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Biofuels: a contested response to climate change

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Biofuels have received increased attention in recent years as renewable alternatives to fossil fuels in the steadily growing transportation sector. Simultaneously, the impact of biofuel technologies has been highly disputed in public debates, where their introduction is alternately presented as a solution to energy-supply and climate-change problems or as a source of environmental and social difficulties. Through qualitative interviews, this article analyzes the Danish public's attitudes toward biofuels. Particular attention is given to popular perceptions of risks and uncertainties associated with biofuels and to problem-solving responsibilities in relation to climate change. The study illustrates the complexity of the concerns involved with the issue, indicating a positive attitude toward biofuels when respondents perceive them as beneficial for climate and the environment. However, when introduced to problems associated with biofuels, respondents modified their support, conditioning acceptance on the viability of solutions. They also demanded interventions with respect to the problem of climate change and asked for decision making based on factual knowledge and democratic discussions at global and local levels.

KEYWORDS: renewable energy resources, public awareness, transportation, environmental perception

Introduction

Unlike Europe, Brazil has produced ethanol (from sugar cane) for many years, starting in the 1930s. In 1975, Brazil implemented the National Alcohol Program in response to worldwide oil- and sugar-market crises and, in 1979, began mass production of dedicated ethanol vehicles (Soccol et al. 2005; Matsuoka et al. 2009). The United States also has had experience with ethanol production, and over the last decade biofuels have become the most common source of alternative energy in the American transportation sector. In 2008, the United States produced nine billion gallons (one gallon = approximately 3.8 liters) of biofuels, compared to only 1.4 billion gallons in 1998 (Delshad et al. 2010; Sorda et al. 2010).

In Europe, biofuel technologies have received renewed attention over the past few years partly because of their promise to reduce carbon-dioxide (CO₂) emissions from transportation sources and partly because of questions concerning energy-supply security (Ryan et al. 2006). Biofuels have not yet been introduced on a larger scale in either the European Union (EU) or Denmark, but in 2007 EU governments set a target of substituting 10% of all land-based transportation fuels with biofuels by 2020 (European Commission, 2007). In 2009, the European Commission introduced a more moderate EU Renewable Energy Directive, mainly in response to rising concern and criticism regarding the biofuel target and its impacts on sustainable development. The Directive retained the 10% objective, but also included any renewable energy source (or combination) in total transportation-energy supply (European Union, 2009). To comply, Denmark has introduced mandatory addition of biofuel in all land transport fuels up to 5.75% in 2012 (Klima-og Energi ministeriet, 2011). Nevertheless, biofuels and their use for transportation remain debated in Denmark and internationally, with initial public support for biofuel technologies all but given.

The question of how people relate to the prospect of using biofuels to reduce CO₂ emissions from transportation vehicles, and particularly the risks and uncertainties associated with large-scale biofuel production, provides the point of departure for this article. We address issues associated with this energy source through qualitative sociological analysis based on both individual and focus-group interviews.

We begin with a short outline of the study’s background and methodology. This is followed by an analysis in three sections. First, we discuss the issue of biofuels as a response to climate change in relation to perceptions of risk and uncertainty. Second, we take a closer look at how people relate to biofuels as a potential solution to climate change. Third, we examine the ways in which people engage with problem solving and apportion responsibility for biofuels and other potential solutions to the problem of climate change: Who is perceived to be responsible for “doing something,” both for making the complex choices among prospective interventions and for putting
strategies into practice. The final section consists of a closing analysis and discussion.

Background

The EU targets for biofuel substitution have raised questions about the technology’s advantages and disadvantages, and the targets are still subject to discussion among governments. In Denmark, as in other countries, the debate has appeared regularly in the public media as well. Proponents argue, for instance, that Denmark can cover a large proportion of its energy needs in an increasingly energy-consuming transport sector with biofuels. Although in the long run, hydrogen may be the solution to oil dependence, it may be necessary to opt for other alternatives before then. Biofuel for transport is also a good alternative for the environment (Vedelsby, 2007).1

By contrast, opponents fear that millions of hectares of rain forest, natural areas, and farmland will be converted into monocultures with the sole purpose of providing raw materials for [biofuel] plants. This may have disastrous consequences for the climate, the local communities, and especially the security of food supplies (Skøtt, 2007).

Complicating the debate is that the term “biofuel” does not refer to a single, fully developed technology or even a single, uniform type of fuel. All biofuels are energy sources derived from biomass, but the liquid biofuels considered for use in transportation can be divided into several types and subtypes according to the kind of biomass and the technologies used for their production. Biofuels for transportation comprise both bioethanol made from sugar components of plant material as a substitute for gasoline and biodiesel made from plant oils or animal fats as a substitute for fossil diesel. A further distinction can be made between so-called first, second, and third generation biofuels.

First generation biofuels are made from conventional food or feed crops using already existing technologies. The typical feedstock used is sugar cane, wheat grains, or corn seeds for bioethanol and rape, sunflower, or palm oils for biodiesel. Second generation biofuels require development of new technologies where cellulose (and eventually lignin) can be used as raw materials. These biofuels are made from nonfood crops, including organic waste, wheat stalks, wood, and specific energy crops such as willow. A third generation of biofuels made from algae culture is considered promising for the future, but needs to be developed further (Benemann, 2008). The diversity of technologies and crops in question makes it difficult to evaluate the advantages and disadvantages of biofuels in comparison with fossil fuels, as well as with other fuel alternatives, and assessments vary widely.

The debate in Denmark mirrors international discussions. In recent years, a dispute about the sustainability of biofuels has emerged in both Brazil and the United States, where ethanol and biodiesel for transportation have been produced for several decades. Studies of both producers’ responsibility (Huertas et al. 2010) and of the public knowledge of and attitudes toward biofuels (Delshad et al. 2010) suggest that climate and social sustainability are important in the public debate on the continued development and use of biofuels. In Europe, also, the issue of biofuels for transportation is contested and involves several large actors from international political institutions to nongovernmental organizations (NGOs) and private companies with vested economic interests.

The present study looks at how members of the general public relate to arguments for and against biofuels, to the interests behind these arguments, and to the actors involved in the biofuel debate. The aim is not to suggest which specific political and economic decisions need to be made with regard to further biofuel use. Rather, the broader objective is to understand and explain the general public’s reflections and attitudes toward the introduction of a new technology to solve (or at least reduce) climate and other common, often global-scale, problems.

Methodology

As the sociological contribution to a large interdisciplinary project, this study forms part of the broad background for formulation of different biofuel scenarios by exploring perceptions of and attitudes toward the introduction of biofuels for transportation among members of the Danish public.2 This task presented a major methodological challenge. Biofuel technologies are still at an early stage of practical

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1 All quotes from Danish sources, including the interview material collected as part of the study, have been translated by the authors.

2 This study is part of the project REBECa (Renewable Energy in the Transport Sector Using Biofuels as Energy Carriers), with eight interdisciplinary work packages. Other aspects of this initiative examine various aspects of biofuels including the development of a number of policy scenarios that explicitly seek to address the concerns of political and other decision makers.
implementation in Denmark, and beyond the currently available first generation, second and third generation biofuels are generally at an early stage of technological development. As a result, much uncertainty remains about the various consequences of a large-scale introduction. Moreover, despite policy and media attention, the technologies are still unfamiliar to the general public. Most of the study respondents had little knowledge and meager or no practical or personal experience with biofuels. Against this background, any discussion of responses to a large-scale introduction of biofuels is largely hypothetical.

This situation poses a problem of more general significance concerning the kind of public response or public acceptability studies that seem in high demand whenever political or market stakeholders consider the introduction of new technologies (see Flynn & Bellaby, 2007): How should we investigate public responses to the hypothetical? More specifically, it raises two particularly important questions for this study. First, what are we really studying when interviewing people about biofuel technologies at such an early stage in their domestic implementation? Second, how do we go about asking people about something so uncertain and so unfamiliar to them in a meaningful and scientifically credible way?

No Pretentions to Fortune Telling

With regard to the first question, it must be underlined that this study does not aspire to sociological fortune telling. It cannot forecast the development of attitudes toward biofuels among the general public, let alone how and to what extent these attitudes will be reflected in actual fuel-consumption practices. Too many unknown and complicating factors are involved, including the future development of biofuel technologies, the social amplification mechanisms often at work in shaping public opinion (Flynn, 2007), and the everyday dynamics underpinning energy-consumption practices in general (see Shove, 2003). Instead, the study illuminates some of the general mechanisms at play when the public is introduced to a new technology. In fact, the responses to the topic of biofuels we find in this study resemble, to a large extent, reactions to other new technologies, such as those involving hydrogen fuel, described in previous studies (e.g., Ricci et al. 2007).

What we find, then, are general patterns of response to uncertainty of knowledge and technological risk, general relations of trust or distrust, and broad beliefs about influence and responsibility. These patterns are very relevant with regard to understanding public responses to specific technologies in retrospect, and to reflecting critically about whether and how to introduce a new technology, but they are not sufficient to predict public responses with any degree of specificity.

Data Collection

With regard to the second question, asking people about something as uncertain and unfamiliar to them as biofuels, an initial choice was made to use qualitative interviews. Valuable attempts have been made to develop quantitative approaches to measuring public perceptions of unfamiliar technologies (see Binder et al. 2012), but a simple, quantitative measure seemed inadequate to capture the full complexity of how the public approaches emerging technologies (see Ricci et al. 2007). While qualitative interviews provide less straightforward answers to issues pertaining to the acceptability or unacceptability of a novel technology, such methods accommodate complexity and ambivalence by allowing room for respondents to explain and clarify the subject matter, the questions asked, and the answers given (see Bellaby, 2007). Moreover, they allow for an open-ended approach in which respondents can give voice to considerations that are not framed by what we or the experts and stakeholders engaged in the biofuel debate would expect or consider critical and relevant (see Ricci et al. 2007).

The choice of qualitative interviews did not, however, eliminate the challenge of eliciting views and perceptions of an uncertain and unfamiliar technology. We deemed it necessary to provide respondents with a presentation of biofuel technologies and the questions and arguments raised in the deliberations over biofuels. This brought to the fore in a very direct way a much-debated question of social enquiry—of whether it is possible to study social “reality” objectively without at the same time shaping this reality (e.g., Blaikie, 2007). Applied to the current case, this becomes a matter of whether it is feasible to conduct research on people’s perceptions of and attitudes toward biofuels without at the same time influencing them on such matters. Interview responses are always created in the interaction between researchers and interviewees, and this is also apparent in the present study. We therefore acknowledge that our presentations and the interview context in general have necessarily framed the responses that we elicited. To avoid shaping responses in a biased way, however, we sought to balance our presentations by giving a fair airing to both positive and negative views of biofuels while at the same time keeping the level of discussion accessible so as not to “blind” respondents with science (see Ricci et al. 2007).

A first step was to form an overview of different biofuel technologies and the diversity of arguments for and against their introduction as an energy source for transportation. As part of this process, we con-
ducted two stakeholder interviews: one with a proponent and the other with an opponent of the large-scale introduction of biofuels for transportation.3

For the primary analysis, we convened a focus group and a series of individual interviews with a total of seventeen respondents, selected through telephone screenings based on a random sampling of telephone-book entries. Variation was secured across demographic criteria, including gender, age, household type, educational level, and region of residence.4 The overall structure of both the focus group and the individual interviews was the same. The idea of the focus group was to experiment with a more graphic presentation of the interview themes while at the same time encouraging internal debate among the participants (Halkier, 2008)—an obvious choice for a highly contested and controversial subject. During all interviews, respondents were first asked openly about their knowledge and perception of biofuels and their possible experiences with them. Only then were they given a short presentation about biofuel technologies, followed by an introduction to the themes of the interview.

Three main themes concerned possible advantages and disadvantages of a large-scale introduction of biofuels in relation to 1) the environment, 2) security of the energy supply, and 3) social consequences. The respondents were presented with arguments raised in relation to each of these themes. In the focus group, posters showing graphic presentations of biofuel technologies and excerpts of media coverage of the biofuel debate were provided in support. We repeatedly stressed that we were interested in the respondents’ immediate, personal thoughts and views as opposed to those of experts and stakeholders. Two further, more general interview themes were introduced for theoretical and practical perspectives: 1) whom to trust and where to place responsibility with regard to making decisions about the large-scale introduction of biofuels and 2) alternative solutions to the transportation sector’s environmental problems.

The interview material was analyzed thematically according to both the predetermined themes of the interviews and themes that appeared and proved prominent during initial readings of the material. Passages related to each theme were coded and marked in the transcripts for subsequent detailed analysis. In the following, the themes are presented according to their analytical prominence and logic. Focus is on the perceptions and attitudes expressed by participants across the themes as well as how they may be understood in relation to broader theoretical and policy debates.

Finally, the question of representativeness is important when using qualitative methods. The choice of in-depth interviews means that the study is not representative in any statistical sense. Nevertheless, we argue that our findings are analytically generalizable from the standpoint that they reflect broad concerns prominent among members of the public in western societies today and extend beyond the specific Danish context in which we conducted our study. For example, quite concurrent with the findings in this study, a Eurobarometer survey from autumn 2011 reported that 89% of Europeans, an increase from 2009, believe that climate change/global warming is a serious problem. Furthermore, the survey indicated that, like the respondents in the present study, the general public in Europe expects political as well as individual solutions to the problems (Eurobarometer, 2011). Despite differences among EU countries, the similarities are dominant both in this and other environmental questions, and we would argue that our respondents’ concerns are likely to reflect impressions in a broader European context as well. The qualitative approach accommodates the complexity of the subject matter and shows the generality of the specific answers.

Risk and Uncertainty Under the Prospect of Climate Change

An important context for the consideration of biofuels for transportation in Denmark, and thus for perceptions and attitudes among the Danish public, is the ever-more urgent question of climate change and the contribution of prevailing mobility practices to it. In recent years, climate-change problems have become increasingly visible and important to people and communities in many parts of the world for a number of reasons.

First, issues pertaining to climate change appear often in the media (Petersen, 2007). We get daily reports on climate disasters, global warming, greenhouse gases, and so forth. Experts of all kinds take part in debates initiated and facilitated by the media. The still more dramatic stories about climate change and the intensive media coverage help to keep climate change on the public agenda (see Carvalho & Burgess, 2005; Petersen, 2007; Jensen, 2011).

Second, politicians and other decision makers in the EU and elsewhere have ventured into the debate. It has become politically expedient to deal with climate change, even in circles that only a few years ago

3 Another important step consisted of a literature review to investigate the state of the art in biofuels.
4 The interviews were conducted in 2008 and the final selection comprised ten women and seven men ranging between 25 and 68 years of age; one student, six with higher educational levels, and ten with lower or no education; three respondents are from Copenhagen, six from the Greater Copenhagen/Zealand area, four from other Danish islands, and four from Jutland.
expressed disdain or indifference. In the scientific community, a general consensus has been established that climate change is at least partly human-induced (see, e.g., Stern, 2007), and this point of awareness, combined with growing public concern, has compelled many leading politicians and other decision makers to seriously address the issue. Agreements are negotiated and meetings held at the highest levels, and only a few political parties reject the problem, although most still find it difficult to identify practical solutions, let alone to implement them.

Finally, tangible phenomena such as warmer weather, exceptionally cold winters, increased precipitation, storms, floods, and so forth have in recent years provided nonexperts with indications that climate change is in fact happening. Climate change is entering a sphere of personal experience for members of the general public when people witness heavier rainfalls, earlier springs, and warmer summers in their own neighborhoods and regions (Petersen, 2007; Jensen, 2011).

The latter point presents an interesting contrast to the observation in German sociologist Ulrich Beck’s (1992) classic work *Risk Society*, where one important feature characterizing early risk society was that risks were invisible to the senses. Beck based this observation on cases of radioactive pollution, pesticide residues in water and food, and other phenomena that cannot be directly sensed, tasted, smelled, or seen. Against this background, Beck argued that life in early risk society was particularly uncertain because modern risks had been “expropriated from the senses” and people had become dependent on expert knowledge to relate to it (see also Wynne, 1996; Jensen & Blok, 2008). Beck’s point was not that invisible and uncertain risks are ignored, but rather that the basic feature of risk society is the awareness of, or the anxiety about, such hazards.

Although controversial from the start, Beck’s characterization of modern risks as invisible was plausible at the time of its formulation two decades ago when global environmental problems existed mainly in researchers’ observations and measurements and remained largely invisible for members of the general public. Today this has changed, or at least people now interpret phenomena such as record-breaking weather reports as tangible signs of climate change. The interviews in our study illustrate this development. One respondent, for example, expressed her concern about climate change in the following terms:

*Female, 61 years:* But it’s so horrible when we see what it does to our world...Now, with climate change...And that’s more or less a matter of fact now. You know...by now, I’ll say, I have reached a certain age, and...we have seen a lot of water these last few years. And we have seen a lot of heat...Then you start thinking, well there is probably something to it, after all.

For this respondent, the personal experience of changes in weather conditions over the course of her lifetime has given resonance to talk about climate change and prompted a sense of urgency. Later in the interview, she pointed out that it would be in everyone’s interest to deal with the problem, the sooner the better, because, as she put it, “it is our common earth.” Her concern about the consequences of climate change for future generations made her uncertain because she could not see any immediate solutions to the problem. The reason was, she believed, that “we have overconsumption that is totally out of proportion.” In that way she connects (over) consumption with the changes that are happening, but she also expresses uncertainty as to what can be done about the problem while at the same time emphasizing the need to do something. Accordingly, the experience of weather changes is attached to the perception that something is wrong with the environment, and put together this promotes a desire that someone ought to do something about it.

This sensibility of pressing concern was widespread among our respondents. Generally, they talked of climate change as an important and tangible problem, and none of them questioned its reality. Previous uncertainty seemed to a large extent replaced by an awareness of risk and a sense of urgency. However, as the analysis in the following section demonstrates, uncertainty still ruled with regard to what can be done and whether biofuels could be part of a meaningful solution.

**Ambivalence Toward Biofuels**

Given general concern about climate change, most respondents spontaneously reacted with positive associations when the term “biofuels” was introduced to them. Thus, the starting point was positive: “when it starts with ‘bio,’ it must be good,” the rationale seemed to be. One of the respondents put it like this:

*Female, 32 years:* But I think...it is definitely positive that...you give the environment a thought, for example by mixing in 3–5% [biofuels], already now, right? But it’s a good idea!

Particularly, second generation biofuels seemed to appeal to the respondents; they supported the prospect of turning waste into energy. A problem or a
nuisance is converted into a solution. In the words of one respondent:

**Male, 47 years:** Now they're working on using waste too, right? Then maybe you can solve a waste problem as well, and liquid manure...

However, some of the respondents immediately followed up their initial expressions of optimism about biofuels with comments questioning their viability as a long-term solution, asking what will be the side effects or the drawbacks. Others became increasingly cautious as, over the course of the interview, they were introduced to some of the contested issues in the biofuel debate. As one woman reflected:

**Female, 37 years:** Well, it sounds very easy to think: “Oh, it’s such a good idea” and things like that. And if it can benefit the environment..., but again, if it’s at the expense of something else then maybe you would rather have some other thing that might be more sensible.

This ambivalence between hopefulness and skepticism was in many cases reflected in a demand for more knowledge—and that decisions about whether and how to introduce and implement biofuel technologies should be made on the basis of this knowledge. One respondent put it this way:

**Female, 32 years:** But it seems to me—and this is the alpha and omega—that we have to know things. You know, that you know, maybe not the answer, because there is no final answer, but at least the costs...of things, before you start. No normal people would accept something they didn’t know, or...[if they did not] know what they were getting into.

One can argue that the respondents expressed conditional acceptance of a phenomenon that they hoped could have a positive effect, but that they realized this is associated with such a high level of uncertainty that the full consequences could not be foreseen. That they did express acceptance, although contingent, seems less a result of an informed evaluation than of an expectant faith that biofuels might provide an acceptable solution to an urgent problem—coupled, for some of the respondents, with a general sense of optimism, or a degree of confidence that unanticipated and unwanted consequences could be handled along the way.

**Female, 59 years:** You have to try to look at the nuances and say: “Well, what is this,” right?...Because there’s the skeptics who of course only look at the disadvantages. And there are those who maybe only look at the good sides, right...But it’s my outlook on life in general that I always take a look at both the advantages and the disadvantages.

**Male, 61 years:** We’ve become much better at being aware that what we do also creates new problems. And that takes us back to the United Nations. Overall, it must be up to the UN to try to manage the global problems, right?

The last of these quotes illustrates the perception that political regulation of a complex case such as the use of biofuels should take place at an international level under the jurisdiction of the United Nations. The respondents’ comments also show the phenomenon often found in studies of how people approach contemporary environmental issues (see Blok et al. 2006) that one accepts the use of, for example, pesticides in agriculture, chemicals for daily use, food additives, and so forth both because one suspects that they are necessary and because one has confidence in the intention of authorities to control adverse side-effects. The underlying motto is “what else can we do?” (Wynne, 1996)—ambivalence and uncertainty are basic conditions of modern, everyday life (Halkier, 2001). In our case, with the introduction of a new product with which people have no experience so far, and of which they can only imagine the consequences, ambivalence between hope and skepticism is marked, especially since even the intended effect of biofuels on climate change is uncertain and disputed.

In short, although the immediate reaction of respondents to biofuels was positive, it was followed by some concern as to whether investing in the technology is the right decision. If the environmental or social consequences outweigh the benefits it might be better to think of alternatives. And if both the full range of benefits and the unintended consequences are unknown, more knowledge is needed before any decision can be made about whether or not to introduce biofuels on a large scale.

**Food Supply and Prices**

One of the unintended consequences of biofuel production discussed in the interviews was their social impact, mainly with respect to land use for production of biofuel crops and the effects on food supply and food prices locally and globally—an issue of particular relevance in relation to first generation...
biofuels that are based on conventional food or feed crops. At the time of the interviews, several stories of rising food prices due to competition over land use between fuel crops and food or feed crops were circulating in the media, an issue several respondents referred to without prompting. Asked whether she had followed the discussion about biofuels in the media, one respondent said:

**Female, 31 years:** Maybe I’m mixing things up, but I have some kind of an idea that it has to do with something about corn?…The problem was that you took in corn for this [biofuel production] and then it was a problem for the poor farmers who couldn’t get enough tortilla flour. But maybe that’s another discussion.

For most of the respondents, the prospect of biofuels causing already poor and disadvantaged people to struggle with dramatically rising food prices was unacceptable. One respondent, for example, was positive toward biofuels, but said:

**Female, 32 years:** On the condition that people don’t suffer from it. That they aren’t...either going to starve or get stripped of their rights, or...Well, this is always what makes it difficult; because if it were so simple, and you could just say, well that’s just it [the right thing to do]...then it would indeed be a good idea. But there are also some minuses that make it complicated.

Particular concern was expressed about poor residents of developing countries for whom rising food prices could be fatal. Nevertheless, the balancing of concerns about climate change and concerns about food is a real dilemma. One respondent expressed this very clearly:

**Female, 25 years:** But if in a few years’ time you have people in...who can’t get the food they need, then you have to assess what’s more important. Is it...the environment, or is it the people? And you can’t settle that, can you? Because they affect each other...And if we get a bad environment, well, then there will also be people who...die because of that.

Seen from this perspective, it makes no sense to distinguish between concerns about climate change and the environment on one hand and human beings and social conditions on the other. Humans and the environment are intertwined and both are circumscribed by a sense of social responsibility for biofuels that are based on conventional food or feed crops. At the time of the interviews, several stories of rising food prices due to competition over land use between fuel crops and food or feed crops were circulating in the media, an issue several respondents referred to without prompting. Asked whether she had followed the discussion about biofuels in the media, one respondent said:

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Seen from this perspective, it makes no sense to distinguish between concerns about climate change and the environment on one hand and human beings and social conditions on the other. Humans and the environment are intertwined and both are circumscribed by a sense of social responsibility for distant others—whether in faraway countries or in future generations (see Popke, 2006). Perhaps because of this dilemma, few of the respondents categorically rejected biofuels as part of an answer to climate change despite the prospect of rising food prices. Conversely, some expressed hope that, for example, new farming and biofuel technologies could make biofuel production more efficient in terms of land and that nonfood crops, waste, or other kinds of biomass could be used for biofuel production as promised by second- and third-generation technologies. Other respondents hoped that diets might adapt in acceptable ways to changes in food supply, or that production of biofuels or biomass for biofuels might provide opportunities for economic growth both locally and in developing countries and thus counter the effects of rising food prices. It was a clear condition for respondents that biofuels should not cause people to starve or otherwise cause serious social consequences either domestically or abroad. The respondents expressed a great deal of concern about these social consequences of biofuel production, but some remained relatively hopeful that they might turn out to be less harmful.

**Damage to the Environment**

Related to the social consequences of land use for biofuel crops is the issue of consequences for the environment. An alternative to the direct use of food or feed crops for biofuels, or of existing farmland for biofuel crops, is an expansion of cultivated land. This may diminish the competitive problem of food versus fuel, but introduces instead a dilemma of environmental protection versus agricultural cultivation.

This issue was a cause of concern among the respondents, particularly regarding the cutting of rain forest and the effects that such activities might have on biodiversity or CO2 levels and thus climate change.

**Male, 33 years:** So, one can say that if they start felling rain forest to grow fuel, well, that’s...basically that’s a bad thing to do.

**Female 32 years:** The more one fells the rain forest, the greater the climatic costs.

Opposition to the felling of rain forest is not a new phenomenon. It has been on the public agenda for years, led by environmental groups such as Greenpeace, Friends of the Earth, and so forth. These groups have clearly argued that the cutting down of rain forest endangers biodiversity and that rain forests help mitigate climate change. Thus, the rain forest has almost iconic status for Westerners, as illustrated...
by a comment from one of the respondents: “You immediately hit the red zone” when someone starts talking about cutting down rain forest. However, some respondents were uncertain whether there could be a need to fell rain forests to make space to grow biocrops.

Female, 44 years: The way the destruction of the rain forest is being handled is not in accordance with...how they should do it, right? At least in the countries I’ve heard of where they do it completely uncritically and without thought for the costs it inflicts on nature there. So...you have to set up some high standards for how to proceed, if you...have to do it. I don’t know if there are other possibilities [than using rainforest].

On one hand, this respondent wants to preserve the rain forest, but, on the other hand, she has an eye on the necessity to provide fuel for transportation. As such, she is conscious that there is a connection between the desire for high mobility and the need for fuel. At the same time, she wishes to preserve nature and rain forests and to avoid climate change. In the quote, she expresses the paradox of most people who want to solve environmental problems, but simultaneously do not want to curtail travel or consumption in general.

Other respondents worried about the preservation of landscape and biodiversity in Denmark and more generally:

Male, 37 years: I believe that still more forest will be cut down...so that we can cultivate fields [for production of biofuels]. And it seems to be at the expense of living organisms like little animals and small game and big game and...it’s the fauna in nature that’ll pay the price.

Thus, if it is necessary to cut down forests, especially rain forests, the attitude among the respondents was that this is highly problematic. This does not necessarily mean, however, that cultivation of new land was categorically unacceptable for them, at least not in faraway places. Some proposed, for example, to search for areas for the production of biofuel crops where nature and the environment will not be endangered. A few suggested reclaiming Danish fallow land for cultivation, but more often the respondents suggested that uncultivated land in Eastern Europe, Russia, and Siberia could be used for the purpose—yet without pointing to any specific area.

**Economic Interests**

Circumscribing the respondents’ concerns and skepticism about the social and environmental consequences of biofuels is considerable suspicion about the economic interests involved in their development. Respondents argued that they found the relationship between economic interests and decisions on implementing biofuel production (as well as the conditions for doing so) very problematic. If a company with economic interests in developing biofuels introduced experts who recommended their promotion, one had to take it with a grain of salt, and, if possible, find other, more independent experts to assess the case. Several respondents were concerned about how money is driving the development.

Male, 37 years: It should not be individuals, and it must not be private companies who are going to decide on it. Because then things go wrong.

Female, 61 years: And then it shouldn’t be private interests, but then I am somewhat naïve: I don’t think it should be private interests that are controlling it. But as I see it…that’s just the way it is.

Male, 61 years: I think one ought to be a little careful, I mean if they have an economic interest in what they say...then I would like to have a second opinion...to express their views too; someone who was not employed in the same company.

The quotations highlight the skepticism of respondents toward recommendations from companies or individuals with economic interests in developing the technology behind biofuels. If, for example, a firm can make a profit on generating the enzymes to be used in second generation biofuels, or constructing plants that can refine organic waste into biofuels, then they did not believe that the firm’s assessment of the necessary technology should stand unchallenged. Several respondents argued that the development should primarily benefit the common interests of society—in this case the climate. There was general agreement among respondents that “money” should not determine whether to develop biofuels. At the same time, the interviews showed that the uncertainty surrounding the general topic also appeared in relation to the question of whom else to trust if one wants an “objective” or “neutral” assessment of the advantages and disadvantages of introducing biofuels.
for transport. This question could not be easily answered in the interviews.

Problem Solving and Responsibility

As we have seen, concerns about climate change were prominent among respondents in this study, and they generally found it important to “do something” about the transportation sector’s large contribution to climate change. At the same time, the uncertainties and risks surrounding biofuels and other potential solutions make problem solving in this area a very complex matter. In this section, we look at respondents’ views on the issue of responsibility for “doing something”—both for making the complex choices among potential solutions and for putting solutions into practice. For respondents, the latter task in particular was underpinned by a dilemma between a demand for climate-change solutions and a desire for continued mobility and prosperity. This dilemma, and respondents’ views on how to handle it, is discussed further in the last part of this section.

Knowledge-Based Decisions

As already noted, respondents found that decisions about biofuels need to be made on the basis of factual knowledge. This is true for other potential climate-change solutions as well. However, a typical answer was that respondents had neither the knowledge nor the influence to determine what should be done about climate change, not least when it comes to choosing between complex and uncertain technological solutions. As two respondents put it:

Female, 49 years: I think, as an ordinary person, to sit here and assess all that: That’s a hard one!

Female, 37 years: As a private person you might have an opinion about it, but fundamentally you know that you’re not the one who’s going to decide. It isn’t Mr. and Mrs. Jones and…people here in our small town. You know, no matter how hard we thump our feet or yell our heads off we won’t be the ones to decide.

We might say that by declaring themselves incompetent or outside of influence in this way, respondents resigned from direct individual responsibility for choosing among potential solutions. This does not mean that they were content to leave decision making to just anyone, or that they resigned from more indirect responsibility for taking part in the broader democratic decision-making process. As we have seen, they almost unanimously agreed that economic interests should drive neither technological development nor decision making. Instead, they pointed to a broadly defined group of “politicians” to take primary responsibility for making choices, based on overall assessments of a wide range of preferably independent expert knowledge. Several respondents singled out a key role for politicians at an international level, to respond to the global character of both the issues involved and the market forces that tend to take control. Some added that the public needs to be heard as well, though still assuming that “politicians” should take charge of collecting and openly displaying all relevant expert and lay views and steer through a democratic process of decision making.

Female, 32 years: Once you’ve found…the side effects and all, then at least you can set up an equation, or several equations…Once the clever fellows in Parliament can set up these equations next to each other, then first of all they can put it up for referendum, with big debates and all. And then it must be up to the people to say: It’s a good thing, or it’s a bad thing.

The overall message here is that to be regarded as legitimate, decision making needs to be carried out through an open, democratic procedure based on political assessments of a broad range of knowledge from reliable and preferably disinterested sources. In this process, respondents positioned themselves as democratic citizens with responsibility, at least in principle, for putting pressure on politicians, participating in the formation of opinions, in referendums, and so forth, but with politicians as more powerful actors located at the center of decision making.

Some respondents also pointed to problems with making democratic decisions in relation to biofuels, or other similar socially and environmentally complex technologies for that matter.

Male, 61 years: When we live in a democratic society, then it is the politicians...And this means that basically it is all of us who have to take a stand. And of course this is also one of the strengths of democracy. But it is not always particularly easy to handle. Sometimes it would be easier if there were only one [person] that could dictate things.

While emphasizing the role of politicians, and in the end all citizens, in democratic decision-making...
processes, this respondent also pointed out the democratic system’s weakness—the difficulty of coming to an agreement and being able to act on it. He concluded that it might be easier for only one authority to solve energy and climate-change problems. Another respondent touched upon the same issue, but was somewhat more radical in his conclusions.

*Male, 46 years:* Democracy...well this is too complicated to leave to each and every one to choose...I can’t stand all that...one has to choose, and one has to get involved...There are many of these things that I actually think you will find to be pseudo discussions when you bring people into it. And it makes it difficult to assign responsibility...And then you just have to make the decisions for people.

These two respondents had similar views on the problems of making decisions about complex issues in a democratic society, but they drew different conclusions. While the former felt that, at the end of the day, it was a strength to involve “all of us,” the other respondent was convinced that engaging the public would prevent the decisions necessary to solve the problems.

**The Problem of Bringing Solutions into Practice**

Deciding which kind of solutions to pursue is a first step. The next is to implement them. On this point, respondents assumed more of a dual perspective. They were not only democratic citizens, but also consumers of fuel, transportation, and mobility. While a growing body of literature discusses the problem-solving potential of citizen-consumers, or of political consumerism, to unite collective and private interests and responsibilities (e.g., Micheletti et al. 2004; Soper & Trentmann, 2008), the response here pointed to a somewhat uneasy relationship between the collective and the private.

For some respondents, their role as consumers of transportation and energy presented an opportunity to make a difference as individuals, and they expressed willingness, some even eagerness, to actively take responsibility for putting solutions to climate change into practice. As expressed by one respondent, a devoted member of an environmental organization:

**Female, 68 years:** I think it is possible to imagine [transportation reductions] if you were to make a great many efforts in everyday life. You know, I can tell from myself, because I’ve tried to say: “Is it really necessary to drive just now? No, you’ll do it to-morrow and then plan a route,” and things like that. And I think you can do that.

Generally, however, there was some hesitation among respondents as to the degree of responsibility they were ready to assume as individual consumers of transportation if it would seriously affect their ability to maintain their accustomed lifestyles. Most respondents said, for example, that there were limits to how much of a premium they would be willing to pay for biofuels, even if biofuels were to turn out to be an acceptable solution to climate-change problems.

*Male, 33 years:* I don’t mind paying more for it, it just depends how much. I’m willing to compromise about comfort as well, but again: how much? All is relative...I think that if something like this is to be a success, well then it has to be that people don’t have to compromise.

For most respondents, the same kind of hesitation applied to the idea of reducing transportation and travelling if that was what it would take to prevent further climate change. Typical responses to whether this was an option included:

*Male, 51 years:* And the way you decide where to produce goods now, that’s who can do it...if not better, then cheaper, right? And that’s nearly all over the world. Then we will have all that transportation cutting across. You know, if we want to be able to get the goods we can get today, plus the ones coming, well, then we will have that transportation.

**Female, 32 years:** I don’t think we can make people restrain themselves. You know, it’s...I like travelling a lot myself. Only right now, I don’t happen to have the “time” for it [laughs, indicating she really means “money”]. No, why is it wrong to get out there and see the world? It’s just that now more people have saved enough so that they can go see the world too.

Comments such as these pointed to the difficulty of giving up the dream of “the good life,” with a spacious and comfortable family home, an ability to acquire all of the material goods imaginable, an opportunity to enjoy luxury travel, and so forth. Moreover, the uncertainties surrounding climate change and the costs and benefits of potential solutions did not make it easier to act as environmentally responsible con-
sumers. Thus, even those respondents who seemed most inclined to believe in the willingness and ability of individual consumers to compromise personal interests in favor of the collective, and who most stressed the civic responsibility of consumers, found “green” living difficult. As the earlier mentioned devoted member of an environmental organization put it:

Female, 68 years: I wrote an article for our latest newsletter about being “the green consumer.” From when you get up in the morning there are...[laughs] it’s really, really difficult to act responsibly and ethically and in an environmentally correct manner and so on, because there will always be something. You know, is this the one I should pick or is it that one and...and how? Or should I stay at home or should I...?

This respondent furthermore confided that she was planning a trip to the Galapagos Islands, even if she did not like to think of the CO2 emissions associated with her travel. She apologized for the trip by explaining that for many years she and her husband had wished to visit the Islands. Like several other respondents, she illustrated the dilemma that many affluent individuals often confront. They want to be environmentally friendly/save energy and to travel, but they feel it is difficult or impossible to do both at the same time. When they have to choose, the choice often favors the trip—one of the reasons being that it is crucial to modern identity to travel (Jensen, 2011).

In short, while expressing serious concerns about climate change and stressing the need for solutions, our respondents still realized that taking personal responsibility will never be easy, especially if it means sacrificing one’s everyday comforts and freedoms, or the promise of future prosperity.

Similarly, several respondents argued, if not for legislation and control, then for other measures of political regulation meant to motivate more climate-friendly behaviors. Examples mentioned were tax reductions on lower CO2-intensive fuels and more CO2-efficient cars, better and cheaper public transportation, and so forth. However, as some respondents pointed out, this would not necessarily resolve the overall dilemma of putting solutions into practice—it may only divert it to a political level. One of the respondents put it like this:

Female, 68 years: I think you could do a lot of things [with regulation], but it’s just that it takes political interference in people’s freedom. And that’s difficult, you know. Who will stand up as a politician and say: “Now, this is necessary!” That doesn’t get you many votes, does it?

In other words, our respondents pointed at personal interests impeding collective solutions to climate change, not only when it came to private companies with vested interests in the development of technological solutions, but also with respect to politicians and even to themselves as citizens and consumers.

Skepticism and Hope

Despite their skepticism and awareness of the dilemmas involved in trying to alleviate climate change, many respondents remained hopeful, or even confident, that solutions would be found and implemented after all. For example, one respondent expressed optimism about the possibility of reducing transportation and travelling via taxes and continued:

Male, 47 years: I don’t think you’re interested in changing your consumption habits, but I simply believe there will be a pressure on politicians to the effect that now something has to happen. Whether that also means stepping in from the public sector to support those areas of research that might develop new things...at least we get some new technologies that will make everything more efficient and less polluting.

The idea expressed here is that general awareness of the problems of climate change will eventu-
ally drive political decision making to find solutions and put them into practice. Part of this optimism hinges on hopes for an ultimate solution in the shape of new technologies that will resolve the climate-change dilemma once and for all. Nevertheless, the overall argument is that problem awareness can open a window, even for difficult political decisions, for unpopular regulation.

This is exactly the more recent point made by Ulrich Beck (2009). He argues that so-called world risk society is faced with the problem, whether recognized or not, of having to make decisions on the basis of not knowing—as in the case of climate change, what can be done about it, and what will be the unintended consequences of our solutions. This means that the boundary between rationality and hysteria becomes blurred. Risk awareness should not be seen as hysteria, however, but as the anticipation of catastrophe. Because of this expectancy, world risk society is also a latently revolutionary society: The belief that the grave risks facing humanity can be averted by political action becomes an unprecedented resource for consensus and legitimacy, nationally and internationally.

We can say that Beck’s optimism is reflected in the hopes of respondents that politicians, locally and globally, will take problem-solving responsibility to find acceptable solutions to climate change. At the same time, however, this is contrasted by their skepticism about whether politicians—or for that matter private companies and people in general—are able and willing to assume this kind of accountability.

Conclusion

Our study found that public awareness of the risk of climate change was high, but that the question of what to do about it was surrounded by uncertainty. The immediate and rather positive reactions of respondents to the idea of using biomass for fuel production were contrasted by their more complex reflections on the risks and benefits of biofuels in relation to the main contested issues in the debate: the social and environmental consequences of large-scale introduction of biofuels.

In general, our respondents looked to politicians to take up primary problem-solving responsibility and not to leave decision making on matters pertaining to biofuels to private companies. The obligation of individuals was regarded with ambivalence and characterized by, on one hand, a demand for solutions to the problem of climate change and, on the other hand, a desire for mobility and prosperity.

The issue of developing biofuels must be understood as part of an overall demand for solutions to major international environmental and climate problems, which, as Beck and others (e.g., Giddens, 2009) point out, have in recent years become important items on the agenda both locally and globally. And this demand was also clearly present among the respondents in our study. Overall, they found it important to search for sustainable solutions that could be implemented and come to fruition in practice. They had different starting points, assumptions, wishes, proposals, and so forth but they all considered the problems to be real and serious—and felt that someone ought to address them. In the following discussion, we describe the major conclusions of our study.

Terms of Solutions

Our respondents agreed that for solutions to be acceptable, the needs and desires of people to travel and be mobile should not be neglected. Several of them, however, saw a paradox of both wanting to continue to travel in the ways to which they are accustomed and to solving environmental and climate problems. Those who considered lifestyle changes necessary particularly pointed to this conflict. One of the respondents expressed her concerns in the following terms:

Female, 61 years: Our earth is our common earth. And it must be in everyone’s interest that we make some changes in our way of living…so that we can respond to the warming that is now extra. It’s not just us humans. There are animals, and there are…gee it’s so intertwined.

Although she did not say it directly, it was probably implicit in the formulation of this observation that a reduction in consumption is needed to mitigate climate change. Her answer could indicate that she was aware of the problem’s complexity but was reluctant to express herself sharply, perhaps because she was not herself able to predict the consequences of the changes she felt were needed, or because she thought it would be extremely difficult or impossible to make the necessary decisions to implement restrictions on consumption.

Another issue concerning reduction in consumption was about equality. A female respondent expressed her opposition to abandoning either travel or anything else in favor of climate or environment if all did not sacrifice equitably. She would not be the only one who did “the right thing,” and even if she were convinced that a reduction in consumption was necessary to address climate-change problems, she underlined that in her opinion any restrictions to mobility (or other consumption goods) must be equal to be regarded as fair and acceptable.
Others argued that technological solutions had to be developed and that this could solve or at least reduce the problems.

**Male, 62 years:** But we have to produce another kind of energy, right?...In the transportation sector one can try to produce either an alternative fuel...or perhaps produce engines that use fuel much more efficiently...Technological development should encourage the type of engine that promotes energy efficiency because it’s quite clear that transport is using...I mean it’s incredible how much people are driving, right?

And here, biofuels could be part of a technological solution, although even technologically optimistic respondents stressed that such interventions had clear limitations because biofuels in their view would hardly be of any significance given the scale of the overall challenge. They agreed that biofuels could only make a limited contribution to mitigating the huge and complex problem of climate change, and the quantitative restriction on biofuels alone challenges the value of greater reliance on the technology. Other respondents emphasized the need for alternatives to the development of biofuels. In the following, one respondent points to other technologies relying on renewable energy:

**Female, 32 years:** Now, I also think that now we have bioethanol, but there’s also wind and water mills and...Well, it’s a better way to create energy, so it is perhaps in that direction we must [turn] instead, but we don’t know as long as we don’t know the impact of biofuels.

Although this respondent initially was sympathetic toward biofuels, she emphasized several times during the interview that there are different alternatives. She expressed an indirect skepticism toward investing in a development with so many conflicting and complex issues built in, as in the case of biofuels.

Our study of public perceptions of biofuels illustrates the complexity of understanding and managing environmental and climate-change issues in the contemporary world. People are convinced of the need for solutions, but they have no clear insight into how to address the problems in practice. Some of our respondents remained hopeful that social and environmental problems could be resolved, but an overall message was that more knowledge is needed to determine whether and how to introduce biofuels and subsequent monitoring is required to avoid the intended and unintended consequences of doing so. In short, biofuels were deemed acceptable only to the extent that the presumed benefits prove substantial and that they are not outweighed by inadvertent social and environmental costs.

**The Implication for Mobility**

One can argue that to be mobile and to travel have essential connotations in the current age. Both are seen as part of “the good life,” and are often perceived as a necessity, a commitment, a prerequisite to “get everyday life to hang together.” Mobility is crucial to the identity of modern individuals and to their self-understanding (see Urry, 2007; Jensen, 2011). The mere idea of reducing the extent of mobility will often prompt people to cling to the idea that technology can enable sustainable transportation. Similarly, several respondents in our study felt that technology would probably be able to resolve the problems of climate change as well as the environmental issues due to energy consumption in general and the challenges associated with the consumption of fossil fuels for transportation in particular. At the same time, most respondents expressed skepticism regarding the side effects of technological development, including the development of biofuels. They acknowledged the paradoxes inherent in these different approaches—and even if they accepted living with it, they still considered it a contradiction or a dilemma and wanted the problem of climate change to be solved.

**Overall Implications**

We have discussed issues concerning the use of biofuels for the purpose of addressing (some of) the environmental and climate-change problems associated with contemporary modes of transportation. Often the notion of complexity is used in social science literature to characterize the relationship between the public and solutions to environmental problems (e.g., Cohen, 2000). In our study, we have pointed to this complexity as well, but have also sought to understand and explain the driving forces behind the complex issue of how and why people perceive and interpret environmental and climate-change problems and their reflections regarding potential solutions. We consider the understanding of this complexity to be an important finding of our study.

More tangibly, we have described how the general public weighs the advantages and disadvantages of possible interventions to transportation-related environmental and climate-change problems and how they reflect on the notion of developing biofuels for this purpose. In that context, we have focused on a number of conflicting aims: human vs. environment, hope vs. skepticism, mitigating climate change vs. maintaining current mobility practices, and techno-
logical fix vs. technological risk. Together, these dualisms lead to a general sense of public ambivalence and this dissonance was in evidence throughout our study, irrespective of the specific issue on the agenda. Our respondents pointed to uncertainty about how to handle and address problems in both their own (everyday) lives and the wider world around them. And they considered environmental as well as climate-change issues as core dilemmas with no easy solutions.

An important conclusion of this work is that there is ambivalent and conditional acceptance among the Danish public about developing biofuel technologies for transportation, and the contingencies have a number of different components. This means that there is no simple answer to the question of whether the public (or individual members) are “for” or “against” the development of biofuels. It depends on the context in general and how this development is executed in practice. Even if the focus of our article has not asserted a specific view on the emergent political and economic decisions in this field, we hope that our findings provide useful background insights for an informed debate, both about the efficacy of continued development of biofuels and about how to make and implement decisions in this complex area within a democratic framework.

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