Tomas Moe Skjølsvold

Towards a new sociology of innovation

The case of bioenergy in Norway and Sweden

Thesis for the degree of Philosophiae Doctor

Trondheim, August 2012

Norwegian University of Science and Technology
Faculty of Humanities
Department of Interdisciplinary Studies of Culture

NTNU – Trondheim
Norwegian University of
Science and Technology

NTNU
Norwegian University of Science and Technology

Thesis for the degree of Philosophiae Doctor

Faculty of Humanities
Department of Interdisciplinary Studies of Culture

ISBN 978-82-471-3717-8 (printed ver.)
ISBN 978-82-471-3718-5 (electronic ver.)
ISSN 1503-8181

Doctoral theses at NTNU, 2012:209

Printed by NTNU-trykk

Preface

"Engage!"

- Jean-Luc Picard

A few days ago I received a phone call from a telemarketing company who wanted to ask me a few questions on behalf of the local electricity utility. I sympathized somewhat with the telemarketer and agreed. One of the first questions he asked me was the following: "If you were to imagine the electricity utility as an animal, what would it be?" I was somewhat baffled by the question because the entire exercise seemed packed with so many dubious processes of interpretation. Let's say that my answer was 'an elephant'. Did I mean that the utility was a wise and robust entity, or did I imply that it was heavy, slow moving and without motoric precision?

Like most other events during the last few months, the question set in motion a series of thoughts related to this doctoral dissertation. If this thesis was an animal, what animal would it be? I considered the chameleon, multifaceted and ever-changing, or a clumsy hedgehog. I thought about the dog, a loyal servant to his master, but soon came to see that a stubborn cat might have been more fitting. I considered a bird (ambitiously high flying), a fish (on deep water) or a great whale (slow and heavy).

However, it was not until I pondered the realm of insects that I came close to something. In the end, my conclusion was that if this thesis was an animal, it would probably be a bee. Perhaps more precisely, it would be a beehive. First, I am terrified of bees. In many ways I am also quite scared of this dissertation. Second, and more importantly, many bees are social or 'communal' creatures. A quick check at Wikipedia suggests that the main advantage of this behavior "appears to be that a nest entrance is easier to defend from predators and parasites". Just like a beehive this dissertation is in many ways a communal effort. While I do not consider my readers to be 'predators' or 'parasites', this thesis has benefitted greatly from the input of many people, something which will hopefully be an advantage in the process of defending it from whoever launches an attack.

Particularly, Marianne Ryghaug and Knut Holtan Sørensen have been outstanding in their efforts to supervise and guide me on the path towards delivering this dissertation. Kari

Bergheim deserves special thank you for being a local oracle of all things. Dick Magnusson at Tema T in Linköping must be thanked for helping out with social and practical matters when I did fieldwork in Sweden, while Jane Summerton should be thanked for arranging much appreciated office space at Tema T during the period. Further, I am greatly indebted to the rest of my many colleagues at the Department of Interdisciplinary Studies of Culture, both for scholarly input and for generally providing a good time and a great place to work. Many of you have read, listened to and commented on bits and pieces which have ended up in this thesis in one form or another: thank you! Just as important, however, these colleagues make the department a great place *not* to work. Keywords: morning coffee, long lunches, strange discussions, wine lotteries, squash, basketball, beer and basse.[1]

The biggest thank you, however, goes to Nina (29) and Even (2), two actors who together with me constantly co-produce the best (and possibly also strangest) collective I know: our little family. Thank you!

Dragvoll, March 2012
Tomas Moe Skjølsvold

[1] International readers will want to check www.basse.no for an introduction to this game.

Table of contents

Introductory essay: towards a sociology of the anatomy of innovation

This doctoral thesis deals with innovation. As I type these first words of the dissertation, there are close to 400 jobs available in Norway, where 'innovation' is part of the job description.[1] Further, there are more than 1000 jobs available where the preferred candidate is expected to be 'innovative'.[2] Meanwhile, innovation is not treasured only in the job market. In 2008 the Norwegian Ministry of Trade and Industry presented a White Paper outlining the broad visions of Norway's current industry innovation policy. Here, innovation was presented as a tremendous force capable of no less than transforming an entire society. The first few sentences of the paper say:

> "The government wants a society where the welfare system is one of the best in the world. We want a society with competitive businesses all over the country. And, we want a society that covers our needs in such a way that we do not ruin things for future generations. Innovation and change will be keys to achieve this." (NOHD 2008, 5) [3]

In fact, if we stick to Norway as an example, it almost appears difficult to find any organisation, company, political party or similar entity without an explicitly formulated view on innovation. It will surprise no one that the Norwegian confederation of trade unions (e.g. LO 2007) and the confederation of Norwegian enterprise (e.g. NHO 2011) actively ponders innovation, but that the same is also true for the Norwegian church might be unexpected (DNK 2011).

In sum, innovation currently comes across as an incontestable concept, applicable in almost any societal question. When societal changes are discussed, the debate is most likely framed through the lens of 'innovation'. Innovation has arguably become what Michel Callon (1986) referred to as an obligatory passage point, it is through the notion of innovation that we tend to discuss how to improve technology, organisations, business, policy, nature and even in some cases religion.

With such an important status, it is not trivial what we mean when we say 'innovation'. What exactly is it that one wants to achieve when promoting innovation? How do we understand innovation and how do we see the innovation process? Who is expected to innovate, and how? I do not intend to answer all of these questions. Rather, I raise them at this point to highlight that their answers are far from obvious.

[1] Stats gathered from a simple search in the job database finn.no
[2] Again stats gathered from a simple search in the job database finn.no
[3] Originally written in Norwegian, my translation.

After this introductory chapter this thesis presents four research papers which deals with innovation in the energy sector. It is probably trivial to highlight that innovation in the oil industry, the wind turbine industry and the nuclear power industry raises different questions with respect to issues such as power, profit, sustainability and ethics to name a few. More specifically, this thesis studies innovation in respect to one particular energy source: bioenergy. It studies bioenergy in two different national contexts: the Norwegian and the Swedish. At this point it is sufficient to provide a somewhat simplistic image of the bioenergy situation in the two countries: bioenergy is used widely in Sweden, while its use is quite limited in Norway. Much more will be said about this later.

If we zoom out and try to tap into the global bioenergy discourse, the dominant message is that there is a need for more bioenergy. In part this is related to the climate change issue where bioenergy is often highlighted as part of the 'solution'. Further, bioenergy is considered to be important as a new business opportunity with a range of positive social and economic benefits. Thirdly, many see bioenergy as important in an energy security perspective.

Before I move on, it would probably help the reader if I clarified what I mean by bioenergy. According to the Intergovernmental Panel on Climate Change (IPCC) who recently published a special report on renewable energy sources and climate change mitigation:

> "Bioenergy can be produced from a variety of biomass feedstocks, including forest, agricultural and livestock residues; short-rotation forest plantations; energy crops; the organic component of municipal solid waste; and other organic waste streams. Through a variety of processes, these feedstocks can be directly used to produce electricity or heat, or can be used to create gaseous, liquid, or solid fuels" (IPCC 2011, 8).

This IPCC report is not only useful for defining bioenergy, it also serves to highlight the prominence bioenergy is currently given in relatively authoritative outlooks of how the worlds energy provision will look in the future. The report considers bioenergy as a component in four different future energy scenarios, ranging from a 'baseline' where changes in the energy system are quite modest to a 'recipe' where the global energy supply by 2050 is radically changed (p. 819). All scenarios, even the most modest, portray a future where the use of bioenergy is significantly increased. The International Energy Agency (IEA) shares this view. In their report 'Energy Technology Perspectives' (2010) they paint a picture of how a global decarbonized energy production regime might look in 2050 (the so called 'Blue MAP

scenario'). Here, the global use of biomass for energy purposes is at least tripled from 2008 levels. In other words, global heavyweight actors on energy and climate questions point to bioenergy as one of the most important 'solutions' for the future.

The global attention and belief in bioenergy as a tool to combat climate changes and to increase energy security is echoed at European, national and regional levels. One example is found in the 'biomass action plan' formulated by the European Commission (2005). Here, the following situation is described: "Europe needs to break its dependence on fossil fuels. Biomass is one of the main alternatives." (p. 16). More recently the Commission (2011) wrote on their website that: "The EU is committed to combat climate change and to increase security of its energy supply. Bioenergy from forestry and agriculture plays a key role for both".

In this dissertation, I mainly focus on Norway and Sweden. Here, too, bioenergy is considered a key element in the quest to reduce CO_2 emissions, create new business opportunities and strengthen energy security. In Sweden, bioenergy has played an important role at the core of Swedish climate and energy policies since the mid-1990s (Anshelm 2009), where it has been integral to what has been described as a 'greening' of the Swedish welfare state (Midttun, Gundersen, and Koefoed 2004). In Norway bioenergy still plays a quite marginal role, but Norwegian policies aim to double the use and production by 2020 (OED 2008). If we take another step down the ladder, strategies at regional and municipal levels indicate the same: bioenergy is seen as one of the primary weapons in the fight for a future energy supply that breaks the dependence on fossil fuels, while providing new opportunities for local business (e.g. Verdal Kommune 2007). In sum, the situation for bioenergy looks bright. The above documents (and countless others) at global, continental, national and municipal levels all portray a future where biomass is one of the most important sources of energy.

However, most of the above sources will also admit that much work needs to be done if we are to experience such a future. In fact, the task at hand is tremendous. But what kind of task is it, and how should this task be understood? If we re-visit the IEA energy technology perspectives report (2010) it is clear that the task is framed as one which is to be tackled through innovation, and that innovation is largely understood as an endeavor which is brought about in private and public research institutes, and in companies with R&D departments. Here, innovation is brought about through a combination of research, development and demonstration (RD&D) of new technology. This view is particularly prominent if we consider the concrete policy advice that the IEA formulates to 'accelerate a low-carbon technology

transition', where four out of six proposals directly addresses how to strengthen the role and impact of RD&D (IEA 2010, 459).

The focus of actors such as the IEA raises the question of how their ideas about innovation can be related to the current practice of entrepreneurs working with renewable energy technologies. Such actors are the centre of attention in this thesis, as I study those who have already begun the 'work' of energy transition through venturing into the bioenergy field. It is safe to say that these actors are innovators; they are introducing modes of energy production which replaces the dominant practices of old regimes. While the documents I have looked at above largely concern how to create an incentive structure that will result in a new energy mix somewhere down the line, e.g. in 2050, this thesis starts with the outlook of those who have attempted to move from vision to action. Thus, an underlying assumption of this dissertation is that while there is a need for grand strategic thinking through scenario and policy making, there is also a need to study and understand current innovation practice. Further, there is a need to situate this practice in a broader context, in order to be able to grasp how such practices are shaped, formatted and understood in relation to the world around. By enhancing understanding of the innovators practice and how this practice is made sense of I seek to illuminate what is often described as 'drivers' or 'barriers' to innovation (e.g. Walker, Di Sisto, and McBain 2008). Theoretically I also hope to contribute to the innovation literature by broadening the scope of what we can and should study when we do research and theorize on innovation.

What I have suggested implies that innovation should be studied as part of a locality, as a situated activity which is first and foremost a social practice. Here, the studied innovation is situated in Norway and Sweden. I will look at the similarities and differences between these countries as 'energy cultures'. Do these energy cultures have any implications for innovation in new renewable energy technologies? Hopefully, this exercise will provide novel insights about why the bioenergy situation in the two countries differ, how the traits of the energy cultures feed into innovation practices, and finally to make a theoretical contribution to broaden our understanding about what innovation is or what innovation could be. Central to the discussion will be the notion of 'socialization of technology'.

The four papers

This thesis consists of four research papers and in what follows I will provide a brief resume of them. All papers are concerned with bioenergy, and can be related to discussions about how innovation occurs, how innovation endeavours are shaped and how we can understand the practice of innovation in a broader setting. This 'broader setting' is represented by numerous actors in the research papers, such as the 'audiences' of the innovators in the form of markets and 'publics', the news media, as well as the scientific community and the ways that policy and planning feeds into innovation. Thus, the papers not only deal with innovation, but with what is often labelled diffusion or non-diffusion of technology, and about how bioenergy 'fits into', 'finds its place' or is socialized into the Norwegian and Swedish energy cultures.

Article one. Organic innovation: innovation practice in the bioenergy industry[4]

Paper one is the article in this thesis which most directly deals with innovation. It represents a quite direct effort at trying to grasp what the 'drivers' or 'barriers' of innovation are for actors in the Norwegian bioenergy industry. How do people end up as bioenergy entrepreneurs, and what are the opportunities and difficulties they face? The paper studies a diverse group of companies working with bioenergy, all located in the middle region of Norway. They are all relatively new companies, or they have recently started working with bioenergy. Thus, they are innovators, and in a sense they are pioneers. Where most students of 'green innovation' apply some variant of a systems perspective and study macro or meso issues (Schiederig, Tietze, and Herstatt 2011), this paper applies an actor-perspective and focuses on the practice of innovation. It does so through the use of Actor-Network Theory (ANT) and the notion of pre-formatted fields which Bruno Latour (2005) presents in *Re-assembling the social*. The paper shows that Norwegian policymakers envision an R&D driven technology development in the years to come. With this in mind the paper asks what the role of R&D is in the innovation practice of the companies observed. Surprisingly, the paper finds bioenergy innovation to be a quite autonomous endeavour where the lack of input from formalized knowledge production such as R&D stands out. In the cases where R&D plays a role it does so as a mediator, translating commercial interests in such a way that they are made relevant also in a climate and sustainability perspective.

[4] Unpublished paper

The innovation efforts are diverse, and there is little in the paper suggesting an emergence of anything like a typical Norwegian 'bioenergy innovation path' such as has been identified for instance in the Danish wind turbine industry (Garud and Karnøe 2003). Instead, we see a varied approach to innovation where actors from different fields are able to venture into bioenergy through an open pragmatism in response to a range of issues. Particularly, the paper finds practice formatted in four ideal typical ways through new markets, regulations, resource availability and particular customer relationships. Thus, the 'drivers' of innovation observed is a mix of a personal ambition on behalf of the innovators, a strong will to create 'new combinations' as well as external stimuli in various forms mobilized as practical innovation tools.

Article two. Curb your enthusiasm: on media communication of bioenergy and the role of the news media in technology diffusion[5]

Although article one highlights the autonomy of individual innovation efforts, it became clear quite early in this process that the situatedness and locality of the innovators greatly influenced their experience of reality. To phrase this in a somewhat stereotypical way: they did not operate in 'social vacuums'. One of the grievances I often heard while doing fieldwork in Norway concerned the Norwegian media coverage of bioenergy. The sentiment was that harmful (or lacking) coverage influenced public perception of bioenergy negatively. This was fascinating: could the news media reporting really be a barrier (or driver) of innovation? Further, what were the differences between the way that Swedish and Norwegian news media reported on bioenergy? Article two is a study of how Norwegian and Swedish mainstream newspapers cover bioenergy. The paper argues that the news media is a site of domestication, in other words that it is a site where bioenergy as a set of technologies are ascribed meaning. Newspapers are 'sites' where the voices of many actors are heard, and this means that there is a collective aspect to the domestication observed here. The paper finds that bioenergy is ascribed diverging meanings in Norway and Sweden, in other words bioenergy 'is' something else in Sweden than it 'is' in Norway. Bioenergy is optimistically covered in the Swedish press where it feeds into an image of Sweden as a 'green' technology pioneer. Bioenergy feeds into environmental, social and economic discourses in a positive way. The sentiment is that bioenergy create jobs, good products and is good for the climate. In the Norwegian newspaper coverage on the other hand, bioenergy is covered in an ambivalent way. This coverage is not negative in character, but when bioenergy is compared to other

[5] Skjølsvold, T.M (forthcoming). Accepted for publication in *Environmental Communication: A Journal of Nature and Culture*.

energy technologies such as hydropower and gas fired power plants it is seen as falling short both in term of technical and economic properties.

The paper identifies a set of local, national and global story-lines about bioenergy. Further three quite distinct modes of domestication of technology are observed in the newspapers: a) mundane techno-optimistic domestication, b) techno-ambivalent domestication and c) techno-resisting domestication. The paper suggests that techno-optimistic media domestication might stimulate innovation efforts, while techno-resisting domestication might provide checks on such efforts. However, the paper acknowledges that little is known about this: the news media have largely been ignored in the traditional innovation literature.

Article three. Publics in the Pipeline: On Bioenergy and its Imagined Publics in Norway and Sweden[6]

'The public' is a much more obvious subject of study than the news media in questions concerning diffusion, implementation and commercialization of technology, and therefore also for the study of innovation. At one level this point is almost trivial: if the public is opposed to a technology it may work as a barrier for innovation, if the public supports a technology it might be a driver. Further, 'the public' is ultimately what makes up a potential market for new technologies. In line with this, article three tries to examine how publics are constructed by bioenergy actors. Further, it sets out to investigate how such constructions relate to action strategies. The article is inspired by quite recent literature from the field of Public Understanding of Science (PUS) which deals with 'imagined publics'. The idea is that 'the public' does not only carry agency and influence processes of science and technology decisions through direct action such as protest or support, but that 'publics' influence such processes more subtly and indirectly (see e.g. Barnett et al. 2010; Walker et al. 2010). 'The public' is powerful also as an imagined entity. It has been demonstrated that such imagined publics may influence the strategies of industrial, scientific and political actors considerably.

The paper shows that the Norwegian and Swedish publics of bioenergy are imagined very differently. In the Norwegian setting the public is perceived as a hostile obstacle, as something which needs to be overcome if bioenergy is to prevail. This hostility is imagined both through the notion of NIMBYism on behalf of the public in relation to specific projects and through the interpretation of non-consumption of bioenergy as a preference for competing

[6] Skjølsvold, T.M (forthcoming). Accepted for publication in Nina Möllers & Karin Zachmann (eds.) *Past and Present Energy Societies. How Energy Connects to Politics, Technologies and Cultures*. Bielefeld: Transcript Verlag.

technologies or as an expression of knowledge deficit. In the Swedish case the publics are imagined differently. First they are imagined to be indifferent about bioenergy. For most actors this perceived indifference is not considered a deficit problem. Rather, 'the publics' are seen as users or customers of smoothly working infrastructures, which happens to be powered by bioenergy. The ignorance, then, is interpreted as a kind of 'seal of approval' ('as long as it works, the Swede is happy'). The exception is that some actors see the perceived ignorance as a democratic problem, and that consequently, the public must be informed. Another public imaginary in Sweden was the public as green, progressive customers, something which was seen as a benefit for the bioenergy industry. The paper further explores how these imagined publics were related to the practical strategies of public engagement mobilized by the bioenergy actors. In one sense the article seem to support that 'the public' as imagined in Norway might be a barrier to innovation. More precisely, the public seems to be one of many elements feeding into a sort of resignation on behalf of many of the bioenergy actors. In Sweden on the other hand, the positive view of publics seem to feed into a more general positive 'buzz', probably favourable and stimulating for innovation.

Article four. What we disagree about when we disagree about sustainability[7]

The final article in this thesis deals with controversies over sustainability. A fundamental assumption of all policy promoting bioenergy and other renewable energy sources is that such energy sources are sustainable or environmentally friendly, or at least that they are more sustainable than what they are meant to replace. If this fundament was removed, there would probably be very little push for innovation in the field; a barrier to say the least. Thus, 'sustainability' or 'climate friendliness' as a concept is probably the main innovation 'driver' for bioenergy. It was in this light that a controversy over the sustainability of bioenergy caught my attention.

In practical terms the sustainability of particular fuels, resources or technologies are often determined through the making of environmental criteria. This paper higglights that there is a notable lack of universally adopted criteria of this type. Such criteria are often established quite pragmatically, and are often subjects of controversy and deconstruction. For those who make decisions this is a problem: how do you make decisions based on unstable information? The paper argues that there is a need to understand controversies over sustainability better, primarily to be able to cope with the inherent volatility of unstable

[7] Paper submitted to a peer reviewed journal on 02.12.2011. Current status: under review.

criteria. Is it possible to strengthen the robustness of our knowledge, to build a sort of readiness to revert previous decisions in our democratic systems?

The proposition of the paper is that a frame analytic approach could bring us in the direction of such a goal. Frame analysis is applied in the study of controversies over bioenergy and peat; two examples where the criteria to measure environmental qualities are seemingly quite well established. None the less, there is controversy: while some claim that bioenergy is 'climate neutral' others claim it is harmful to the climate. Frame analysis allows us to study the knowledge claims of such controversies as quarrels about calculation and about inclusion and exclusion from such calculations. Thus, strategies of framing are ways to broaden or narrow the scope of our understanding of a given topic, in this case about our understanding of what is sustainable. The volatility of such definitions and criteria is probably a quite universal problem for emerging environmental technology. Through paraphrasing Donna Haraway (1991) the paper suggests that such volatility can be understood as 'trickster qualities'. The paper argues that frame analysis could be employed as a practical tool to identify such trickster qualities, potential volatility in current criteria, and to assess the robustness of new criteria. This might be a way to strengthen the democratic process, possibly removing some of the ideological pressure involved in difficult decision making processes

Four research papers and beyond

As I embarked on this project I was determined to study innovation in bioenergy and closely related topics. However, as the summaries above suggest, and as will become more evident when the four research papers are presented in full later on, they all tell quite different stories. Only one of the papers directly studies the innovation practices of bioenergy entrepreneurs. An obvious question, then, is why the papers turned out the way they did, given my original intentions. A possible explanation may have been that I found related topics along the way that I personally found more interesting. However, I think there is more to be said about this than what such an individualistic interpretation can provide. Perhaps there is something about bioenergy which forces a broader perspective or perhaps bioenergy situated in the Norwegian and Swedish energy cultures opens up for new types of research questions? In the following, I will attempt to re-situate these quite diverging papers in a broader story about innovation, or more specifically in a story about how to understand and study innovation with a concept such as 'energy cultures' as a backdrop. How can such notions broaden our understanding of innovation?

A technical fix for our problems: from linear to systemic and multilevel approaches

Innovation is certainly not a new subject of study. However, recent problems associated with a range of issues, the most pressing perhaps being climate change, have introduced a sense of urgency into much current innovation thinking. This is particularly pertinent in discussions about renewable energy technologies. The political goal is simple: we need to develop and deploy technologies which curb the emissions of climate gases. Climate change, however, is not the only problem addressed by new renewable energy technology. In many settings renewable energy can provide a viable route towards increased energy security in a world where access to fossil fuels is increasingly becoming scarce and volatile (see e.g. Hopkins 2008, for a much cited discussion on 'peak oil'). Further, renewable energy has been launched as a way to stimulate the economy and generate wealth while addressing social questions related to job creation and welfare provision. Consider the ideas about a ‘green new deal’ as a case in point. Proponents of the green new deal upholds that massive government investments in new renewable energy technology and related infrastructure might not only bring us out of the climate crisis, but that it would also boost the economy and bring us out of the current economic crisis. (see e.g. Barbier 2010, for a discussion). In any case, renewable energy has emerged as a variant of a quite common concept in the modern era: a ‘technical fix’. This notion implies that the problems faced by mankind can be ‘solved’ through the application of new technology rather than through altered practices (see e.g. Winner 1986, for a range of examples). Globally we are currently struggling to come to terms with a ‘climate crisis’, an ‘energy crisis’ and an ‘economic crisis’. Renewable energy technology is frequently portrayed as a set of technologies which might bring us out of them all.

Let us continue with the climate crisis as an example for which renewable energy and other low carbon technologies are considered a technical fix. A nice illustration of the problem in question can be found in a relatively recent report by the United Nations Development Program (UNDP 2009). In a very straightforward way, the report highlights that a combination of increased demand for energy and an increase in CO_2 emissions related to energy production and consumption has resulted in the need for a technological revolution. The UNDP labels their technological fix ‘low carbon technologies”. Figure 1 depicts the problem: rising emissions, rising energy demand, and the solution: low carbon technology.

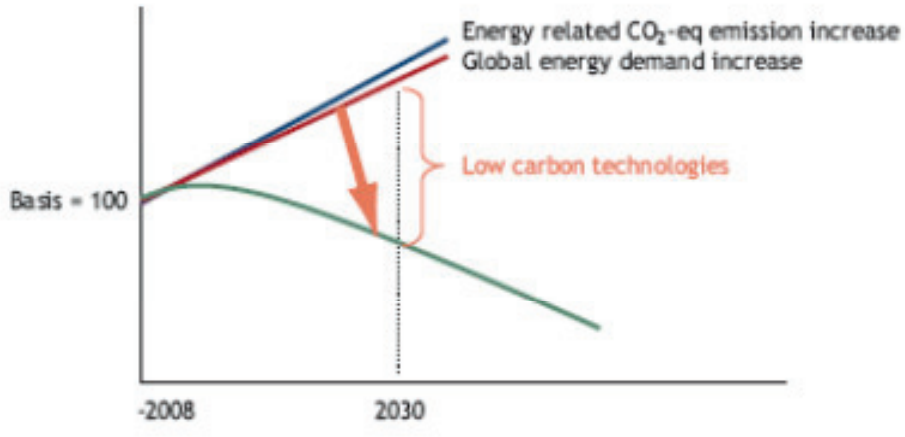


Figure 1: a technical fix for the climate problem as presented by the UNDP (2009, p.3)

In the UNDP graph there is a significant gap between the present-day situation and a future where the technological fix is applied. The question is: how do we get from here to there? How is innovation understood by actors working to introduce such a technological fix? One answer is found in the by now quite famous, much cited and influential 'Stern Review' where UK economist Nicholas Stern attempts to develop an economics of climate change (Stern 2007). Chapter 16 of the report is of particular interest to our discussion, since it deals with policies for "accelerating technological innovation". The chapter can be read as a guide to innovation which culminates in a series of policy advices. Underpinning this advice is a particular view of what innovation is, and what an innovation process looks like. In Stern's model, innovation occurs in time and space between research on the one hand and consumers on the other. Innovation begins with research and ends in the hands of the consumer. In-between, the process moves from basic R&D via applied R&D into demonstration, commercialization, market accumulation and finally diffusion. During all these stages the process may be influenced by the business and finance community via investments, and/or by the government who can intervene through policy. Figure 2 represents the innovation process, or the innovation chain, as it is presented in the Stern Review.

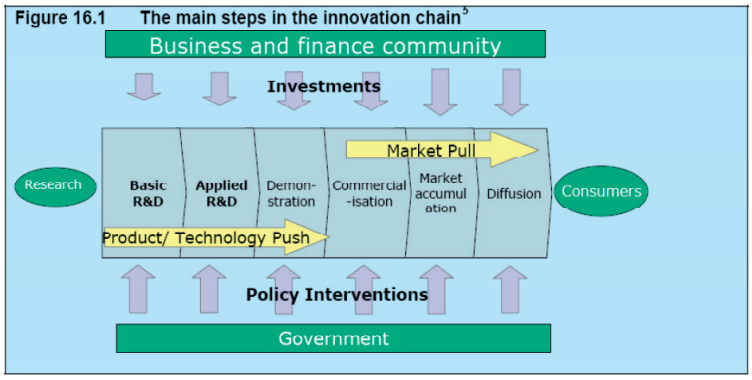


Figure 2: The main steps of the innovation chain as presented in the Stern review (2007, 349)

This understanding of what innovation is, underpins much of the policy advice provided by Stern. There is a massive focus on boosting R&D efforts in the public and private sector, preferably in combination with economic stimulus schemes meant to help cater for the commercialization of the innovations which emerge from the R&D efforts.

A quite similar story is told in the already cited UNDP report. Here, innovation is described as a four-step process moving from a) R&D through b) Demonstration, through c) Deployment, and finally ending up in d) Diffusion. Through these phases, the UNDP envisions a learning curve where the cost of each unit produced is reduced at every stage, down to the point where the technology finally becomes commercially competitive during the stage of technology diffusion. Figure 3 displays how the UNDP envisions achieving the technical fix through innovation.

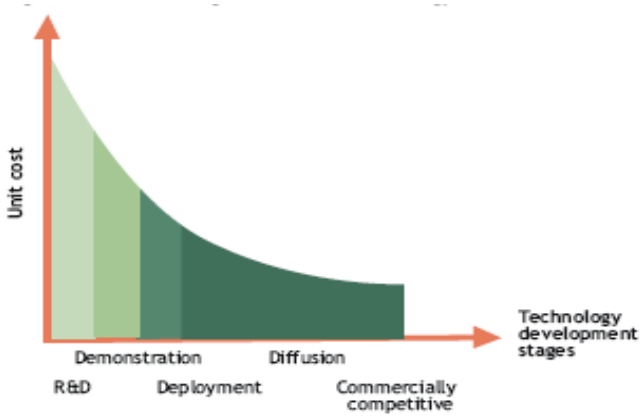


Figure 3: the four stages of innovation and the drop in production costs, as envisioned by the UNDP (2009, p. 79)

As readers of this thesis will most likely recognize, the ideas presented by the Stern Review and the UNDP are not new. In fact, what we see above are accounts that are close to perfect replicas of what is most commonly labeled 'the linear model of innovation' (see Godin 2006, for a review). From a scholarly perspective this model has been 'debunked' and discredited because most innovation endeavors simply do not look like the above descriptions. A much cited example pointing to its low standing is found in Nathan Rosenberg's *Exploring the black box. Technology, economics and history*, where he claims that: "Everyone knows that the linear model of innovation is dead. That model represented the innovation process as one in which technological change was closely dependent upon and generated by prior scientific research." (Rosenberg 1994, 139). Rosenberg's words are echoed in a critique of the Stern Review by Keith Smith 14 years later. Smith writes:

> "The *Stern Review* approaches the innovation issue by recommending policies based on R&D and commercialization strategies, seeing the problem essentially in terms of a low level of R&D in energy and transport sectors. This is, in effect, to deploy the so-called 'linear model of innovation', in which innovation proceeds in a more or less linear fashion through to engineering and applied development, and then to diffusion" (Smith 2008, 13)

In all fairness, it should be highlighted that Stern's version of the model does include a notion of both innovation 'push' and innovation 'pull', something which means that it acknowledges that there is agency both amongst those who 'make' technology and amongst those who are seen as 'end users' of technology. This pull, however, is limited to the notion that users of technology are parts of markets and that they can therefore create demands for new products.

While the linear model of innovation is in many ways seen as academically 'dead', the two examples above clearly show that the linear model is very much alive and kicking as an influence on the discourse surrounding innovation. When it is picked up by the likes of the Stern review and the UNDP, it certainly also has 'real-world influence' in terms of shaping what we do to improve our innovation capacity as societies. This view is supported by Benoît Godin who has published a historical account of the linear model's construction and influence. Godin highlights that while the linear model of innovation has lost most of its credence as a framework for research, it still carries significant influence as: "the model continued to feed public discourses and academic analyses—despite the widespread mention, in the same documents that used the model, that linearity was a fiction" (Godin 2006, 659).

So, where am I going with this? The intention of this dissertation is not to set up a polemic with the linear model of innovation per se. This would most likely be somewhat of a straw man, even though it might be a productive straw man. Still, it is important to highlight that we have inherited a certain way of thinking about innovation and technological change from the linear model, and that some of the ideas and logic behind the model are still quite active, when it comes to its practical and political consequences. More specifically these consequences are related to the prominence given to R&D and scientific research in questions concerning innovation. Innovation is typically seen as having a known starting point; R&D and science. Without R&D, nothing will happen, something which has obvious consequences for those seeking a technical fix to a problem such as climate change (or energy security or economic crisis). This is easily recognized in Nicholas Stern's attempts at providing hands on policy advice, where R&D is placed at the center stage. As Godin (2006) points out, the linear model has probably been the most durable, influential and successful conceptualization of technological development and change ever created. The question, then, is what more recent approaches to innovation have added to this image, and what implications this has for those seeking the technical fix?

From a scholarly perspective the understanding of innovation has moved from the notion of a linear flow from R&D to diffusion towards the understanding of innovation as something that happens as part of a system. In principle this represents a break with the linear idea: in a system there is no clearly formulated starting point or ending point. Rather, it is the totality of components in a given system that boosts or hinders innovation.

This has been most clearly formulated in the innovation systems literature. The general idea is that there exists innovation systems at different levels such as national innovation systems (Lundvall 1992), regional innovation systems (Cooke, Gomez Uranga, and Etxebarria 1997), sectoral systems of innovation (Malerba 2002), technological innovation systems (Carlsson 1995) or even global innovation systems (Sagar and Holdren 2002). Such systems are often thought of as a type of 'innovation infrastructure' (Cooke 2001), and this infrastructure is seen to enable or disable innovation performance. The performance or the potential of such systems are not measured at the scale of individual technologies, products or companies but are most commonly measured at the level of the system: e.g. the nation, the region or the sector. Carlsson et al. (2002) say: "when interested in the performance of an innovation system […] the main focus is on the performance of the entire system". This performance can be measured via proxies for knowledge generation such as number of patents, patent applications, through bibliometric studies or through accounting

for matters such as the number of scientists and engineers, through proxies for use of technology such as market shares, exports and diffusion rates for specific technologies (Carlsson and Jacobsson 1993; Carlsson et al. 2002; Rickne 2001).

How are such innovation systems described? In their answer to this question, Carlsson et al. (2002, 234) borrows insight from systems engineers when they posit that innovation systems are made up of:

- *Components*: The operating parts of a system, e.g. individuals, firms, banks, universities, R&D institutes or public policy agencies. Components may be physical artifacts such as technologies or they may be institutions, e.g. legislation, tradition or social norms.
- *Relationships:* The links between the components in the system. Such relationships are considered inter-dependent: the components of a system cannot be divided into independent subsets because the system is more than the sum of its individual parts. Examples of such links may be the way policies relate to firms, the effect of venture capital, technology or knowledge transfer between system components etc. Relationships involve both market and non-market links. Interaction between components is dubbed 'feedback', and the degree of feedback determines if a system is 'static' or 'dynamic'. Dynamic systems are desired, because they are considered more robust than their static counterparts.
- *Attributes:* the attributes are the properties produced by the components and the relationships between them. It is a sort of sum or aggregate: the characteristics of a system. For innovation systems, Carlsson et al. (2002, 235) say: "The function of an innovation system is to generate, diffuse, and utilize technology. Thus, the main features of the system are the capabilities (together representing economic competence) of the actors to generate, diffuse, and utilize technologies (physical artifacts as well as technical know-how) that have economic value"

Thus, a well-functioning innovation system has a set of components which are related to each other in such a way that the attributes of the system boosts the innovation performance of the system itself. In principle this represents a break with linearity: there is no known 'starting point'. Rather, flows of knowledge can move in many directions, and the knowledge may have multiple sources.

Are there any kind of components and any type of relationships between these components which are considered favorable in the literature? Actually, it is interesting to note that there is a significant overlap between those privileged by the linear model of innovation

and the components highlighted in the innovation systems literature: namely those associated with specialized knowledge and formalized R&D. Porter and Stern (2001) for example, highlights the "need for high quality human resources, especially scientific, technical and managerial personnel" as well as a "strong basic research infrastructure in universities" as important input variables together with risk capital and information infrastructure (p. 30). Similarly, the much cited work of Nelson and colleagues (1993) spends countless pages focusing on the role of R&D and formalized knowledge, and on how such knowledge in various ways links to firms, individuals, policy etc. The idea is not so strange, of course, because places such as universities and research institutions might work as 'reservoirs of knowledge' (Jacobsson 2002). The pooling of this knowledge into firms, individuals, policy, etc., may be seen as leading to learning and innovation, as is posited in the linear model. The systems approach, however, highlights that this may happen intentionally through processes of knowledge and technology transfer, or it may happen unintentionally through more informal channels and processes that are often labeled technology or knowledge 'spillovers' (Asheim and Isaksen 2002; Black 2004). It should also be pointed out that knowledge may have other sources than universities and R&D, 'spillovers' for example might just as well be the result of relationships (feedback) between different companies, individuals etc. Also, knowledge may arise from processes like learning from new applications or production (Bijker 1995), or imitation (Hansen 2009). Further, a number of scholars have pointed to pro-active policies as well as the public and their acceptance of new solutions as important components in successful innovation systems, particularly if new, green solutions are sought (Cooke 2009).

In sum, the current advice from the scholarly community for those seeking transition through innovation is that we should try to stimulate the formation of well-functioning innovation systems at various levels. In practical terms this probably means funding universities and other R&D institutions to do research in the areas that we want innovation to occur and to encourage the exchange of knowledge between R&D and industry actors. Further, to create policies which stimulate companies working in such areas (subsidies and tax benefits are two possibilities), and in other ways try to establish favorable conditions for the system. If successful, the outcome can be measured through a rise in the number of patent applications, industry performance, etc., at the systemic level (e.g. nation, region, globe, or sector).

At this point it is quite interesting to note that even though the linear model of innovation 'is dead', the practical implications of what I have suggested above sound

remarkably similar to the implications of a linear approach. Innovation is still understood to be firmly rooted in science and R&D, even if these components are not necessarily the starting point of the process. Thus, the emerging policy advice will resemble what Keith Smith (2008, 13) somewhat patronizingly dubbed "the R&D + commercialization approach".

Before we move on, it might be fruitful to look at one example of how a more practical than scholarly oriented actor has picked up the ideas of the innovation systems literature and applied them in their own thinking on innovation. One such example is found in a report by the Organization for Economic Co-operation and Development (OECD 2005). The report is particularly interesting for our discussion, both because it deals with innovation in the energy sector, and because Norway is one of nine countries given a case study treatment. The report calls for an understanding of energy innovation through the notion of 'energy technology innovation systems' or 'national energy innovation systems'. As suggested by the brief glance at the scholarly literature above, the OECD greatly focuses their attention to the role of R&D in distributing knowledge. However, there is also significant focus on matters such as market development through commercialization programs as well as other economic policies that might increase the competitiveness of new renewables.

My interest in this particular report has also emerged from the fact that it attempts to describe the Norwegian energy innovation system. This is interesting, because it could serve as a gateway to understanding the systemic conditions for innovation in the renewable energy sector in Norway, and therefore also for the innovators in bioenergy. However, the discussion in the report is not very helpful: it almost exclusively circles around the relationships between Norwegian R&D actors and the oil and gas industry. In this account the Norwegian energy technology innovation system appears as a kind of spin-off from the oil and gas industry and its related R&D efforts. This impression is strengthened as the report analyzes one particular technology in addition to the general energy innovation system: hydrogen fuel cells. The OECD interprets the Norwegian hydrogen fuel cell innovation as firmly rooted in an innovation system where a) the oil and gas industries and b) various R&D institutions are the two major influences. An obvious question to raise here is how bioenergy fits into this image. This, however, is a question for later. At this stage; the points from the OECD should only be considered a teaser; I will return with much more detail on the Norwegian and Swedish situation later.

The linear model of innovation and the innovation systems literature generates certain expectations regarding what innovation could and should be, and about how innovation processes are shaped. This tends to culminate in a specific set of policy recommendations,

often in the form of advice meant to boost R&D and to increase the impact of R&D. This is typically combined with economic policies aimed at helping in the 'commercialization phase'. However, in extension of these perspectives, there is a third alternative which represents another way of thinking about systems. This is the so-called multi-level perspective (MLP). MLP is first and foremost a conceptual framework, a way of thinking about change and innovation. The framework considers the possibility of change at three different levels: niche, regime and landscape. These levels form a hierarchy, with niche at the bottom and landscape on top. The basic idea is that changing the architecture of the level becomes more difficult as you move up the ladder, because on top there is more order, more structuration and higher levels of entrenchment. At niche level the room for change is largest. Here, new knowledge is created, while the actors explore and experiment with the opportunities of new technologies (e.g. Geels 2007). Meanwhile there is a social practice involved, tied to the task of building support and legitimacy. The regime level is configured more stable, and there is much more routine here than at niche level. Social groups such as engineers and other professionals share cognitive norms and routines, and these stable conditions may lead technological trajectories to become longer and more entrenched (e.g. Moors, Rip, and Wiskerke 2004). Landscape is the most difficult level to change, and changing it is often a very gradual and indirect process. Here we find elements such as the material infrastructure, political culture and social values (see e.g. Geels 2011; Kemp and Rotmans 2005).

The policy implications of MLP have been somewhat different from what we have seen in the linear and innovation system approaches. While these latter perspectives also seek change, they do so relatively indirectly under the assumption that funding R&D will ultimately result in the desired technological transition. MLP on the other hand, has a much more direct and interventionist agenda for promoting transition. It broadly focuses on change through two strategies. First, it is often advocated that one should stimulate particularly promising niches through what is called 'strategic niche management' (e.g. Kemp, Schot, and Hoogma 1998). An alternative lies in an over-arching societal transition approach often referred to as 'transition management' (e.g. Kemp, Loorbach, and Rotmans 2007). The idea behind transition management is to create arenas for transition, and transition networks of 'frontrunners' who are linked by joint work to develop visions and images of what the transition might be. In this sense, MLP recognizes that innovation activities are highly political in character, something that more 'standard' innovation systems approaches are often criticized for neglecting (Kasa 2011). Such networks of 'front-runners' are used to build

coalitions, for negotiations and mediation, and to create new networks and institutional structures (see e.g. Kemp, Schot, and Hoogma 1998; Rotmans et al. 2000).

MLP, however, and particularly the political implications derived from it in the shape of transition management are not without its critics. Elizabeth Shove and Gordon Walker (2007), for example have raised a number of critical questions. First, they have been concerned with the politics of transition management and the question of whether transitions really can be managed. Second, they have been concerned with what they see as a series of somewhat naïve assumptions about the politics of transition management. A goal such as 'sustainability' might be desirable enough, but what are the day-to-day politics of such transition management? Further, how should one deal with the volatility of a category such as 'sustainability'? Shove and Walker writes: "Advocates of sustainable transition management do not always appreciate the deep ambivalence of sustainability as a category and its power as legitimising discourse" (2007, 766). Thus, while MLP and transition management recognizes the politics involved in building support, networks, front-runners, etc., there are problems insofar as that it overlooks "Fundamental conflicts […] between opposing interests and ideologies" (766), something which represents a democratic challenge. The same sense of naïveté can be traced when Shove and Walker point to the absence of opposing forces, the 'transition management' sought by those who do not necessarily seek 'sustainability' or other noble goals:

> "[What about] transitions which appear to be heading in exactly the opposite direction, which emerge from the left field, `managed' by actors whose interests are not part of the consensus vision and whose `malignant' priorities lie elsewhere" (Shove and Walker 2007, 767)

As an example, Shove and Walker provide the spread of air-conditioning and standardized indoor climate across the globe as a resource intensive technological practice, clearly a transition of sorts, but of a type not much discussed in the MLP literature. Thus, while MLP might provide a somewhat different and probably more viable route towards the 'technical fix' than the linear and innovation systems approaches, there is clearly room for elaborating more on the topic of innovation and diffusion of technology.

While there are clear and obvious differences between MLP and other innovation systems literature, it makes sense to speak of them together as systemic approaches to innovation. They share a set of strengths which makes them suited to study a specific type of research questions with a specific set of methods. Typically, these are studies which seek to discover factors that feed into the innovation performance of whatever system is studied at an

aggregate level. The question for me, however, is how these mainstream approaches to the study of innovation perform with respect to practice. In other words; how can they help illuminate specific innovation processes, the shaping and experience of such processes and in identifying actors who are potentially implicated by and participating in such processes? How are such processes formatted? To use a bodily metaphor: how well do the systems approaches inform us about the 'anatomy of innovation'? My argument is that in such questions, the standard perspectives of innovation studies lack the needed tools to be a fully fruitful framework. To use another metaphor, the innovation systems approach seems capable of accounting for the 'topography of innovation', but to study the anatomy or practice of innovation an alternative is required. Thus, my proposition is that there is a need for an expanded innovation concept. My suggestion is to bring additional elements into our thinking about how innovation works. In other words I want to do in practice what Erving Goffman (1974) or Michel Callon (1998) might have referred to as a re-framing of the problem or the concept.

If we are to expand the innovation concept, what are we to expand it with? How can we begin to re-frame or expand the concept of innovation in such a way that practice, and the situatedness of practice is accounted for? Since this thesis deals with innovation in bioenergy, my suggestion is that we begin thinking about these matters via a relatively recent 'framework of energy cultures' formulated by Janet Stephenson and her colleagues (2010). The goal is to examine more closely the setting where the innovation endeavors in question take place. This will allow us to compare the Norwegian and Swedish energy cultures. Hopefully this exercise will bring us in the direction of some tentative hypotheses with respect to how the innovation concept could be expanded so that we can capture the 'anatomy' of innovation. Further, the investigation of the Norwegian and Swedish energy cultures might inform us more specifically about what conditions bioenergy innovators in Norway and Sweden work under.

Energy culture and the anatomy of innovation

Janet Stephenson and her colleagues (2010) recently published a conceptual framework for the study of 'energy cultures' inspired by both Actor-Network Theory (ANT) and classical sociology. The framework is meant to cater for a better understanding of matters related to energy from a social scientific point of view. The idea is to create an integrated 'roadmap' for social scientific studies of energy, which aims both to contribute to the question of what to study and what methodologies to apply. Basically, the framework suggests that scholars seeking an understanding of energy cultures should focus on material culture (e.g.

technologies, buildings, policy), cognitive norms (e.g. beliefs, understandings), and energy practices (e.g. activities, processes). Thus, their work echoes that of scholars like Aune (1998, 2007) and Palm (2009), who have also pointed to the importance of the material, symbolic and practical conditions of energy consumption and production. Figure 4 presents the core components of the energy cultures framework in its most basic form.

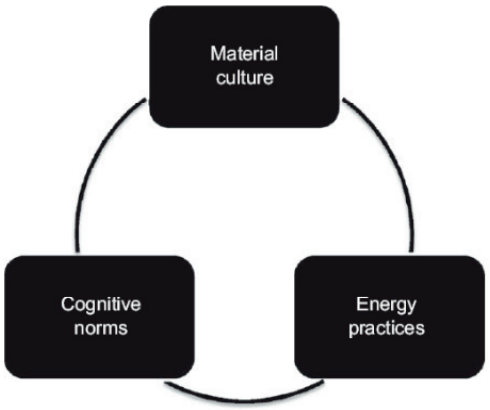


Figure 4: The core concept of the energy cultures framework: the interactivity between material culture, cognitive norms and energy practices (Stephenson et al. 2010, p. 6124)

The framework is developed first and foremost to study energy practices of groups or 'clusters' of energy consumers for example in a region. However, the authors also highlight how their approach could illuminate the study of larger collectives, such as nations. For instance, the authors attributes New Zealanders renowned acceptance for low indoor temperatures to an energy culture which differs in character from European or American cultures, where indoor temperatures are expected to be higher.

For our discussion here, which primarily concern innovation, the authors' ideas regarding changes in energy cultures is of particular interest. In this thesis I am first and foremost concerned with the practice of innovation. One way to look at the practice of innovators is to treat it as a direct attempt to bring about change in the energy culture. Introducing a new technology, for example, is a direct attempt to change what the authors describe as 'material culture'. One example from the field of bioenergy would be the introduction of bioenergy fuelled combined heat and power plants (CHP), in collectives previously powered by nuclear or hydroelectric power stations. If there is public opposition against the new technology, successful innovators would not only have to change the material culture, they would probably also have to engage the cognitive norms contributing to

resistance in one way or the other. Ultimately, successful innovations must also alter energy practices. As a basic example: re-fuelling a pellets heater is a task different from flicking the switch on an electric panel oven.

The somewhat trivial examples above show some contours of how 'energy cultures' might be of interest to students of innovation in renewable energy. They also serve as explicit reminders of a general point often stressed by scholars in ANT; that the traditional focus on the production side in innovation studies should be expanded, as the network of actors and actants tied to an artefact is never asymmetrically found only on the production side (e.g. Geels 2004; Miettinen 1999). This means that the linear approach to innovation must be left behind. This insight also raises serious challenges for innovation systems thinking, where we have seen that the practical implications are often quite similar to those of the linear approach. The non-duality of producers and users might provide us with a route towards expanding the innovation concept, in such a way that it also accounts for the countless possible agencies of an energy culture, and their link to the practice of innovation. I will return to this in more detail later. If we relate the examples above to the three levels of the MLP approach: niche, regime and landscape, the energy cultures approach is not limited to the study of either one of these, but sweeps across them. In my account of the Norwegian and Swedish energy cultures, we will not see much of what MLP would dub the niche level, but rather see a blend of what can be characterized as landscape and regime.

In light of the illustrations above, my basic argument is simple: innovation in bioenergy and other new renewable energy technologies are practices which are embedded in energy cultures consisting of materiality, norms and practices. Successful innovators will not only have to make their technologies work in a way they themselves find satisfactory. They have to situate new technologies in relation to existing materiality, practices and norms. This implies changing the energy culture materially, practically, and normatively and it is in this light that expanding the innovation concept to include the 'anatomy' of innovation is important. First, because we might lose sight of practice if we only stick to the study of topography, and second since there may be elements in the energy culture which would remain blind-spotted through topographic studies.

How can we then begin to understand the possibilities for changing an energy culture? One way to study change, or the possibilities of change goes through the study of the dynamics that are in play when change appears difficult, when practices and behaviors are stable and entrenched. In their framework for studying energy culture, Stephenson and her colleagues (2010) argue that stability emerges through alignment between material culture,

energy practices and cognitive norms. Such alignment could lead to 'self-reinforcing dynamics' (p. 6125) which are similar to what is often described as path dependency, where positive returns associated with one set of practices: "yields effects which pre-dispose the organisation to do at least some things in the same way the next time around" (Coombs and Hull 1998, 247).

In the following I will move from the abstract idea of 'energy cultures' to a more descriptive comparison of the Norwegian and Swedish energy cultures. The goal is that this might inform us about the reality faced by innovators in these contexts and that this endeavor can pave a way towards our theoretical quest to expand the innovation concept (or grasping the anatomy of innovation) and the empirical goal of better understanding the innovation practices of the Norwegian and the Swedish bioenergy actors.

The Norwegian energy culture: a culture of export and economic rationality

The differences between the Norwegian and Swedish energy cultures are arguably largest in terms of materiality. This is reflected in the way energy is produced, consumed and shaped through policy in the two countries. In the Norwegian case, the materiality of the energy culture is tightly linked to the topography of the country and to the available natural resources. This is particularly visible on the production side where Norway's many waterfalls have secured rich access to hydroelectricity. From 1905 up to 1990 Norway's hydroelectric capacity was steadily expanded, resulting in a close to complete dominance on behalf of hydroelectricity today. In 2009, the total production of electrical power in Norway was 131 733 GWh. More than 126 000 of these were produced hydroelectrically (SSB 2011c). Hydroelectricity has shaped Norway both socially and materially. The energy from some of Europe's largest electricity generation works located far outside the country's urban centers supported the rise of internationally competitive energy intensive industries such as aluminum processing plants. Thus, hydroelectricity has been described as vital to the Norwegian national innovation system (Wicken 2009).

Others have highlighted the cultural significance of the hydroelectric infrastructure. Knut Holtan Sørensen, for example writes that "Hydroelectricity came to symbolize light, heat, cleanliness, work and economic growth" (Sørensen 2007b, 10)[8] and further, that hydroelectricity has become a Norwegian 'gold standard' of energy production. Hydropower allows for the large scale generation of electricity cheaply, produces cheap electricity for the

[8] Originally written in Norwegian, my translation.

consumer and is of little aesthetic disturbance, located 'out of sight' for most consumers. Further, hydropower is compatible with the current challenges of climate change since it produces near zero CO_2 and is considered to be 'green' by default. With this as a backdrop it should come as no surprise that hydropower is overwhelmingly positively viewed by the Norwegian public: more than 91 percent reported positive attitudes towards it in a recent survey, something which was only matched by solar power, an energy source hardly used in Norway (Karlstrøm 2010).

In sum, historically hydropower appears to be the single most important trait of the Norwegian material energy culture. However, over the last decades two notable exceptions have emerged: oil and gas. Since the so-called Norwegian oil and gas adventure began in the mid 1960's Norwegian wealth, policy, and identity has been heavily linked to Norway's production and export of oil and natural gas from the North Sea (see e.g. Tamnes 1997, particularly chapter 4). Since then, Norway has developed a series of quite robust industries associated with oil and gas. Today, these industries are described as a 'backbone' of the Norwegian national innovation system, as well as a vital political instrument for both job creation and economic policy (Engen 2009).

The Norwegian abundance of energy, through hydroelectricity and petroleum has arguably also been very formative for another cornerstone of the materiality of the Norwegian energy culture, namely the broad lines of Norwegian energy policy (Sørensen 2007a). This comes across, for instance, in the way that Norwegian White Papers in the 1970s and 1980s never considered a matter such as energy savings to be an end in itself. Instead, Norwegian policies have sought to "improve the profitability of the production and use of energy" (Ryghaug and Sørensen 2009, 985). In other words, Norwegian energy endeavors have always strived to be directly profitable. This is clearly visible in the domestic efforts related to hydropower, and in the oil exporting efforts of the country (see e.g. Hanson, Kasa, and Wicken 2011). In practical terms this means that when one energy carrier is to substitute another, the cost is expected to drop. When energy of lower quality is to be introduced, it is at worst expected to keep the costs at current levels (Ryghaug and Sørensen 2009). As a result, subsidies have never been a particularly relevant policy tool in the Norwegian setting. One could perhaps expect this to change as renewable energy technologies became more tightly linked to the climate change discourse. However, this has not happened: the Norwegian mantra has been to promote new renewable energy technologies through a focus on cost-efficiency and neutrality of technology choice (Hanson 2011). In other words, Norwegian energy policies have been rooted in quite strict ideals of economic rationality, dubbed by

Ryghaug and Sørensen (2009, 985) as 'the iron cage of economics'. This strict economic rationality, combined with the quest to remain a strong export oriented energy nation is also echoed in much of the current rhetoric around the role renewable energy technologies might have in the future of Norway. For instance, with the EU renewable energy directive as a backdrop, many have called for a massive up-scaling of Norway's renewable energy efforts, not necessarily to cater for Norwegian energy needs, but to take the potentially very lucrative role as a future 'green battery of Europe' (e.g. Gullberg 2011). In sum the image above shows that materially Norway is first and foremost geared towards energy export and economic profit, whereas for most other countries energy security is comparatively of greater concern.

The material elements on the production side of the Norwegian energy culture have impacted Norwegian households and industry materially, and it has also catered for the emergence of a set of cognitive norms leading to high levels of energy consumption. In sum, this can be dubbed the Norwegian 'comfort culture' (Aune 2007; Aune, Ryghaug, and Godbolt 2011). On the one hand, hydroelectricity produces an abundance of cheap electricity, on the other hand oil and gas provides unprecedented wealth.

The comfort culture can be described materially by a considerable increase in in household size since 1980 (Bøeng and Larsen 2008), and an increased household consumption capacity (see e.g. Hille, Aall, and Klepp 2007, for an example related to furniture sales). As Thomas Berker and Helen Gansmo (2010, 136) note: "Norwegians own more things than ever before, which they store in ever larger homes". At this point it should come as no surprise that most energy consumed in these homes is hydroelectricity. Households are largely heated by panel ovens and electric floor cables, stoves and hot water is also heated electrically. The exception lies in the fireplace that many households have installed, which is fuelled by bioenergy in its most traditional form: firewood. However, firewood is: "used by many first and foremost for the pleasant atmosphere, and only secondarily for heat" (Bøeng et al. 2011, 97).[9]

The material comfort culture is backed up by a set of expectations and norms. Margrethe Aune (1998, 2007) has highlighted that most norms affecting Norwegian energy consumption is associated with comfort, or more specifically the Norwegian notion of 'coziness'. However, her studies also indicate that there is a potential conflict of norms between 'comfort norms' on the one hand and 'environmental norms' on the other.

[9] Originally written in Norwegian, my translation.

Subsequent work supports this. Næss and Ryghaug (2007), for example, explicitly refers to the Norwegian energy culture as a 'comfort culture' where 'the good life' is associated with high levels of energy consumption. Thomas Berker and Helen Gansmo (2010) illustrates this explicitly with respect to the bathroom as an example, while Aune and Berker (2007) suggest that the 'comfort culture' is also relevant in the context of the workplace. When this culture collides with environmental norms anchored in climate change, the practices of the comfort culture do not appear to change. Rather, an element of guilt is introduced at the individual level (see also Aune, Ryghaug, and Godbolt 2011; Næss and Ryghaug 2007). Thus, comfort trumps environmental concern as a norm influencing energy consumption.

The materiality and norms described above are accompanied by highly energy intensive practices, both in households and industry. Timo Myllyntaus (1995), for example, notes that Norway is the most 'electricity intensive' nation of all the OECD countries. Industry, however, has actually reduced their energy use substantially over the last years. This is partly due to more effective energy use, in other words changed practices and technologies, but much can also be attributed to a number of factories and processing plants being closed down.

For our discussion on bioenergy, it is however interesting to note that in the Norwegian energy culture only one small trace of bioenergy can be seen: the 'cozy' fireplace so treasured by many Norwegians. None the less, the elements I have pointed to constitute the material, normative and practical backdrop for any innovation activity in the Norwegian energy sector, also for the bioenergy entrepreneurs. This means that bioenergy innovators as a minimum need to change the material culture if they are to succeed. But how does the prospect for change in the Norwegian energy culture look today? Are any significant changes, or attempts at changing the energy culture observable, and can these changes inform us about the room for innovation for entrepreneurs in bioenergy and other renewable energy technologies?

Arguably, the most significant recent attempt at changing the materiality of Norwegian energy production is an attempt to stabilize and solidify the energy culture. I am speaking here about Norway's quite intense efforts to realize gas fired power plants with carbon capture and storage (CCS) technology. The large scale employment of this technology would allow Norwegian households to maintain the 'comfort culture', and provide the needed energy to sustain the energy intensive industry. Further, it would represent a merger between the interests of the climate and those vested in petroleum, an area of quite obvious tensions in the

past. In other words, the introduction of gas fired power plants with CCS would mean changing the materiality of energy production, while not disturbing the norms and practices. It would be a technical fix for numerous issues. This makes sense also in an innovation systems perspective, given that the needed competence to execute what the Norwegian prime minister referred to as the 'Norwegian moon landing' is largely found in existing industries closely related to oil and gas. This has led scholars such as Andreas Tjernshaugen (2009) to the conclusion that in the Norwegian case CCS has become a "necessary compromise" which has been embraced with an "unusually strong" political enthusiasm. Similarly, Sjur Kasa (2011) has concluded that the Norwegian 'climate battle' is fought with innovation policy.

In sum, the image of the Norwegian energy culture appears as an energy culture where there are in-fact a number of entrenched practices, or what Stephenson and colleagues (2010) dubbed 'self-reinforcing dynamics'. Historical abundance of energy combined with energy policies based on strict economic rationality and expectations of direct profit, as well as great expected comfort levels suggests that entrant energy technologies have to live up to great expectations with respect to both its technical and economic performance.

The Swedish energy culture: a culture of energy security

Geographically Norway and Sweden are neighbors, but their energy cultures are quite different. For one the Swedish do not have an equivalent to the Norwegian oil and gas industries, but this is not the only dissimilarity. The contrast between the countries is particularly visible if we look at the material culture. As in Norway this has partly to do with topography and available natural resources. Sweden, like Norway, has waterfalls which are used to produce hydroelectricity. However, these resources are not as well distributed throughout Sweden as they are in Norway (Thue 1995). Thus, hydroelectricity never gained the complete dominance that it did in Norway, something which means that Sweden has never been able to benefit from the type of electricity abundance that Norwegians have. A related point raised by Jonas Anshelm (1992) is that the mood of the Swedish opinion concerning further expansions of the Swedish hydroelectric capacity has shifted quite radically. Since the early 1980s, he claims, waterfall conservation has been favored, adding to the difficulties of expanding hydropower in Sweden.

Another separating aspect is that Sweden produces substantial amounts of nuclear power. The Swedish debates concerning nuclear power in the 1950s seem to have been fuelled by a desire to achieve an abundance of energy, 'too cheap to meter'. At the time, a drastic expansion of energy generation capacity was considered a prerequisite for further

growth and modernization. There was a strong belief in scientific and technical progress, and that science would quite soon eliminate the hazards associated with nuclear power (Anshelm 2000). In such a perspective, the Swedes may have thought that they had discovered their own 'gold standard' of energy production when the first commercial reactor was launched in 1965 (Gimstedt 1995). However, the situation would not remain that way for long. During the 1970's the mood of the opinion changed, and in 1980 the Swedes conducted a referendum, deciding that all nuclear reactors should be closed down by 2010, and that the Swedish energy system should undergo a major transition. We know today that the goal of shutting down all nuclear reactors have yet to be fulfilled, but the situation illustrates that expanding Sweden's nuclear capacity further would be a controversial task.

Thirdly, and perhaps most importantly when we have bioenergy as our frame of reference, another major material difference between Sweden and Norway lies in the infrastructure for heat distribution. While Norway predominantly heats its buildings electrically, Sweden has steadily expanded a network of district heating and combined heat and power (CHP) since 1948, when the country's first district heating operation was launched in Karlstad (Westin and Lagergren 2002). In other words, where Norway largely is what we can call a 'mono grid' energy supply nation where (close to) all energy is delivered via electrical cables, Sweden is a 'dual grid' nation with one grid of electrical cables and one grid of pipelines for heat delivery. This is particularly important for Swedish residential households, where roughly one third of all energy consumed comes from district heating (Energimyndigheten 2010, 11). The existence of this infrastructure has been particularly important for the possibility of expanding the Swedish biomass energy capacity. The Swedish energy authorities have statistics for the fuel input in these systems dating back to 1970. At this time they were in all practical terms exclusively fuelled with oil, biomass accounted for 0.3 TWh of the energy input. In 2009, biomass accounted for 42.2 TWh of the energy input in these systems, while fossil fuels (oil and gas) accounted for roughly 5 TWh (Energimyndigheten 2010, see table for figure 30, p 26-27). Given some of the properties of grid based systems such as high investment costs and long lead time (see e.g. Summerton 1992), the existence of this grid in Sweden and its non-existence in Norway[10] should not be underestimated as a material factor enabling or disabling change with increased use of biomass for energy as an outcome. In sum, the Swedish production of energy has historically

[10] Non-existence is an exaggeration when it comes to Norway, but Norwegian district heating is miniscule compared to Sweden. Currently, Norwegian district heating output is 4.3 TWh, (SSB 2011b), in other words, roughly the output of Sweden around 1970.

been much more heterogonous than its Norwegian counterpart. Further, where the Norwegian situation has been characterized by energy richness, self-supply and export, the Swedish situation has been anchored in limitations, and the main focus has been to secure access to energy.

With this in mind we can move to the next major element of the Swedish material energy culture, the broad lines of Swedish energy policies and the political-economic reasoning behind them. Ann-Sofie Kall (2011) highlights that Swedish energy policy has been characterized by an 'energy dilemma'. On the one hand, Sweden had effectively banned expansion of nuclear power and hydroelectricity. Meanwhile, the formulated policies prescribed a transition of the energy system with the outcome being increased use of renewables. However, it has never been clear what this transition would consist of. Kall describes a peculiar situation where on the one hand the goal was to introduce renewable energy sources, while on the other hand, renewable energy sources were distrusted by both politicians and the Swedish industry. Perman (2008) highlights that up until the early 1990s energy policy in Sweden was largely centered on securing energy access to the industry. Could renewable energy really deliver what hydroelectricity, nuclear power and oil had delivered in the past? This backdrop of energy security is, of course, a contrast to the Norwegian situation, where scarcity has not been an issue. The difference between Norway as a nation where energy is to be exported and profitable, and Sweden, where energy is first and foremost a security of supply issue (like it arguably is for most countries) is also visible when it comes to economic reasoning. While Norway has had quite strict demands with respect to economic profitability and technical performance resulting in rhetoric of energy 'economization', the Swedes have explicitly sought to *save* energy as a means in itself. This is one aspect that all parties in an otherwise quite divided Swedish policy field has been able to agree on (Anshelm 2004). A related point is that the need to secure energy has led subsidies in various forms to be a much more viable policy option in Sweden than in Norway. Ragnar Löfstedt (1996), for example, shows that various forms of government subsidies have been vital for many successful producers of bioenergy in the Swedish context.

While the materiality of energy production and policy is quite divergent in Norway and Sweden, there are similarities on the consumption side. The consumption capacity of Swedish households has increased every year since 1995 (SCB 2011), something which is reflected in increased consumption of electrical devices and a general increase in the use of energy for heating, both electricity and district heating (Ek and Söderholm 2010; Energimyndigheten 2010).

As in Norway, this pattern is backed up by a set of norms, but there are somewhat different interpretations of which norms these are. Rita Erickson (1997) suggests that what we see in Sweden is something else than a 'comfort culture'. Rather, she highlights that the Swedish culture is one where high levels of energy consumption is a necessity not to break any social codes. For instance, she notes that the Swedes quite strict housekeeping standards leads to high electricity consumption, that perceived health benefits result in both high indoor temperatures and excessive ventilation and that a strict sense of punctuality results in excessive use of cars or other energy intensive modes of transportation. Kajsa Ellegård (2004) on the other hand suggests that Swedish norms are anchored in a culture of 'freedom', strongly resembling the Norwegian comfort culture. Regardless of which interpretations of Swedish norms are correct the result is the same: high levels of energy consumption.

Potential rival norms in Sweden are similar to those in Norway. Permann (2008) and Hallin (1994) notes that Swedish households have been quite prone to change their energy systems, particularly in response to high prices, suggesting that price sensitivity may compete with the need for comfort. Further, environmental norms have been characterized as quite strong in Sweden (e.g. Wiidegren 1998), but it is unclear how this affects energy choices.

What does all of this tell us about the room for bioenergy innovators in Sweden? Have there been any significant changes in the Swedish energy culture in recent times, perhaps echoing the Norwegian effort to introduce gas fired power plants with CCS, and if so; how can they inform us about the possibilities for renewable energy innovators? The answer to this question is probably best found if we look at an economic downturn experienced in Sweden during the early 1990s. It was in response to this crisis that the Swedish social democratic party formulated their policies to transform Sweden in a more sustainable direction, first and foremost to 're-start the economic wheels' (Anshelm 1995; Perman 2008). The sentiment at the time was that if Sweden invested heavily in such a transition they could create somewhere between 150 000-200 000 new jobs, which in turn would help the economy get back on track. A few years later, the Swedish Prime Minister Göran Persson formulated his by now famous ideas about 'the green welfare state' (det gröna folkhemet), where renewable energy sources would be integral. Thus, renewables emerged strongly as a technical fix not only for the environment, but for the economy in Sweden, perhaps acting as a forerunner to the current ideas about a 'green new deal'. At the time, the political confidence was greatest in bioenergy, while wind, solar power etc. were considered as options laying farther into the future (Kall and Widén 2007). In other words there was a strong link between policies for sustainability, economic growth and energy security which from this time all favored biomass energy

solutions. From this point in time it appears as if bioenergy had solved the Swedish 'energy dilemma' emerging as what Kall described as a politically 'harmonizing' technology (Kall 2011).

In sum we now see the contours of two distinct energy cultures, which differ across several mainly material dimensions. Norway is largely a self-supplied and energy exporting nation, with its logic anchored in 'the iron cage of economics', suggesting that energy production should always be economically profitable. Sweden, is an energy importing nation that focus on energy security. Norway produces close to all its electricity hydroelectrically, while Sweden has a mixed system where nuclear power, hydroelectricity and fossil fuels have all been important. Where Sweden is a 'dual grid' energy supply nation where centrally distributed heat is an important energy carrier, Norway is a 'mono-grid' nation, where heat is a product of electricity. Further, we have seen how the major new material development in Norway has been the efforts to realize gas-fired power plants with CCS, while the Swedish effort has been manifested through a move towards increased use of renewables, particularly bioenergy.

It is quite likely that the situation described above has implications for bioenergy innovators. Our look at the energy cultures of Norway and Sweden illustrates that Norwegian and Swedish innovators in bioenergy presently work under different conditions, and that the technology and fuels are faced with a different set of expectations regarding what they should deliver in questions related to economy, energy security, etc. One may say that the innovation practice in the two countries is embedded in different settings. However, many of the central elements in the Norwegian and Swedish energy cultures would probably have been missed if we had only considered them in an innovation systems perspective. In this thesis, as already suggested I aim to re-frame innovation and to expand it in such a way that the specific energy-cultural traits of Norway and Sweden are accounted for, while keeping a focus on practice. In other words I want to explore the relational practice-based links between the various elements of the energy cultures; what do they 'do' in relation to specific innovation endeavors and what the innovation endeavors do in relation to the energy culture? In sum this amounts to an interest in the practice of innovation and the socialization of technology. Consequently it is relevant to ask how we can theorize around such an expanded innovation concept?

The practice of innovation and socialization of technology

It is clear that moving from the study of systems, or topography to the study of practice, or anatomy requires an alternative analytical approach. We have seen that the strength of the systems approach is the study of aggregates. This does not mean that there is no 'relational practice' in systems, but that relational practice tends to be reduced to some standardized measure, and then aggregated to be able to say something about the impact of this specific measure on the innovation performance of the system as a whole. One way that such relational practice can be reduced is for example through a term such as 'social capital' which might serve as a measure for how to capitalize on the 'sum' of relational practices in a given network or system. Phillip Cook writes: "[S]ocial capital is the key element of the hidden power of networks, both social and institutional, that has always been at the heart of the regional innovation systems approach." (2008, 42)

However, I am somewhat uneasy about this quite drastic reduction of content primarily because we might miss out on what is really going on. Further, what type of reduction would do justice to the differences between the Norwegian and Swedish energy cultures and the way that the 'sum' of relational practice in these cultures affects innovation performance? As an alternative route to the study of practice, relationships and technological socialization I suggest that we go via Actor-Network Theory (ANT). How can ANT contribute to the study of innovation, and help us expand or re-frame the innovation concept in such a way that we come closer to an understanding of the anatomy of innovation? More specifically, how can ANT as a practice-based perspective be coupled with the notion of socialization of technology? While maintaining a focus on the localized practice of innovators, I hope that this will allow us to explore the relationships between the individual innovation processes and the various collectives they are part of.

One of the cornerstones of ANT is that it conveys a non-dualistic account of the relationship between 'technology' and 'society'. In this sense, ANT is a form of relational materialism which sets it apart from most other social scientific modes of thought (e.g. Law 1992; Law and Mol 1995). Bruno Latour makes this point explicit in '*Reassembling the Social*' (2005) where he highlights that ANT should be considered a 'sociology of associations' as opposed to the standard 'sociology of the social'. The point is that a quest to reveal 'hidden' social forces as social-structural explanations is a fundamentally reductionist project (social capital as an explaining force in innovation systems would be an example of such a case). Rather than a search for social structures with hidden power, ANT promotes observing actions and effects. In other words ANT encourages us to study the way that the

practice of actors is related and what such practices 'do'. As suggested by the notion of relational materialism, agency is not an exclusively human property in ANT; on the contrary agency might be carried by all sorts of objects. ANT scholars use the term 'actants' to get this point across. A human might be an actor, but a piece of wood may also carry agency, generate effects and create relations. When it does it is an actant. An actor-network, then, is a network that cannot be reduced to 'the network' or 'the actors', it is the sum of associations between a set of humans and non-humans which may be stable for some time (e.g. Callon 1987).

I see ANT as a particularly fruitful tool for the study of innovation, first and foremost because it explicitly takes into account the 'social' qualities of technology. It acknowledges that innovation is a complex practice; the making of hybrids and something which is manifest through a thorough account of the practice based strategies of actors struggling to bring about socio-technical change. Michel Callon's (1987) observation about innovating engineers having to be just as much 'sociologists' as they have to be engineers to be successful in their endeavors is a good example. Second, the notion that non-humans carry agency and form relations explicitly allows us to account for the 'socialization' of technology, which I will return to shortly. Thirdly, ANT is explicitly concerned with the study of change, so much that Bruno Latour actually contemplates 'sociology of innovation' as an alternative name for ANT (2005, 9). Graham Harman (2009) points out that this is an underlying theme of Latour's metaphysics: the world is never the same from one moment to the next; it is constantly created and re-created. Therefore, in my view, ANT is particularly useful in cases where the normative idea that there should be change has already been formulated so clearly, as in the current discourse of renewable energy technologies.

For our discussion, the key message to take away from this is the focus on action and effects, in other words practice; what the innovators do, and the fact that agency is relational and can move in multiple directions. This allows for the movement away from the study of 'topography' and into the study of 'anatomy' and 'socialization of technology'. The latter implies socialization of technology in to something. Given my earlier discussion in this chapter, it is tempting to suggest that this 'something' is the Norwegian and Swedish energy culture. In relation to ANT, this might appear as somewhat of a double-edged sword, because 'energy cultures' could be read as an example of the 'hidden' social forces so heavily frowned upon by ANT.

To loosen this potential knot, I will borrow Latour's notion of 'preformatted fields' or formatted settings. The idea of formatted fields can be read as an attempt by ANT to bridge the gap between the observation that individual actors do not necessarily begin 'from scratch',

that something larger than the actors can actually be there; assemblages which although they are fleeting, may have some sort of stability that feed into the practice of other actors. However, the formatted settings are not supposed to be seen as potential causal explanations for action. To use some overtly stereotypic examples: someone does not drink plastic bottled beer because of their working class heritage. Similarly, someone does not prefer Beethoven over AC/DC because of their bourgeoisie affiliation. Such notions of 'class' would according to Latour probably consist of a set of competences, an available 'short cut' or a repertoire of 'ready-made' modes of action which can be 'downloaded' by individual actors. If this mode of thought is applied to class affiliation, the working class plastic beer bottle drinker would most likely be explained by the fact that this actor, in his sphere has access to a set of competences which can be quite easily downloaded through the various actors and actants constituting the sphere, and presumably – plastic bottle beer drinking is one such mode of action. In this way, Latour's notion of a formatted field is not entirely different from what John Law (1992) highlights when he says that 'structure' might still be a fruitful term if it is applied as a verb rather than as a noun. Another example provided by Latour of a formatted field or setting is the supermarket, an assemblage which can quite clearly format the action of the shoppers:

> "Even when one has to make the mundane decision about which kind of ham to choose, you benefit from dozens of measurement instruments that equip you to become a consumer – from labels, trademarks, barcodes, weight, and measurement chains, indexes, prices, consumer journals, conversations with fellow shoppers, advertisements, and so on" (Latour 2005, 210)

In other words, from taking part in a broader collective – the supermarket, the shopper gains access to a range of potential modes of action which are distinct for shoppers.

Let us now return to the notion of socialization of technology. Now that we have established that technologies can carry agency and that they are relational, accepting 'socialization' of technology is a small step. 'Socialization' is a term commonly mobilized in what Latour would call the 'sociology of the social', referring to the process where individuals 'find their place' in a broader social context. In their introductory book on sociology, for example, Macionis and Plummer (2005) writes: "Socialization [is a] lifelong experience by which individuals construct their personal biography, assemble daily interactional rules and come to terms with the patterns of their culture" (p. 159). In other words, there is a notion of the individual as embedded in something else, such as a family, a culture or a society. When the idea of socialization is applied to technologies, this is anchored

in the same idea of embeddedness (Bijker and d'Andrea 2009). With the notion of embeddedness, we are still firmly focused on practice, both of actors and actants. As a contrast to the idea of socialization and embeddedness, let us think for a moment about a term such as 'diffusion' which is central to both linear and systemic innovation approaches. The term is commonly mobilized to describe how technologies 'spread' from one realm, such as the hands of the innovator, the laboratory or other similar sites, into the hands of its users. Here, little will change, apart from the fact that 'end-users' will have the new technology. Thus, technologies are non-relational; they simply slip unnoticed into the new setting, exempt from the issues that humans have to deal with. There is no need for technologies to 'find their place'. Instead, the dominant notion seems to have been that once we (the humans) have created the technology "we can go home" (Latour 2011). As several scholars have highlighted in the past (e.g. Kårstein 2008; Sørensen 2005), such notions of diffusion or non-diffusion and its associated mode of thought underestimates the creative effort involved in innovation processes, and the fact that the success of innovation processes depends just as much on input from the 'end user' side of the equation. Technologies are not diffused into or spread over a passive mass of receptors; the technologies and practices become situated in a setting where politics, culture, humans and non-humans constantly link up and disconnect to co-shape each other in unpredictable ways. In other words new technology or practice may shape its users, but similarly, users of technology shape or domesticate practice and technology. This process does not 'end' at any specific point; as long as the technology is in use it may create new effects, new relations and therefore change the collective(s) it is part of. In this way, understanding the anatomy or practice of innovation is not the same as accounting for an act of creation and a subsequent act of diffusion, it is a matter of making sense of a non-stop, constantly changing socio-technical trajectory.

This suggests that the process of socialization of technology might be shaped in any number of ways, but it is unlikely to look entirely random. Technologies are introduced into settings which can contain a number of pre-formatted fields as discussed earlier. These provide tools and instruments which the humans and non-humans may (or may not) use in their endeavors to successfully establish bioenergy in the Norwegian and Swedish setting. Such tools and instruments might be enabling, or they may be disabling, but we should remember that there is no determinism in this. We do not know how or if the tools will be mobilized, and further, what happens to the tools as the new elements are introduced. What kinds of preformatted competences could we expect to discover in the Swedish and Norwegian setting? In what follows, I want to explore a set of potential fields which may

influence how bioenergy is 'socialized' into the Norwegian and Swedish energy cultures. This discussion will culminate in a number of expectations or loose hypotheses which will be discussed in relation to the four research papers of this thesis

One example of a plausible path for socialization of technology may be found through looking at what several scholars have referred to as the 'Norwegian-making' of the Norwegian petroleum industry (e.g. Kårstein 2008; Nilsen 2001; Sørensen 2005). The main point of this argument is that when Norway found oil and became a petroleum nation, the result was not simply that existing technologies and practices established elsewhere were 'diffused' into an emerging Norwegian industry. Rather, the technologies of the multinational oil companies were not necessarily suited to collect north-sea oil. This paved the way for direct participation in the innovation processes by actors like Norwegian ship owners, shipbuilding yards and oil companies (Sørensen 2005, 10). Another point is that the new industry and technology was met with a set of quite specific expectations with respect to properties such as risk and workers welfare, which was unheard of for instance in the American oil industry. This resulted in a co-shaping of the entrant technologies, the emerging industry and the broader Norwegian discourse and in turn novel forms of organization and technological change in the petroleum industry that were distinctly 'Norwegian' in character. This was also a step towards protecting Norwegian commercial interests. As the historian Francis Sejersted describes it: "[T]he oil activity was expected to be integrated in the Norwegian society, it was supposed to sprinkle society, and create wealth and welfare everywhere"[11] (Sejersted 1999, 25). The Norwegian-making of the petroleum industry serves as an example of how the sterile notion of 'diffusion' is misleading. For our discussion on innovation and renewable energy, the point is not this particular story of the relationship between petroleum technology and Norway, but that competences and tools resting in the Swedish or Norwegian energy cultures might format innovation in such a way that 'Norwegian-making' or 'Swedish-making' of technology becomes a result. Thus, my first expectation is to encounter socialization of bioenergy as 'Norwegian-making' or 'Swedish-making'.

Judging from the accounts of the energy cultures, 'Norwegian-making' will most likely concern adjustment with respect to technical and economic efficiency, but it may also emerge as an issue related to how the Norwegian public views bioenergy compared to other energy technologies. 'Swedish-making', on the other hand, is likely to revolve around

[11] Originally written in Norwegian, my translation

adjustment in terms of meeting the needs related to security of energy supply. Expectations about 'Norwegian-making' or 'Swedish-making' could be communicated through multiple channels, e.g. via the public, the media or political actors.

The second mode of socialization I expect to see is related to politics, and how political processes feed into the process of socialization of technology. What types of competences or tools are distributed through the Swedish and Norwegian energy policies, and do they help or hinder the successful socialization of bioenergy? In Sweden we have seen how bioenergy moved from being somewhat of a political outcast, grouped together with a cluster of distrusted renewable energy sources, up to the point where it was warmly embraced by most political actors as what Ann-Sofie Kall dubbed 'a politically harmonizing technology'. In Norway, bioenergy has not been at the forefront of the political agenda. It has been overshadowed by competing energy technologies. The question is: can we see the traces of politics as a pre-formatting field in the two settings?

Thirdly, I expect to see a form of socialization of technology which is explicitly related to climate change and the issue of sustainability more broadly. This is another issue that might appear quite different in the two countries. In Norway, hydropower has ensured an energy provision which is 100 percent renewable.[12] Thus, the societal 'pull' to introduce more 'green' power has probably not been as strong in Norway as in Sweden. The Swedish energy provision, on the other hand, has been more troubled in terms of quarrels over sustainability. Nuclear power has its obvious issues as far as waste storage goes, whereas coal and oil is related to other environmental challenges. Thus, 'sustainability' might distribute different competences in different settings, perhaps partly because 'sustainability' as a concept has undergone a process of 'Norwegian-making' or 'Swedish-making' in itself.

Before we move on to a synthesis of the four research papers of this thesis, let us quickly recap the line of argument presented in this introductory chapter. My point of departure was that bioenergy has emerged as a 'technical fix' for several problems. In Norway it has been a technical fix related to the climate issue, whereas in Sweden bioenergy has been tightly linked to climate change mitigation, securing energy supply, and to a certain extent also as a tool to ensure economic development.

In order to reach a future where the 'fix' is applied, most actors will agree that innovation will be needed. Innovation can be theorized in a number of ways. Today the dominant approach is some variant of the innovation systems approach, where 'innovation

[12] In some recent years Norway has actually been a net-importer of electricity, so today this is not always true. In 2011, however, Norway was quite clearly a net exporter of electricity (SSB 2011a)

infrastructures' at an institutional level is largely considered what determines the innovative capacity of a system. Thus, the dominant innovation studies approach today is mainly concerned with what we can call the 'topography' of innovation. However, through outlining the Norwegian and Swedish energy cultures, I concluded that such a topographic perspective would probably be unable to capture and account for the kinds of practices that I set out to study. Thus, I have argued that the innovation concept should be expanded or re-framed, and that a viable route could be to move from the study of topography to the study of anatomy, in other words the study of embedded relational practice and socialization of technology. Finally, I have suggested that we can understand the paths of socialization of technology through mobilizing the notion of pre-formatted fields or settings which may distribute 'ready-made' modes of action and competence through various forms of tools.

In the following I will tell a quite broadly synthesized story about how the four research papers of this thesis can illuminate such matters. In what way are the research papers suited to help us re-frame and expand the innovation concept towards the anatomy of innovation? Further, what can the papers tell us about the way that technology is socialized into the Norwegian and Swedish energy cultures, and about the practices which underpin this socialization? Further: how does the innovation practice become formatted in these settings? I have expected to see formatting in the form of 'Norwegian-making' and 'Swedish-making'. But how do such processes occur for bioenergy, and how are the processes made sense of? Further, I have expected that political reasoning might format innovation practice. Will the differences between Swedish and Norwegian policies be manifest in the practice of the innovators? Finally, I have expected to find that innovation practice will be formatted by ideas anchored in sustainability and 'climate neutrality'. How might the tools and competences provided by such terms feed into innovation?

Three dimensions of socialization of technology

Through a re-reading of the four research papers of this thesis it is possible to outline three modes, or three dimensions of socialization of technology which becomes visible when we move from studying the topography of innovation to the anatomy of innovation. These can be described as three dimensions of socialization of technology. The three dimensions are socialization of technology through: a) Framing; b) Embedding and c) Practice. These dimensions are not mutually exclusive, and in a successful process of socialization of technology we can most likely observe all three dimensions. In what follows I will account for the three dimensions, as they emerge from the re-reading of the research papers, in relation

to the Norwegian and Swedish energy cultures and the earlier formulated expectations about the formatting of bioenergy innovation practice.

The first dimension of socialization of technology: the framing of technology

In this context framing of technology has to do with meaning making: the way technology is understood or made sense of in relation to a set of issues for example norms, policies etc. Here, framing is particularly visible in relation to my expectation about sustainability or environmental friendliness as a pre-formatting field for bioenergy innovation. Specifically this means that the 'image' of bioenergy in relation to matters such as climate changes and other environmental issues becomes important in relation to innovation. This means that if bioenergy is to become a successful technical fix for the climate change issue it must have been established as a 'green', 'sustainable' technology.

Following this, it is pertinent to ask how notions such as 'greenness' or 'sustainability' feed into the practice or the anatomy of innovation? As we saw in Sweden, sustainability as an idea has been nicely aligned with the country's social, economic and energy policies. In other words, the issue of sustainability not only feeds into the practice of innovation, but may also be a source of formatting of the practice of policy production. In all research papers of this thesis sustainability as a pre-formatting field is visible. In paper 1, 'Organic innovation', the bioenergy industry highlights that the sustainability and climate friendliness of bioenergy is what makes it relevant to try to socialize bioenergy into the Norwegian collective at all. Here, the sustainability of bioenergy is a firmly established and non-negotiable fact, something which is not surprising given that we hear the voices of the bioenergy industry. In paper 2, 'Curb your enthusiasm' which analyzes Norwegian and Swedish newspaper coverage of bioenergy we see some of the same. While there are clear differences between the news media coverage of the two countries, bioenergy is framed as a 'green' alternative in both cases. In Norway, the green framing of bioenergy is countered by competing images: bioenergy as technically and economically inferior compared to competing energy technologies like hydropower and gas fired power plants with CCS. Thus, the sentiment seems to be that if it were not for the climate issue, trying to socialize bioenergy into the Norwegian energy culture would have been close to pointless. In other words, the paper highlights that while there are visible pre-formattings which mainly hinders socialization of bioenergy, the idea of sustainability is a constant source of helpful tools and equipment. In Sweden, the sustainability or greenness of bioenergy is much more closely aligned with a

series of other positively charged images than the case is in Norway. 'Sustainability' feeds into the framing of Swedish consumers as progressive and forward thinking, as well as into a framing of Sweden as a leader in the field of environmentally friendly technology. Paper 3, 'Publics in the pipeline' portrays the same Swedish image where 'greenness' of bioenergy is considered a substantial help to the innovators in the process of technology socialization.

On the other hand, 'Publics in the pipeline' also exemplifies how the framing of fuels and technologies as 'sustainable' or 'environmentally friendly' is potentially questioned. This is particularly visible in the Norwegian case. While the green component of bioenergy is non-negotiable from an industry perspective, the industry actors highlight that for the Norwegian public, bioenergy as an actant generates mixed reactions as an 'environmental technology'. For instance, we get the impression that parts of the Norwegian environmental movement are opposed to bioenergy for environmental reasons. This discrepancy is worth pondering upon further: on one hand you have an industry and a set of policies which promote bioenergy for the sake of sustainability or climate friendliness. On the other hand, the industry say that it faces opposition from the general 'public' and the environmental movement who highlights that bioenergy is a non-sustainable solution. For one, this emphasizes that socializing technologies, fuels and practices into a collective such as 'the Norwegian' is an extremely heterogeneous task. Further, it suggests that terms such as 'sustainable' and 'climate friendly' are in themselves relational and practice based, and consequently negotiable within a given collective. This echoes the warnings of Shove and Walker (2007) about the volatility of categories such as 'sustainable', and introduces another set of complex issues to be tackled for those attempting to socialize new socio-technical solutions into a collective; namely that of democracy. The framing of technology is one thing, but how should we deal with competing images and framings?

In paper 4, 'What we disagree about when we disagree about sustainability' such dynamics are studied explicitly with respect to two sources of energy: bioenergy from Norwegian forests and peat. My inspiration for this study was found in Sweden, where the issue of peat emerged as a tangential theme in several interviews. Many found it odd that peat had obtained a status as semi-sustainable ('slowly renewable') in Sweden, and I could sense a sort of embarrassment about the fact that Sweden, alongside a few other nations were lobbying in the EU system for peat to gain a status as a 'renewable' or a 'climate neutral' source of energy. While I found the discussions over peat slightly odd due to its marginal status as a fuel, I saw clear parallels in a debate which raged in the Norwegian newspaper Klassekampen and on the internet research portal forskning.no. The center of attention here

was bioenergy, and the issue at stake was whether or not it could be considered 'climate neutral'. Scientists, foresters, politicians and environmental organizations were involved. The debate illustrated that there existed a divergence in opinion concerning how bioenergy should be treated. In some circles it was socialized as a fully integrated part of the 'solution' to the climate issue, among others bioenergy was considered worse than coal. While sustainability as a concept has been an important source of formatting enabling the distribution of tools to innovators and policy makers, debates such as this put into question the robustness of sustainability as a pre-formatting field. A worst-case scenario (for the bioenergy industry) could be the disconnection between sustainability as a term and bioenergy, a de-assembly which would de-legitimize bioenergy as a 'technical fix'. The paper serves as a movement towards expanding the innovation concept and illuminates the anatomy of innovation by highlighting the practice not only of creating technology, but also the practice of attributing meaning to technologies, the making of their status and image, and that these are essential parts of the process of socialization of technology. A topographic perspective would have been unable to account for the way these forms of agency co-influence the fate of bioenergy in a given collective.

A similar dynamic can observed in Paper 2, 'Curb your enthusiasm', in the mainstream newspaper stories that dealt with what I have called 'global story-lines'. Here, the positive connotations that bioenergy provided in terms of 'greenness' and 'sustainability', in both Sweden and Norway were reversed, as bioenergy moved from being a 'green source' of energy, to representing first and foremost a danger for all the starving children of the world. In a way this might represent the ultimate challenge of socialization in our globalized setting: the potential collectives that need to be conquered and brought on board are countless, and new collectives can emerge from the left field at any given moment. This also serves to highlight the continuous character of the process of socialization of technology. While a topographic study would be over once the technology was successfully diffused into the hands of 'end-users', the anatomic perspective clearly shows this not to be the case. Here, bioenergy was seemingly successfully socialized on many levels, but the emergence of a new framing, a new image, a new way of interpreting what bioenergy 'was' threatened this status. This is a reminder that the process of socialization of technology does not stop. As we will see later, such dynamics of continuous socialization can be a source of innovation opportunity, but in this case it led to a backlash as the imagery of climate change mitigation was replaced with the imagery of starvation. For some these dynamics are good news, for others they are bad

news, but the mutual lesson is one of both stability and change: the work is never finished, it always continues in some form or another.

The second dimension of socialization of technology: the embedding of technology

The second mode or dimension of socialization of technology deals with the embedding of technology. By embedding of technology I mean the way that (new) technologies become situated in a given collective, the way technologies relationally are 'placed' in a new setting packed with pre-existing materiality, norms, practices etc, and the ways that this collective and the new technology co-shape each other. There is a clear relationship between the framing and embedding of technologies; how a technology is perceived is likely to affect how the technology becomes embedded in the new collective and vice versa. In this thesis, the embedding of technology is visible first and foremost through my expectations about the formatting of bioenergy innovation practice through processes of 'Norwegian-making' or 'Swedish-making' and my expectations about formatting through policy.

'Norwegian-making' or 'Swedish-making' as a source of formatting and embedding of technology is perhaps most clearly visible in paper 2, 'Curb your enthusiasm' and paper 3, 'Publics in the pipeline'. These papers can be read in relation to each other. 'Curb your enthusiasm' provides an account of how Norwegian and Swedish mainstream newspapers cover bioenergy, while 'Publics in the pipeline' deals with how the bioenergy industry actors make sense of their publics and navigate in relation to the publics. As such, the papers can also be read as direct efforts to expand the innovation concept. First, because Curb your enthusiasm look at factors which have usually been ignored in innovation studies. Further, because the paper highlights how 'the media', a seemingly exogenous variable in relation to innovation and diffusion, plays a role in technological socialization. Finally, Publics in the pipeline points to 'the public' as a crucial actant in the process of socialization of technology.

In 'Curb your enthusiasm' a clear difference in the coverage of bioenergy is observed between Norwegian and Swedish newspapers. As I have highlighted earlier this partly has to do with the framing and the establishment of an image of what bioenergy 'is' in relation to a number of other actants. However, the difference between Norway and Sweden also points to different expectations with respect to embedding: the role an energy technology should have in the Norwegian and Swedish collectives. Bioenergy is reported on through local, national and global story-lines, which can be read as expressions of pre-formatted fields distributing expectations to energy technologies. In Norway, both local and national story-lines can be

read as calls for ‘Norwegian-making’, or alternatively as stories about how bioenergy fails to meet the criteria of ‘Norwegian-made’ energy technology. These stories compare bioenergy to the merits of other energy technologies, particularly with respect to qualities such as economic and technical efficiency. Thus, the Norwegian energy culture distributes various competences and expectations, which are here expressed through the media coverage. This formatting highlights how energy production should be directly profitable and cater for the needs of the energy intensive industry, something which represents a challenge, or a barrier to the successful socialization of bioenergy in the Norwegian context. In one example from this paper, bioenergy was simply characterized as ‘not suited’ to meet the Norwegian energy challenges, especially compared to alternatives like gas fired power plants with CCS or hydropower. Hence, my expectations about formatting anchored in ‘Norwegian-making’ were quite clearly met, and the tools distributed through this field stand out as one of the most visible barriers or challenges for innovators who seek to socialize bioenergy into various Norwegian collectives.

The pressure to ‘Norwegian-make’ can also be recognized in ‘Publics in the pipeline’. This paper studies how actors in and around the Norwegian and Swedish bioenergy industry perceives their publics; how their publics are imagined. The argument of the paper is that such imagined publics are actants, producing real effects and relations. There is probably some sort of co-production at work here, something which was also highlighted by several interviewees. These interviewees’ ideas about ‘the public’ were in part informed by media coverage. Thus, the media comes across as a central channel for distribution of competence, not only for the bioenergy actors, but also for ‘the public’. This obviously complicates accounts of agency and effects in questions about socialization of technology and highlights how close-up studies of the anatomy of innovation may cast light on other processes than those normally highlighted in topographic innovation studies. Such studies of the media also points to the close relationship between framing and embedding as processes of socialization of technology.

One way to interpret the ideas the bioenergy actors have about ‘the public’ is that they represent expectations about effects generated by media coverage. In Norway, many industry actors expressed how they could ‘sense’ public opposition towards their technological solutions, in part because of public expectations about what an energy technology should be, and the ways in which the public was used to having their energy produced. Thus, the public might be another actor, a part of the collective communicating the expectations anchored in ideals of a ‘Norwegian-made’ pre-formatting, which in turn is a challenge for those seeking to socialize bioenergy in to the Norwegian setting.

The signs of 'Swedish-making' in 'Curb your enthusiasm' take a different form than what I had expected. The Swedish newspapers provide a more flattering image of bioenergy than the Norwegian. However, the coverage does not appear formatted by a Swedish energy culture anchored in a quest for energy security. Instead, much coverage is actually related to the prospects of Sweden profiting by building this industry. This is somewhat surprising since I earlier portrayed Sweden as characterized by an energy culture where energy security achieved partly through import, has been a cornerstone. When it comes to certain bioenergy technologies, however, Sweden has knowledge and competence that others seek. This represents a break with the dominant strands of the Swedish energy culture. Perhaps the Swedish mastery of bioenergy has opened the door to a new confidence where 'energy security' is no longer enough, but where exports – both of knowhow and technology have become viable and desirable options? This interpretation clearly shows the relatively active role of technological actants in transforming the collective they become part of. From being socialized and embedded in the Swedish setting first as a 'solution' to the Swedish energy dilemma, bioenergy has created a number of new and highly fruitful links and collectives, and now emerges not only as a means to secure domestic energy supply, but is at the center stage of a possible industrial adventure. Here we have arrived at one of the core insights which may be achieved through studying the anatomy of innovation; the socialization of technology does not end when the technology is safely 'in the hands of the users'. As Latour (2011) has pointed out, we cannot 'go home' and leave the technology to itself. The socio-technical trajectory continues, with new connections and disconnections constantly being made. Just like humans are never 'done' socializing, the same is true for technologies. This insight would probably have been missed in a topographic study of institutional stimuli and resulting innovation performance at a systemic level, where the process would have been considered as over once the technology has reached the desired 'diffusion rate'.

A similar confidence on behalf of many Swedish bioenergy actors is observable in the paper 'Publics in the pipeline' where the Norwegian actors were somewhat uneasy in their relationship with the publics. The Swedish actors on the other hand were confident that the Swedish publics approved of, and in fact – were proud of the Swedish bioenergy development. For one, this might be indicative of a relatively successful socialization process, where the result is an integrated relationship between the actors and actants constituting the socio-technical system of energy production and consumption based on bioenergy. Further, it highlights how the socialization of bioenergy has taken quite radically different paths in Norway and Sweden. If the Swedish bioenergy actors' interpretation of their publics is

correct, this also suggests that 'the public' as a Swedish collective distributes expectations and competences compatible with innovation in bioenergy.

However, 'Publics in the pipeline' also hinted at a prior process of 'Swedish-making', which resembles what I had expected. Here, bioenergy was 'Swedish-made' because it was able to help secure energy supply to Swedish consumers. This image was conveyed via a series of interviewees who highlighted that for the Swedish public bioenergy was 'nothing but energy'. In their view of the public it did not matter that the energy in question was bioenergy, it could just as well have been hydro or nuclear power. As highlighted by one interviewee: "as long as it works, the Swede is quite happy". This suggests that before bioenergy could emerge as a new green business opportunity, it had to be successfully socialized into a context where securing one's own energy needs was the prioritized task. Again, this highlights the complexities and longitudinal qualities of socialization of technology as a non-stop trajectory without a final destination in the hands of end-users. The actors and actants continued to interact in what might turn into a fruitful process of learning, as it appeared to do here. This suggests that the relational practice of actors and actants in socio-technical collectives in itself can be a significant 'driver' of innovation. Here, this appears to have paved the way for further innovation activity on behalf of Sweden as a 'bioenergy user'. This might be thought of as a sort of practice-based momentum, detectable through the study of the anatomy of innovation.

My second expectation was related to politics; the political reasoning in the two countries, and that the innovation practice in the two countries would somehow be formatted by the opportunities and challenges anchored in the ready-made practices, tools and competences found in politics. The place where you might expect to see the political formatting most clearly would perhaps be in the paper 'Curb your enthusiasm', the analysis of the mainstream newspaper coverage of bioenergy. After all, here you have all the heavy hitters of industry, politics and science folded out over several hundred pages. Clearly, there are political messages in the reporting, but in the Norwegian case these are mostly of a quite trivial character. There are numerous examples of industry actors who express dissatisfaction with the current political framework bioenergy operates within. This has, for instance, to do with the perceived lack of government subsidies and state support. This might be interpreted as lack of political 'will' to help bioenergy of course, in other words a lack of proper political formatting and a lack of tool-distribution. However, it might also simply be a vent for general frustration on behalf of the industry actors. In fact, in the Norwegian newspaper reporting, bioenergy comes across as a relatively harmless figure. However, this might actually tell us

something quite important about how the political field formats the opportunities of renewable energy innovation in Norway more broadly. The absence of controversy around bioenergy might signify that the political field does not distribute tools, competences or obstacles of particular relevance to the bioenergy actors. Rather, 'indifference' is probably the most fitting description of the message conveyed. Indifference, however, is certainly also a way of formatting, in the sense that it is definitely not helping. Perhaps these dynamics can be attributed to the fact that bioenergy does not pose any serious threat to the broader lines of the Norwegian energy culture? It is not considered a serious challenger to hydropower, nor does it pose a threat to the petroleum interests. Therefore it does not challenge the power of any significant political players and interests.

This impression is strengthened by the fact that when bioenergy was discussed by the voices of government it was most often represented by the minister of agriculture and food, while the minister of petroleum and energy or the minister of commerce were hardly heard. Similar dynamics will be highlighted later in a discussion of Paper 1, 'Organic innovation' where we will see that bioenergy has been more successfully socialized into the Norwegian collective as an actant which first and foremost have tasks associated with forestry and agriculture as opposed to e.g. petroleum and hydroelectricity; actants with tasks associated with energy production. The same image comes across in paper 4, 'What we disagree about when we disagree about sustainability', a study of (among other things) the way bioenergy is debated in more niche and opinion based newspapers. Here too, if government flags support for bioenergy, this is done through the minister of food and agriculture. As suggested this may hint at bioenergy being quite successfully embedded in some elements of the Norwegian policy realm, such as those primarily concerned with social and welfare policies for the rural areas where forestry and agriculture is important (in Norwegian, 'distriktspolitikk' or 'regionalpolitikk'). This would provide certain tools and a certain set of equipment that would be especially helpful for the kind of community based local bioenergy production that there are several examples of in 'Organic innovation'. On the other hand, the unsuccessful socialization of bioenergy into other policy areas, such as energy policy facilitate hierarchical thinking where bioenergy does not measure up to other energy technologies. This might also shed some light on why large scale energy production based on bioenergy comes across as a difficult endeavor in the Norwegian setting. Thus politics do play a role in the formatting and embedding of the innovation practice in Norway, but largely as a barrier or hindrance, because other energy technologies seem more prioritized.

The fingerprint of Swedish energy policy is less clearly visible in 'Curb your enthusiasm' where bioenergy is first and foremost a market commodity. It is bought and sold; it generates wealth, national feelings of pride and it is 'green'. However, it almost comes across as a non-political actant. This is somewhat surprising, because much literature suggests that political support, particularly in the form of various subsidies have been of tremendous importance to the growth of the industry. This has already been highlighted earlier in this introductory chapter. Pending an economic downturn in the late 1980s and early 1990s the Swedish poured subsidies into renewables, particularly biomass to 're-start the economic wheels' (Anshelm 1995; Kall 20011; Perman 2008). Clearly, this political practice was of importance for the constitution of new socio-technical collectives where bioenergy was important through the provision of tools and competences which have helped the industry. This political practice framed bioenergy not only as being at the core of the climate question, but also gave it an important role in social and economic matters. This process appears to have facilitated the continuously successful socialization of bioenergy in the Swedish collective. Why are there virtually no traces of this political backdrop in the newspaper reporting on bioenergy in the period studied?

My interpretation is that this can be attributed to the kind of socialization and learning process that have already been discussed in relation to 'Swedish-making' of bioenergy. Consider the following scenario. First, the subsidies and economic support mechanisms were essential in an early stage of the socialization process. This was particularly important when the markets for the fuels and technologies associated with bioenergy were small and unstable. As bioenergy became tighter integrated in the Swedish energy culture, or more successfully socialized into the Swedish collective, the nature of the markets changed. The practices became more dis-entangled from and less formatted by Swedish energy policies as I have described them in this introductory chapter. Instead, the nature of the market practice has changed from being pre-formatted by politics, to themselves being pre-formatting fields distributing competence and tools to innovators. This is what we see expressed in the media coverage in the paper 'Curb your enthusiasm'. This interpretation highlights how an actant like bioenergy continues to be active and create effects long after its 'diffusion'. Here it is the quite complex interplay of politics, markets and technology which gradually changes, up to the point where a new formatting field is actually established. This, of course, does not mean that politics today is insignificant; I have no basis to make such a claim, but in the newspaper coverage it is surprisingly marginal.

The third dimension of socialization of technology: the practice of innovation

So far, we have seen how framing and embedding are two central and related dimensions in the process of socialization of technology. We have seen how processes of framing and embedding are practice based and relational, but we have yet to hear much from the prime advocates of bioenergy as a socio-technical solution: the innovators themselves. The third dimension of socialization of technology; practice brings these actors on to the center stage. It should not come as a surprise at this point, that innovation practice is closely related to framing and embedding, and as we shall come to see the practice of innovation often comprise strategies of both framing and embedding.

Paper 1, 'Organic innovation' is the only paper in this thesis which directly deals with the practice of innovation, and it does so in the Norwegian context. This is probably the paper in this thesis which lies closest to the traditional innovation literature. It traces how a series of Norwegian actors struggle to make room for socio-technical solutions based on bioenergy which represents new elements in the collectives they are introduced to. However, the paper diverges from much of the innovation literature since it studies innovation anatomy rather than topography. Therefore the paper is another step towards expanding or re-framing the innovation concept. The paper studies anatomy by looking at innovation practice: what do the industry actors do in their efforts to socialize bioenergy in the Norwegian energy culture? Here, the socialization of the technology resembles what we have earlier seen referred to as 'Norwegian-making', but the 'Norwegian-making' occurs in a different way than we have seen in the Norwegian petroleum industry. The technological solutions are 'Norwegian-made' as actors try to socialize the technology into quite localized settings where the tools and competences for a 'Norwegian-made' formatting are found.

These actors may sell heat to a local school building; make biogas based on local raw materials or produce pellets from a local breed of pine. In fact, the companies are very diverse in character, and the same can be said about the innovation practices they display. 'The Norwegian-making' of bioenergy in these examples concerns how to integrate bioenergy successfully in local collectives, and in turn how such collectives are changed in interaction with the new technology. In this paper there are both success stories and stories where bioenergy is unsuccessfully socialized. In many cases, the tools that enabled successful innovation were found in a combination of pre-existing non-human actants and social practices that were combinable with the new elements introduced by bioenergy. In one example, a group of foresters teamed up to produce wood chips and deliver heat to a local

public school building. Here, a series of pre-existing material factors were essential tools. First, and most obvious, were their ownership of forest, and the strong culture of forestry and agriculture which characterizes this local collective. Forestry and agriculture are struggling sectors in Norway, and when bioenergy emerged as an option, it was through the tools and competences distributed via agricultural and forestry based networks that bioenergy innovation was formatted. In this sense, the introduction of bioenergy did not represent a break with a pattern of the Norwegian energy culture; it represented a way forward and a way to extend another type of trajectory rooted in forestry. This was strengthened by the idea of bioenergy as a sustainable and climate neutral source of energy, something which ensured local political support. On the other hand, the introduction of bioenergy into this trajectory quite clearly transformed the way this culture of forestry and agriculture was performed via new machines, new uses for the forest, new modes of cooperative organization and new commercial practices. As a story about socialization of technology this story has a tentatively 'happy ending', but on a theoretical level it might also serve as a warning about not making too generalized explanations based on a notion such as 'the Norwegian energy culture'. While there may be entrenched practices and lock-ins in such a culture, other equally relevant tools and competences may exist, that might actually enable innovation, in this case through a quite local practice of 'Norwegian-making'.

On the other hand, there are also examples in 'Organic innovation' where the technology socialization process does not have a 'happy ending'. One example is found in an attempt to construct a biogas facility relatively centrally located in a small town. As in the example above, the effort was enabled by a set of pre-existing non-human actors, namely the organic waste streams of several municipalities and the microbial activity within them. Thus, the practices associated with energy generation from biomass were nicely aligned with the practices of waste and sludge handling and treatment. However, establishing an association between the two was not enough to ensure success. The attempted socialization of this technology into the local collective was side tracked by an unexpected effect, namely public opinion, which in this case formed around the concept of 'trash' as opposed to the idea of 'energy'. The public was frightened that a facility producing energy based on trash would attract undesired elements such as vermin and smell. Thus, the facility emerged as a strong actant before its construction, generating all sorts of effects that resulted in an alternative, less central siting of the plant. Here, its socialization was considerably easier. This can be interpreted as a failure to 'Norwegian-make' the biogas facility, which would first and foremost be a facility for waste treatment, and only secondarily an energy production site.

This represents a contrast to the standard mode of energy production in the Norwegian energy culture. It also points to the strong relationship between framing, embedding and practice, and how these three dimensions of socialization of technology should be accounted for in relation to each other.

A central finding in 'Organic innovation' is related to the diversity of innovation practices observed. Different actors pursue a range of strategies in their efforts to socialize the technology into the Norwegian energy culture. In the paper, four ideal typical routes to innovation are suggested: regulation formatted innovation practice, market formatted innovation practice, resource formatted innovation practice and customer formatted innovation practice. As the labels imply, the actors mobilize a range of tools and competences in their endeavors, and it is possible to observe how an internal drive, or will to innovate links up to different types of actants to form new collectives.

At a basic level, the examples of innovation practice in 'Organic innovation' illustrate some of the complexities of processes of diffusion of technology, highlighting how technological objects, or even ideas about technological objects become part of a world where they are interpreted and made sense of, and the way the actants themselves shape the world around them. Both examples also highlights that there can be several active preformatting fields in one local setting formatting action, and that such fields are not necessarily aligned. In other words they do not necessarily distribute the same kinds of competences or provide the same kinds of opportunities or challenges. In the example of the biogas facility, it is quite clear that the image of bioenergy as 'sustainable' provided a set of tools which allowed the idea and the assemblage behind the idea to become relatively robust. Faced with obstacles anchored in public demand for cleanliness and 'Norwegian-made' energy production, however, this was not enough. This also suggests a route towards expanding the innovation concept, because it highlights that issues such as 'public engagement' and 'public understanding' of technology are vital for innovators attempting to socialize technology into a new collective. Here, the efforts of socialization of technology did not fail because of inferior technology, but because the public was not convinced.

Conclusion: towards a new sociology of the anatomy of innovation

In a recent essay entitled *Love your monsters* Bruno Latour (2011) discusses the relationship between an environment in crisis and the technology we humans have created in the modern era. One of Latour's points is that we have expected far too much from science and technology alone. We have created countless technologies meant to help us progress, only to learn that they fail us. Rather than bring us forward, they bring doom and ecological catastrophe. However, Latour firmly asks us not to blame the technology alone for this misfortune. It is our ideas about what innovation, science and technology is, he claims, and the consequences of these ideas which are to blame. The modern model that Latour criticizes here is one where there is no notion of socialization of technology. We humans create technology, and then we leave it to 'diffuse' on its own. In Latour's own words: "it is as if we decided that we were unable to follow through with the education of our children".

The topographic perspective on innovation which is primarily concerned with how 'innovation infrastructure' affects innovation performance at aggregate levels shares some problems with the model of modern technology criticized by Latour. With this perspective technology largely remains a series of 'dead' artifacts which 'spread' from the hands of technology creators through processes of diffusion to its final destination in the hands of 'end users'.

In this thesis I have proposed that we should expand, re-frame and re-think the concept of innovation. The main focus has been on various modes of innovation practice and meaning-making associated with innovation practice. This shift of focus implies a move from the study of topography to what I call the study of anatomy of innovation. So how should students of the anatomy of innovation proceed?

A re-reading of the four research papers of this thesis suggests that a new sociology of the anatomy of innovation should rest on at least three central pillars. In other words there are at least three dimensions to socialization of technology:

- **Framing**: the way new technology is given meaning, for instance in relation to central questions that the technology is supposed to address. For new renewable energy technologies this would typically be questions of 'sustainability' or questions of 'climate friendliness', but other framings and images might be just as relevant. For instance: how is the technology understood in an energy security perspective, an economic perspective, etc. Accounting for the images attributed to

technologies allows us to evaluate the relationship between publics and technologies, and how this relationship changes over time.

- **Embedding:** the way new technologies become situated in new collectives; for instance a town, a region or a nation, and the way that the new actant form relations to the actors and actants which already constitute the collective. The way the technology becomes embedded in the new collective might, of course, happen in a number of ways. In this thesis we have seen embedding for instance as 'Norwegian-making' and 'Swedish-making'. In this light, framing and embedding are two interwoven dimensions which are best accounted for in a non-dual manner.

- **Innovation practice:** the strategies, tools, resources and modes of action mobilized by advocates of particular socio-technical solutions in order to advance their status in particular collectives. In this thesis, the actors studied in this way have been industrialists, people starting new bioenergy companies in a setting where bioenergy represents a quite unusual mode of energy generation. I suspect that the study of such actors might be quite typical for the study of this dimension of socialization of technology, but other actors and other types of strategies such as scientists, and their research as well as politicians and their policy making might also be of relevance here.

Through introducing a new sociology of the anatomy of innovation we have come to see much more clearly that a 'technical fix' is never purely technical. Humans and non-humans are part of the same sphere, interwoven in a continuous process of mutual socialization. This shift might provide a more realistic view on what we can achieve through introducing new technology. It is a perspective which does not help you in creating utopian scenarios of technological saviors, but at the same time there is little ground for techno-pessimism on the basis of what we have seen. Instead, the perspective is quite sober, and may be said to be what Bruno Latour (2011) dubbed 'compositionist': "Human development […] is a process of becoming ever-more attached to, and intimate with, a panoply of nonhuman natures".

As human-to-human relationships some relationships between humans and technology will be shattered, and some will be long lasting. However, few – if any, will be infinite. The dream of a 'final' technological solution is not likely to disappear any time soon. A new sociology of the anatomy of innovation might be a fruitful corrective in this respect.

Methodology

In 2011 Brian Eno released the album 'Drums between the Bells' together with the poet Rick Holland (Eno 2011). Despite its pompous tendencies, I recommend the album. This, however, is beside the point. The reason I bring this up at the beginning of my discussion on methodology is the albums 6th track, a floating piece of ambient music focussed on Holland's poem *The Real*, read by the South African student Elisha Mudly. I first heard the track during the summer of 2011, a period I spent in a bubble of writing, wrestling a pile of data, trying to transform the data into some publishable research papers. What had I found? What had I seen? What had I read? And more importantly; how could all of this be presented in a coherent way? At one level, these questions were fuelled by what I believe to be a quite healthy dose of methodological doubt. I found that transforming interview transcripts, newspaper articles, observations and interpretations into authoritative knowledge, into 'science' was no small task. Could I trust these data, these statements, to inform me in any way about what was really going on? It was probably in light of doubts about all of this that the words of Rick Holland struck a chord with me:

The flourish
seeing the real in things
really seeing the real
describing the exact actuality
of what it is you see

At one level discovering these words were comforting. They suggest that descriptions are sufficient to capture reality, that there are links between what the eye perceives and what 'stuff' actually is. Look at the stuff and describe the stuff – no more, no less. But is this sufficient for science, for publishable research? Although I sympathize when Bruno Latour rhetorically asks: "what is so wrong with 'mere descriptions'?" (2005, 136), my practical hypothesis is that 'pure' descriptions of this type would fly poorly in encounters with the peer review system. But what is the task at hand, then? Is it to discover the links between different types of 'stuff', to see how new stuff emerges out of old stuff? Is it to deduce theory from stuff? Is it to look at one type of stuff to say something about another kind of stuff? Is it to look at how stuff is transformed? Or perhaps to understand what stuff means? All of the above, and many other research strategies are possible, but they all imply interpretation. In the

back of my mind I can already hear the positivist question: "Is what you seem to see really the real?" Rick Holland is onto the same idea when he continues:

or what it is you seem to see
you really seem to see the real
the exact and actual reality
of the real in things you seem to see
the real thing

I must stop before this gets out of hand. My intention has not been to write a dissertation unravelling the 'true' nature of reality. I am quite pragmatically oriented, but the above words do point to some real and tangible challenges for most scientific practice. In what follows I will provide a more thorough overview of the data and methodology used to make this thesis than there has been room for in the scope of the four research papers tailing this introductory chapter.

The data and methods mobilized are of qualitative character. Roughly speaking, the data can be grouped in two. One is based on interviews carried out in Norway and Sweden, the other is based on various written sources such as newspapers, industry journals, and website material. Further, I have attended a number of industry conferences to get a feel of what the most pressing debates are in the Norwegian and Swedish bioenergy industries are, and to get some glimpses into what is going on in the industry from another perspective than what is achieved in the interviewer-interviewee setting.

Gathering data in Norway and Sweden: A chronological tale of two fieldworks

The interview data mobilized in this thesis were gathered through two fieldworks: one in Norway, the other in Sweden. More specifically, most interviews were carried out in the middle region of Norway and Östgötaland, Sweden. I will structure my discussion as a chronological story, starting with the first interviews I carried out in 2008, and ending with the final interviews conducted in 2010.

First, I should point out that there is an asymmetry between the Norwegian and Swedish fieldworks. The Norwegian data were gathered over a relatively long stretch of time. The first interviews were performed in October 2008, while the last interviews were carried out towards the end of 2009. In Sweden, on the other hand, the fieldwork was more

condensed, with most interviews done in April, 2010. The reason for this asymmetry is twofold. First, there is a pragmatic side to this: I live in Norway, and therefore have easier access to Norwegian actors. However, there is also a more direct scholarly reason, which brings us to the very beginning of this chronological tale of methods. Embarking on this project, I admittedly knew very little about both bioenergy in general, as well as about what kind of industry to look for. Therefore, in addition to 'reading up', seven interviews were carried out in Norway in 2008, in order to get some basic understanding of what this 'stuff' was, what kinds of industries we were talking about and how to proceed. In this round I did interviews with:

- Three central scientists with extensive experience in bioenergy research. These interviews focused on the scientists' views on bioenergy, both in terms of technical and economic properties, but also about what the scientists thought about the commercial potential of bioenergy. Further, the interviews addressed bioenergy in a climate and sustainability perspective, as well as links between research and the bioenergy industry.
- The project managers of two publicly funded projects in the middle region of Norway, whit the mandate to work for increased use of bioenergy, as well as establish networks between the bioenergy actors of the region and cater for the exchange of knowledge. The focus in these interviews was on the bioenergy industry of the region, and on how and why bioenergy should play a greater role in Norway. These interviews were also important for my sampling of companies to be studied at a later stage. In other words, these were partly sampled based on what has been described as 'snowball sampling' (e.g. Bijker 1995).
- One representative from the municipality of the largest city in the region, and a representative from the agricultural administration in the Northern County of middle Norway. These interviews were conducted in order to gain an impression of how two of the regions' presumably most important public actors saw, or did not see, bioenergy as parts of their strategies related to matters such as energy, climate, commerce etc.

Throughout this project I have followed a strategy of conducting interviews in a semi-structured way. In practical terms this means that I developed relatively loose interview guides which I brought to the interviews. With some exceptions the interview guides did not consist of concrete questions, but rather consisted of a list of topics which I wanted to cover during the interviews. As the examples above illustrates, the actors interviewed could be of

quite diverging character, and they were sometimes interviewed with the intention of collecting different kinds of information. However, as the project progressed, a list of more or less common themes to be addressed in all interviews emerged. At this point, it might also be worthwhile to note that all interviews were recorded digitally, before they were transcribed. I transcribed some of the interviews, particularly in the early phase of the project myself, but mostly, this work was done by hired assistance.

Towards the end of this initial round of interviews I had a list of around 15 potential companies in or related to the region who worked with bioenergy or related technologies. I ended up studying 12 of these in 2009. Table 1 presents an overview of the Norwegian companies studied and of the respondents interviewed in connection to them.

Table 1: companies studied in Norway

Company type	**Number of interviews**	**Interviewees**
Small pellets factory	2	Manager, representative of owners
Pellet oven producer	1	Manager/entrepreneur
Biogas facility	1	Manager
Biogas facility/pig farm	1	Owner/farmer
Wood chip log producer	1	Manager
Boiler wholesale and small scale heat delivery	1	Manager
Micro powerplant producer	3	Manager "inventor" Scientist
Small scale heat delivery based on pellets	2	Manager Sales representative
Small scale heat delivery based on locally produced wood chips	5	Manager Three shareholders Heat operator in school
Small town electricity utility/district heating company	2	Manager Owner
Large town electricity utility/district heating company	1	Head of heat division
Large pellets factory	3	Senior consultant Owners Member of the board
Number of companies = 12	**Total Number of interviews = 23**	

As is evident, the companies were quite different in character, ranging from a family run pig farm on one hand, to the world's second largest pellets factory on the other. In most cases at least one of the interviews related to the company were conducted on the company production site, and were accompanied by a quite extensive 'guided tour' on the site demonstrating the company's activities. The interviews in this phase would typically last from 1-2 hours and covered several relatively broad topics:

- The history of the company.
- The technology, the fuels and the raw materials used by the company, including notions such as production chains etc.
- Sources of knowledge, practical skills, labor etc.
- The political, social and economic framework for the bioenergy industry and the company, including the current market situation, relationship with 'the public', 'the media' etc.
- Business strategies: how to 'win ground'.
- The experience of 'drivers' and 'barriers'.

In this phase, I also conducted a number of interviews with actors 'around' the industry. These actors were considered helpful or important by one or more of the companies studied. Typically, these would be actors and agencies which could provide funding, practical aid, or in other ways be of assistance to the bioenergy actors. In other words, this was another instance where 'snowball' sampling was of importance. Such interviews were conducted with:

- Two departments of the government agency Innovation Norway.
- One scientist with extensive competence in both bioenergy and technology commercialization.
- One representative from a major Norwegian venture capital investor.
- Two representatives from municipalities in the northern county of middle Norway.

These actors were primarily interviewed about their own roles in relation to the bioenergy industry, but the interviews also covered more general topics. Altogether, the Norwegian interview data consists of 35 interviews.

At this point I had gained a quite thorough image of the Norwegian situation. I had reached what is often referred to as the point of data saturation (e.g. Denzin and Lincoln 1998), in other words the stories I was told became increasingly similar to (many stories) I had already heard. This impression was strengthened through my attendance at two quite

large industry conferences. Thus, it was time to introduce the comparative element to this project through doing a similar fieldwork in Sweden. For practical and biographical reasons I wanted to condense the stay in Sweden. At this point I knew somewhat more about what to look for than when I set out in Norway. For the purpose of studying bioenergy activities, the town of Linköping and the region of Östgötaland was chosen. The region is well known for its various bioenergy efforts. As a bonus, Linköping University has a lively STS community, and I was able to be a guest and to have a nice office at the university while doing the fieldwork.

To get a good sample of companies from the region I used three strategies. First, I quite actively used the internet before going to identify possible companies. This brought me part of the way, but I had no way of knowing, of course, whether or not the companies' presence online in any way reflected how the industry looked 'on the ground'. Second, I used the contacts I gained at Linköping University, many of them quite well informed about energy matters, and thirdly I used the snowball method, whereby companies I had interviewed told me about other cases they thought might be of interest. After a month in Sweden I had managed to study 11 companies. The procedure of the interviews resembled the industry interviews in Norway. I interviewed at least one key informant in every company, and took quite extensive guided tours of the company's production sites. In some cases interviews were also conducted with several respondents. Table two presents an overview of the Swedish companies studied and the interviewees in these companies. The themes covered in these interviews were roughly speaking the same as in Norway.

Table 2: companies studied in Sweden

Company type	**Number of interviews**	**Interviewees**
Wood chips producer	2	Manager Forest Machine operator
Municipal electricity utility/district heating utility	1	General manager
Wood chip producer/small scale heat provider	1	Manager
Biogas producer	3	Manager Owner Customer
Producer of technology for biogas production	2	Manager Senior employee

Farm/producer of RME (bio oil)	2	Farm owner Machine operator
Farm/producer of straw for heating	1	Farm owner
Forest managers/wood chips producers	1	Senior forest manager
Biomass trading company	3	Owner Manager Junior employee
Producer of wood chips	2	Manager Owners
Producer of technology for small scale RME production	1	Manager
Number of companies = 11	**Total number of interviews = 19**	

As in Norway, I also conducted some interviews in Sweden with actors who were not directly involved in the bioenergy industry, but who had extensive knowledge, and were considered helpful by those in the industry. These were:

- One scientist.
- Two representatives from the municipality of the largest town in the region.
- Two representatives from the local energy office.

The total number of interviews conducted in Sweden was 24, something which makes a total of 59 interviews for Norway and Sweden altogether. Figure 5 illustrates a quite typical event in a quite typical day in the field: a proud industry representative shows off the by-product of biogas production.

Figure 5: Guided tour of a biogas facility from the researcher's point of view

Documents

To complement the interviews I have used written sources to cast light on various research questions in this thesis. The main bulk of these written accounts consist of newspaper material. In the following I will describe these data, and I will also describe the links between the interviews I conducted and these data. My interest in newspaper material first emerged during my fieldwork in Norway. Many of the companies I interviewed were struggling. Many explanations were given for the situation, but a recurring theme was the media coverage of bioenergy. The actors did not suggest a causal relationship between media coverage and their own misfortunes, of course, but the media coverage of bioenergy appeared as yet another element feeding into their problems. This led me to the idea of comparing the news media coverage of bioenergy in Norway and Sweden. At this point, I wanted to have the image of bioenergy generated in the mainstream media. For this reason, I chose three Norwegian and three Swedish newspapers which all can be characterized as 'mainstream'. They are of the most sold newspapers in their categories. While they might have had political affiliations historically, their current profiles are quite neutral: there is little suggesting any particular bias with respect to bioenergy. I selected a tabloid newspaper, a regional newspaper and a national 'quality' newspaper from both counries. The newspapers were Adresseavisen, Aftenposten and VG in the Norwegian case and Östgöta Correspondenten, Svenska Dagbladet and Aftonbladet in Sweden. The newspapers were accessed via the searchable media database retriever[13] where I searched for articles containing Norwegian and Swedish equivalents to the terms 'bioenergy', 'bio heat', 'biofuels', 'bio gas' and 'pellets'. This search might certainly have excluded some relevant articles; but the idea was to generate a fair overview or a cross-section of how bioenergy was covered in Norwegian and Swedish the newspapers. I believe this aim was achieved.

Another written account which was used as a data source was the Norwegian and Swedish industry journals 'Bioenergy'. As I started this project I began prescribing to these journals first and foremost to get a feel of what was moving in the industry, but also to be updated on the views of the Norwegian and Swedish bioenergy associations, who publish the journals. Six Norwegian issues and six Swedish issues of this journal were used as direct sources of data for this thesis.

Thirdly, I have used data gathered from niche- and opinion oriented newspapers, as well as websites. My inspiration to use these sources as data was found while I was on fieldwork in Sweden. One of the things that came up in these interviews was that all actors

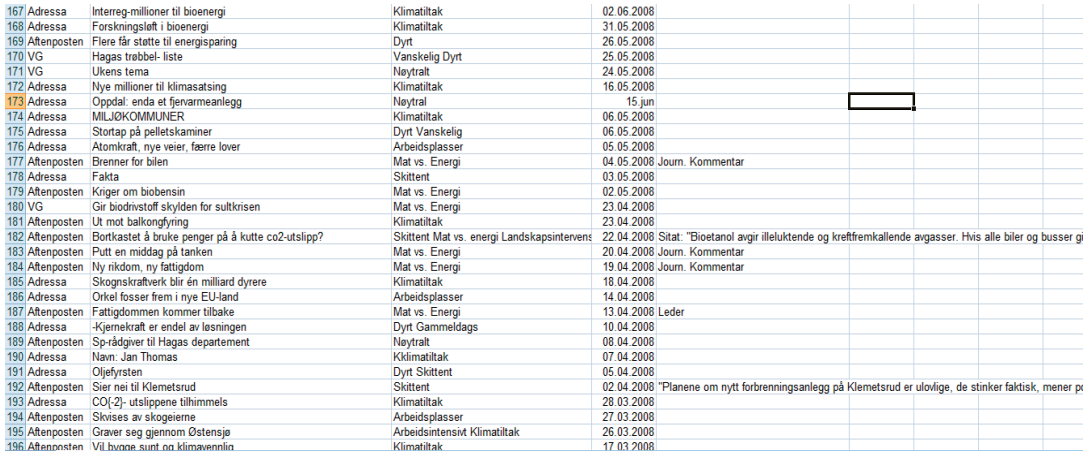
[13] See www.retriever.no

considered bioenergy ‘green’ or ‘climate neutral’. Meanwhile, the topic of ‘peat’ emerged as a strange entity, resembling the ugly duckling little brother of bioenergy. For some, peat was a ‘guilty pleasure’ while others expressed an embarrassment over the fact that that Sweden in many ways was associated with peat and a European peat lobby. Meanwhile, there was a quite fierce debate raging in the Norwegian leftist newspaper ‘Klassekampen’ and on the Norwegian internet research portal, forskning.no. This debate concerned the status of bioenergy from Norwegian forests: is it really ‘sustainable’, ‘climate neutral’ or ‘green’? To me, an outsider trying to understand the dynamics of the bioenergy industry and how this industry fitted in with the rest of society, all of this was somewhat puzzling. What was really the relationship between peat and bioenergy, and why was there diverging opinions about the status of both peat and bioenergy as sustainable or non-sustainable? To try to make sense of it all, I gathered 19 opinion pieces/chronicles from Klassekampen and 17 opinion pieces/chronicles from forskning.no, all published from March 2010-May 2011. Further, I gathered the main arguments of the peat controversy from the implicated actors’ websites. This material was the basis for the analysis of this thesis final research paper.

Analysis

Throughout the work with this thesis, the analysis of data has been inspired by grounded theory (GT), more specifically with an open GT approach (e.g. Corbin and Strauss 1990). To some degree I have used software in the analysis process. Specifically I have used ATLAS.ti, and the open source alternative WEFT QDA for the analysis of interview material, while I have used Excel to make a quite simple database of the newspaper material.

In GT, the analysis of the data and the data collection are interrelated processes. This has quite clearly been the case also in this project, where preliminary findings and analysis have formed the basis for new data collection. For instance, interviews in Norway and Sweden inspired the collection of textual data. The key idea in GT is to discover concepts or themes (often dubbed codes) which are to be used as the main unit of analysis. Examples from this thesis are the different kinds of innovation practices seen in ‘organic innovation’ or the story-lines analyzed in ‘curb your enthusiasm’. Figure 6 is a screenshot from the database of Norwegian newspaper articles that was used in ‘curb your enthusiasm’ displaying some of the preliminary categories uncovered through the reading of the data.



167	Adressa	Interreg-millioner til bioenergi	Klimatiltak	02.06.2008					
168	Adressa	Forskningsløft i bioenergi	Klimatiltak	31.05.2008					
169	Aftenposten	Flere får støtte til energisparing	Dyrt	26.05.2008					
170	VG	Hagas trøbbel- liste	Vanskelig Dyrt	25.05.2008					
171	VG	Ukens tema	Nøytralt	24.05.2008					
172	Adressa	Nye millioner til klimasatsing	Klimatiltak	16.05.2008					
173	Adressa	Oppdal: enda et fjervarmeanlegg	Nøytral	15.jun					
174	Adressa	MILJØKOMMUNER	Klimatiltak	06.05.2008					
175	Adressa	Stortap på pelletskaminer	Dyrt Vanskelig	06.05.2008					
176	Adressa	Atomkraft, nye veier, færre lover	Arbeidsplasser	05.05.2008					
177	Aftenposten	Brenner for bilen	Mat vs. Energi	04.05.2008	Journ. Kommentar				
178	Adressa	Fakta	Skittent	03.05.2008					
179	Aftenposten	Kriger om biobensin	Mat vs. Energi	02.05.2008					
180	VG	Gir biodrivstoff skylden for sultkrisen	Mat vs. Energi	23.04.2008					
181	Aftenposten	Ut mot balkongfyring	Klimatiltak	23.04.2008					
182	Aftenposten	Bortkastet å bruke penger på å kutte co2-utslipp?	Skittent Mat vs. energi Landskapsintervens	22.04.2008	Sitat: "Bioetanol avgir illeluktende og kreftfremkallende avgasser. Hvis alle biler og busser gi				
183	Aftenposten	Putt en middag på tanken	Mat vs. Energi	20.04.2008	Journ. Kommentar				
184	Aftenposten	Ny rikdom, ny fattigdom	Mat vs. Energi	19.04.2008	Journ. Kommentar				
185	Adressa	Skognskraftverk blir én milliard dyrere	Klimatiltak	18.04.2008					
186	Adressa	Orkel fosser frem i nye EU-land	Arbeidsplasser	14.04.2008					
187	Aftenposten	Fattigdommen kommer tilbake	Mat vs. Energi	13.04.2008	Leder				
188	Adressa	-Kjernekraft er endel av løsningen	Dyrt Gammeldags	10.04.2008					
189	Aftenposten	Sp-rådgiver til Hagas departement	Nøytralt	08.04.2008					
190	Adressa	Navn: Jan Thomas	Klklimatiltak	07.04.2008					
191	Adressa	Oljefyrsten	Dyrt Skittent	05.04.2008					
192	Aftenposten	Sier nei til Klemetsrud	Skittent	02.04.2008	"Planene om nytt forbrenningsanlegg på Klemetsrud er ulovlige, de stinker faktisk, mener p				
193	Adressa	CO(-2)- utslippene tilhimmels	Klimatiltak	28.03.2008					
194	Aftenposten	Skvises av skogeierne	Arbeidsplasser	27.03.2008					
195	Aftenposten	Graver seg gjennom Østensjø	Arbeidsintensivt Klimatiltak	26.03.2008					
196	Aftenposten	Vil bygge sunt og klimavennlig	Klimatiltak	17.03.2008					

Figure 6: Screenshot from database

In all cases the analysis took the form of a two-step process. First, was what we can call a 'loose' analysis, which began as an idea informed by the empirical material. In this case, ideas about categorizations, coding and ways to understand the material emerged. Secondly, the material was re-read in a much more thorough and coherent way. In this process the codes usually changed quite a lot, and their content was refined. In the reading of the newspaper material for the paper 'Curb your enthusiasm', for example, the idea of a code encompassing the notion of food vs. energy emerged very early in the process. It was not before a more thorough reading of the material was done, however, that it became clear that this particular code was part of a global storyline, as opposed to many of the other codes, which formed local and regional story-lines.

Assessment of the data

My intention in this thesis has been in various ways to study what we can call the 'room' for bioenergy innovation in Norway and Sweden. I have done so through interviews and 'guided tours', through the study of newspapers (both mainstream and niche), through looking at website material and industry journals. Have these data been suitable for my purpose of study? First, there is a question of whether or not I have been able to capture the Norwegian and Swedish bioenergy industry as such. In both cases, most interviews have been conducted in a geographical-specific region of the country. Both Norway and Sweden are characterized by differences between for example north and south and I can certainly not exclude the possibility that I would have found a slightly different image had I chosen other locations to study. However, given my theoretical point of departure for this discussion it should not come

as a surprise that I do not seek statistically generalizable facts. Rather, I have been concerned with the world as experienced 'on the ground' and how this experience is linked to the broader Norwegian and Swedish settings. In this light, I believe the geographical-specific interview data that I have used have been suitable, and that they can in fact be employed to say something about the Norwegian and Swedish situation. When I have used other data sources than interviews, I have done so because something has been highlighted to me as important in interview situations. In other words, peat and the media coverage of bioenergy were studied because actors in the Norwegian and Swedish bioenergy industry highlighted them as a meaningful part of their practice, or as elements which helped them make sense of their own practice. The pursuit of emerging topics in this way is also in line with the ideals postulated in grounded theory.

Another possible objection is that in some of the cases studied I have conducted relatively few interviews. Do one or two interviews provide the full picture of the companies studied? Most companies studied here, are actually quite small in terms of number of employees, so I believe the answer to the question is yes. Even in the physically largest operation studied here, the world's second largest pellets factory, the total number of employees was not higher than 35, and roughly half of this number worked with loading and unloading of pellets. In some cases the number of employees was not more than one or two, while most companies studied had between 5-10 employees. In sum, I feel relatively confident that the data at hand can illuminate the questions I have sought to answer in this thesis.

References

Anshelm, Jonas. 1992. *Vattenkraft och naturskydd*. Linköping: Universitetet i Linköping, Tema Teknik och Social Förändring.

———. 1995. *Socialdemokraterna och miljöfrågan: En studie av framstegstankens paradoxer* Stockholm: B. Östlings bokförlag Symposium.

———. 2000. *Mellan frälsning och domedag : om kärnkraftens politiska idéhistoria i Sverige 1945-1999*. Stockholm: Symposion.

———. 2004. *Det vilda, det vackra och det ekologiskt hållbara. Om opinionsbildningen i Svenska Naturskyddsföreningens tidskrift Sveriges Natur 1943-2002*, *Skrifter från forskningsprogrammet Landskapet som Arena*. Umeå: Landskapet som Arena.

———. 2009. *Att ersätta kärnkraften med bioenergi - om en omstridd idé i den offentliga energipolitiska debatten i Sverige 1979-2000*. Linköping: Tema T, Linköpings Universitet.

Asheim, Bjørn T., and Arne Isaksen. 2002. "Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge." *The Journal of Technology Transfer* no. 27 (1):77-86. doi: 10.1023/a:1013100704794.

Aune, Margrethe. 1998. *Nøktern eller nytende. Energiforbruk og hverdagsliv i Norske husholdninger*, Center for technology and society, Norwegian University of Science and Technology, Trondheim.

———. 2007. "Energy comes home." *Energy Policy* no. 35 (11):5457-5465. doi: 10.1016/j.enpol.2007.05.007.

Aune, Margrethe, and Thomas Berker. 2007. "Energiforbruk i boliger og yrkesbygg: Utfordringer og muligheter." In *Mellom klima og komfort - utfordringer for en bærekraftig energiutvikling*, edited by Knut Holtan Sørensen Margrethe Aune. Trondheim: Tapir akademisk forlag.

Aune, Margrethe, Marianne Ryghaug, and Åsne Lund Godbolt. 2011. "Comfort, consciousness and costs – transitions in Norwegian energy culture 1991-2010." *Energy efficiency first: The foundation of a low-carbon society. ECEEE 2011 Summer Study Proceedings*.

Barbier, Edward B. 2010. *A global green new deal*. Cambridge, UK: Cambridge University Press.

Barnett, Julie, Kate Burningham, Gordon Walker, and Noel Cass. 2010. "Imagined publics and engagement around renewable energy technologies in the UK." *Public Understanding of Science*. doi: 10.1177/0963662510365663.

Berker, Thomas, and Helen Jøsok Gansmo. 2010. "Paradoxes of design: energy and water consumption and the aestheticization of Norwegian bathrooms 1990–2008." *Sustainable Development* no. 18 (3):135-149. doi: 10.1002/sd.454.

Bijker, Wiebe E. 1995. *Of Bicycles, Bakelites and Bulbs. Toward a Theory of Sociotechnical Change*. First MIT Press paperback edition, 1997 ed. Cambridge, MA: MIT Press.

Bijker, Wiebe E., and Luciano d'Andrea. 2009. *Handbook on the Socialisation of Scientific and Technological Research*. Rome: Technological Responsibility.

Black, Grant. 2004. *The Geography of Small Firm Innovation*. Boston: Kluwer Academic Publishers.

Bøeng, Ann Christin, Elisabeth Isaksen, Sayida M. Jama, and Marita Stalund. 2011. Energiindikatorer for Norge 1990-2009. Oslo: Statistics Norway.

Bøeng, Ann Christin, and Bodil M. Larsen. 2008. "Husholdningenes energiforbruk: Vi bruker mindre energi i hjemmet enn før " *Samfunnsspeilet* no. 22 (4).

Callon, Michel. 1986. "Elements of a sociology of translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay." In *Power, Action and Belief: A New Sociology of Knowledge*, edited by John Law, 196-233. London: Routledge.

———. 1987. "Society in the Making: The Study of Technology as a Tool for Sociological Analysis." In *New Directions in the Sociology and history of Technology*, edited by Wiebe E. Bijker, Thomas P. Hughes and Trevor Pinch. Masachusetts: MIT Press.

———. 1998. "An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology." In *The Laws of the Markets*, edited by Michel Callon. Oxford: Blackwell Publishers/TheSociological Review.

Carlsson, B., and S. Jacobsson. 1993. "Technological systems and economic performance: the diffusion of factory automation in Sweden

" In *Technology and the Wealth of Nations: The Dynamics of Constructed Advantage*, edited by D. Foray and C. Freeman. London: Pinter Publishers.

Carlsson, Bo. 1995. *Technological Systems and Economic Performance: The Case of Factory Automation*. Dordrect, The Netherlands: Kluwer Academic Publishers.

Carlsson, Bo, Staffan Jacobsson, Magnus Holmén, and Annika Rickne. 2002. "Innovation systems: analytical and methodological issues." *Research Policy* no. 31 (2):233-245. doi: 10.1016/s0048-7333(01)00138-x.

Commission, European. 2011. *Agriculture and bioenergy* 2011 [cited 29.11 2011]. Available from http://ec.europa.eu/agriculture/bioenergy/index_en.htm.

Communities, Commission of the European. 2005. *Biomass Action Plan*, *Communication from the commission*. Brussels.

Cooke, Philip. 2001. "Regional Innovation Systems, Clusters, and the Knowledge Economy." *Industrial and Corporate Change* no. 10 (4):945-974. doi: 10.1093/icc/10.4.945.

———. 2008. "Regional Innovation Systems, Clean Technology & Jacobian Cluster-Platform Policies." *Regional Science Policy & Practice* no. 1 (1):23-45. doi: 10.1111/j.1757-7802.2008.00002.x.

———. 2009. Transition Regions: Green Innovation and Economic Development. In *the Summer Conference 2009*. CBS - Copenhagen Business School, Denmark.

Cooke, Philip, Mikel Gomez Uranga, and Goio Etxebarria. 1997. "Regional innovation systems: Institutional and organisational dimensions." *Research Policy* no. 26 (4-5):475-491. doi: 10.1016/s0048-7333(97)00025-5.

Coombs, Rod, and Richard Hull. 1998. "`Knowledge management practices' and path-dependency in innovation." *Research Policy* no. 27 (3):237-253. doi: 10.1016/s0048-7333(98)00036-5.

Corbin, Juliet M., and Anselm Strauss. 1990. "Grounded theory research: Procedures, canons, and evaluative criteria." *Qualitative Sociology* no. 13 (1):3-21. doi: 10.1007/bf00988593.

Denzin, Norman K., and Yvonna S. Lincoln. 1998. *Strategies of qualitative inquiry*. Thousand Oaks, Calif.: Sage.

DNK. 2011. *Høring - NOU 2011:11 Innovasjon i omsorg*. Oslo: Den Norske Kirke.

Ek, Kristina, and Patrik Söderholm. 2010. "The devil is in the details: Household electricity saving behavior and the role of information." *Energy Policy* no. 38 (3):1578-1587. doi: 10.1016/j.enpol.2009.11.041.

Ellegård, Kajsa. 2004. "Vardagslivets valfrihet - om energianvänding, vardagsliv och bebyggelsesmönster." In *Krävs Energi i Samhällsplaneringen? En Antologi*, edited by Gösta Blucher and Göran Graninger. Linköping: Stiftelsen Vadstena Forum.

Energimyndigheten. 2010. *Energy in Sweden - facts and figures 2010*: Statens Energimyndighet.

Engen, Ole Andreas. 2009. "The Development of the Norwegian Petroleum Innovation System: A Historical Overview." In *Innovation, Path Dependency, and Policy. The Norwegian Case*, edited by Jan Fagerberg, David C. Mowery and Bart Verspagen. New York Oxford University Press.

Eno, Brian. 2011. *Drums Between the Bells*: Warp.

Garud, Raghu, and Peter Karnøe. 2003. "Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship." *Research Policy* no. 32 (2):277-300. doi: 10.1016/s0048-7333(02)00100-2.

Geels, Frank W. 2004. "From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory." *Research Policy* no. 33 (6-7):897-920. doi: 10.1016/j.respol.2004.01.015.

———. 2011. "The multi-level perspective on sustainability transitions: Responses to seven criticisms." *Environmental Innovation and Societal Transitions* no. 1 (1):24-40.

Geels, Frank W. 2007. "Transformations of Large Technical Systems." *Science, Technology & Human Values* no. 32 (2):123-149. doi: 10.1177/0162243906293883.

Gimstedt, Ole. 1995. "Mutual Trust: The Purchasing of the First Swedish Commercial Reactor." In *Nordic Energy Systems. Historical Perspectives and Current Issues*. Canton, MA: Science History Publications.

Godin, Benoît. 2006. "The Linear Model of Innovation." *Science, Technology & Human Values* no. 31 (6):639-667. doi: 10.1177/0162243906291865.

Goffman, Erving. 1974. *Frame Analysis. An Essay on the Organization of Experience*. Boston: Northeastern University Press. Reprint, 1986.

Gullberg, Anne Therese. 2011. "Norge som Europas grønne batteri." *Klima* no. 3:6-7.

Hallin, Per Olof. 1994. "Energy, Lifestyles and Adaptation." *Geografiska Annaler. Series B, Human Geography* no. 76 (3):173-185.

Hansen, Gard Hopsdal. 2009. *Encounters on the far side. Internationalization and domestication of Norwegian lifeboats in China*, Department of Interdisciplinary Studies of Culture Norwegian University of Science and Technology, Trondheim.

Hanson, Jens. 2011. "Innmatingstariffer - marked som læringsarena." In *Energirikdommens paradokser. Innovasjon som klimapolitikk og læringsutvikling*, edited by Jens Hanson, Sjur Kasa and Olav Wicken. Oslo: Universitetsforlaget.

Hanson, Jens, Sjur Kasa, and Olav Wicken. 2011. *Energirikdommens Paradokser. Innovasjon som klimapolitikk og næringsutvikling*. Oslo: Universitetsforlaget.

Haraway, Donna J. 1991. *Simians, Cyborgs, and Women. The Reinvention of Nature*. London: Free Association Books.

Harman, Graham. 2009. *Prince of Networks. Bruno Latour and Metaphysics*. Melbourne: re.press.

Hille, John, Carlo Aall, and Ingun Grimstad Klepp. 2007. Miljøbelastninger fra norsk fritidsforbruk – en kartlegging. Sogndal: Vestlandsforskning.

Hopkins, Rob. 2008. *The transition handbook: from oil dependency to local resilience*. Dartington: Green Books.

IEA. 2010. *Energy Technology Perspectives 2010. Scenarios & Strategies to 2050*. Paris: International Energy Agency.

IPCC. 2011. Renewable Energy Sources and Climate Change Mitigation. Special Report of the Intergovernmental Panel on Climate Change. Cambridge.

Jacobsson, S. 2002. "Universities and industrial transformation: an interpretative and selective literature study with special emphasis on Sweden." *Science and Public Policy* no. 29 (5):345-365. doi: 10.3152/147154302781780831.

Kall, Ann-Sofie. 2011. *Förnyelse med förhinder*, Institutionen för Tema, Linköping University, Linköping.

Kall, Ann-Sofie, and Joakim Widén. 2007. *Det stora i det lilla och det lilla i det stora. Politik och teknik i omställningen av energisystemet*, *Arbetsnotat Nr. 37*. Linköping/Uppsala: Program Energisystem.

Karlstrøm, Henrik. 2010. Den deregularte forbruker. Norske strømforbrukeres holdninger til strømmarkedet, fornybar energi og bærekraftig kraftproduksjon. NTNU, institutt for tverrfaglige kulturstudier.

Kasa, Sjur. 2011. "Innovasjonspolitikkens maktkamper." In *Energirikdommens paradokser. Innovasjon som klimapolitikk og næringsutvikling*, edited by Jens Hanson, Sjur Kasa and Olav Wicken. Oslo: Universitetsforlaget.

Kemp, René, Derk Loorbach, and Jan Rotmans. 2007. "Transition management as a model for managing processes of co-evolution towards sustainable development." *International Journal of Sustainable Development & World Ecology* no. 14 (1):78-91. doi: 10.1080/13504500709469709.

Kemp, René, and Jan Rotmans. 2005. "The Management of the Co-Evolution of Technical, Environmental and Social Systems." In *Towards Environmental Innovation Systems*, edited by Matthias Weber and Jens Hemmelskamp. Heidelberg: Springer Berlin.

Kemp, René, Johan Schot, and Remco Hoogma. 1998. "Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management." *Technology Analysis & Strategic Management* no. 10 (2):175-198. doi: 10.1080/09537329808524310.

Kommune, Verdal. 2007. Energi- og klimaplan for Verdal kommune (2008-2011).

Kårstein, Asbjørn. 2008. *HyNor - den norske hydrogenveien*, Department for interdiciplinary studies of culture, Norwegian University of Science and Technology, Trondheim.

Latour, Bruno. 2005. *Re-assembling the social. An Introduction to Actor-Network-Theory*. New York: Oxford University Press.

———. 2011. "Love your monsters." *Breakthrough Journal* no. 1 (2).

Law, John. 1992. "Notes on the Theory of the Actor-Network: Ordering, Strategy, and Heterogeneity." *Systems Practice* no. 5 (4).

Law, John, and Annemarie Mol. 1995. "Notes on materiality and sociality." *The Sociological Review* no. 43 (2):274-294. doi: 10.1111/j.1467-954X.1995.tb00604.x.

LO. 2012. *Innspill til innovasjonsmeldingen*. Landsorganisasjonen i Norge 2007 [cited 26.01.2012 2012]. Available from http://www.lo.no/s/Naringspolitikk/Innovasjon-og-naringsrettet-FoU/Innspill-til-Innovasjonsmeldingen/?c=443&t=681.

Lundvall, Bengt-Åke. 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.

Löfstedt, Ragnar E. 1996. "The use of biomass energy in a regional context: The case of Växjö Energi, Sweden." *Biomass and Bioenergy* no. 11 (1):33-42. doi: 10.1016/0961-9534(96)00005-0.

Macionis, John J., and Ken Plummer. 2005. *Sociology. A Global Introduction*. Essex: Pearson Education Limited.

Malerba, Franco. 2002. "Sectoral systems of innovation and production." *Research Policy* no. 31 (2):247-264. doi: 10.1016/s0048-7333(01)00139-1.

Midttun, Atle , Mari Hegg Gundersen, and Anne Louise Koefoed. 2004. "Greening of Nordic Electricity Industry: Policy Convergence and Diversity." *Energy & Environment* no. 15 (4).

Miettinen, Reijo. 1999. "The riddle of things: Activity theory and actor-network theory as approaches to studying innovations." *Mind, Culture, and Activity* no. 6 (3):170-195. doi: 10.1080/10749039909524725.

Moors, Ellen H.M, Arie Rip, and Johannes S.C Wiskerke. 2004. "The Dynamics of Innovation: A Multilevel, Co-Evolutionary Perspective." In *Seeds of Transition. Essays on novelty production, niches and regimes in agriculture.* , edited by J.S.C Wiskerke and J.D. van der Ploeg. Aasen, The Netherlands: Koninlkijke Van Gorcum.

Myllyntaus, Timo. 1995. "Kilowatts at Work: Electricity and Industrial Transformation in the Nordic Countries." In *Nordic Energy Systems. Historical Perspectives and Current Issues*, edited by Arne Kaijser and Marika Hedin. Science History Publications: Canton, MA.

Nelson, Richard R. 1993. *National Innovation Systems. A Comparative Analysis*. New York: Oxford University Press.

NHO. *Styrk landsdekkende virkemidler*. Næringslivets Hovedorganisasjon 2011 [cited 26.12.2012. Available from http://www.nho.no/forskning-og-innovasjon/styrk-landsdekkende-virkemidler-article23003-75.html.

Nilsen, Yngve. 2001. *En felles plattform? Norsk oljeindustri og klimadebatten i Norge frem til 1998*

Senter for Teknologi, innovasjon og kultur, University of Oslo, Oslo.

NOHD. 2008. *Stortingsmelding nr 7 (2008-2009) Et nyskapende of bærekraftig Norge.* : Nærings og handelsdepartementet.

Næss, Robert, and Marianne Ryghaug. 2007. "Nye energiholdninger? Når komfortkulturen møter klimatrusselen." In *Mellom klima og komfort - utfordringer for en bærekraftig energiutvikling*, edited by Margrethe Aune and Knut Holtan Sørensen. Trondheim: Tapir Akademisk Forlag.

OECD. 2005. Innovation in energy technology: synthesis report. Paris: OECD.

OED. 2008. Strategi for økt utbygging av bioenergi. Olje- og Energidepartementet

Palm, Jenny. 2009. "Placing barriers to industrial energy efficiency in a social context: a discussion of lifestyle categorisation." *Energy Efficiency* no. 2 (3):263-270. doi: 10.1007/s12053-009-9042-1.

Perman, Karin. 2008. *Från el till värme. En diskursanalytisk policystudie av energiomställning på statlig, kommunal och hushållsnivå*, Örebro universitet

Örebro.

Porter, Michael E., and Scott Stern. 2001. "Innovation: Location Matters." *MIT Sloan Management Review*

no. 42 (4):28-36.

Rickne, A. 2001. "Regional Characteristics and Performance: Evidence from Biomaterials Firms." In *New Technological Systems in the Bio Industries*, edited by B. Carlsson. Boston: Kluwer Academic Publishers.

Rosenberg, Nathan. 1994. *Exploring the black box. Technology, economics and history.* . New York: Cambridge University Press.

Rotmans, Jan, René Kemp, M.B.A van Asselt, Frank W Geels, G. Verbong, and K. Molendijk. 2000. *Transitions and Transition Management: the Case of an emission-poor energy supply*. Maastricht: ICIS.

Ryghaug, Marianne, and Knut H. Sørensen. 2009. "How energy efficiency fails in the building industry." *Energy Policy* no. 37 (3):984-991. doi: 10.1016/j.enpol.2008.11.001.

Sagar, A. D., and J. P. Holdren. 2002. "Assessing the global energy innovation system: some key issues." *Energy Policy* no. 30 (6):465-469. doi: 10.1016/s0301-4215(01)00117-3.

SCB. 2011. Hushållens ekonomiska standard. Stockholm: Statistiska centralbyrån.

Schiederig, Tim, Frank Tietze, and Cornelius Herstatt. 2011. What is Green Innovation? – A quantitative literature review. In *The XXII ISPIM Conference 2011*. Hamburg.

Sejersted, Francis. 1999. *Systemtvang eller politikk: om utviklingen av det oljeindustrielle kompleks i Norge*. Oslo: Universitetsforl.

Shove, Elizabeth, and Gordon Walker. 2007. "CAUTION! Transitions ahead: politics, practice, and sustainable transition management." *Envionment and Planning A* no. 39:763-770.

Smith, Keith. 2008. *Climate change and radical energy innovation: the policy issues* Oslo: Centre for Technology and Culture.

SSB. *Elekrtisitetsstatistikk, desember 2011*. Statistist Sentralbyrå 2011a [cited 20.02.2012. Available from http://www.ssb.no/emner/10/08/10/elektrisitet/.

———. *Fjernvarmestatistikk 2010. Sterk økning i fjernvarmeforbruket*. Statistics Norway 2011b. Available from http://www.ssb.no/fjernvarme/.

———. *Produksjon av elektrisk kraft, etter art, fylke og eigargruppe. 2007-2009. GWh* Statistics Norway 2011c [cited 03.01.2012. Available from http://www.ssb.no/elektrisitetaar/tab-2011-04-13-09.html.

Stern, Nicholas. 2007. *The Economics of Climate Change: The Stern Review*. New York: Cambridge University Press.

Summerton, Jane. 1992. *District heating comes to town: the social shaping of an energy system*. Vol. 80, *Linköping studies in arts and science*. Linköping: Institutionen för Tema, Linköpings universitet.

Sørensen, Knut Holtan. 2005. "Jakten på innovasjon: fra nasjonsbygging til do.com." In *Det Norske Samfunn*, edited by Ivar Frønes and Lise Kjølsrød. Oslo: Gyldendal akademiske.

———. 2007a. "Energiøkonomisering på Norsk: fra ENØK til Enova." In *Mellom klima og komfort. Utfordringer for en bærekraftig energiutvikling*, edited by Margrethe Aune and Knut Holtan Sørensen. Trondheim: Tapir Akademisk.

———. 2007b. "Fra "hvite kull" til grønn varme? Utfordringer for energi." In *Mellom Klima og komfort. Utfordringer for en bærekraftig teknologiutvikling*, edited by Knut Holtan Sørensen Margrethe Aune. Trondheim: Tapir Akademisk Forlag.

Tamnes, Rolf. 1997. *Oljealder. 1965-1995*, *Norsk utenrikspolitikks historie*. Oslo: Universitetsforlaget.

Thue, Lars. 1995. "Electricity Rules. The formation and development of the Nordic electricity regimes." In *Nordic Energy Systems. Historical Perspectives and Current Issues*, edited by Arne Kaijser and Marika Hedin. Canton, MA: Science History Publications.

Tjernshaugen, Andreas. 2009. *Fossil interests and environmental institutions: The politics of CO2 capture and storage*, Institutt for sosiologi of samfunnsgeografi, University of Oslo, Oslo.

UNDP. 2009. *Handbook for Conducting Technology Needs Assessment for Climate Change*. New York: United Nations Development Programme.

Walker, G., N. Cass, K. Burningham, and J. Barnett. 2010. "Renewable energy and sociotechnical change: imagined subjectivities of 'the public' and their implications." *Environment and Planning A* no. 42 (4):931-947.

Walker, Helen, Lucio Di Sisto, and Darian McBain. 2008. "Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors." *Journal of Purchasing and Supply Management* no. 14 (1):69-85. doi: 10.1016/j.pursup.2008.01.007.

Westin, Paul, and Fredrik Lagergren. 2002. "Re-regulating district heating in Sweden." *Energy Policy* no. 30 (7):583-596. doi: 10.1016/s0301-4215(01)00126-4.

Wicken, Olav. 2009. "The Layers of National Innovation Systems: The Historical Evolution of a National Innovation System in Norway

" In *Innovation, Path Dependency, and Policy. The Norwegian Case*, edited by Jan Fagerberg, David C. Mowery and Bart Verspagen. New York: Oxford University Press.

Wiidegren, Örjan. 1998. "The New Environmental Paradigm and Personal Norms." *Environment and Behavior* no. 30 (1):75-100. doi: 10.1177/0013916598301004.

Winner, Langdon. 1986. "Building the Better Mousetrap." In *The Whale and the Reactor*, edited by Langdon Winner. Chicago: The University of Chicago Press.

Organic Innovation: Innovation practices in the Bioenergy Industry

Abstract

Innovation is considered a key in our quest to meet the challenges of climate change. The scholarly literature has recognized this through a focus on 'green' innovation, which is most commonly studied in an aggregated fashion at macro or meso levels. This paper zooms in on individual innovation processes and focus on the innovation practices of Norwegian bioenergy innovators. In the Norwegian discourse, technology developments and innovation are expected to be R&D driven. This paper, however finds that the bioenergy innovation practices are relatively autonomous, independent of what goes on in R&D. Rather than codified scientific and technical knowledge, the innovation endeavours are driven by the practical work and knowhow of the innovators in combination with a set of tools and competences distributed from markets, access to resources, new regulations and customer relationships. The paper considers these modes of innovation as a subset of a broader category: organic innovation.

Key words: innovation, practice, bioenergy, Actor-Network Theory

Is not included due to copyright

Curb your enthusiasm: on media communication of bioenergy and the role of the news media in technology diffusion[1]

Abstract

There is widespread agreement that the mitigation of climate changes requires societies across the globe to speed up the diffusion of renewable energy technologies. This paper pursues an interest in the diffusion of one such technology: bioenergy. It does so through a study of how bioenergy is covered and communicated in the news media of Norway and Sweden, countries where the diffusion of this technology looks radically different. Mobilizing a domestication perspective, it finds that the news media in the two countries ascribe diverging meaning to the technology, offering its audiences clearly varied images of what bioenergy "is". In other words, the technology is domesticated in different ways, suggesting that media coverage plays a role in systems of innovation and diffusion. How this affects the public, however, is an under analysed element in the innovation and diffusion literature, and the paper calls for further investigation into this matter.

Key words: domestication, media analysis, bioenergy, diffusion, Norway, Sweden

[1] This paper is forthcoming in *Environmental Communication. A Journal of Nature and Culture*.

Is not included due to copyright

Publics in the Pipeline: On Bioenergy and its Imagined Publics in Norway and Sweden[1]

In 2009 I attended the Norwegian Bioenergy Days – a conference where the bioenergy industry gathered to discuss the state of their bioenergy fuels, technology and markets.[2] Recurring themes at the conference were red numbers, difficult markets and bankruptcies. Many participants had a bleak outlook because they were unable to generate profits. One presenter asked: "Is something going to happen soon, or should we find another industry?"[3] The discussions circled around flawed policy, but also around the relationship between bioenergy and competing technologies.[4] The conference participants claimed that other renewable energy technologies like wind and solar power were seen as better alternatives than bioenergy. This, they claimed, was reflected in the media coverage on bioenergy and in the way politicians spoke of it. Most importantly, they pointed to a broader collective referred to as 'the public'[5] as either unaware of the possibilities offered by bioenergy or holding negative attitudes towards it.

From an industry perspective bioenergy had an image problem. The industry's concerns about public ignorance and negative attitudes paved the way for presentations about how they could engage the public to improve the perception of bioenergy. As an outsider observing from a science and technology studies perspective, I found this illuminating. The bioenergy industry's efforts to improve the reputation of bioenergy are examples of what

[1] This paper is forthcoming in Nina Möllers and Karin Zachmann (eds.): "*Past and Present Energy Societies. How Energy Connects Politics, Technologies and Cultures*", to be published on Transcript Verlag in May, 2012. See http://www.transcript-verlag.de/ts1964/ts1964.php

[2] The Norwegian bioenergy industry is quite small, but includes players working with many fuels and technologies like pellets, wood chips, biogas, biodiesel and ethanol. See Norsk Bioenergiforening: *Bioenergi i Norge*. Oslo: Nobio, 2010.

[3] Geir Skjervak: "Kvar Blir det av det Store Pelletsløftet i Noreg?" Conference paper, "Bioenergidagene 2009", Rica Nidelven Hotell, 23-24.11.2009.

[4] 'Bioenergy' refers to energy derived from biological sources. It is considered a renewable form of energy and often highlighted in policies meant to increase the share of renewable energy technologies. See e.g. European Parliament: "Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources", in: *Official Journal of the European Union*, 5.6.2009.

[5] 'The public' as a concept has a long tradition in subjects like philosophy and political science. See e.g. Jürgen Habermas: *The Structural Transformation of the Public Sphere*. Cambridge, MA: MIT Press, 1989. In my paper, I use the notion of 'the public' as it appears in the literature on 'Public Understanding of Science and Technology'. Here, 'the public' is used pragmatically, to describe actors implicated by scientific or technological activity. For more, see the section entitled "From Publics to Imagined Publics" in this paper.

Bruno Latour and others refer to as translation; that is strategies to enlist and interest others to their technology.[6] Thus, the conference participants had moved beyond the ideas postulated in the linear models of innovation and diffusion where the success or failure of technologies is largely seen as determined by the technology's technical and economic properties.[7] Rather, the participants proposed translation strategies that sought to attach bioenergy to positive symbolic universes, for example through presenting it as a futuristic, simple, climate friendly or economically sound competitor to other energy technologies.[8]

Inspired by this, the point of departure for this paper is an interest in the development of such strategies. Specifically, I am interested in the rationale behind their formulation. In most presentations at the conference this rationale was anchored in beliefs about the nature of the collective referred to as 'the public' and beliefs about 'public' perception of bioenergy. In this paper I examine the relationship between the bioenergy industry and this collective from the perspective of industry actors, policy and decision makers. Empirically, I will examine two questions:

1) How do the actors who work to improve the position of bioenergy perceive this collective – how do they imagine 'the public'?

2) How do such imagined publics influence the formulation of strategies of public engagement?

I pursue these questions comparatively, looking at Norway and Sweden. The paper is based on fieldwork from these countries conducted in 2009-2010, and on studies of newspapers from 2007-2009.

The paper is structured as follows. I set out to outline the theoretical foundations of the concept 'imagined publics', before looking at earlier studies of imagined publics of renewable

[6] Bruno Latour: *Science in Action*. Cambridge, MA: Harvard University Press, 1987, 132.

[7] The linear model of innovation's origin is unclear. See Benoit Godin: "The Linear Model of Innovation. The Historical Construction of an Analytical Framework", in: *Science, Technology & Human Values* 36:4 (2006), 639-667 for a discussion of how the model has shaped thinking on innovation and technology diffusion over the last 50 years.

[8] E. g. Anne Jordal: "Korleis Utvikle og Lansere Meir Konkurransedyktige Pelletskaminar?" Conference paper, "Bioenergidagene 2009", Rica Nidelven Hotell, 23-24.11.2009, discussed framing pellet ovens as 'future heat' or 'automated stoves' arguing that this would convince 'the public' about the environmental potential and convenience of pellet heaters. These symbolic frames would bring customers to pellets who would otherwise buy air-to-air heat pumps.

energy. I proceed to present the paper's methodology before examining the context for this discussion: Norway and Sweden as energy regimes, focusing on bioenergy. Also, a brief analysis of how Norwegian and Swedish newspapers have covered bioenergy is presented. I then move on to the discussion on bioenergy and its imagined publics in Norway and Sweden.

From Publics to Imagined Publics

For the last 25-30 years a body of literature has been engaged with what has been labelled 'public understanding of science and technology' (PUS).[9] This line of thought emerged in response to the influence of 'the deficit model of public understanding'.[10] Here, public opposition to and concerns about scientific and technological development is rooted in a lack of public knowledge or understanding of science and technology.[11] Thus, technologies or science are not seen as problems, 'the public' is. A typical policy response to this understanding of public agency has been to employ top-down approaches to by-pass public concerns.[12]

This has been criticized by the PUS literature, first by a call for attention to possible 'public' participation in science and technology,[13] a critique highlighting "opposition between technocracy and public participation".[14] Now the idea of public participation has been refined to the point where 'participation' is no longer necessarily a goal, but one of many forms of 'public engagement' with science and technology.[15] Recently, scholars have found

[9] Steve Miller: "Public Understanding of Science at the Crossroads", in: *Public Understanding of Science* 10:1 (2001), 115-120 dates the start of this intellectual tradition to a publication by the Royal Society in the UK entitled "The Public Understanding of Science" from 1985.

[10] See Alan G. Gross: "The Role of Rhetoric in the Public Understanding of Science", in: *Public Understanding of Science* 3:1 (1994), 3-23 for a discussion on this model's influence.

[11] Steve Rayner: "Democracy in the Age of Assessment: Reflections on the Roles of Expertise and Democracy in Public-Sector Decision Making", in: *Science and Public Policy* 30:3 (2003), 163-170.

[12] E.g. John Durant: "Participatory Technology Assessment and the Democratic Model of the Public Understanding of Science", in: *Science and Public Policy* 26:5 (1999), 313-319.

[13] E.g. Edna F. Einsiedel, Erling Jelsøe and Thomas Breck: "Publics at the Technology Table: The Consensus Conference in Denmark, Canada and Australia", in: *Public Understanding of Science* 10:1 (2001), 83-98 or Heather Dietrich and Renato Schibeci: "Beyond Public Perceptions of Gene Technology: Community Participation in Public Policy in Australia", in: *Public Understanding of Science* 12:3 (2003), 381-401.

[14] Noortje Marres: "The Issues Deserve More Credit", in: *Social Studies of Science* 37:5 (2007), 759-780, 766.

[15] Gene Rowe and Lynn J. Frewer: "A Typology of Public Engagement Mechanisms", in: *Science, Technology and Human Values* 30:2 (2005), 251-290.

'engagement with' the public to be an industry and government norm, particularly for those working with controversial science or technology.[16]

A related question deals with how industry and policy makers formulate strategies of public engagement – and further, about the rationale behind their formulation. These are the questions that primarily interest me in this paper. One way to address this is to look for subtle and indirect links between collectives like 'the public', the industry and policy makers. Inspired by what Allesandro Maranta and colleagues coined 'imagined laypersons'[17] in a discussion of how experts think non-experts relate to their activity, a recent strain of literature has studied such matters via the idea of 'imagined publics'.[18] Their premise is simple. These authors claim that 'the public' does not carry agency only through action. Rather, 'the public' is also powerful as an idea. When industrialists and policy makers make decisions, they do so in light of an imagined public response.[19] Imagined publics give life to "shared repertories and expectations amongst actors in technical-industrial networks", expectations which are "anticipated and internalised into organisational practices and working practices". [20] Thus, there is reason to believe that while studying the Norwegian and Swedish bioenergy industry I will find links between their imagined publics and their actual practice of public engagement.[21]

---

[16] Related to renewable energy see Julie Barnett, Kate Burningham, Gordon Walker, and Noel Cass: "Imagined Publics and Engagement around Renewable Energy Technologies in the UK", in: *Public Understanding of Science*, published online before print on June 30, 2010, http://pus.sagepub.com/content/early/2010/06/21/0963662510365663.abstract.

[17] Allesandro Maranta, Michael Guggenheim, Priska Gisler, and Christian Pohl: "The Reality of Experts and the Imagined Lay Person", in: *Acta Sociologica* 46:2 (2003), 150-165.

[18] E.g. Brian Wynne: "Reflexing Complexity. Post-genomic Knowledge and Reductionist Returns in Public Science", in: *Theory, Culture and Society* 22:5 (2005), 67-94.

[19] These ideas are not entirely new. In 1927, John Dewey wrote that political orders "impute a public only to support and substantiate the behaviour of officials" – thus, publics are imagined to legitimate and give substance to government systems. Dewey cited in Rebecca Ellis and Claire Waterton: "Environmental Citizenship in the Making: The Participation of Volunteer Naturalists in UK Biological Recording and Biodiversity Politics", in: *Science and Public Policy* 31:2 (2004), 95-105, 103.

[20] Gordon Walker, Noel Cass, Kate Burningham and Julie Barnett: "Renewable Energy and Sociotechnical Change: Imagined Subjectivities of 'the public' and their implications", in: *Environment and Planning* 42:4 (2010), 931-947, 943.

[21] Several studies dealing with 'public perception' of bioenergy exist. Typically, they use quantitative methods to measure 'public attitudes' towards bioenergy. E.g. Henrik Karlstrøm: *Den Deregulerte Forbruker,* Trondheim: Institutt for Tverrfaglige Kulturstudier finds roughly 70 percent of Norwegians to be positive towards bioenergy. A focus on 'imagined publics' complements this approach, by showing how public imaginaries inform industrial behaviour.

Studies of imagined publics are particularly pertinent if the science or technology is controversial. Earlier studies show that renewable energy projects generally[22] and bioenergy projects particularly[23] are prone to controversy; frequently surrounded by supporters, protesters and debate. This is probably why there already exist a number of studies dealing with the imagined publics of renewable energy technology. What can be learned from these studies?

Most existing literature is concerned with the imagined publics of the renewable energy industry in the UK. Gordon Walker and Noel Cass argue that prior to the liberalisation of the UK energy utilities and infrastructure in 1989, 'the public' was imagined as "'end-of-wire' captive consumers".[24] Following the liberalisation and the tailing variety in modes of energy production, the importance of 'the public' has increased and its roles have multiplied. The authors identify publics imagined as captive consumers, active consumers, service users, green investors, local beneficiaries, project protestors, project supporters, project participants, technology hosts and energy producers.[25] This plurality is reflected elsewhere. Kate Burningham and colleagues found publics imagined as 'users' or as 'neighbours'.[26] Julie Barnett and colleagues[27] found publics imagined as ignorant or concerned about renewable energy developments and that the renewable energy industry imagined the public through the 'deficit model of public understanding'.[28] This public imaginary, the authors claim, led to the formulation of strategies of public engagement meant to educate the public, and to rectify public concerns. Similarly, Gordon Walker and colleagues[29] found the renewable energy industry to imagine its publics as opposed to renewable energy based on the NIMBY ('not in my back yard') concept.[30] Thus, the industry sees publics mostly as hostile obstacles to their

[22] Gordon Walker: "Renewable Energy and the Public", in: *Land Use Policy* 12:1 (1995), 49-59.

[23] Bishnu Raj Upreti and Dan van der Horst: "National Renewable Energy Policy and Local Opposition in the UK: the Failed Development of a Biomass Electricity Plant", in: *Biomass and Bioenergy* 26:1 (2004), 61-69.

[24] Gordon Walker and Noel Cass: "Carbon Reduction, 'the Public' and Renewable Energy: Engaging With Socio-technical Configurations", in: *Area* 39:4 (2007), 458-469, 466.

[25] Walker and Cass: "Carbon Reduction, 'the Public' and Renewables". 465

[26] Kate Burningham, Julie Barnett, Anna Carr, Roland Clift and Walter Wehrmeyer: "Industrial Constructions of Publics and Public Knowledge: A Qualitative Investigation of Practice in the UK Chemicals Industry", in: *Public Understanding of Science* 16:1 (2008), 23-43.

[27] Barnett, Burningham, Walker, and Cass: "Imagined Publics and Engagement in the UK".

[28] Gross: "The Role of Rhetoric in the Public Understanding".

[29] Walker, Cass, Burningham and Barnett: "Renewable Energy and Sociotechnical Change".

[30] The NIMBY concept has been criticised as a theoretical model for explaining negative attitudes towards renewable energy. However, empirical research suggests that NIMBYism is still understood by industrial players and policy makers as the main obstacle to renewable energy developments. See

development. To summarize past research on imagined publics of renewable energy, Dandy Norman's words seem fitting: "The actors in the renewable energy industry have a strong tendency to define 'the public' as 'concerned'". Further, he notes that this has "strong impacts on the 'engagement' activities" of the actors involved.[31]

Based on the studies from the UK cited above, it is likely that the study of the Norwegian and Swedish bioenergy players will reveal a plurality of imagined publics. One way to categorise this plurality is Mike Michael's differentiation between 'publics in particular' (PiPs) and 'publics in general' (PiGs).[32] While discussing publics in relation to science, his argument is that PiGs are defined in relation to 'science' in general while PiPs are defined in relation to particular scientific enterprises. As an example, 'science' has one public (PiG), while the human genome project has another (PiP). This differentiation is applicable also to bioenergy. 'Bioenergy' as a generic concept has one public (PiG), particular bioenergy enterprises such as a combined heat and power plant or a particular bioenergy company might have another (PiP). In Michael's account, PiPs tend to form around particular issues, resulting in publics having strong interests. Therefore, they are often either project protesters or project supporters.[33]

It will be interesting to see if Norwegian and Swedish bioenergy actors differentiate between PiPs and PiGs, and whether or not they have moved beyond imagining the public through the deficit model of public understanding.

Methodology

The methodology mobilized here is two-fold. First, I set out to analyse how Norwegian and Swedish newspapers cover bioenergy. By studying 437 Norwegian and 598 Swedish newspaper articles[34] I shed light on how bioenergy is communicated in contemporary Norway and Sweden. This information is used to generate hypotheses about Norwegian and Swedish bioenergy actors and their imagined publics.

---

e.g. Patrick Devine-Wright: "Beyond NIMBYism: Towards an Integrated Framework for Understanding Public Perceptions of Wind Energy", in: *Wind Energy* 8:2 (2005), 125-139.

[31] Dandy Norman: *Stakeholder Perceptions of Short-rotation Forest for Energy*. Farnham: Forrest Research, 2010, 11.

[32] Mike Michael: "Publics Performing Publics: Of PiGs, PiPs and Politics", in: *Public Understanding of Science* 18:5(2009), 617-631.

[33] Walker and Cass: "Carbon Reduction, 'the Public' and Renewable Energy".

[34] Three Norwegian and Swedish newspapers were accessed. The Norwegian papers were *Adresseavisen*, *Aftenposten* and *Verdens Gang*; the Swedish were *Östgöta Correspondenten*, *Svenska Dagbladet* and *Aftonbladet*. The papers were accessed via the media database Retriever.

The second source of data consists of interviews with 44 persons in Norway and Sweden,[35] six issues of the Norwegian professional journal 'Bioenergi'[36] and six issues of the Swedish equivalent journal[37] (also named 'Bioenergi'). The interviewees were players in the bioenergy industry, public employees and decision makers working with bioenergy as well as scientists working with bioenergy. The interviews were 40 minutes to two hours long, and recorded and transcribed before they were coded and analysed. The analysis and coding were inspired by Grounded Theory.[38] Here, pieces of data are compared with each other and with the emergence of similarities and differences groups of categories are formed. These categories form the basis for the analysis of how the Norwegian and Swedish bioenergy actors imagine the publics of bioenergy.

The Need to Introduce Bioenergy: Norway and Sweden as Energy Regimes

Norway and Sweden are ideal contrasts since they represent different 'energy regimes'. In Norway, almost all electricity is hydropower.[39] Much of this is used for space heating.[40] In principle, this stationary energy base is 'green', which could indicate that there is little need to introduce bioenergy. Two aspects complicate this. First, Norway is actually a net importer of electricity in a 'normal' year,[41] which means that the consumed electricity is not necessarily 'green'. Second, there has been an increased focus on energy efficiency and energy quality. In

[35] All interviews used as data for this paper was carried out by the author with the exception of three Norwegian interviews conducted together with Gard H. Hansen. The interviews were conducted in Norwegian and Swedish. All quotes in this paper, both from interviews and written sources have been translated to English by the author. The interviewees have been anonymized and are presented with pseudonyms.

[36] *Bioenergi*: 3-6, 2009 and 1-3, 2010. Professional journal published by the Norwegian bioenergy association.

[37] *Bioenergi*: 3-6, 2009 and 1-3, 2010. Professional journal published by the Swedish bioenergy association.

[38] Anshelm Strauss, Juliet M. Corbin: *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Newbury Park, CA: Sage, 1990.

[39] IEA Energy Statistics: "Electricity/Heat in Norway in 2008", 2008, http://iea.org/stats/electricitydata.asp?COUNTRY_CODE=NO, Accessed: 01.09.2011

[40] Norway uses the largest share of electricity for space heating of all countries studied by the IEA. See Fridtjof Unander, Ingunn Ettestøl, Mike Ting and Lee Schipper: "Residential Energy Use: An International Perspective on Long-Term Trends in Denmark, Norway and Sweden", in: *Energy Policy* 32:12 (2004), 1395-1404.

[41] Marit Tyholt, Anne Grete Hestnes: "Heat Supply to Low-energy Buildings in District Heating Areas: Analysis of CO2 Emissions and Electricity Supply Security", in: *Energy and Buildings* 40:2(2008), 131-139.

this perspective it is better to use electricity for purposes other than space heating.[42] Thus, bioenergy has primarily been given political attention in Norway as a potential replacement for space heating based on hydroelectricity.[43] Parliament representative Trond Martin Sæterhaug summarized this notion in 2009 stating that "using electrical power for space heating is like bathing in champagne".[44]

Despite its 'green' and 'efficient' qualities, bioenergy is a marginal technology in Norway with an annual consumption of 14.5 TWh[45] or around 6 percent of all energy consumed.[46] Even if the goal of doubling this by 2020[47] is met, it will remain a niche, a modest addition to the Norwegian energy total. Instead, the major Norwegian energy-political effort over the last years has been geared towards developing carbon capture and storage (CCS) and the employment of this in gas power plants.[48]

The Swedish situation is different with a historically more diverse energy production. Fossil fuels, hydroelectricity, and nuclear power have all been important.[49] Today, Sweden has one of the highest consumption rates of bioenergy in the world.[50] Bioenergy started to receive attention in Sweden in the 1970s. It was first seen as a means to rid Sweden of its dependence on foreign fossil fuels and nuclear power, and later as a tool to mitigate climate changes.[51] Bioenergy broke through to the mainstream of Swedish energy technologies in the

---

[42] Ivar S. Ertesvåg, Michael Mielnik: "Exergy Analysis of the Norwegian Society", in: *Energy* 25:10(2000), 957-973, 957 say: "The notion of energy quality follows from the second law of thermodynamics. Some forms of energy can be converted into any other form, whereas other forms cannot. Electricity can be converted into mechanical work or into heat. For practical purposes, hot-water thermal energy can most often only be used for heating. On the other hand, for space heating hot waste-water suffices, whereas an aluminium plant requires electrical energy".

[43] Olje og Energidepartementet: *Strategi for økt utbygging av bioenergi*, Olje- og Energidepartementet, 2008, http://www.regjeringen.no/upload/OED/Bioenergistrategien2008w.pdf, Accessed: 04.07.2011.

[44] Håkon Arntsen, Sivert Rossing: "Fikk 15 Millioner til Strømsparing i Fylket", in: *Trønderavisa*, 15.09.2009.

[45] Olje og Energidepartementet: *Strategi for økt utbygging av bioenergi,* 7

[46] This number includes the transport sector. See Statistisk Sentralbyrå: "Energi". http://www.ssb.no/energi/, Accessed: 01.09.2011.

[47] Olje og Energidepartementet: *Strategi for økt utbygging av bioenergi*, 12

[48] Andreas Tjernshaugen: "Fossil Interests and Environmental Institutions: The Politics of CO2 Capture and Storage" (Unpublished Ph.D diss. Universitetet i Oslo, 2009).

[49] See e.g. Arne Kaijser, Marika Hedin: *Nordic Energy Systems. Historical Perspectives and Current Issues*. Canton, MA: Watson Publishing International, 1995.

[50] Energimyndigheten: *Energiförsörjingen i Sverige*. Energimyndigheten, 2009.

[51] Jonas Anshelm: *Att ersätta kärnkraften med bioenergi - om en omstridd idé i den offentliga energipolitiska debatten i Sverige 1979-2000.* Linköping: Tema T, Linköpings Universitet, 2009 and Ann-Sofie Kall: "Förnyelse med förhinder" (Unpublished Ph.D diss. Linköpings Universitet, 2011).

early 1990s[52], a decade characterised by a 'greening' of the Swedish welfare state. It has been at the core of Swedish energy policy since 1997[53], acting as a 'politically harmonizing technology' by bridging a gap that existed between advocates of nuclear power and renewable energy technologies.[54] Today, bioenergy accounts for roughly one third of the total Swedish consumption. Its share is larger than fossil fuels, nuclear power and hydroelectricity.[55]

Thus, the roles of bioenergy in Norway and Sweden are substantially different. In Norway, it is a niche technology, primarily introduced to replace electricity for space heating. It is at the core of Swedish energy policy and is currently the largest energy producing technology in this setting. How will these circumstances influence the imagined publics of bioenergy in Norway and Sweden? To generate hypotheses about this I will now look briefly at how Norwegian and Swedish newspapers have covered bioenergy.

Broadening the Context: Norwegian and Swedish Media Coverage of Bioenergy

The reading of the analysed newspapers shows substantial differences between the coverage of bioenergy in Norway and Sweden. In summary the Swedish newspapers are more supportive of bioenergy than the Norwegian. The Swedish newspapers support bioenergy through presenting it as 'green' or 'environmentally friendly'[56], but also as competitive in other ways. Bioenergy is presented as a safe and comfortable technology[57] that has brought wealth and prosperity to local communities.[58] It is frequently described in patriotic terms, as a 'Swedish' way of being green, an area where the rest of the world seeks Swedish aid.[59] In summary – the technology is presented as good for the wallet, good for the climate, and good for Sweden.

---

[52] Kall: *Förnyelse med förhinder,* 143-199

[53] E.g. Atle Midttun, Mari Hegg Gundersen, Anne Louise Koefoed: "Greening of Nordic Electricity Industry: Policy Convergence and Diversity", in: *Energy & Environment* 15:4(2004), 633-656

[54] Kall: *Förnyelse med förhinder*, 172.

[55] Energimyndigheten: *Energiförsörjingen i Sverige*, 35.

[56] Svenska Dagbladet: *Satsar Stenhårt på att Förse Polen med Miljövennlig Fjärrvarme,* 29.07.2009 is a typical example highlighting the 'green' aspect of the technology.

[57] E.g. Svenska Dagbladet: *Elda snyggt och säkert*, 12.12.2009 notes how bioenergy heating solutions are better than other solutions at providing heat, but also in terms of aesthetics and safety.

[58] E.g. Östgöta Correspondenten: *Linköpingsföretag gör Milliardaffär*, 05.06.2010 discusses bioenergy primarily as a local-industrial stimulant and generator of wealth.

[59] E.g. Östgöta Correspondenten: *Sydkoreansk Stad vill Lära av Linköping*, 12.05.2010 shows how a South-Korean town wants to learn from a Swedish town, while Östgöta Correspondenten: *Världsnaturfonden Lyfter Fram Linköpingsföretag*, 30.09.2010 highlights how the World Wildlife Fund praised a Swedish bioenergy company.

The Norwegian press is less supportive. It does not portray bioenergy negatively, but with ambiguity and ambivalence. Bioenergy is presented as 'green'[60], but this is not sufficient, because it is always compared with other energy technologies that are seen as technically and economically superior.[61] In other words, the Norwegian story about bioenergy is a story about a 'green' technology, but… as an energy technology it is seen as falling short based on technical and economic arguments.

Furthermore, bioenergy was described in the newspapers with a third set of arguments in both countries. The production of bioenergy was cast against the production of food, resulting in bioenergy being framed as a controversial symbol of the North's dominance over the South.[62]

How does all of this influence the investigation of imagined publics of bioenergy in Norway and Sweden? First, earlier research has found publics imagined as 'concerned' about or opposed to renewable energy developments[63], framed through the deficit model of public understanding.[64] In the following I expect to find such imagined publics in both Norway and Sweden. Second, the role of bioenergy differs in Norway and Sweden. As a marginal Norwegian technology its expansion will be tailed by the construction of facilities – changing landscapes, creating noise and smell, increasing traffic and other controversial side-effects. The ambivalent Norwegian newspaper coverage might be a hint of such controversy. There is less of this in Sweden, since much infrastructure needed to distribute bioenergy is already in place. Thus, I expect publics explicitly imagined through mobilisation of the NIMBY concept in Norway while I believe there will be less of this in Sweden. Third, the patriotic coverage of bioenergy in Swedish newspapers and the position of bioenergy in Sweden suggest publics to be imagined more positively.

---

[60] E.g. Aftenposten: *Lover mer enn Enoksen*, 22.09.2007 portrays bioenergy as the 'green coal of the future'.

[61] Adresseavisen: *Spår Vannkraft-Boom i Norge*, 25.09.2009 suggests that hydroelectricity and gas power-plants are the future, while Adresseavisen: *Søker om forlengelse*, 22.12.2008 writes that compared to competing technologies bioenergy is 'unsuitable'.

[62] Verdens Gang: *Matvaregiganter i Heftig Krangel*, 10.08.2007, Aftenposten: *Det Sier seg Selv at vi har et Problem*, 11.09.2009, Aftonbladet, *Etanolen Skövlar Naturen*, 28.07.2007 and Svenska Dagbladet, *Världensbanken Pekar på Biobrensle*, 07.07.2008 are all examples of coverage presenting bioenergy primarily as a competitor to food production.

[63] Barnett, Burningham, Walker, Cass: "Imagined Publics and engagement"; Walker and Cass: "Carbon Reduction, 'the Public' and Renewable Energy"; Walker, Cass, Burningham and Barnett: "Renewable Energy and Sociotechnical Change" and Norman: *Stakeholder Perceptions.*

[64] Gross: "The Role of Rhetoric in the Public Understanding".

Imagining the Publics of Bioenergy in Norway and Sweden

The interviewees in both countries had clear ideas about 'the publics' of bioenergy. Altogether five ideal typical domestic imagined publics were found; two Swedish and three Norwegian. Further, many Norwegian actors related their stories so explicitly to Sweden that they ended up imagining a Swedish public. As we shall see, the imagined publics frequently informed the bioenergy players' strategies of public engagement.

The Local Publics

In both countries, the most prominent imagined publics were 'local' publics. In Norway local publics were imagined as 'neighbours' or 'protesters' of specific projects. Local publics were imagined as PiPs[65] (publics in particular) with strong interests related to particular facilities, products or companies. As expected, these publics were regarded in light of the NIMBY concept and understood by the interviewees as selfishly concerned about how bioenergy developments would disturb local communities in terms of aesthetics and safety. This was related to issues like visual pollution, increased traffic, reduced air quality, foul smell, and so forth. One example was given by the manager of one of the largest Norwegian biogas facilities. He imagined the public in relation to the companies' experiences with the construction of a biogas plant a few years back:

> "Well, we were not allowed to build the plant where we wanted. It was a political decision. […] Basically the decision was based on fear. Fear of birds [and other vermin that the plant might attract], smell, all kinds of stuff. The public was very much against us. There were demonstrations and we didn't really get the message across. It's not so easy when everyone is against you, and this is quite typical for our kind of operation".[66]

While some imagined the publics based on earlier interaction with groups of opponents, other accounts were anchored in what appeared as an industrial mode of 'common sense' regarding how publics of bioenergy act. For example, the head of a district heating company imagined the public as responding to their technology instinctively based on NIMBY logic:

> "I think it's the same everywhere, at least for the technology we work with. Every time someone has a new project, there are these reactions, especially from the neighbours who begin with their protests as soon as they hear about it. It's not simple, of course.

[65] Michael: "Publics Performing Publics: Of PiGs and PiPs".
[66] Interview with manager Andre Jørgensen in his office, 30.09.2009.

> The public suddenly doesn't care so much about the climate and the environment when it comes to this".[67]

The development of a bioenergy industry in Norway will affect local communities substantially through construction work. In many cases the result will be an altered landscape with new industrial facilities. As in the quotes above, the bioenergy industry imagines the publics as opposed to such development. This view often leads the industry to craft strategies of public engagement meant to limit the impacts of opposition. The manager of the district heating department of a large energy utility explained how engaging with the public was vital prior to announcing the construction of a new facility:

> "Well, you can't just go ahead and say that you have decided about the location of a plant. For us, we take preliminary rounds with different departments at the administrative level, and we have meetings with the boards of various cooperative housing associations nearby, very lively meetings. Then we inform the municipal opposition, and then the board of the neighbourhood. We do all this before officially saying what we have decided, because keeping a dialogue with the public is considered important. Although all this takes some time, it minimizes the risk of having the regulation application thrown back in our faces with an answer of finding an alternative location".[68]

The quote illustrates how 'public engagement' through communication at various levels is considered an industry norm. However, it is not done for the sake of the public. The goal is not public participation in the decision making process, the engagement is meant to limit the impact of expected opposition.

The local imagined publics in Sweden were different. These were not imagined as neighbours or protesters, but as passive consumers. As such, however, they were imagined as a group without a direct relationship to bioenergy. Instead, they were considered consumers of services, hooked up to an infrastructure where bioenergy was important. In other words, this public was imagined to buy heat, electricity, bus fares and cars, while bioenergy was imagined as 'invisible' to the public. The Swedish interviewees did not imagine publics via the NIMBY concept found in Norway or the UK.[69] A manager at a large Swedish wood chips and pellet producer described the situation in this manner:

---

[67] Interview with manager Bernt Knutsen at district heating facility, 20.10.2009.
[68] Interview with department manager Christian Haugen in his office, 12.10.2009.
[69] E.g. Walker, Cass, Burningham and Barnett: "Renewable Energy and Sociotechnical Change".

> "The Swedish public, I guess, is largely positive towards bioenergy, or perhaps more precisely: it is ignorant about it. I mean, I don't think most people are aware of how important it is, and that it heats their homes and actually provides the light in their light bulbs. And I think this is a good sign – as long as it works, people don't care where the energy comes from".[70]

Similar sentiments were expressed by a market trader for stationary biofuels:

> "The average Swede […] does not care about bioenergy. He has a vague idea about it being something other than coal and fossil fuels, and the label 'bio' suggests that it is green. As long as it works, the Swede is quite happy".[71]

It is noteworthy that the interviewees did not see the imagined public's ignorance as a problem; in fact some respondents interpreted it as a seal of approval. A senior employee at the transport office of Linköping Municipality highlighted this by showing that the ignorance and approval had not always been there. When bioenergy was introduced, it was associated with occasional problems, resulting in bioenergy becoming the scapegoat:

> "People are not riding the bus because it is powered by biogas; they ride the bus because they need to go somewhere. And today, biogas works as well as any other fuel, and the air quality is much better now than when the buses used diesel. But in the beginning, there were some problems with the biogas buses. They did not work properly in the winter, and as you know it can be quite cold in Linköping during those months. And then some people certainly raised their voices against biogas".[72]

This illustrates the difference between imagining publics of novel, potentially controversial technology and of a smoothly working infrastructure. This point might seem trivial, but it suggests that while the technology improves, the nature of the relationships between 'publics' and industry changes. The imagined public is altered from active complainers to ignorant and unaware consumers. This also seems to have had an influence on how the industry players reflect on the need for public engagement. One interviewee highlighted that the most important thing they could do was to "produce as good services as we possibly can so that they stay happy".[73] Another said it was important to "listen if the public reported any

[70] Interview with manager Dan Eklund in his office, 07.04.2010.
[71] Interview in market trader Einar Carlström in his office, 20.04.2010.
[72] Interview with senior employee Frederica Jansson in her office 24.04.2010.
[73] Interview with manager Gunnar Lögnes in his office, 13.04.2010.

concerns".[74] In other words, public engagement appeared less important when the publics were not imagined as problems.

In summary, bioenergy in Sweden has been described as invisible and the publics imagined as blissfully ignorant. For the majority of bioenergy players this was unproblematic. As we will see, however, there was one deviation from this way of framing the relationship between bioenergy and its publics. Here too, bioenergy was seen as an invisible aspect of daily life, but this was considered a democratic deficiency problem. The argument was that the public needed to know and understand the energy technology if they were to make informed decisions, a concern that was first and foremost raised by the Swedish bioenergy association through the industry journal 'Bioenergi'. One article stated:

> "Ask your neighbour, your cousin or a large share of the Swedish public […] and most will completely have missed the remarkable development that has happened and that continues today".[75]

A similar article highlighted that the public should "wake up and realise how important bioenergy is".[76] This image of deficiency on behalf of the public was accompanied by voices highlighting that the public needed to be engaged through information. An editorial stated:

> "First and foremost we want the energy authorities to do a better job when they present statistics so that journalists and others can do a good job when informing the public [...] [I]f this is not done we have to fill that gap […] [I]n a democracy it is important that the public gets relevant or accurate information, or they cannot produce informed opinions".[77]

Thus, where some saw the imagined publics' ignorance as unproblematic; others saw it as a problematic call for public engagement, primarily through strategies of information.

The Public as Customers

In both countries I also discovered publics imagined as customers. These are examples of publics in particular, imagined in relation to specific bioenergy products. In Norway, such publics were understood via the deficit model of public understanding as ignorant and

[74] Interview with senior employee of company producing wood chips, Harald Ström at production site, 17.04.2010.
[75] Anders Haaker: "Är Bioenergi Något Nytt?" in: *Bioenergi* 1 (2010), 9.
[76] Jan Ridfeldt, Gun Blomquist Bergman: "Underskatta Inte Bioenergins Betydelse!" in: *Bioenergi* 3 (2010), 44-45.
[77] Gustav Melin: "Kylan, Värmen och Elen", in: *Bioenergi* 1 (2010), 11.

disinterested in relation to the products offered by the bioenergy industry. Here, the disinterest was seen as a problem for the industry since it was understood to result in non-consumption.

This articulation of the public was particularly prominent amongst respondents working with pellets. These actors imagined their public as people in the market for a new heating solution. The interviewees claimed that this group was uninformed about the possibilities of bioenergy and therefore chose competing solutions. The manager of a leading pellets company framed the problem in the following way:

> "We have tried everything to increase the sales, but it feels as difficult as cracking the DaVinci code. The problem for us is that people don't know about pellet heaters. The sales persons have to spend a lot of time explaining how they work, and the consumers take a long time to decide. For us, branding and information towards the public are prioritised tasks."[78]

Similar sentiments were presented by a senior representative of a company that shortly before I interviewed them had decided to abandon the private market in favour of the municipal heating market. Public ignorance and lack of knowledge were highlighted as integral to the decision:

> "Selling to municipalities and public agencies is one thing. They are professionals. They have engineers that make decisions and personnel such as janitors that can be trained. Individuals and normal households do not have this, so they generally tend to choose other solutions such as heat pumps – often because of misunderstandings."[79]

Several respondents related the perceived knowledge deficit to aspects like lack of trust, familiarity or experience with the technology. Thus, they engaged the public to increase its knowledge of the technology. This was done through standard information and advertisement campaigns, but also through more direct engagement. In one case, a company tried to establish a new network of pellet users by providing the public with technology free of charge:

> "We are trying to get the information directly to the customers. And we think that if they know someone who uses a pellet heater and is happy with it they might consider it themselves. So what we did was to produce flyers that we gave to every household in the region where we highlighted the benefits of pellets and promised that we would

[78] Interview with manager Ingrid Johnsen over the telephone, 22.07.2009.
[79] Interview with senior representative Jan Andresen in company sales hall, 19.05.2009.

install pellet heaters and allow people to use them – free of charge – for a period of time. If they were not happy, we would also collect the heater, free of charge."[80]

When Swedish respondents imagined the public as customers, they did so differently. Their imagined public was quite local in character, probably due to the situation in the area where the interviews were conducted. The public as customers were not the imagined publics of 'bioenergy', but rather the imagined public of a cluster of companies and research institutions that worked with biogas.

This public was imagined as supportive of bioenergy both by politicians and companies with a regional profile. They clearly imagined the publics outside the deficit model of public understanding as a proud group of customers with a preference for 'green' products. The head of one large regional biogas company explained:

> "The public is very interested in what we do, and I actually think they are somewhat proud of this company. This is one of the few things that we here at this little place are best at in the world, and I have the feeling they appreciate that."[81]

The public was imagined as a resource, a source of opportunity and potential. A representative of the environmental office in Linköping municipality elaborated:

> "Bioenergy is popular, absolutely. Take biogas as an example. More and more customers are buying biogas cars, more and more people are thinking about it. There is a great public acceptance of the technology, and I will also claim – a pride in it."[82]

Many actors highlighted an appreciation for the public support, and that their engagement with the public was aimed at maintaining the positive relationship. A senior employee at the traffic department of Linköping municipality gave an example:

> "A few times a year we have these events that we call 'open municipality'. Basically, what happens is that the different offices of the municipality set up stands at town square, and then people can come chat with us about whatever they want. And this has been important, for instance in relation to the biogas projects, to avoid any confusion. I mean, there have been instances when someone has been concerned, but through these events there is a direct line of sorts, and most of the times we are able to cool down the worries."[83]

---

[80] Interview with manager Kristine Vold over the telephone, 03.08.2009.
[81] Interview with manager Lars Knutson in his office, 20.04.2010.
[82] Interview with environmental office representative Monica Fall in municipal office, 15.04.2010.
[83] Interview with senior employee Nils Åkerfeldt in traffic office, 13.04.2010.

In other words, the respondents still deemed public engagement through conveying positive images of bioenergy important, despite the unproblematic relationship with the public, and maintained that this was best done through two-way communication.

The Strange Norwegian PiG and its Swedish Cousin

So far, the publics have been imagined as publics in particular in relation to specific bioenergy projects or specific bioenergy products. In Norway, I also discovered an imagined public in general (PiG), primarily imagined by 'experts' – scientists, employees of public agencies, and others more indirectly related to the bioenergy industry. They imagined 'the public' as less tangible and localizable than 'neighbours', 'protesters' or 'customers'. Instead, they imagined an abstract 'Norwegian public' that was opposed to bioenergy because it was incompatible with the idea of 'pure nature', an idea believed to be cherished by the Norwegian public. An employee of a public agency working with bioenergy in Sør-Trøndelag explained how this mentality differed between Sweden and Norway:

> "There is a difference in mentality between Sweden and Norway. I mean, hacking away on the forests with the goal of extracting as much as possible biomass would be politically very difficult here. Take this thing with stumps. People wouldn't accept the kinds of large scale interventions into nature that we would need to extract them at any reasonable scale here in Norway. That would be extremely controversial."[84]

The imagined publics' reaction to bioenergy was a question of bioenergy vs. nature; a battle lost by bioenergy. As in the quote above, many interviewees contrasted the 'Swedish public' to the Norwegian. The Swedish public was seen as an 'ideal public', readily accepting issues seen as problematic in Norway. Thus, the respondents not only imagined a Norwegian PiG, but also a Swedish PiG, more positive towards bioenergy than reported by the Swedes. Another example of the public imagined this way was presented by a Swedish professor working at a Norwegian university:

> "It is a sort of strange thing this bioenergy here in Norway. In many ways it has become something negative, something bad. Take the environmental movement, for example. You can almost say that in Sweden, they are pro bioenergy, whereas they are basically against it here in Norway. And if you go to an industry conference here in Norway and look at the average age of the participants, you will not exactly see a

[84] Interview with employee Ola Nordmann in his office, 30.09.2009.

young crowd. And this says something about the position of bioenergy with the general public, I think."[85]

Imagined Publics, Real Effects

Over the last paragraphs I have studied how bioenergy in Norway and Sweden have imagined their respective 'publics'. This exercise has illustrated that technology developments are not value-free processes of diffusion, but that the adoption of energy technologies occurs in a complex setting where the agency of multiple actors influence the outcome. 'The public' in its various guises can be a player who can protest, participate and support. The notion of 'imagined publics' illustrates that 'the public' may appear in these processes more indirectly. The public does not actually have to protest a development in order to influence the process, if those trying to implement the technology believe protests to be likely.

In Norway and Sweden the publics were imagined differently. The Swedish publics were imagined either as ignorant consumers or supportive customers. In Norway, they were imagined as concerned about or opposed to bioenergy based on NIMBY logic, as ignorant non-customers or as opposed to bioenergy because it interfered with the idea of 'pure nature'. These ways of imagining the publics resulted in different strategies of public engagement. Some Swedish players saw public ignorance as a democratic problem and concluded it would be their task to enlighten the public. The Swedes who imagined the public as supporters wanted to preserve the situation and considered the best way to be open two-way dialogue. In Norway, the industry pre-emptively responded to expected NIMBY responses through meetings with perceived stakeholders, mainly to limit the consequences of protests. The ignorant non-consumers were engaged through information campaigns as well as more active attempts to bring them on board as trustworthy users of the technology.

The ways that the publics of bioenergy are imagined in Norway and Sweden also tells us something about the role of bioenergy in Norwegian and Swedish culture. In particular, the notion of bioenergy as invisible to the Swedish publics even though it is the major energy technology in the country stands out as a contrast to the Norwegian situation where bioenergy, a marginal technology, appears controversial. It is likely that this can be attributed to the historical circumstances whereby bioenergy was introduced in Sweden, that is through familiar infrastructure for district heating and combined heat and power.

[85] Interview with Professor Pär Vargas over the telephone, 07.10.2009.

Bibliography

Primary Sources

Adresseavisen, 2007-2009 [Sør-Trøndelag, Norway]

Aftenposten, 2007-2009 [Norway]

Aftonbladet, 2007-2009 [Sweden]

Bioenergi, 3-6, 2009 and 1-3, 2010 [Norway]

Bioenergi, 3-6, 2009 and 1-3, 2010 [Sweden]

Interviews, 2009-2010

Svenska Dagbladet, 2007-2009 [Sweden]

Verdens Gang, 2007-2009 [Norway]

Östgöta Correspondenten, 2007-2009 [Östgötaland, Sweden]

Secondary Sources

Anshelm, Jonas. *Att Ersätta Kärnkraften med Bioenergi – Om en Omstridd Ide i den Offentliga Energipolitiska Debatten I Sverige 1979-2000*. Linköping: Tema T, Linköpings Universitet, 2009.

Arntsen, Håkon, Rossing, Sivert. "Fikk 15 Millioner til Strømsparing i Fylket", in: *Trønderavisa*, 15.09.2009. http://www.t-a.no/nyheter/article75326.ece, Accessed 01.09.2011.

Barnett, Julie, Burningham, Kate, Walker, Gordon, Cass, Noel. "Imagined Publics and Engagement Around Renewable Energy Technologies in the UK", in: *Public Understanding of Science*, published online before print on June 30, 2010. http://pus.sagepub.com/content/early/2010/06/21/0963662510365663.abstract.

Burningham, Kate, Barnett, Julie, Carr, Anna, Clift, Roland, Wehrmeyer, Walter. "Industrial Constructions of Publics and Public Knowledge: A Qualitative Investigation of Practice in the UK Chemicals Industry", in: *Public Understanding of Science* 16:1 (2008), 23-43.

Devine-Wright, Patrick. "Beyond NIMBYism: Towards and Integrated Framework for Understanding Public Perceptions of Wind Power", in: *Wind Energy* 8:2 (2005), 125-139.

Dietrich, Heather, Schibeci, Renato. "Beyond Public Perceptions of Gene Technology: Community Participation in Public Policy in Australia", in: *Public Understanding of Science* 12:3 (2003), 381-401.

Durant, John. “Participatory Technology Assessment and the Democratic Model of the Public Understanding of Science”, in: *Science and Public Policy* 26:5 (1999), 313-319

Einsiedel, Edna F., Jelsøe, Erling, Breck, Thomas. “Publics at the Technology Table: The Consensus Conference in Denmark, Canada and Australia”, in: *Public Understanding of Science* 10:1 (2001), 83-98.

Ellis, Rebecca, Waterton, Claire: “Environmental Citizenship in the Making: The Participation of Volunteer Naturalists in UK Biological Recording and Biodiversity Politics”, in: *Science and Public Policy* 31:2 (2004), 95-105.

Energimyndigheten. *Energiförsörjingen i Sverige*. Stockholm: Energimyndigheten, 2009.

Ertesvåg, Ivar S., Mielnik, Michael: “Exergy Analysis of the Norwegian Society”, in: *Energy* 25:10 (2000), 957-973.

European Parliament: “Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources”, in: *Official Journal of the European Union*, 5.6.2009.

Goodin, Benoit. “The Linear Model of Innovation. The Historical Construction of an Analytical Framework”, in: *Science, Technology and Human Values* 36:4 (2006), 639-667.

Gross, Alan G. “The Role of Rhetoric in the Public Understanding of Science”, in: *Public Understanding of Science* 3:1 (1994), 3-23.

Habermas, Jürgen. *The Structural Transformation of the Public Sphere*. Cambridge, MA: MIT Press, 1989.

IEA Energy Statistics: “Electricity/Heat in Norway in 2008”, 2008, http://iea.org/stats/electricitydata.asp?COUNTRY_CODE=NO, Accessed 01.09.2011.

Jordal, Anne. “Korleis Utvikle og Lansere Meir Konkurransedyktige Pelletskaminar?” Conference Paper. ”Bioenergidagene, 2009”, Rica Nidelven Hotell, 23.11.2009.

Kaijser, Arne, Hedin, Marika, eds. *Nordic Energy Systems. Historical Perspectives and Current Issues*. Canton, MA: Watson Publishing International, 1995.

Kall, Ann-Sofie. “Förnyelse med Förhinder” (Unpublished Ph.D. diss., Linköpings Universitet, 2011).

Karlstrøm, Henrik. *Den Deregulerte Forbruker*. Trondheim: Institutt for Tverrfaglige Kulturstudier, 2010.

Latour, Bruno. *Science in Action*. Cambridge, MA: Harvard University Press, 1987.

Maranta, Allesandro, Guggenheim, Michael, Gisler, Priska, Pohl, Christian. “The Reality of Experts and the Imagined Lay Person”, in: *Acta Sociologica* 46:2 (2003), 150-165.

Marres, Noortje. “The Issues Deserve More Credit”, in: *Social Studies of Science* 37:5 (2007), 759-780.

Michael, Mike. “Publics Performing Publics: of PiGs, PiPs and Politics”, in: *Public Understanding of Science* 18:5 (2009), 617-631.

Midtun, Atle, Gundersen, Mari Hegg, Koefoed, Anne Louise. “Greening of Nordic Electricity Industry: Policy Convergence and Diversity”, in: *Energy & Environment* 15:4 (2004), 633-656.

Miller, Steve. “Public Understanding of Science at the Crossroads”, in: *Public Understanding of Science* 10:1 (2001), 115-120.

Norman, Dandy. *Stakeholder Perceptions of Short-Rotation Forest for Energy*. Farnham: Forest Research, 2010.

Norsk Bioenergiforening. *Bioenergi i Norge*. Oslo: Nobio, 2010.

Olje og Energidepartementet. *Strategi for økt Utbygging av Bioenergi*. Oslo: OED, 2008. http://www.regjeringen.no/upload/OED/Bioenergistrategien2008w.pdf, Accessed: 04.07.2011.

Rayner, Steve. “Democracy in the Age of Assessment: Reflections on the Roles of Expertise and Democracy in Public-Sector Decision Making”, in: *Science and Public Policy* 30:3 (2003), 163-170.

Rowe, Gene, Frewer, Lynn J. “A Typology of Public Engagement Mechanisms”, in: *Science, Technology and Human Values* 30:2 (2005), 251-290.

Skjervak, Geir. ”Kvar Blir det av det Store Pelletsløftet i Noreg?”. Conference Paper. ”Bioenergidagene, 2009”, Rica Nidelven Hotell, 23.11.2009.

Statistisk Sentralbyrå. ”Energi”, 2011, http://www.ssb.no/energi/, Accessed: 01.09.2011.

Strauss, Anshelm, Corbin, Juliet M. *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Newbury Park, CA: Sage, 1990.

Tjernshaugen, Andreas. “Fossil Interests and Environmental Institutions: The Politics of CO2 Capture and Storage” (Unpublished Ph.D. diss., Universitetet i Oslo, 2009).

Tyholt, Marit, Hestnes, Anne Grete. “Heat Supply to Low-energy Buildings in District Heating Areas: Analysis of CO2 Emissions and Electricity Supply Security”, in: *Energy and Buildings* 40:2 (2004), 131-139.

Unander, Fridtjof, Ettestøl, Ingunn, Ting, Mike, Schipper, Lee. “Residential Energy Use: An International Perspective on Long-term Trends in Denmark, Norway and Sweden”, in: *Energy Policy* 34:12 (2008), 1395-1404.

Upreti, Bishnu Raj, van der Horst, Dan. “National Renewable Energy Policy and Local

Opposition in the UK: The Failed Development of a Biomass Electricity Plant", in: *Biomass and Bioenergy* 26:1 (2004), 61-69.

Walker, Gordon. "Renewable Energy and the Public", in: *Land Use Policy* 12:1 (1995), 49-59.

Walker, Gordon, Cass, Noel. "Carbon reduction, 'The Public' and Renewable Energy: Engaging with Socio-technical Configurations", in: *Area*, 39:4 (2007), 458-469.

Walker, Gordon, Cass, Noel, Burningham, Kate, Barnett, Julie. "Renewable Energy and Sociotechnical Change: Imagined Subjectivities of 'The Public' and Their Implications", in: *Environment and Planning* 42:4 (2010), 931-947.

Wynne, Brian. "Reflexing Complexity. Post-genomic Knowledge and Reductionist Returns in Public Science", in: *Theory, Culture and Society* 22:5 (2005), 67-94.

What we disagree about when we disagree about sustainability[1]

Abstract

Criteria for sustainability are frequently contested and changed based on competing or new types of knowledge. This is a potential problem for policy and decision makers struggling to come up with policies regarding environmental threats and pondering which technologies to promote, which to avoid, and when dealing with past choices made on different or false knowledge claims. Such questions may be incentives for status quo as making mistakes might cause public contempt for politicians and experts. Complex issues like environmental impacts cannot be expected to be managed through criteria without controversy and change. Understanding the dynamics of such controversies is important to be able to cope with them. In this article I propose an analytical approach based on the notion of 'framing' intended to contribute towards this goal. Empirically it builds upon the study of two controversies about the sustainability of energy sources: One about peat, the other about bioenergy

Key words: Frame analysis, sustainability, controversy, natural resources, renewable energy, bioenergy, peat

[1] This paper was submitted to a peer reviewed jurnal on 02.12.2011. Current status: under review for publication

Is not included due to copyright