. Some firms suggested that they would benefit the region by realising socio-economic projects in terms of hydrogen infrastructure and realisation of other hydrogen activities.

Figure 10: Firms expectations of their contribution to the Groningen-Assen region (Q16, survey)

To understand what the region needs for firms to include the hydrogen economy into their business plans it is also important to understand what aspects firms expect that are needed for the transition. Question 17 (*Lacking*) and 18 (*Governm*) asked firms to pick options what they are missing the most for the adaptation in terms of commercial roles (Figure 11) and from governmental institutions (Figure 12). Subsidizing institutions and educational roles on hydrogen are missing, according to the survey. Most of the firms answered they need subsidizing institutions. This is a common trend in the survey as this is confirmed in Question 18 to also be the largest demand from firms and when asked if firms could achieve the transition without governmental support (Q12) the vast majority answered that they need it to accomplish the transition to hydrogen.

Firms also need educational institutions. The reasons firms gave as to why they need educational institutions is on the one hand the lack of capable personal and on the other hand to be more engaged with these institutions to acquire valuable knowledge over time. In “Anders” firms acknowledged the need for commercial parties that could supply hydrogen. Firms said to have need for (hydrogen) fuel stations, machinery and public support.

Figure 11: (Commercial) Roles that are missing for firms transition (Q17, survey)

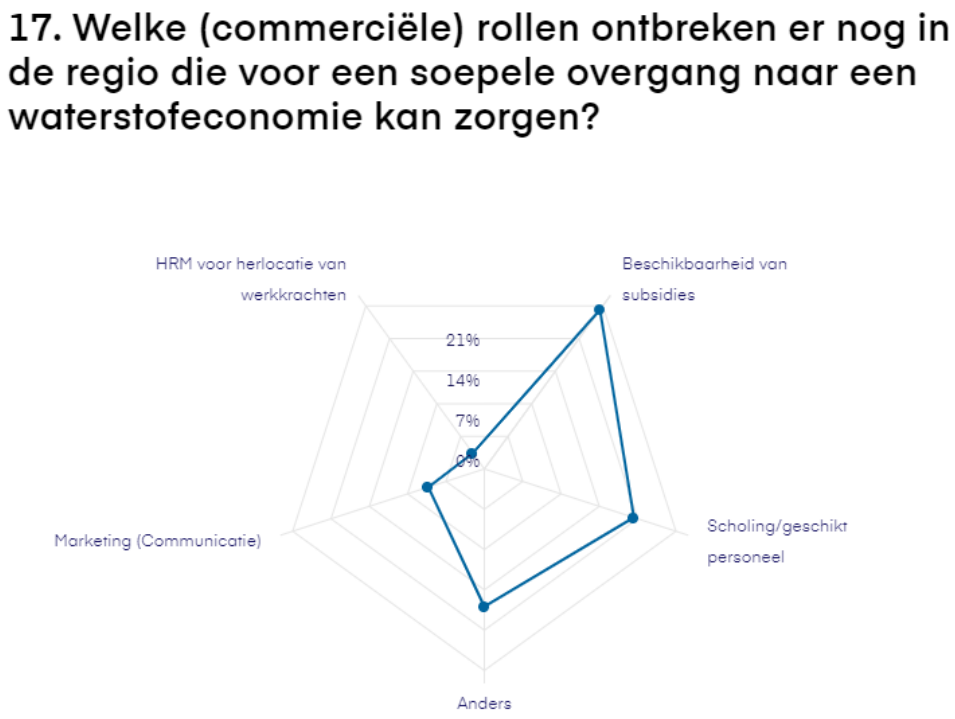


Figure 12: (Governmental) Roles that are missing for firms transition (Question 18, survey)

When firms were asked about what they need from governmental institutions, again firms called for financial aid. From the sample the most frequently picked option (30%) was that firms need subsidies, in order to achieve transition towards a hydrogen economy in the region Groningen-Assen.

Remarks and comments in the option “Anders” explained that firms need investments for infrastructure and transportation of hydrogen for accessibility, as well as training of personnel. This is in line with the statistic that 25 % needed the government to ease accessibility of green hydrogen.

4.7 Threshold for firms: regression analysis

The descriptive statistics and trends from the survey, have shown some results for what firms expect as constraints and opportunities of implementing hydrogen into their business. To explore if there could be a threshold for firms that explains the degree of engagement in a hydrogen economy, a regression analysis has been conducted. Table 2 and Table 3 show the descriptive statistics of the variables and their correlation respectively. Regressing the variables 1 by 1 against the dependent variable worked, however, the author opted for the following 2 regression models, as these were the only multivariable models to enable the author to explain some of the results.

In Table 2 the outcomes of the ordered logistic regression analysis, ologit, are shown (Model 1). The regression analysis is based on the main research question that seeks to find an answer to “*What are the constraints and opportunities for firms in the region to implement the hydrogen economy Groningen-Assen for their business?”* The aim of the regression is to find factors that explain the degree of engagement a firm has towards implementing hydrogen into their business, explained as to whether firms find it achievable to join the hydrogen economy Groningen-Assen (dependent variable *Achievable*). The dependent variable *Achievable*, based on survey question 11, explains the degree of engagement firms have in the hydrogen economy. The model predicts the influence of different factors, split into advantages and disadvantages, based on the AMC-framework and the conceptual model (Stadtler & Lin, 2017) on the likelihood of firms implementing hydrogen into their business. The independent variables, *Advantage* and *Disadvantage* explain the different opportunities and constraints firms experience for the implementation of hydrogen. These variables have been chosen based on the conceptual framework. Other variables, such as *Law* had been included as well, however then the regression failed to reach convergence. The regression was conducted for 39 observations.

Table 2: Ordered logistic regression results (Model 1)

	1	
VARIABLES	Achievable	SE
2.Adv. Concpositie	3.238*	1.871
3.Adv. Financial	2.752	2.801
4.Adv.Marktaandl	2.380	1.727
5.Adv. Verduurzm	2.229	1.802
6.Adv.Weingveran	1.378	2.438
2.Disadv. Financ	2.533*	1.459
3.Disadv. Niethaal	17.58	1,608
4.Disadv. Risico	1.220	1.622
5.Disadv. Sectvsc	1.428	1.509
/cut1	1.188	1.135
/cut2	2.776**	1.310
/cut3	5.046***	1.401
Constant		
Observations	39	

*** p<0.01, ** p<0.05, * p<0.1

Stata output is provided in appendix 9.4.1

The first model shows the prediction that there is a significant positive relation towards firms that seek to improve their competitive advantage and the implementation of hydrogen. This is predicted

at the confidence interval of p<0.1 with a positive coefficient of 3.238 (log odds). This means that when firms see it as the biggest advantage of hydrogen to improve their competitive position in the market, the log odds for firms to embrace the hydrogen economy into their future business is increased with 3.24 (odds 25). Therefore it could be said that firms see it to be more achievable to implement hydrogen into their future business plan when the main advantage of hydrogen is to improve the competitive position in the market.

The independent variable Disadvantage included negative factors, constraints, for firms when implementing hydrogen into their business. Results indicate that when firms see costs for hydrogen as main constraining factor (2.Disadv. Finance), there also seems to be a significant relation for firms approach to adept hydrogen into their business plans. This is at the significance level of p<0.1 with a confidence interval of 2.53. For firms this would mean that if the main disadvantage of hydrogen for firms is financial, the log odds for firms to see the hydrogen economy achievable in their business plans is increased with 2.53 (odds 12.5). This could predict that if the main constraint that firms experience when implementing the hydrogen economy into their business are costs for the transition, they are more likely to see the hydrogen economy achievable for their firm.

It should be noted that this seems like an unnatural or counter-intuitive statement, as constraining factors have a positive coefficient. The author therefore considers these results as suggestions, which will be elaborated on in chapter 5. Most firms acknowledged costs for the transition towards hydrogen to be relatively high, while still answering that they absolutely see the hydrogen economy into their business (5), or are looking for options to implement hydrogen (4).

After the regression model in Table 2, the author has added more variables into the ologit regression model. Unfortunately, Stata was not able to find convergence into the regression.

To counter this problem, the author opted for a second model (Model 2), transforming the dependent variable into a dummy variable. This reduces the categories for the dependent variable from 4 into 2 and makes the categories larger than before; the options are either Yes… (1) or No…(0) for firms to implement hydrogen into their business.

Table 3: Logistic regression output (Model 2)

VARIABLES	Achievable	SE
2.Adv. Concpos	1.048	2.136
3.Adv. Financial	-0.183	2.342
4.Adv. Mrktaandl	0.469	1.963
5.Adv. Verdrzming	1.555	1.924
6.Adv. Weinigver	-	
2.Disadv. Financ	3.138*	1.714
3o.Disadv. Niethlb	-	
4.Disadv. Risico	1.491	1.917
5.Disadv. Sectovsc	-1.690	1.798
Constant	-1.386	1.118
Observations	39	

*** p<0.01, ** p<0.05, * p<0.1
Stata output is provided in appendix 9.4.2

For Model 2 a logistic regression is used, as for this model the dependent variable is now a dummy variable and an ologit model is not applicable anymore. Outcomes of the logistic regression differ

slightly from the ologit model. In comparison, now the independent variable Advantage does not show significance for any of the factors (Table 8).

Considering Disadvantage, again the variable is significant for the factor Financiën. Results of this logistic regression predict that when firms see costs for hydrogen as main constraining factor (2.Disadv. Financ), firms are more likely to include hydrogen into their business plans. This is at the significance level of $p<0.1$ with a confidence interval of 3.14. For firms this would be that if the main disadvantage of hydrogen for firms is financial, the log odds for firms to see the hydrogen economy achievable in their business plans is increased with 3.14. This predicts that if the main constraint that firms experience when implementing the hydrogen economy into their business are costs for the transition, they are more likely to see the hydrogen economy achievable for their firm. This is in line with the ologit regression (Model 1), however for the logistic regression (Model 2) only the main constraint costs seem to be a significant factor in relation to implementing the hydrogen economy into firms business plans, ruling out any significance for the given advantages. Again, arguably this seems to be a suggestion more than real evidence, as the outcomes of a variable representing constraints should not have a positive coefficient. Therefore the author, again, considers outcomes from this model as suggestive, which will also be elaborated on in chapter 5.

5 Discussion and conclusion

5.1 Discussion

5.1.1 Discussion of methods

The literature partly answered the research question on how firms may adept to a structural change towards and environmental economy and what firms could potentially have interest in hydrogen. To explore if firms experience the same factors for adaptation to a hydrogen economy further analysis was needed. This would be interesting for the local government and the economic region of Groningen-Assen to better understand how to engage firms and to effectively foster their transition. For these firms an analysis was done on the regional impact they potentially have, in terms of socio-economic supply and demand. A survey among firms was selected as the most sensible approach for this.

Firms were selected based on their potential involvement with hydrogen, based on the NortH2 report and the SBI tool. This may have caused a certain bias, as these firms are expected to be more involved with hydrogen than other firms. In a first attempt, the firms were approached with the help of a free online tool which unfortunately proofed outdated (included lots of firms that were not active anymore and was incomplete). Firms were then googled for their contact details (as these were not provided in any of the tools) and the investigator approached the selected firms by email and/or phone. Also employees of selected firms were contacted through the platform of Linkedin and with the help of experts in the field, which proofed to be more successful.

The survey consisted of 21 questions. Firms were asked to pick factors they think were helpful and lacking in the area to implement the hydrogen economy into their businesses and potential alternatives for their upcoming energy transition. Questions were specifically focused on the regional obstacles and also they were asked how their transition to hydrogen may benefit the region.

From the results, an ordered logistic regression analysis was done in order to find the most influential factors for the hydrogen transition of firms. From these factors a conclusion was foreseen in terms of supply and demand of opportunities and constraints that firms experience for the transition.

It has to be noted for the regression that when putting in all the dependent, independent and control variables into a logit or ologit regression, unfortunately Stata was unable to find convergence in the analysis. To counter this problem, the investigator has chosen to conduct smaller regressions, solely using factors based on the AMC-framework (Stadler & Lin, 2017), to find a threshold for firms within tighter boundaries of smaller groups of variables.

5.1.2 Discussion of results

5.1.2.1 Regional impact

The main goal for the governmental institutions of the region in Groningen-Assen is to make the region into a hydrogen hub and to stimulate socio-economic growth, as the fossil-fuel industry starts to loose importance. While the fossil industry has been the source of income for the region in recent years (Provincie Groningen, 2019; Regio Groningen Assen, 2021), now alternatives are sought because of climate change, and the (local) governmental institutions have heavily bet on hydrogen, as this seems to be a serious alternative for natural gas in terms of infrastructure.

As these incentives are clear for governmental institutions, it is of importance whether or not firms expect to contribute to the region likewise. The firms answered mainly that they expect to increase knowledge in the region (Figure 10). Although this is not the main reason local governments want to create the hydrogen economy, this could be of value to improve the socio-economic situation, as

increasing knowledge in the region might change the region into a niche knowledge hub. The main reason for governmental institutions to be investing in hydrogen economy Groningen-Assen has been to stimulate economic development in the region. Only 14% of firms expect to attract additional economic activities to the region by implementing the hydrogen economy into their business plan.

5.1.2.2 Modelling

To add to answering the main research question the author ran multiple regression models, with the dependent variable (*Achievable*), asking to what extent firms see the implementation of hydrogen into their business, in combination with main factors of opportunities and constraints that came across in the literature. This had some success only for the basic factors that predict benefits for implementing hydrogen (Advantages) and the main constraints for implementing hydrogen (Disadvantages).

After the regression models from Table 2 and Table 3 , the author had added more variables into the regression models. Unfortunately, the regression models did not converge. This is probably due to the low amount of cases compared to the amount of survey questions and variables. Therefore the author finds difficulty in establishing a clear threshold for firms in the region Groningen-Assen, to implement the hydrogen economy for their business. From the ologit regression, it seems to be significant that firms are more likely to implement hydrogen into their business if the largest opportunity of hydrogen is to improve the firms' competitive advantage in the market, and that costs of the transition towards implementing the hydrogen economy into their business are the major constraints. As the statistics of the constraints seem arguable (positive coefficients for negative factors), the author finds the outcomes to be more suggestive, rather than real evidence, for both regression models. In the logistic regression only the constraint financial has been found to be significant. Again, as this outcome seemed to be contradictive the author cannot present this outcome as evidence, but more as a suggestive factor of importance. Therefore this research has found some factors that could suggest indications of firms that have an increased motive to be willing to engage into the hydrogen economy, however this may not be clear cut.

5.1.2.3 Interpretation

Urgency and complexity of the energy transition has made it important to analyse factors that could indicate constraints and opportunities for firms, to have them engage in new businesses concerning the energy transition, like hydrogen economy Groningen-Assen. With previous research focussing on factors that firms deem important to have interest in new environmental projects and alliances, this research aimed to find factors that would explain opportunities and constraints in a hydrogen economy (Lin, 2012; Stadler & Lin, 2017).

When answering the main question of the research: "*What are the constraints and opportunities for firms in the region to implement the hydrogen economy Groningen-Assen for their business?* it would be desirable to find clear indications as to in what extent firms seek to implement hydrogen into their business.

Expectations from the literature had been formulated in the hypothesis that factors that influence firms decision to implement hydrogen into their business mostly concern constraints in regulation and financial capability, while possible opportunities involve firms to be part of a competitive niche market and effectively reducing their emission output.

To answer the research question, some important trends have been found from the survey analysis. Contextual factors explained that, in the sample, firms in the region Groningen-Assen expect to be more than mere consumers of green hydrogen. Most firms within the sample support the hydrogen

economy, really taking advantage of a hydrogen economy as a business opportunity. The firms that are most interested in a hydrogen economy are firms in the construction- and in the electricity sector, however it should be noted that these were also part of the preselection.

In terms of constraints unclear law and regulation is seen as a rather problematic factor. While not significant in the regression, 22/41 scored the clearness of law and regulation to be 2/5 or lower, with most firms (12) rating it 2/5. These findings are also in line with the literature and hypothesis, as Colaner et al. (2018) stressed that (unclear) regulation may influence long-terminism of firms which influences their approach to sustainability measures, that could constraint further implementation of hydrogen. Remarks from firms further explained costs concerning investments for hydrogen being the main problem for implementation, which were in line with the expectations. However, stakeholder and shareholder issues were mentioned multiple times as well. Some of these findings are in line with the literature on environmental strategies, as here cross-sector and stakeholder dilemma's apply (Geissdoerfer et al., 2018; Pedersen et al., 2021).

For the factors and motives it is important to understand the desirability for firms to adapt to a hydrogen economy. The outcomes suggested that firms think it is desirable to join the hydrogen economy as most of the firms answered yes. Outcomes from the regression analyses suggests that when specific factors are met, improving competitive advantage it could be more desirable for firms to adapt to a hydrogen economy. As mentioned before, the regression outcomes may not be hard evidence, therefore count as a cautious suggestion.

Answering the question if it is possible for firms to adapt to a hydrogen economy, mostly the descriptive statistics and partly the regression analyses could provide an answer. Again if the right conditions are met, it could be more likely for firms to implement hydrogen into their future business plan, if the major opportunity is to increase their competitive advantage. However, there is a major need for governmental aid, as the survey shows that firms in the region need subsidies to achieve transition towards the hydrogen economy.

Strategic factors concerned mostly weighing of constraints and advantages. Firms' competitive advantage was the most important opportunity for firms in the sample. This competitive advantage may hint towards more engagement into the hydrogen economy than simply using hydrogen as energy carrier and a vision towards a more complicated business structure, while managing cross-sector engagements (Pedersen et al., 2021). While competitive advantages would be great for business, some firms in the region Groningen-Assen consider the competitive advantage of hydrogen to be short-term positive, as competition may implement hydrogen later on. This could become much cheaper which would create a level playing field in the market again.

The regional impact firms could have depends on how firms and governmental institutions will cooperate in the future. Firms are expecting a knowledge gap in the region, as they expect a lack of knowledge and experience of people and institutions with hydrogen in the near-future. Also in terms of the amount of personnel from the region, firms are worried that demand for capable personnel is not met. Access of green hydrogen in the region seems also to be problematic, firms from the sample stressed the need of product, as they mentioned that it is hard to acquire sustainable hydrogen in the region Groningen-Assen. This is supported in the results from what firms need from governmental institutions, as the survey data gives accessibility of hydrogen as one of the main demands. Still, the main problem according to firms is the cost of implementing hydrogen into their business. From the survey data, supported by the regression analyses, it is clear that firms struggle to make the transition by themselves and require need in terms of financial aid.

In terms of what firms expect to add to the region of Groningen-Assen, is more knowledge and educational opportunities like internships. Surprisingly, and in contrast to governmental expectations (Regio Groningen-Assen, 2021; Provincie Groningen, 2019), a minority of firms from the sample expect they could contribute to increase employment opportunities for the region. This seems to be undesirable for the local governments, as they were aiming for large economic benefits in the region, especially in terms of jobs, by investing into hydrogen hub Groningen-Assen.

5.1.3 Strengths and limitations

After writing this research there have been some strengths and limitations that have to be mentioned. Because this research is meant for a thesis, the factor of time has played a large limiting role in terms of respondents and therefore results. The reduced sample size unfortunately caused issues in the regression analyses. Further difficulties occurred in terms of tools, networks and reachability of respondents. The COVID-19 pandemic hindered some of the progress made in terms of accessibility of firms and tools like ArcGIS that are provided by the university and do not run as easy on the author's own computer.

Due to the type of research, acquiring detailed answers was not possible. While firms left remarks and comments to elaborate, qualitative research could have explained certain obstacles or motives more in-depth.

An important strength of the research, being a quantitative analysis, is the ability to gain data from multiple firms in different sectors. Moreover, the survey data provided great insights in firms main motives and trends in terms of the transition towards hydrogen.

5.2 Conclusions

In addition to existing literature on motives of firms and opportunities and constraints for the region Groningen-Assen (Lin, 2012; Stadler & Lin, 2017; Los & Van Dijk, 2020; Pedersen et al.,2021), this research has explored opportunities and constraints concerning firms in the transition towards a hydrogen economy. This study offered insights in the factors that could suggestively mean firms are more willing to implement hydrogen into their business strategy. Outcomes suggest: Firms in the region Groningen-Assen could be more willing to implement hydrogen into their business when seeing hydrogen as a possible opportunity, to improve their competitive advantage, provided they see costs of implementing hydrogen as the major constraint for their business. Important trends are a lack of clear law and regulation for firms to follow, which may hinder the transition and the need for improved accessibility for green hydrogen. Firms expect to encounter a possible knowledge gap, as they fear for a lack of capable personnel, within the region. Arguably, the most important finding is that firms have interest in the transition to hydrogen, however there needs to be more financial support for them to achieve this transition towards implementing hydrogen economy Groningen-Assen into their business.

6 Policy implications

As local governments are aiming for the region Groningen-Assen to become a hydrogen hub, they should consider the motives of firms. While this research has not been able to find a clear obstacle for firms in the region, it suggests that governments can nudge more firms into joining the hydrogen economy by finding firms that look to increase their competitive advantage in the market but consider costs for implementing the hydrogen economy into their business as the main constraint. Another important factor is law and regulation. From the survey analysis it is clearly a problem for firms in the region. Governmental institutions should elaborate on this topic, as it is their responsibility, and make sure that law and regulation on the topic of hydrogen are clear for firms, so that firms will be able to understand how they can work with hydrogen.

In terms of firm demands, more financial aid is needed to implement the hydrogen economy for firms. They are willing to make the transition, however experience to be unable due to a lack of financial capability. Firms also acknowledge the difficulty to acquire green hydrogen. Therefore governments should seek to aid transportation of green hydrogen, or regional production. This should improve accessibility and reduce costs for firms which would ease some of the constraints firms experience in the region of Groningen-Assen and could promote the hydrogen economy.

More long-term engagement from governmental institutions is needed as well. Firms expect a lack of capable personnel which could also be an opportunity for the region. Governments should initiate and promote the hydrogen economy Groningen-Assen in educational institutes from al schooling levels, as this would benefit firms in terms of future employees, as well as make for a unique regional opportunity which could create a competitive advantage compared to other regions. This could eventually lead to a welcome economic boost, not by firms directly, but from specialization in the region.

7 Reflection

This quantitative research has been conducted as the term “Hydrogen economy Groningen-Assen” becomes more and more popular. The aim was to find a certain threshold for firms so local governments could then understand if firms are thinking alike, or what they need.

In terms of literature, the author found interesting papers regarding governmental institutes and firms transition behaviour, which could be used for the research. It proved more difficult to find firms that were willing to complete the survey. To tackle this problem, the investigator conducted a more “aggressive” approach by actively contacting employees and representatives of potentially responding firms, transition-and hydrogen groups via Linkedin. This helped and also provided more information on the topic as interaction with experts became an option as well.

In terms of results and the regression analysis, there were some setbacks. The program of Survio.com would sometimes transform the data without the investigator asking for it and needed manual alterations. In terms of regression analysis, unfortunately a lot of variables were difficult to interpret for Stata, which is understandable as there were lots of nominal variables and factors. In hindsight, the author should have opted for more quantified variables and should have scaled down the amount of questions, as it was hard to find respondents. It was also the first time the author made use of an ordered logistic regression analysis, which was time-consuming to understand.

In terms of outcomes of the research it would have been more interesting to have found a clear threshold, combination of opportunities and constraints, for firms to implement hydrogen. Nonetheless, trends and outcomes of the survey could be of interest for firms and governmental institutions, as they give insight in how firms think about the hydrogen economy Groningen-Assen and would find suggestions on some of the opportunities and constraints

This research could therefore function as a pilot research for governmental institutions like Regio Groningen-Assen. They may have a larger reach in terms of firms and/or contacts in the region. A larger amount of cases could be valuable when conducting this type of research. Another approach could be purely qualitative research on the motives of firms by in-depth expert interviews in the region of Groningen-Assen.

8 References

Aigbedo, H. (2021). An empirical analysis of the effect of financial performance on environmental performance of companies in global supply chains. *Journal of Cleaner Production*, 278.

Carballo-Penela A., Castromán-Diz JL. (2015). Environmental policies for sustainable development: an analysis of the drivers of proactive environmental strategies in the service sector. *Business Strategy and the Environment 24*(8): 802–818

Centraal Bureau voor de Statistiek. (2021). SBI-hiërarchie CBS. [online] Available at: https://sbi.cbs.nl/CBS.TypeerModule.TypeerServiceWebAPI/content/angular/app/#/tree [Last accessed 5 May, 2021].

Chen MJ., Miller D. (2015). Reconceptualizing competitive dynamics: a multidimensional framework. *Strategic Management Journal.* 36: 758–775

Clifford, N. J., Cope, M., Gillespie, T. W. and French, S. (eds) (2016). *Key methods in geography.* Third ed. London: SAGE.

Colaner, N., Imanaka, J. L., Prussia, G. E. (2018). Dialogic collaboration across sectors: Partnering for sustainability. *Business and Society Review*, 123, 529–564.

Correljé, A., Linde, C. V. D., & Westerwoudt, T. (2003). *Natural gas in the Netherlands: from cooperation to competition*? Amsterdam-Zuidoost, Oranje-Nassau Groep.

Dyllick T. and Muff K., (2016). "Clarifying the Meaning of Sustainable Business : Introducing a Typology from Business-As-Usual to True Business Sustainability,". *Organization & Environment*. 29(2), pp. 156–174

Drimble.nl. (2021). *Bedrijvenregister*. [online] Available at: https://drimble.nl/bedrijf/ [Accessed 17 April 2021].

FaillissementsDossier.nl. 2021. *Standaard Bedrijfsindeling SBI branche codes - FaillissementsDossier.nl*. [online] Available at: https://bit.ly/3uokV1W [Accessed 9 June 2021].

Geissdoerfer, M., Morioka, S. N., de Carvalho, M. M., Evans, S. (2018). Business models and supply chains for the circular economy. *Journal of Cleaner Production*, 190, 712–721.

Gigler, J., & Weeda, M. (2018).*Contouren van een Routekaart Waterstof.*

Godula-Jopek, A, Jehle, W, Wellnitz, J, & Godula-Jopek, A (2012), *Hydrogen Storage Technologies: New Materials, Transport, and Infrastructure*, John Wiley & Sons, Incorporated, Weinheim

Kassinis G, Vafeas N. (2009). Environmental performance and plant closure. *Journal of Business Research*. 62(4): 484 – 494

Lin H. (2012). Cross-sector alliances for corporate social responsibility partner heterogeneity moderates environmental strategy outcomes. *Journal of Business Ethics*. 110(2): 219–229.

Los, B. & Dijk, van, J. (2020). *The Employment Impact of the NortH2 Project*.

Marin-Vinuesa, L., Scarpellini, S., Portillo-Tarragona, P., & Moneva, J. (2020). The impact of eco-innovation on performance through the measurement of financial resources and green patents. *Organization and Environment*, 33(2), 285–310

Ministerie van Economische Zaken en Klimaat. (2020). *Derde kwartaalrapportage gepubliceerd*. Available on: https://www.rijksoverheid.nl/actueel/nieuws/2020/11/24/definitief-einde-gaswinning-groningen-wettelijk-geregeld [Accessed 5 Feb. 2021]

Pedersen, E., Lüdeke-Freund, F., Henriques, I., & Seitanidi, M., (2021). Toward Collaborative Cross-Sector Business Models for Sustainability. *Business & Society*, 60(5), 1039–1058.

Provincie Groningen (2019). *Investeringsagenda waterstof Noord-Nederland: Op weg naar emissievrije waterstof op commerciële schaal. Groningen*: Provincie Groningen.

Regio Groningen-Assen. (2021). *Eén economisch profiel voor de regio - Regio Groningen Assen*. Available at: https://regiogroningenassen.nl/een-economisch-profiel-voor-de-regio .[Accessed 12 March 2021].

Slawinski, N., Bansal, P. (2015). Short on time: Intertemporal tensions in business sustainability. *Organization Science*, 26, 531–549.

Slawinski, N., Pinkse, J., Busch, T., Banerjee, S. B. (2017). The role of short-termism and uncertainty avoidance in organizational inaction on climate change: A multi-level framework. *Business & Society*, 56, 253–282.

Stadtler, L., and Lin, H. (2017) Moving to the Next Strategy Stage: Examining Firms' Awareness, Motivation and Capability Drivers in Environmental Alliances. *Bus. Strat. Env.,* 26: 709– 730

Survio.com, 2021. *Survio® | Online Survey Software* [online] Survio®. Available at: https://www.survio.com/en/ [Accessed 24 February 2021].

Viscussi, K., Vernon, J., & Harrington, J. (2005). *Economics of regulation and antitrust*. MIT press.

9 Appendix

9.1 Supporting documents

Survio, survey outcomes

surveyreportFINAL.pdf

Survey excel sheets

surveydataFINAL.xlsx

surveydataFINALV2.xlsx

surveydataFINALV3DependentDummy.›

Complete list of SBI codes

https://bit.ly/3uokV1W (www.faillissementsdossier.nl, 2021)

9.2 Do file

Thesis.do - Printed on 30-7-2021 15:45:31

```
label define kennis 1 "erg weinig" 2 "weinig" 3 "voldoende" 4 "veel" 5 "erg veel"
label values Question2 kennis

label define profijt 1 "erg weinig" 2 "weinig" 3 "weet niet" 4 "veel" 5 "erg veel"
label values Question7 profijt

label define H2economie 1 "Ja, De waterstofeconomie is interessant voor het bedrijf" 0 "Nee, de
waterstofeconomie is niet interessant voor het bedrijf"
label values Question11 H2economie

label define energiegroen 0 "nee" 1 "ja"
label values Question13 energiegroen

label define waterstofinv 0 "nee" 1 "Nog niet, maar het bedrijf heeft wel interesse" 2 "Ja"
label values Question14 waterstofinv

gen Appli_3 = "Anders" if Question3Anders!= "No"
replace Appli_3 = "Grondstof" if Question3Alsgrondstof== "Yes"
replace Appli_3 = "Verhandlbaar" if Question3Alsverhandelbaarp== "Yes"
replace Appli_3 = "Grenerg" if Question3Alsgroeneenergi == "Yes"
encode Appli_3, gen(Application)
drop Appli_3


gen Roles = "Anders" if Question6Anders != "No"
replace Roles = "Consumerende" if Question6Eenconsumerende== "Yes"
replace Roles = "Producerende" if Question6Eenproducerende== "Yes"
replace Roles = "Ondersteunende" if Question6Eenondersteunende== "Yes"
replace Roles = "Geen" if Question6Geenrol== "Yes"
encode Roles, gen(Role)
drop Roles


gen Reasons = "Anders" if Question8Anders != "No"
replace Reasons = "Transitie" if Question8Helptdeenergietra== "Yes"
replace Reasons = "GenOmzet" if Question8Genereertmeeromze== "Yes"
replace Reasons = "NieuwMarkt" if Question8Potentiëlenieuwem== "Yes"
replace Reasons = "Invulling" if Question8Geeftmeerinvullin== "Yes"
replace Reasons = "Nvt" if Question8Nvt== "Yes"
encode Reasons, gen(Reason)
drop Reasons


gen Disadvantages = "Anders" if Question9Anders != "No"
replace Disadvantages = "NiethaalOvh" if Question9Niethaalbareoverh== "Yes"
replace Disadvantages = "Socioeco" if Question9Socioeconomischen== "Yes"
replace Disadvantages = "Agglomeratie" if Question9Agglomeratie== "Yes"
replace Disadvantages = "Risico" if Question9Risico== "Yes"
replace Disadvantages = "Financiën" if Question9Financiën== "Yes"
replace Disadvantages = "SectOverschr" if Question9Sectoroverschrijde== "Yes"
encode Disadvantages, gen(Constraint)
drop Disadvantages


gen Options = "Anders" if Question10Anders != "No"
replace Options = "GrStroomZon" if Question10Groenestroomzon== "Yes"
replace Options = "Biogas" if Question10Biogas== "Yes"
replace Options = "Geotherm" if Question10Geothermischeener== "Yes"
replace Options = "H2Oenergie" if Question10Energieuitwater== "Yes"
encode Options, gen(Option)
drop Options


gen Voordelen = "Anders" if Question15Anders != "No"
replace Voordelen = "Verduurzaming" if Question15Verduurzaming== "Yes"
replace Voordelen = "Finanhoger" if Question15Hogerefinanciële== "Yes"
replace Voordelen = "VerbMarktaandeel" if Question15Verbredingvanhet== "Yes"
replace Voordelen = "Concpositie" if Question15Hetbehoudenvane== "Yes"
```

Page 1

```
replace Voordelen = "WeiVerandering" if Question15Erzijnrelatiefw== "Yes"
encode Voordelen, gen(Advantage)
drop Voordelen


gen Regio = "Anders" if Question16Anders != "No"
replace Regio = "WerkCreëren" if Question16Werkgelegenheidcr== "Yes"
replace Regio = "KennisRegio" if Question16Kennisinderegio== "Yes"
replace Regio = "RegEconomie" if Question16Regionaleeconomie== "Yes"
replace Regio = "Uitstootverlg" if Question16Uitstootvanindus== "Yes"
replace Regio = "SchoolEnStage" if Question16Kansenvoorschole== "Yes"
encode Regio, gen(Regional)
drop Regio


gen Ontbreken = "Anders" if Question17Anders != "No"
replace Ontbreken = "GeschPers" if Question17Scholinggeschikt== "Yes"
replace Ontbreken = "Subsidies" if Question17Beschikbaarheidva== "Yes"
replace Ontbreken = "HRMherlocatie" if Question17HRMvoorherlocati== "Yes"
replace Ontbreken = "Marketing" if Question17MarketingCommuni== "Yes"
encode Ontbreken, gen(Lacking)
drop Ontbreken


gen Overh = "Anders" if Question18Anders != "No"
replace Overh = "Subsidiëren" if Question18Subsidiëren== "Yes"
replace Overh = "Certificeren" if Question18Certificerenvanp== "Yes"
replace Overh = "DoelenAfbFoss" if Question18Doelenstellenafb== "Yes"
replace Overh = "ToegangH2" if Question18Toegangtotwaters== "Yes"
replace Overh = "SteunregelVerz" if Question18Steunregelingenve== "Yes"
encode Overh, gen(Governm)
drop Overh


encode Question4, gen(Law)
encode Question5, gen(Safety)
encode Question13, gen(Grnenerg)
encode Question20, gen(Employees)
encode Question21, gen(SBIcode)

ren Question2 Knowledge
ren Question7 Benefit
ren Question11 Achievable
ren Question14 InvestH2
ren Question12 Support

drop Question3Alsgroeneenergi Question3Alsgrondstof Question3Alsverhandelbaarp Question3Anders
Question4 Question5 Question6Eenconsumerende Question6Eenproducerende Question6Eenondersteunende
Question6Geenrol Question6Anders Question8Helptdeenergietra Question8Genereertmeeromze
Question8Potentiëlenieuwem Question8Geeftmeerinvullin Question8Nvt Question8Anders
Question9Niethaalbareoverh Question9Socioeconomischen Question9Agglomeratie Question9Risico
Question9Financiën Question9Sectoroverschrijde Question9Anders Question10Groenestroomzon
Question10Biogas Question10Geothermischeener Question10Energieuitwater Question10Anders Question13
 Question15Verduurzaming Question15Hogerefinanciële Question15Verbredingvanhet
Question15Hetbehoudenvane Question15Erzijnrelatiefw Question15Anders Question16Werkgelegenheidcr
Question16Kennisinderegio Question16Kansenvoorschole Question16Regionaleeconomie
Question16Uitstootvanindus Question16Anders Question17Scholinggeschikt Question17Beschikbaarheidva
 Question17HRMvoorherlocati Question17MarketingCommuni Question17Anders Question18Subsidiëren
Question18Certificerenvanp Question18Doelenstellenafb Question18Toegangtotwaters
Question18Steunregelingenve Question18Anders Date Time Completedin Source Email Question1

label variable Application "Question 3"
label variable Role "Question 6"
label variable Reason "Question 8"
label variable Constraint "Question 9"
label variable Option "Question 10"
label variable Advantage "Question 15"
label variable Regional "Question 16"
```

Thesis.do - Printed on 30-7-2021 15:45:31

```
123   label variable Lacking "Question 17"
124   label variable Governm "Question 18"
125
```

9.3 Stata outputs

9.3.1 Model1

```
. ologit Achievable i.Disadv i.Advantage

Iteration 0:   log likelihood = -49.216969
Iteration 1:   log likelihood = -38.993138
Iteration 2:   log likelihood =  -38.22151
Iteration 3:   log likelihood = -38.140368
Iteration 4:   log likelihood = -38.129994
Iteration 5:   log likelihood = -38.129223
Iteration 6:   log likelihood = -38.129065
Iteration 7:   log likelihood =  -38.12903
Iteration 8:   log likelihood = -38.129021
Iteration 9:   log likelihood = -38.129019

Ordered logistic regression                     Number of obs     =         39
                                                LR chi2(9)        =      22.18
                                                Prob > chi2       =     0.0083
Log likelihood = -38.129019                     Pseudo R2         =     0.2253

------------------------------------------------------------------------------
  Achievable |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      Disadv |
  Financiën |   2.533314   1.458607     1.74   0.082    -.3255028    5.392131
  NiethaalOvh |   17.58268   1608.041     0.01   0.991    -3134.119    3169.285
      Risico |   1.219724    1.62171     0.75   0.452    -1.958769    4.398217
  SectOverschr |   1.427761   1.509144     0.95   0.344    -1.530107     4.38563
             |
    Advantage |
  Concpositie |   3.238057   1.870577     1.73   0.083    -.4282064    6.904321
  Finanhoger |   2.752014   2.800526     0.98   0.326    -2.736916    8.240944
VerbMarktaandeel |   2.379863   1.726969     1.38   0.168    -1.004933     5.76466
  Verduurzaming |   2.229347   1.801738     1.24   0.216    -1.301996    5.760689
  WeiVerandering |   1.378168   2.438418     0.57   0.572    -3.401042    6.157379
-------------+----------------------------------------------------------------
       /cut1 |   1.187667   1.135264                      -1.03741    3.412744
       /cut2 |   2.776489   1.309804                      .2093199    5.343659
       /cut3 |    5.04648    1.40137                      2.299847    7.793114
------------------------------------------------------------------------------
Note: 1 observation completely determined.  Standard errors questionable.
```

9.3.2 Model 2

```
. logit Achievable i.Advantage i.Disadv

note: 6.Advantage != 0 predicts success perfectly
      6.Advantage dropped and 1 obs not used

note: 3.Disadv != 0 predicts success perfectly
      3.Disadv dropped and 1 obs not used

Iteration 0:   log likelihood = -21.590516
Iteration 1:   log likelihood = -15.136845
Iteration 2:   log likelihood = -14.735365
Iteration 3:   log likelihood = -14.723927
Iteration 4:   log likelihood = -14.723901
Iteration 5:   log likelihood = -14.723901

Logistic regression                             Number of obs     =         39
                                                LR chi2(7)        =      13.73
                                                Prob > chi2       =     0.0561
Log likelihood = -14.723901                     Pseudo R2         =     0.3180
```

Achievable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Advantage						
Concpositie	1.048181	2.136008	0.49	0.624	-3.138317	5.234679
Finanhoger	.1827309	2.342931	-0.08	0.938	-4.774792	4.40933
VerbMarktaandeel	.469347	1.963242	0.24	0.811	-3.378538	4.317232
Verduurzaming	1.55495	1.923573	0.81	0.419	-2.215184	5.325085
WeiVerandering	0	(empty)				
Disadv						
Financiën	3.138051	1.713733	1.83	0.067	-.2208046	6.496906
NiethaalOvh	0	(empty)				
Risico	1.491048	1.917407	0.78	0.437	-2.267001	5.249096
SectOverschr	1.689915	1.797639	0.94	0.347	-1.833392	5.213222
_cons	-1.386294	1.118034	-1.24	0.215	-3.577601	.805012