

Pure Plant Oil

Obstacles in the diffusion of an alternative car fuel in the Netherlands

Academic paper

Energy System Transitions

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Abstract

This paper focuses on pure plant oil (PPO) as an alternative to diesel. PPO is produced locally and is an example of a decentralised energy system, which is assumed to be the solution for smoothening the transition to renewable energy. The paper notices that the production and adoption of PPO has taken off in various countries in Europe, but to a lesser extent so in the Netherlands. Therefore the main question this paper answers is *what factors have constrained the development and diffusion of PPO in the Netherlands?* It is found that the Dutch government does not contribute to the sector-wide development and diffusion of PPO. Up until today, PPO has not had a fair chance to develop and diffuse, because the socio-economic conditions necessary for this were not in place. Dominant social and political discourses around biofuels are examined and it is concluded that they form an obstacle in the further development and diffusion of PPO. Four institutional factors that constrain innovation and disadvantage marginalised views are discussed. They include the Dutch tax regime, the regulation on the mandatory blending of petrol and diesel with biofuel, locked-in infrastructure and the myopic views of politicians and large oil companies. The 'governance by challenge' paradigm forms the basis of this paper's policy recommendation.

List of acronyms

PPO	Pure plant oil
MLP	Multi-Level Perspective
EROEI	Energy returned on energy invested
EU	European Union

Note: Beatrix Jacobs was responsible for sections 1, 2 and 3. Tobias Frankema was responsible for section 4, and Lisanne Brummelhuis was responsible for section 5. Sections 6 and 7 were written by all three students.

1. Introduction

Our modern society has become highly dependent on energy supply systems. This dependence is emphasised by the European Commission, which denominated energy “the lifeblood of our society” (Verbong & Loorbach, 2012). The energy supply system, defined as “all those actors and artefacts that together produce the societal function energy”, is a critical infrastructure because all sectors in our society depend on a reliable and affordable system (Verbong & Loorbach, 2012). However, the uneven geographic distribution of energy resources has made energy supply systems vulnerable to political instability and turmoil. Moreover, the scarcity of fossil fuels is on top of the political agenda. The transition from fossil fuels to renewable energy presents one of the biggest current challenges for European governments (Oteman et al., 2014). Also for the Netherlands it is essential to become less dependent on the uncertain fossil energy sources and to encourage the development of the renewable energy sector. In other words, we need to change the way we generate and consume energy. Whereas in countries like Germany and Sweden there has been an active and successful attempt at both state and society levels to realise a shift to a renewable energy system, the Netherlands is lagging behind in this regard. Even though both nations and markets are constrained by existing fossil fuel energy systems and their infrastructural and economic path dependencies, the Netherlands seems to be constrained to a greater extent than its neighbours. A possible reason for this is the interaction between the dominant social and political discourses around biofuels and the institutional framework.

One particular line of thought, which is focused on in this paper, believes the solution for smoothening the transition to renewable energy lies in creating decentralised energy systems. In cases like these, ordinary citizens can make a significant contribution to addressing the global environmental issues of our era through the creation of new institutions for cooperation at a local level. Whereas, interestingly, the most powerful actors and institutions including governments, the scientific community, business and the environmental lobby have been unable to deliver (Hisschemöller, 2012). Pure plant oil (PPO) as an alternative to diesel is an example of such a decentralised energy system. Even though it cannot really be classified as a ‘local’ initiative, it is decentralised in that farmers cooperate on a regional scale to process the rapeseed grown on their land. Running cars on vegetable oil is certainly not a new phenomenon, considering Rudolf Diesel first ran a car on peanut oil all the way back in 1897 (Van der Laak et al., 2007). Nonetheless, growing energy crops is hardly attractive from an economic perspective; fossil fuel production is simply cheaper, and we, together with the government, have become addicted to the relatively inexpensive supply of fossil fuels (Verbong & Loorbach, 2012). That being said, production and adoption of PPO as an alternative to diesel has taken off in various countries in Europe, but to a lesser extent in the Netherlands. This paper studies why this is the case. Therefore our research question is the following: *what factors constrain the successful development and diffusion of pure plant oil in the Netherlands?*

The following outline will be maintained throughout the paper. Section two elaborates on the

methodology used to conduct the research. Section three examines the theory on energy transitions, with a special focus on the shift to decentralised energy initiatives and PPO. Sections four and five investigate which factors constrain the development and diffusion of PPO in the Netherlands. In particular, the institutional framework and dominant political and social discourses that shape the landscape in the Netherlands are examined. In the fifth section the findings from previous sections are discussed and several policy implications are suggested. The final section provides an answer to the research question and a number of concluding remarks.

2. Methodology

This paper is based on a review of current literature. However, since the topic of PPO is surrounded by a lot of controversy, the literature is complemented with two interviews. These interviews are useful in that they provide views and experiences that are difficult if not impossible to find in scientific journals. The two stakeholders that were interviewed are the following:

- Hein Aberson, founding director of Solaroilsystems, a company that grows rapeseed for the production of PPO in Friesland, the Netherlands. See Annex 1 for a transcript of the interview.
- Jaap Dun, farmer and owner of 110 ha of agricultural land in Musselkanaal, Groningen, the Netherlands. See Annex 2 for a transcript of the telephone interview.

Other key stakeholders involved in the discussion surrounding PPO include the fossil fuel sector, the Dutch government, the European Union (EU) government and environmental organisations. Stakeholders not in favour of the use of biofuels – for example environmental organisations such as Greenpeace – were not available for personal communication. However, the viewpoints of all stakeholders are included in our analysis.

In order to fully understand the reasons for success or failure of an innovation like PPO, the dynamics in the socio-technical regime need to be looked at. Therefore, discourse analysis is used to investigate the viewpoints of different stakeholders. Reports from, amongst others, Greenpeace and KNAW and official statements from the Dutch government are cited. Moreover, a close look is taken at the institutional framework in the Netherlands, and in particular whether it enables or constrains the development of innovations like PPO.

3. Shifting to decentralised energy systems

3.1 Energy transitions

Since initiating change is often a competitive and hostile activity (Lindblom, 1997), transition management tries to develop arenas, processes and strategic agendas that facilitate, stimulate and guide action (Verbong & Loorbach, 2012). This process is challenging, because our current energy systems are deeply entrenched in our economy, consumption patterns, regulations and infrastructure. In order to fully

understand the challenge of innovation processes that can bring about transformations in socio-technical (energy) systems in favour of sustainable development, a broader analytical perspective is needed. The Multi-Level Perspective (MLP) on socio-technical transitions offers such a framework (Verbong & Loorbach, 2012). The MLP conceptualises transformations as the result of processes occurring at and between three interconnected levels: niches, regimes and landscape. As one can imagine, radical innovation originates in niches. Niche technologies such as PPO often face severe competition from dominant designs, like conventional diesel. Incumbent firms producing the dominant design may not be interested in the innovation and could even sabotage its introduction (Van der Laak et al., 2007). In the MLP framework, niches are protected from harsh selection criteria and resistance from prevailing regimes. Moreover, niche markets can be special geographical locations but also specific application domains, and act as stepping stones for wider diffusion (Van der Laak et al., 2007).

However, promising niches are provided with breakthrough opportunities only when landscape pressures such as changing oil prices destabilise prevailing regimes. In the Netherlands, it should be noted that the Dutch state and big oil companies like Shell are critical factors within the 'landscape'. These actors have the (lobbying) power to influence the occurrence of disturbances that would destabilise prevailing regimes and allow for innovations to break through (Hisschemöller et al., 2006). In order to understand these processes, we need to look at the dominant political and social discourses, which will be elaborated on in section 4.

Verbong and Loorbach (2012) argue that, from a MLP, energy transitions are inevitable in the long run due to emerging alternatives combined with increasing landscape pressures. While it might be impossible to predict or direct transitions, it should be possible to at least influence ongoing transition dynamics in terms of speed and direction. In other words, analyses in terms of transitions could help to identify dynamics - such as emerging innovations and lock-in - that can be influenced. The way in which dynamics are influenced in the Netherlands is explained in section 5, which focuses on the institutional framework.

In the Netherlands, the development and introduction of renewable energy has been slow and complicated, partly due to lock-ins in the incumbent energy regime (Verbong & Loorbach, 2012). One of the basic contributions any government could make is the creation of niche markets, where, as mentioned above, innovations have the chance to fully develop into marketable products (Hisschemöller et al., 2006). Nonetheless, as the following sections will show, the Dutch government does not contribute to the sector-wide development and diffusion of PPO. This could be unfortunate, because even the best technologies may fail if the necessary socio-economic conditions are not in place (Hisschemöller et al., 2006). Before moving to the analysis of the factors that constrain the development and diffusion of PPO, the shift to decentralised energy initiatives will be explained and the characteristics of PPO as an alternative biofuel will be described.

3.2 PPO as a decentralised energy system

Decentralised energy initiatives are characterised by a 'localist' path to sustainability through local ownership, organisation and consumption of a range of goods and services (Hess, 2009). This definition implies that, according to this type of system, citizens are both energy users and producers. As was confirmed by both Hein Aberson and Jaap Dun (see Annex 1 and 2 respectively), there are a number of driving forces in setting up small-scale energy production and distribution facilities, including environmental concerns, cost efficiency, security of supply (and reliability of delivery) and possible future sustainability requirements. More specifically, Jaap Dun decided to grow rapeseed for biodiesel because as an arable farmer he did not only want to rely on his food crops (Dun, personal communication, 23-01-2015). Hein Aberson explains that he wants to support the farmers and that he feels like showing that there exist other ways, referring to decentralised energy systems (Aberson, personal communication, 28-01-2015).

The main crops for PPO are rapeseed and, to a lesser extent, sunflowers. The Noord-Nederlandse Oliemolen BV is an example of a decentralised energy initiative or 'localist' path where farmers made PPO from rapeseed to satisfy their own energy demand and that of others (Van der Laak et al., 2007). Unfortunately, due to the decision of the Dutch Ministry of Finance to end the tax exemption for this specific PPO project, the oil mill had to close in 2011. From an economic perspective, growing rapeseed to sell PPO is today hardly attractive, because the excise duties in place make it too expensive an option. These financial aspects will be further discussed in section 5.

Interestingly, the energy returned on energy invested (EROEI) of PPO is about 14, whereas for crude oil it is nowadays between 7 and 10 (Reinshagen, 2013). This means that with an investment of x litres of diesel into both, the energy return on PPO is higher than the energy return on crude oil. PPO is only suitable for use in diesel engines, which would still have to be adapted slightly in order to resolve the issue of the oil's viscosity. The technology for doing this was pioneered by the German scientist Ludwig Elsbett. Aberson and Elsbett together did research on the opportunities for PPO in the Netherlands. In the process, Elsbett was able to share his experiences of the PPO success in Germany with Aberson (Aberson, personal communication, 28-01-2015). Nevertheless, the fact that the engine requires modification before being suitable to run on PPO is a technological limitation.

However, growing rapeseed provides a farmer with more benefits than his own sustainable and locally produced biofuel. Only 7.8% of the total dry mass of rapeseed that can be grown on 1 hectare is used for PPO production; the rest is not taken out of the nutrient cycle, as it is used as animal feed and soil enhancer (rapeseed roots contain 8 tonnes of carbon per hectare) (Aberson, 2011). Moreover, rapeseed is planted in a crop rotation system, reinforcing the positive effect it has on soil quality. This is important to keep in mind, since rapeseed is often classified as a first generation biofuel crop that competes with food production. This classification is a typical example of how biofuels are negatively stigmatised, an aspect that will be elaborated on in the next section.

4. The dominant social and political discourse around biofuels

In this section we will elaborate on the several discourses surrounding biofuels in general and PPO in particular. First we will discuss the role of discourses in energy transitions and how they can influence the outcome of attempts to introduce innovative technologies. Then we will briefly address the characteristics of governance in the Netherlands and how this affects the way in which discourses are produced. Third, we will elaborate on the role of epistemic communities in constructing biofuel discourses. Next we will discuss some of the general discourses that paved the way for biofuels to emerge as valid alternatives to fossil fuels. Finally, we will focus on two controversial discourses surrounding PPO: the first versus second generation biofuel debate, and the food versus fuel debate.

Discourses are strongly related to power (Sengers et al., 2010). They produce new and reproduce existing power structures. Furthermore, they have the power to include and develop some practices as well as exclude and act as an obstacle for other ones. Discourses are constrained by institutions and this relation determines what can be said with meaning (Hajer, 1995). Together with interests, discourses and institutions interact and produce policy outcomes that can be incremental, radical or somewhere in between, depending on the dominant power structures in a certain society (Kern, 2011). In order for radical policy change to occur, which is a requirement for the widespread diffusion and development of PPO, new discourses need to emerge because these are able to transform existing interests.

Governance in the Netherlands is characterised by policy networking (Hisschemöller et al., 2006). Due to rapid changes in the global socio-economic environment, the power of traditional nation-states is declining. Instead, governments promote the formation of policy networks in which socio-economic actors interact. The main focus inside these networks is on collaboration rather than competition, which leads to a limited production of innovative ideas. As actors with vested interests become part of the governance setting, this reproduces specific discourses, which hinders the stimulation of technological progress (Hisschemöller et al., 2006). In the fuel sector, socio-economic actors with large interests in maintaining the status quo - which is characterised by heavy dependence on fossil fuels - will exert influence to block new ideas that threaten their power position. As Lindblom (1997) notes, initiating change can be a very competitive and even hostile activity. He also suggests that the most effective way to block change is to make people fear change and leave them unaware of the possibilities through misrepresentation and diversion. One could argue this has been successfully done in the case of PPO in the Netherlands. Presenting misinformation and generating confusion are common tools in achieving desired outcomes. Those actors who resist innovative change possess the required resources to make a stand in combination with the incentives to do so (Lindblom, 1997). Oil companies have economic incentives to block the diffusion of PPO as they compete over market share in the fuel sector. Furthermore, these actors possess substantial economic and human resources to exert influence on the policy making process and communicate information to the masses.

Epistemic communities play an important role in the production of discourses and thereby in influencing the policy making process (Bäckstrand, 2003). Reports publicised by for example environmental organisations and articles publicised in scientific journals are frequently used as policy inputs and provide legitimacy to policy outputs. So far, scientists have failed to conduct and communicate comprehensive studies on the possibilities of PPO in the Netherlands. A recent study by the University of Twente failed to include all output factors in determining the EROEI of rapeseed production in the Netherlands (Van Duren et al., 2015). Another example is the report on biofuels by the Royal Dutch Academy of Sciences (2015), which presents inaccurate calculations on required arable land needed to replace all fossil fuels in the Netherlands with PPO. The Greenpeace report on biofuels (2013) stresses the impacts of land use change caused by the production of PPO and fails to address the sustainability gains of locally produced rapeseed oil. The common feature of these publications is the disregarding of PPO farmers. Aberson states: "Researchers often conduct desk research and neglect practical knowledge, which produces incorrect information" (Aberson, personal communication, 28-01-2015). The lack of involvement of these stakeholders diminishes both the quality and legitimacy of these studies, and must be addressed with caution when using them as policy input. These studies damage the reputation of both PPO and the scientific community, the latter being responsible for conducting objective and comprehensive research and communicating this to the public. As mentioned above, presenting misinformation and creating confusion among the wider public are ways to block innovative change, which so far has been relatively successful.

Over the past few decades, several discourses have emerged which paved the way for biofuels to emerge as valid alternatives to fossil fuels (Ulmanen et al., 2009). After the oil crisis in the 1970s, a discourse emerged throughout the developed world stressing the urgency of reducing dependency on fossil fuels, arguing for more diversification and greater efficiency. At the same time an environmental discourse emerged showing concerns over degrading environmental circumstances due to industrial practices. Another discourse centred on agriculture in the EU: European agriculture was characterised by overproduction and a costly system of subsidies, which did not seem sustainable in the light of further European integration. Besides these positive discourses, others emerged that constrained the possibilities of further development and diffusion of PPO. Although a small niche market of PPO was constructed by 2005, further expansion was hampered partly because of emerging societal discourses on biofuels (Ulmanen et al., 2009). In conducting research on biofuel discourses in the Netherlands, Sengers et al. (2010) concluded that there has been a discursive shift over the years, which changed the image of biofuels. While in the beginning the emphasis was on the positive technological and economic opportunities, the current dominant discourses focus on environmental degradation and rising food prices due to an increasing demand for biofuels. The EU, in promoting the diffusion of biofuels through Directives and allowing temporary tax exemptions for biofuel pilot projects, substantially helped the Dutch biofuel advocacy coalition in constructing a positive biofuel discourse (Ulmanen et al., 2009). On

the other hand, an advocacy coalition emerged arguing against the case of biofuels and PPO. Members of this coalition include epistemic communities, universities, NGOs, and large oil companies such as Shell (Ulmanen et al., 2009). The anti-biofuel advocacy coalition helped constructing two controversial discourses involving PPO.

The first discourse is the first- versus second-generation biofuel debate. Researchers have labelled ethanol, biodiesel, and PPO as first generation biofuels for three main reasons. Firstly, these biofuels require the usage of agricultural crops as feedstock. Secondly, they are considered inefficient in terms of EROEI, and lastly they have proved to be of limited value in the reduction of greenhouse gases (Ulmanen et al., 2009). The classification of biofuels into first and second generation types causes certain images to emerge and act as boundary objects in the search for optimal outcomes (Hisschemöller, 2008). Labelling a certain biofuel as a first generation type will cause it to be associated with negative characteristics such as being unsustainable, competing with food crops, and being unpromising for further development and diffusion (Hisschemöller, 2008). The categorisation of biofuels also fails to highlight the differences that exist within these separate categories. Future technological developments that improve production techniques and make these first generation biofuels more sustainable will not change the fact that they are classified as such. It is hard to overcome these negative stigmas when influential actors, such as scientists in environmental reports, continually reproduce this discourse. Actors with an interest in the diffusion of PPO in the Netherlands argue against the classification, pointing at the numerous advantages rapeseed production provides, such as increased soil fertility and the sustainable manner of obtaining livestock feed (Bos, 2013). These crop-specific advantages are neglected due to the classification and “limits the development possibilities substantially” (Aberson, personal communication, 28-01-2015). As the anti-biofuel lobby has an interest in maintaining these classifications, it is in their interest to dedicate resources in order to continually reproduce this specific discourse.

The second major discourse is the food versus fuel debate. The anti-biofuel advocacy coalition challenges the sustainability of biofuels by stressing negative side-effects of fuel crop production such as loss of biodiversity, deforestation, rising food prices and negative social impacts in developing countries due to direct and indirect land use change (Sengers et al., 2010). Especially the emphasis on unforeseen greenhouse gas emissions by indirect land use change is arbitrary, since these impacts are not directly observable (Palmer, 2014). Another example is the link between biofuels and rising food prices. Instead of attributing the rising food prices to land use change, some scholars argue that this was to a large extent the result of widespread speculation on the global food market, enabled by lax financial regulation (Ghosh, 2010). In absence of clear causal mechanisms, one must be careful in drawing conclusions, as many claims are normative in nature. In spite of these great complexities and uncertainties, the anti-biofuel advocacy coalition sought to establish the story of unsustainable biofuels as the dominant discourse. Furthermore, the coalition is dedicating substantial resources in maintaining this dominance in spite of claims suggesting alternative discourses. In the Netherlands, domestically produced rapeseed oil

“does not compete with food crops, as it grows in a crop rotation system” (Aberson, personal communication, 28-01-2015). Also, “the use of rapeseed in crop rotation increases soil fertility, and the food crop output of the next harvests by 10-30%” (Aberson, personal communication, 28-01-2015). However, the dominant discourse around biofuels neglects these crop-specific benefits, and thus proves to be an obstacle in the further development and diffusion of this biofuel.

In sum, discourses play a significant role in societies. They can both enable and constrain certain developments. The governance system in the Netherlands, characterised by the involvement of socio-economic actors in the policy making process, tends to continually reproduce specific discourses beneficial for these actors. A discursive shift from a positive techno-economic to a negative socio-ecological discourse has taken place. New discourses must become dominant in order to remove the negative stigmas surrounding biofuels in general, or at least those surrounding separate sustainable crops. By involving stakeholders with practical knowledge, more objective and legitimate scientific studies can be conducted, which can in turn challenge the dominant social and political discourses.

5. Institutions as barriers to innovative change

This section analyses how the institutional framework inhibits the development and diffusion of PPO in the Netherlands. Institutions refer to the “formal and informal rules that enable or constrain the behaviour of actors involved in a specific policy subsystem” (Hisschemöller & Bode, 2011). Organisations will also be included as institutions in this analysis, because organisations play a dominant role in implementing or enforcing rules and regulations (Hisschemöller & Bode, 2011). In order to understand how institutions shape our way of thinking and acting, it is important to keep in mind that institutions play a guiding role in what we conceive as ‘normal’ behaviour and ‘taken-for-granted’ knowledge. This often constrains people’s ability to think innovatively and explore out-of-the-box scenarios (Hisschemöller & Bode, 2011).

The vested interests of the Dutch government and large oil companies often resist the adoption of innovative technologies. Both benefit from the fossil fuel sector and therefore it is likely that they try to maintain the status quo. In this section, four institutional factors that constrain innovation and disadvantage marginalised views will be discussed. These institutional factors are the Dutch tax regime, the regulation on the mandatory blending of petrol and diesel with biofuel, locked-in infrastructure and the myopic views of politicians and large oil companies.

The first institutional factor is the Dutch tax regime. The Dutch government levies excise duty on certain consumer goods such as fuel (e.g. petrol, diesel or LPG), alcoholic drinks and tobacco products. The main purpose of this excise duty is to generate revenue for the central government (Rijksoverheid, 2015). In 2011, 14% of the total tax income of 130 billion euros came from fossil fuels (Den Brinker, 2012). It is likely that these financial benefits play an important role in the government’s decision to not implement a separate excise rate for biofuels in the Excise Act. Therefore, today the excise rate for

biofuels is equal to the excise rate for fossil fuels (Rijksoverheid, 2015). This has been different between 1997 and 2011 when the government issued tax exemptions for several specific projects. Alcohol producer Nedalco was in 1997 the first company that succeeded in convincing the government of the importance of a tax exemption for the annual production of 30 million litres of bioethanol (Suurs & Hekkert, 2009). This tax exemption, however, turned out to be insufficient to cover the investments and the project discontinued. In 2002 Solaroilsystems also demanded a tax exemption and the government eventually agreed with this request (Van der Laak, 2007). According to Aberson, this form of financial support was an important asset in the promotion of PPO to potential consumers: in 2010, Solaroilsystems sold between 5 and 6 million litres of PPO (Aberson, personal communication, 28-01-2015).

These tax exemptions were not part of a policy strategy and were only issued on project-specific grounds. In order to stimulate the growth of the PPO industry, however, the government should have decided to support the PPO sector as a whole. In contrast to the Netherlands, the German government did exempt all pure biofuels from the mineral oil tax in 2003 (Fell, 2012). This tax exemption applied to bioethanol E85, biodiesel, biogas and PPO and provided consumers of biofuels with an economic benefit, since biofuels were now cheaper than petrol and conventional diesel (Fell, 2012). As a result, the biofuel market expanded, farmers purchased mills to produce pure plant oil and medium-sized petrol stations were doing business independent from fossil fuel companies (Fell, 2012). The German example shows that tax support could play a major role in the expansion of an alternative fuel sector. However, the German PPO wonder only lasted three years. In 2007 the lobbying effort of the German Petroleum Industry Associations (MWV) resulted in the obligation of biofuel blending and the abolition of the tax exemption for pure biofuels (Fell, 2012). The PPO tax gradually increased from 0 in 2007 to 45 cents per litre in 2012, resulting in a declining market share of pure plant oils (EREC, 2012). Both the German and Dutch situations show that excise rates equal to those of fossil fuel are fateful for the PPO sector. Rapeseed farmer Jaap Dun adds to this: “the government pretends to be your best friend, but when we need support (in the form of a subsidy or tax exemption), there is nothing they can do” (Dun, personal communication, 23-01-2015).

The second institutional barrier that obstructs the development of alternative biofuels such as PPO is the regulation on the mandatory blending of petrol and diesel with biofuel. The Renewable Energy Directive 2009/28/EC set the objective of reaching 20% of the EU’s energy consumption through renewable energy sources by 2020 (Directive 2009/28/EC). This Directive on the promotion of renewable energy includes a mandatory share of 10% renewable energy sources (RES) in transport for each Member State. In order to reach this target, all Dutch diesel and petrol suppliers are obliged to blend their regular fuel with a set percentage of biofuel (Van Cuijck, 2013). This blending obligation appears to be a positive measure for the PPO sector, but in reality this is not quite true. The Dutch State Secretary of Finance Frans Weekers used it as one of his main arguments to abolish the tax exemption that applied to three specific projects (Weekers, 2011). Weekers declared that because there is no separate tax rate for biofuel blends,

it would be unfair to continue the tax support for three specific PPO projects. As a result of this decision, the investments made by these three organisations, such as the Noord-Nederlandse Oliemolen BV, could not be recovered. According to Aberson, the abolition of the tax exemption was the main reason that the mill went bankrupt (Aberson, personal communication, 28-01-2015). Instead of promoting local and sustainable biofuel initiatives as a means to reach the targets set by the EU, the government chose to implement a blending requirement. Considering the vested interests of the oil companies, it is likely that large oil companies had a stake in this decision. Moreover, this new regulation provided the oil companies with the opportunity to show the world that they also promote nature conservation and climate protection by the use of biofuels (Fell, 2012). At the same time, the fossil fuel companies would not lose any market share because they would maintain the power to decide where to buy the biofuels for their blends. We can conclude that the blending obligation was an unfavourable development for sustainably grown and locally produced biofuels such as PPO. This regulation, implemented to reach an important target from the Renewable Energy Directive, forms an institutional barrier for the PPO sector.

The lock-in of systems through technological and social path dependency is the third institutional factor that impedes the development and diffusion of PPO in the Netherlands. This is for example reflected in the infrastructure, which does not encourage the development and diffusion of PPO. PPO differs from fossil diesel in several aspects. The most important difference is the viscosity: diesel has a viscosity of $5 \text{ mm}^2/\text{s}$ at 20°C and the viscosity of rapeseed oil at this temperature is $70 \text{ mm}^2/\text{s}$ (Krammer & Barten, 2011). Only at temperatures above 90°C the viscosity of rapeseed oil approaches that of diesel. The two main issues resulting from this difference are cold start problems and deterioration in the atomisation behaviour during fuel injection (Krammer & Barten, 2011). In order to use PPO in diesel engines the engine must be made compatible with the properties of PPO. In the agricultural sector the use of PPO is more common than in the consumer car sector. Several tractor models from brands such as John Deere, Fendt and Deutz are now being sold ready to operate on PPO (Krammer & Barten, 2011). In the automotive sector, however, existing diesel engines still need to be modified before they can run on PPO. Even though the costs of this modification have declined to between 2,000 and 2,500 Euros, the fact that engine modification is demanded to run on PPO is still a barrier for the development of the PPO sector (Aberson, personal communication, 28-01-2015). A considerable upfront investment is required to make a vehicle suitable for operation with PPO. This institutional barrier of locked-in infrastructure and the use of fossil fuels is a vicious circle that could be broken by supporting PPO. Supporting the use of PPO (for example in the form of a tax exemption) would lead to a larger share of cars that are technically suitable to run on PPO. This would be beneficial for the PPO sector and would decrease our dependency on fossil fuels. Unfortunately, this dependency is in the interest of both the government and the fossil fuel sector, which leads to the fourth and final institutional barrier: myopia.

Myopia is the relative dominance of short-term goals over long term ones (Stokman, 2009). Both the interests of the government and large oil companies are strongly related to short-term success.

Politicians strongly value economic growth, because economic growth is often regarded as a necessary condition for re-election. According to Stokman (2009), politicians believe that tax exemptions for renewable energy sources slow down economic growth. This relates to the first institutional barrier we discussed; the Dutch tax regime. Fiscal measures that support the use of sustainable resources such as PPO would result in less tax income from fossil fuels and are thus not implemented. Besides politicians, large corporations such as oil companies also value short-term successes over long-term ones. Their main priority is shareholder value, often reinforced by connecting shareholder value to a bonus system; this relates the income of the executives directly to the financial success of the company (Stokman, 2009). It is not surprising that the combination of the government's and oil companies' myopic views lead to the overuse of scarce natural resources (Stokman, 2009). The decision to introduce blending requirements instead of a tax exemption for pure biofuels could also be related to this myopic view. This regulation would neither threaten the large oil companies, because they would not lose any (significant) market share, nor would the government have to lose any income from the excise tax. By promoting the blending requirements the government and large oil companies communicate that they care about the environment and our natural resources. The blending requirements and tax exemptions are presented as equal measures to stimulate biofuels (Fell, 2012). The long-term effects, however, differ greatly and most politicians seem to be ignorant of these different consequences. Their myopic views - reinforced by large oil companies' focus on shareholder value - constrain the development and diffusion of alternative biofuels such as PPO in the Netherlands.

6. Discussion and policy recommendations

As discussed in section 3, governance in the Netherlands is characterised by policy networking. Characteristic of this type of governance is that non-governmental actors that used to be governed become part of the governance itself (Hisschemöller et al., 2006). These actors become institutionalised and resistant to innovative views and alternative solutions. As a result, governance by policy networking often excludes marginalised views and prevents technological innovation. This type of governance is not very supportive for the development of locally produced biofuels such as PPO and therefore we suggest a more supportive policy context. Hisschemöller et al. (2006) identified a governance paradigm that in our view would form the ideal policy context for energy transitions. This "governance by challenge" paradigm, characterised by several aspects that would improve the conditions for innovative technologies to develop and diffuse, forms the basis of our policy recommendation.

In our opinion, the government should take on the difficult task of removing the privileges from vested interests. Vested interests, for example oil companies, use their privileged position in the governance network to keep potential challengers at a disadvantage (Hisschemöller et al., 2006). They do this by presenting the ideas of challengers as infeasible and by using their power to influence policy formation. The government should be aware of this and should offer marginalised views access to the

regime in order to give them the opportunity to be heard. In the case of PPO, the media and regime players such as Shell were consulted, and not the people from the PPO sector. The social and political discourse around PPO dominated the policy making process, while experts like Hein Aberson did not get the opportunity to present real facts and figures (Aberson, personal communication, 28-01-2015).

Since dominant discourses exert power through language, generalisations can be harmful. The categorisation of biofuels into first and second generation limits the development and diffusion of PPO, even though it does show potential. In order to produce objective and legitimate discourses, it is vital that scientific studies conducting research on innovative technologies involve a wide variety of stakeholders, including those with practical knowledge. Publications have the potential to alter socio-economic actors' perceptions and preferences and should therefore be comprehensive (Palmer, 2014).

Besides producing legitimate policy input, existing regulation that inhibits the competition on the transportation fuel market should also be addressed. An example of this kind of regulation is the blending obligation. This mandatory blending regulation gives oil companies the opportunity to run the show: they can decide where to buy the biofuels for their blends and keep their dominant position in the governance setting. The fact that the implementation of this regulation was used as an argument to abolish the tax exemption for several small PPO -producers shows that creating a level playing field was no priority of the Dutch government. In order to support technological innovation, we therefore recommend policymakers and Dutch politicians who are part of the policy making process to focus on the provision of a level playing field. Moreover, the creation of niche markets is of great importance when accommodating innovations. Therefore the Dutch government should facilitate and contribute to this creation. Up until today, PPO has not had a fair chance to develop and diffuse, because the socio-economic conditions necessary for this were not in place.

We also recommend the Dutch government to (re)introduce a tax exemption for PPO in order to facilitate the development and diffusion of this sustainable biofuel. The Dutch Ministry of Economic Affairs is the guiding ministry regarding energy policy; it decides which projects are supported financially and together with the Ministry of Finance it determines the excise rates. However, for both ministries it is economic growth, rather than the environment, that is their first concern. Even though this short-term focus on economic growth makes us richer in the short run, it limits the opportunities for future generations. Therefore we need tax measures that promote sustainable resources such as PPO, which lead to a reduction in the use of fossil fuels. Large oil companies will then also be further incentivised to focus on the development of sustainable technologies. Since not only PPO but also many other sustainable resources can be produced in a decentralised way, we will become less dependent on oil producing countries while at the same time stimulating our own economy.

7. Conclusion

It can be concluded that the factors affecting the development and diffusion of innovations are numerous, complex and interrelated. This paper has analysed the position of PPO as an alternative fuel in the Dutch energy sector, with a focus on the obstacles that prevent PPO from being an integral part of the Dutch energy portfolio. From a transition management perspective, it is recognised that the Netherlands needs to change its way of generating and consuming energy. However, the Dutch government does not accommodate innovations, which by definition are necessary to initiate change. One way it could have done this is by encouraging the creation of niches, which would have protected PPO from resistance of prevailing regimes. Big oil companies like Shell and the Dutch government form influential parts of the 'landscape', and the destabilisation of this landscape and the current energy regime would have allowed for innovations to develop. This paper shows that both parties attempt the opposite, i.e. to stabilise the current regime. Therefore we conclude that they are big barriers in the development and diffusion of PPO.

We have examined the dominant social and political discourses around biofuels in general and around PPO in particular. We can conclude that these prove to be an obstacle in the further development and diffusion of PPO in the Netherlands. Because of a discursive shift to socio-ecological discourses concerning rising food prices and environmental degradation, biofuels are associated with negative side effects. Although locally produced PPO in the Netherlands does not account for these effects, the generalisation causes this biofuel to be associated with negative social and environmental impacts. Scientists have, to a large extent, failed to present comprehensive studies involving a wide range of stakeholders, including those with practical knowledge.

Furthermore, we identified four institutional factors that constrain innovation and disadvantage marginalised views. The first institutional factor is the Dutch tax regime. The Dutch government did not implement a separate excise rate for biofuels in the Excise Act, while a tax exemption has proven to be necessary for the creation of a market for PPO. Another institutional barrier related to this is the mandatory blending regulation. This regulation gave big oil companies the opportunity to take the business of biofuels into their own hands. Furthermore, the development and diffusion of PPO is constrained by the lock-in of systems through technological and social path dependency. This is for example reflected in car engines, which do not support the use of PPO. Finally, the myopic views of politicians and large oil companies form an institutional barrier, as their interests are strongly related to short-term successes while PPO is typically a long-term investment. Nevertheless, long-term investments like these are the key to a sustainable energy system that would benefit both current and future generations.

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