9th ESA conference, Lisbon 2.-5.9.2009

RN12

Bioenergy production models and social sustainability at Finnish farms

Suvi Huttunen

Introduction

Problems related to energy production have become one of the most significant social question also regarding rural areas. There is an apparent need to find a model for sustainable energy production that ideally would encompass economic, environmental and social sustainability. (Elliott 2000) One important solution to carbon dioxide emissions as well as to the depletion of fossil resources lies in the renewable natural resources that exist in rural areas. However, sustainable and reasonable utilisation of these resources is not simple, but requires specific analysis on the impacts of different production models (Mol 2007). And at the same time we must ask who can utilise these resources in the countryside and how could they contribute to (sustainable) rural development.

On the other hand, among both rural research and rural policy making especially in Europe during the last 10 years, there has been a wide discussion on multifunctional agriculture. (Arovuori et al. 2006, Wilson 2008). Multifunctionality means the ability of agriculture to provide other beneficial commodities and non-commodities besides the more traditional food and fibre. These can be for example rural landscape and rural viability. Observed through multifunctionality, agriculture and rurality can be seen as a wider unit and multufunctional agriculture is actively producing sustainable rural development. Thus, recognising multifunctionalty as an essential element of agriculture means also that sustainable development gains a central position in analysing the countryside. (Marsden ja Sonnino 2008, Marsden 2003). Farms producing renewable energy are in general pluriactive, thus they are practicing more than one business. However, energy producing farms can also been seen as multifunctional in a different way than farms concentrating merely on food production, the various side products of energy production becoming important part of the multifunctionality. (Järvelä et al. 2009)

The purpose of this article is twofold: first the possibilities to produce bioenergy in farms are examined from farmer's perspective. Second an additional interest is in finding out what kind of social sustainability can be associated with energy production in farms and does it have potential to promote social sustainability more widely in the region. The research is based on interviews of energy producing farmers in Finland.

In Finland bioenergy production in farms has traditionally been heat production using wood fuels for the farm's own needs. Increasingly, it has also meant production of wood based heat for selling purposes, thus forming an additional income source for the farm. This line of business is called heat entrepreneurship. Heat entrepreneurship began in Finland in the beginning of 1990s and the amount of heat entrepreneurs has been rapidly rising especially during the 2000s. At the end of year 2006 there were about 330 heat plants operated by heat entrepreneurs, and about 200 heat entrepreneurs. The majority of heat entrepreneurs are farmers. (Alanen 2007)

Bioenergy production in farms can also mean biogas production and its utilisation as heat, electrcity and traffic fuel and in some farms it means the production of biodiesel for the same purposes. In Finland there were 8 farms producing biogas and 4 farms currently building a biogas reactor in 2006. In addition there is one larger unit managed in co-operation by several farms (Kuittinen et al. 2007). The eldest of these plants have been built already at the 1980's, but most of them are quite recent and built during the last five years. Currently there are no statistics on the farms producing biodiesel, but it can be estimated that biodiesel is produced in about 20 farms. The production of biogas or biodiesel in farms can seldomly be considered as auxiliary production line. It is rather an addition to the food production reducing the need to buy energy and making the farm more multifunctional.

The fourth way[i] for Finnish farms to take part in bioenergy production is the cultivation of reed canary grass. During the last five years it has become increasingly popular especially due to the activity by Vapo, Finnish peat and bioenergy company. Vapo has made cultivation contracts with farms and committed to buy the reed canary grass they produce. However, reed canary grass cultivation is not energy production as such since the farmer is not producing electricity, heat of traffic fuels. This is the reason why it is left outside the scope of this study.

This chapter is structured as follows. First the definition of social sustainability is assessed and the framework for analysing social sustainability in bioenergy production is presented. At the analysis section, bioenergy production models at Finnish farms are presented and related to social sustainability. Finally, the implications of the social sustainability of farm-based bioenergy production are discussed.

Social sustainability in rural areas and in bioenergy production

The concept 'sustainable development' entered the global arena via the Our common future report by Bruntland's commission in 1987. The definition for sustainable development given in the report was as follows: "Sustainable development is development that…." (WCED 1987). The definition is very broad and general. Basically, it emphasises human needs and intergenerationality, but no clear programme for sustainable development can be derived from it. Due to the popularity gained by sustainable development, it has been used for various purposes and it has also been widely criticised (e.g. Meadowcroft 2000). There have been many attempts to clarify the definition of sustainable development, but one can say that finding an exact definition that qualified everywhere and for all purposes seems rather difficult if not impossible, as well as setting a definite set of generally suitable indicators[ii] Still, or maybe just because of this, it is very fruitful to use sustainable development in examining questions related to development and well-being locally.

Usually, sustainable development is divided into economical, ecological and social dimensions, and very often and additional cultural dimension is extracted from the social dimension. These dimensions are closely intertwined, and its impossible to fully separate them. Very often the dimension are contradicting and the main interest seems to be concentrating on balancing economical and ecological sustainability, while social sustainability remains more vague.

In the literature, there are several studies relating bioenergy and renewable energy production to sustainable development and also studies on the social effects and implications of bioenergy production (e.g. Domac et al. 2005, del Río and Burguillo 2008, Bucholz et al. 2007). The purpose here is to utilize this literature for creating a

framework for analysing social sustainability in bioenergy production in Finnish farms. The framework is made specially for this study in order to clarify the analysis, and it not suggested to be used as such in other studies. Sustainable development and especially social sustainability is always locally bound and criteria used for analysing it should also be locally established (e.g. Dryzek 2005:158).

In 'Our Common Future', social sustainability is implied by inter-generational and global equity. Social sustainability is developed further in Agenda 21, as the concept of sustainable livelihoods is introduced. Sustainable livelihoods has been used and developed mostly within development studies. Thus, it concentrates on poverty reduction. The concept sustainable livelihoods unites all the dimensions of sustainable development, but there the main focus is on assessing people and their capabilities (cf. Sen 1999) to act within the boundaries set by external factors and the key question is how people can reach and maintain sustainable livelihood. Sustainable livelihood contains the ability to resilience and various strategies related to the changing external factors and stresses on livelihoods. (Scoones 1998) Thus the concept is very interesting and relevant also in assessing issues not so directly linked to poverty reduction, but having to do with social sustainability in a wider scale. People's assets and their opportunities and restrictions to utilise their assets define their capabilities and reinforcing capabilities can be regarded as a significant part of social sustainability. In the analysis of social sustainability this has been called for example ability to control changes (Saastamoinen et al. 2006), control over one's own life (Rannikko 1999) or enlargement of capacity to act (Leskinen ym. 2006).

The key in sustainable livelihood is wellbeing and the ability of people to define their own goals for wellbeing. Wellbeing is also central for social sustainability (e.g. Elliott 2005). In these cases wellbeing is understood as a wide concept going beyond mere material wellbeing and encompassing such issues as quality of life and control over one's own life. In addition, socially sustainable development encompasses social justice and participation (Elliott 2005: 13, Rannikko 1999, Rantala et al. 2006).

Social sustainability has been related to the other dimensions of sustainable development in various ways. Perhaps the most common way sees the dimensions as equal and partly overlapping and real sustainable development is achieved only after sustainability is achieved in all the dimensions. This model is pictured as the overlapping circles. (Elliott 2005:13, Connelly 2007). Juurola and Karppinen (2003) stress that social sustainability requires environmental sustainability and that economic sustainability is the last one, that can be built only on ecologically and socially sustainable development. However, it seems difficult to assume that on dimension of sustainable development requires another dimension, especially when different analyses of sustainable development stress different dimensions (Connelly 2007). These preferences cannot be driven from any definition of sustainable development, but they are always related to values and are in such a way part of the plurality and contested nature of sustainable development (Connelly 2007). Rather sustainable development contains all its dimensions, but the dimensions themselves have to be analysable separately. On the other hand in longer time-perspective it is difficult to consider e.g. social sustainability being possible without ecological or economical sustainability.

Time-perspective of social sustainability seems to be problematic also in other ways. We have to deal with the most common problems of sustainable development: what do we want to sustain? How long should we sustain them? And what if the development that now seems to be sustainable is not sustainable from the point of view of the next generations? As an example one can consider the housing politics in Finland after the Second World War. As Finland lost considerable amount of land area in the eastern

parts of the country to Soviet Union, the people living in these areas had to move and find places to live. These people were mostly farmers. The government took an active role in this housing project and issued new areas or farms to start their life with. This was done either by taking parts of existing larger farms or by giving people opportunity to move previously uninhabited areas. At the time it certainly seemed reasonable, but at longer run it was maybe not so smart to create habitation into remote areas and to cut large farms into many smaller ones. Many of these farms have proven to be unviable during the following generation, and people have moved to larger towns and cities. (See e.g. Tykkyläinen 1995).

Despite the difficulties the time-perspective is integral in social sustainability. Ignoring the time-perspective, it would be more correct to talk about social impacts rather than social sustainability. (Leskinen et al. 2006, Juurola and Karppinen 2003). It is essential to consider sustainable development and social sustainability in particular as a process, where the aim is to develop and reinforce people's capabilities to obtain and increase their wellbeing. Thus, the main objective is not any stable sustained condition, but ability to cope successfully as the conditions set by the society and the environment change within such limits that coping is possible.

Another problem related to sustainable development and social sustainability is scale. What seems to be sustainable locally is not always sustainable globally. In this study, the scope of the locally collected interview data sets limits to the possibilities of global assessment. And the focus here is on the interviewed individuals, energy producing farmers and their view on the social sustainability of their life analysed in the potential increasing of their capabilities and its consequences. Over-generational assessment is even impossible using this data, where the possible effects on future generations can only be speculated. Thus in this study the assessment is made on individuals and thus the assessment is also local.

What then are the special characteristics of social sustainability in bioenergy production, or what is the framework used in the analysis? While assessing bioenergy production one has to consider the entire production chain with various different phases and impacts. What are the raw materials energy is produced from, what technology is used for the conversion, how and in what form is the produced energy used and distributed? (Buchholz et al. 2007). All the phases have integral issues related to social sustainability and thus it is important to find out how the production chain works. In this way also all the actors and social networks related to energy production and their role is found out.

Domac et al. (2005) list some benefits related to bioenergy production. These are increased standard of living, that includes for example employment, environment, health and education and social cohesion and stability that is related to migration form the countryside, local development and pluriactivity in the rural areas. Del Río and Burguillo (2008) add participation and institutional development. Also in Finland the production forest based energy has usually been related with positive effects on employment and income and ameliorating business opportunities in remote areas. (Rikkonen and Tapio 2009, Peltola 2007, Leskinen et al. 2006, Åkerman and Jänis 2005). Heat entrepreneurship has managed to reinforce the capabilities of the entrepreneurs by the positive sum effects and thus created social sustainability. (Peltola 2007).

Employment becomes easily the focus point, when assessing social benefits of economic activities, since they are maybe most easily measurable. In renewable energy production, the most important employment effects come via bioenergy production,

since there the need for workforce continues to be significant even after the build-up phase, in processing and transporting the fuel and in managing the power or heating plant. The employment effects in bioenergy production come often in remote areas, where employment is normally hard to find, and where people are also suffering of under-employment, thus bioenergy production has potential to also make employment opportunities more equal between different regions. (Del Río and Burguillo 2008) Similarly, the income arriving from bioenergy production has potential to equate income levels between regions. This can be reflected to for example migration between regions.

Especially in developing countries (modern) bioenergy production has ameliorated the availability of energy and thus reducing poverty. (e.g. Kemmler and Spreng 2007). On the other hand, renewable energy production has ameliorated the availability of energy also among poor in industrial countries, by reducing the fuel prices, as local fuels seem to be cheaper than imported fuels. (fuel poverty) (Illsley et al. 2007).

Social sustainability of bioenergy production includes acceptability of technology in all the production phases. This can be observed for example in the way other people like neighbours or community members regard the production activity. An important issue is also the existence of customers: are they easy to find? Also appreciation relates to acceptability. If the positive effects outweigh the negative in the general opinion, the technology becomes acceptable. Thus acceptability does not mean that the activity has no negative effects. (Elghali et al. 2007, Bergman 2008) On the other hand, acceptability can be affected by some aspects of social sustainability, like increasing participation and participatory decision-making, as well as increasing level of knowledge. (Bergman 2008)

From this basis, social sustainability in farms-scale bioenergy production is separated into three main parts that structure the analysis. These parts are: 1) Farmer's life 2) Farm and its future 3) Local area. These are the further separated into smaller parts as can be seen in Table 1.

Table 1. The framework for analysing social sustainability in farm based bioenergy production.

1. Farmer's life	Income, livelihood • Material wellbeing • Availability of energy
	Control over one's life • Freedom of choice • Participation • Ability to adjust to changes - resilience
	Quality of life • Relationships • Activities • Living environment
2. Farm and its future	Continuity of the farm • Possibilities for the next generation to live on the farm • Attractiveness of the area as a place to live
3. Local area	Income, livelihood • Employment, equality of employment • Other impacts on income, equity in their division. • Availability of energy
	Acceptability of technology
	Community • Social contacts • Coherence, dependencies • Trust • Participation
	Livelihood structure and attractiveness of the area

Data and methods

The data consists of 31 interviews of bioenergy producing rural entrepreneurs. The majority, 29 of them were full or part-time farmers engaged in dairy, beef or crop production or combinations of these. Two of the interviewed were not farmers but engaged with forestry in other ways. The part-time farmers had another job outside the farm or were engaged in other entrepreneurial businesses besides farming or energy production. The interviewees included 15 heat entrepreneurs from the area of Central Finland[iii], 10 biogas producers and 6 biodiesel producers. Some of the interviewees were participants in same energy production co-operatives or consortiums or were co-operating in other ways. All the interviewees were male.

The interviews were carried out between fall 2006 and fall 2007 at the interviewees' homes or at the energy production plant. In the interviews a list of questions structured in four themes was used, but the order of the questions varied from one interview to another and also additional questions were asked, depending on the issues that came up along each interview. The covered themes included: 1) farm and energy production in practice 2) drivers and barriers for the energy production 3) possibilities for energy production at farms in general and 4) relationship to the environment. The interviewees' were also asked to draw an operational diagram of their energy production activity. In this study the focus is on the practical arrangements of the

energy production and the drivers and barriers for the production, because issues related to social sustainability were mainly dealt with this part of the interviews.

The analysis focuses on mapping the energy production activity from the point of view of the producer, in a way that enables to find out the main common points and differences in the tree different ways of bioenergy production, both from the perspective of the production and social sustainability.

Models for bioenergy production in Finnish farms

Heat entrepreneurship

Model for heat entrepreneurship in a farm from farmer's perspective is presented in Figure 1. The inner circle represents farmer's own activities regarding heat production. The next circle includes other actors and functions closely related to heat entrepreneurship. The outer circle shows other actors and functions that are supporting to the heat entrepreneurship. Many actors and functions are situated in between two or even all the circles. For example in the case of the two innermost circles this means that in some heat entrepreneurs the activity is done within the heating business and some use external services to fulfil the activity and so on depending which circles are included. The arrows represent material flows. Dashed arrows are possible functions that are not included in all heat enterprises, like utilising other raw materials in the heat production alongside with woodchips.

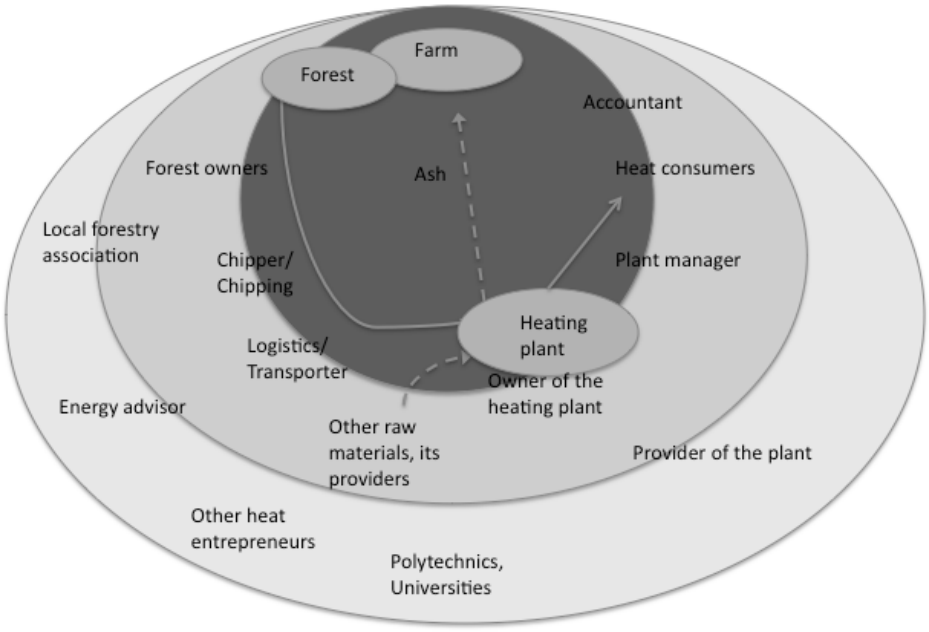

Figure 1. Model of heat entrepreneurship from the entrepreneurs point of view.

The role of heat entrepreneurs is strongly affected by the form or the business. Heat entrepreneur can be working as a single entrepreneur, part of a small entrepreneurs' consortia, or part of a co-operative. Single entrepreneur needs more partners outside the heating business, whereas in larger co-operative the members themselves can do much. Also the responsibility, amount of work and earned income are more significant in a single entrepreneur business compared to shared business.

The basic business idea in heat entrepreneurship is to sell heat produced usually from wood chips. The customer(s) have made contracts with the heat entrepreneur committing to buy the heat they need for a certain price. Most of the interview heat entrepreneurs have only one customer, municipality that buys the heat for a certain building or sells it forward for a larger heating network. It is also possible that the municipality owns the heating plant and the entrepreneur only manages it. In some cases the entrepreneur provides heat for a private business or for state owned building. The wood for heating is usually obtained from forests owned by the entrepreneur(s). Also a lot of wood chip is made from bought material. Some use external services for chipping and logistics, others de everything by themselves. It is also possible that different members of the heat entrepreneurship co-operative or consortia are responsible for different phases in the wood collecting and heating processes. In fact, it seems typical that the membership has formed on the basis of the possibilities for different members to fulfil different roles, starting even from accounting. Thus there is a lot of variation on the issues that are performed within the heating business and which are bought from outside.

As a more distant actors related to heat entrepreneurship there commonly are local forestry association, which advises for suitable forests for attaining raw material. Additionally other heat entrepreneurs and providers of the heating plant are helpful whenever problems arise. Even here it is possible that the provider of the heat plant and even local forestry association are members in the heat entrepreneurship co-operation. Also energy advisors working at regional forestry centres as well as universities and polytechnics may be helpful for heat entrepreneurs.

Analysing through social sustainability, heat entrepreneurship has changed the entrepreneur's life. For some it has meant a significant additional income that enables the farmer to continue living in the farm. For all, the additional income is not crucial, but heat entrepreneurship means more a suitable addition to the farm's activities and a welcomed extra to income. As heat entrepreneurship is different to farming it has widened the livelihood options to other areas and increased possibilities to utilize forests beneficially. Thus farmer-heat entrepreneurs are less dependent on one income source and their economic capital is wider. However, heat entrepreneurship is no guarantee for increased income. For all farmers the obtained addition to income has not been sufficient and they are looking for other options or possibilities to expand the heat entrepreneurship business. In addition, some farmers have become heat entrepreneurs driven by other than financial benefits, such as the possibility of heat own farm more practically and in these cases the financial benefits have remained minor. However, mostly the heat entrepreneurs are very content with the business and find it economically feasible and as increasing assets.

Appreciation of own work has increased since the engagement in the heat entrepreneurship business. A farmer can feel inferiority in normal farming due to the subsidies and as a result it feels good to be doing "real" work, in a business that is profitable without subsidies. Also the farmers feel that the image of wood energy production is very positive and that increases the appreciation of own work. Although at the beginning the idea of wood energy instead of oil may have caused suspicions among people living in the municipality and decision-makers. And this has caused troubles while establishing the business. However, after the plant has been built and it has been successfully operating for a while, the suspicions have faded and support for the plant has become strong. At the moment all the heat entrepreneurs feel that their business is widely appreciated among the community and even wider.

The value of heat entrepreneurship can be seen at the level of relationships. On the other hand, being on duty 24 hours a day is hard and has caused troubles in family life

especially when starting the operation of the heating plant when alarms have in general occurred often. But on the other hand the formation of strong networks with other members of the heat entrepreneurship co-operation or other related partners has increased dealings and contacts, in a way that has also passed on to free-time. Working as a farmer is often felt as lonely drudgery and heat entrepreneurship offers a welcomed change, because it offers opportunities to work together and share responsibilities. As an additional benefit, heat entrepreneurship may have produced valuable contacts in the business-world and with municipal decision-makers.

Some heat entrepreneurs take the business purely as a nice and interesting hobby that as a bonus gives a small financial benefit for forest management. Also those who had significant income from heat entrepreneurship, state that the business has given them an important new challenge. It has been fascinating to put one's mind to a new issue, or to widen one's understanding on wood heating that was previously only used in a small scale in the farm. Another socially important thing is the felt increase in value of own forests and the forests in the near areas more widely. Also the landscape is felt to have improved. This is due to increased management of young forests and also clearing of roadsides and other thickets.

The future is perceived by the stability of own livelihood and on the other had by the possibilities of the next generation. The latter especially if the farmer-heat entrepreneur is older and has children. For children they can sketch entrepreneurial opportunities especially within heat entrepreneurship and some see them also as financially beneficial enough as the main business. On the hand, it was worrying that heating with wood fuels and especially collecting wood fuels is not regarded as trendy occupation, and it may be that in the future there are no interested people for this sector.

More widely, heat entrepreneurship is regarded as providing opportunities for the entire region. This is due to increased employment, especially as being able to offer additional work for those underemployed, like local forestry workers, and also by being able to offer price for the wood that otherwise would not have markets. Thus, it is typical for heat entrepreneurs to regard the entrepreneurship as strongly benefiting the region. The municipality benefits, because fuel comes from inside and heat users get heat at lower price than heating with oil would offer. In this way also the availability of and access to energy is improved.

Another regionally and locally significant issue is that some of the heat plants and their model of operation is a local sight. People who are interested in starting heat entrepreneurship, and also other interested come to se the plants, even from abroad. In addition heat entrepreneurship has supported and even created new local manufactures, especially when the manufacturer is co-owner in a heat enterprise.

Biogas production

The models related to biogas production are considerably more similar compared to heat entrepreneurship. The production model is pictured in figure 2 using the same principles as for heat entrepreneurship in Figure 1. Apart from one large co-operative, the energy production activity is independent and based on one single farm. Biogas is produced by anaerobic digestion, using mainly cow or pig manure or sometimes other farm-based or industrial biowaste. Some farms also cultivate energy plants to be used in biogas production. If industrial wastes are used, the biogas producer can gain extra income from the waste management. The produced biogas can be used as such in the farm to produce heat and electricity or it can be stripped to be used as traffic fuel.

Besides biogas, the anaerobic digestion process also gives digestate, which is the solid residue of the digestion process. The digestate can be used as fertilizer in the farm, very much in the same way as manure. The nutrients in the digestate are more easily usable and it contains less odour compared to untreated manure.

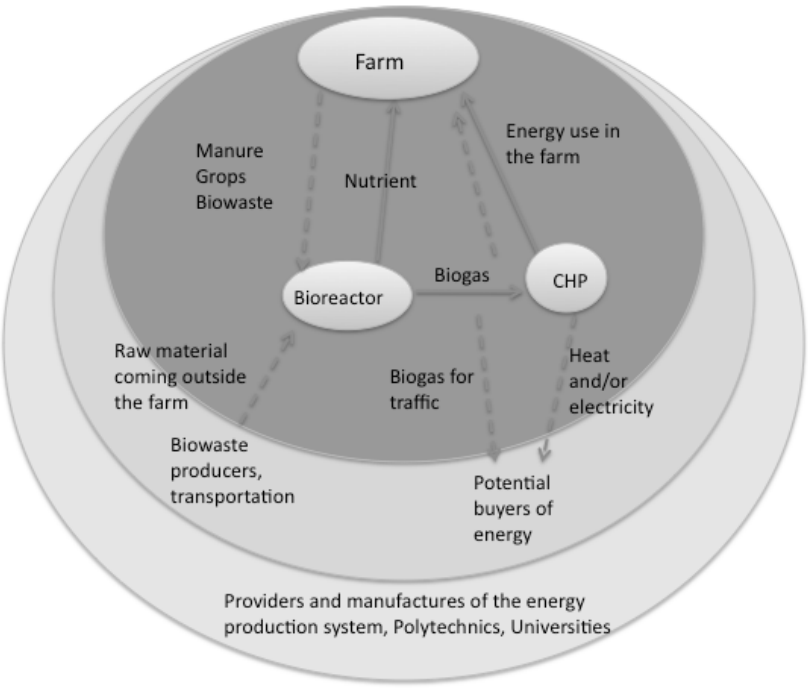

Figure 2. Model of biogas production on farm, from the point of view of biogas producing farmer. CPH means combined production of heat and power.

The produced energy is mostly used in the farms and as heat. Some of the interviewees produced also electricity and one produced traffic fuels. However, several had plans to start electricity and traffic fuel production in the near future, especially if the technology becomes more easily available and selling of electricity and traffic fuels becomes more profitable. Electricity and traffic fuels are more easily sellable than heat. Still mainly the energy will be used in the farm and many had hopes of not having to buy external energy.

In its simplest form, biogas production is solution to the farm's manure management problems and at the same time provides heat for the farm's needs. In this case the biogas production has no connections whatsoever outside the farm. The projected changes and extensions, for example in the form of electricity production or utilisation of industrial biowaste, in the future bring about the possibility for more contacts and also have potential to increase the economic incentives for biogas production.

Investment costs in biogas production are high and this is a major factor in both inhibiting farms from starting biogas production and reducing the profitability of the action. Majority of the biogas producers, especially ones who have started their production earlier than five years ago, have got their biogas reactor and some other necessary equipment as some kind of pilot versions in co-operation with a university or polytechnic. Thus they have avoided at least part of the investment costs. Some of the interviewees have developed the biogas production system themselves and by doing so successfully gained the possibility to sell similar equipment for other farmers. If is

succeeds, this provides an opportunity for a new kind of business in the countryside including also consulting.

Currently, the income in biogas production comes from the reduction of the farms energy bill. Selling electricity is not economically profitable with the current Finnish legislation that contains no feed-in tariffs. However, the interviewees were quite optimistic about the profitability of selling electricity in the future, especially if the price of electricity increases and the legislation changes as the Finnish government has promised. Thus in the future the position of biogas producers and their capabilities can fortify, even if at the moment biogas production means more costs and it restricts other development of the farm, due to the high investment costs.

As briefly mentioned before, the significance of biogas production for the farmers comes more from the manure management part, than from the possibility to gain money. Digested manure contains less odours and thus it is easier to use as fertilizer on the fields, at least what comes to the neighbours. Another important factor for the biogas producing farmers is the challenge the production offers. Many consider the production as an interesting hobby, but it contains also wider meaning. Biogas production in the Finnish conditions at farm scale is still so rare, that the most suitable production concepts are strongly under development. It is interesting for the farmers to be a part of this development work and being able to manage the biogas production process is an important asset to the farmer's skills. Taking this a step further, if somehow farming became unprofitable for the biogas producing farmer, he would have gained significant skills that could be used for example in the waste management sector. Thus, the capabilities of the farmer have increased.

Compared to heat entrepreneurship, biogas production includes much less social networking. Mostly the production is based on a single farm and no external inputs or outputs are needed. Many of the interviewed biogas producers stated that they are able to discuss problems and interesting issues with some other biogas producers, but this is not the case for all. Some felt that they were quite alone with the biogas production and it hasn't really been what they expected it to be, especially what comes to profitability. The latter seems to be the case mostly with producers who have only recently started the production. Biogas production in Finland is still rare, and the producers have to work hard to promote it and even to get the production started. So, despite much talk in the media even the officials are not necessarily aware of the required permits or available grants regarding biogas production. Thus, biogas production can be regarded as pioneering work and it requires a lot from the producer; enthusiasm and passion for technological development work.

Attitudes, regarding biogas production in the near communities of the producers, have been suspicious. It has been considered as a fool's errand and it has been laughed at. From the producer's part a strong belief in what he is doing is thus required. On the other hand, there has been a major change in attitudes during the last couple of years and the producers are not laughed at anymore. Currently, many biogas producers show their farm and biogas production plant for busses full of interested people, and the near community has begun to value the biogas production activity. This has resulted in increased self-esteem and appreciation of own work.

The biogas producers believe strongly in the possibilities of the production in the future. Some even see it as a possibility for their children, especially if the selling of electricity and traffic fuels becomes feasible. To some extent the farmers also consider possibilities to stop conventional farming and become energy producers using cultivated crops and waste materials.

The benefits of biogas production are seen as regarding entire Finland, not just the near community or region. Biogas production could be a solution for sustaining the Finnish energy production. It could replace imported energy and simultaneously treat unutilised waste materials. The income would benefit mostly the countryside, areas that from the interviewees' opinion need it most crucially.

Biodiesel production

Biodiesel producers were the smallest group among the interviewed farmers. Biodiesel production was also the one that was mainly regarded as simply a hobby or just experimental activity by the producers. The production model for farm based biodiesel production is presented in Figure 3. Biodiesel is produced mainly from rapeseeds via compression and estherification. All biodiesel producers do not perform the estherification part themselves, but take the vegetable oil somewhere outside the farm to be processed into biodiesel. As by-products from biodiesel production the farmers also get straw, glycerol, protein rich animal feed, and in some cases also all, or part of the vegetable oil is used as such and not processed into biodiesel. All the by-products can, or at least are aimed to, be used profitably, thus they can also bring extra income for the farm. If the animal feed is not sold, it is used to feed the farm's own animals. Biodiesel is mostly used at the farm, but it can also be sold outside the farm.

Biodiesel production is performed based on one farm or as co-operatives of several farms. Biodiesel producers seem to be quite well connected and they provide an important support network for each other. Also the equipment manufacturers provide important assistance to biodiesel producers. The producers are also quite well connected to the surrounding community due to various collaborations with possible raw material obtaining and utilisation of the side-products. Comparing the networking of farm based bioenergy producers; biodiesel producers can be placed between heat entrepreneurs and biogas producers. Biodiesel producers have clearly wider production related network that biogas producers, but smaller than heat entrepreneurs.

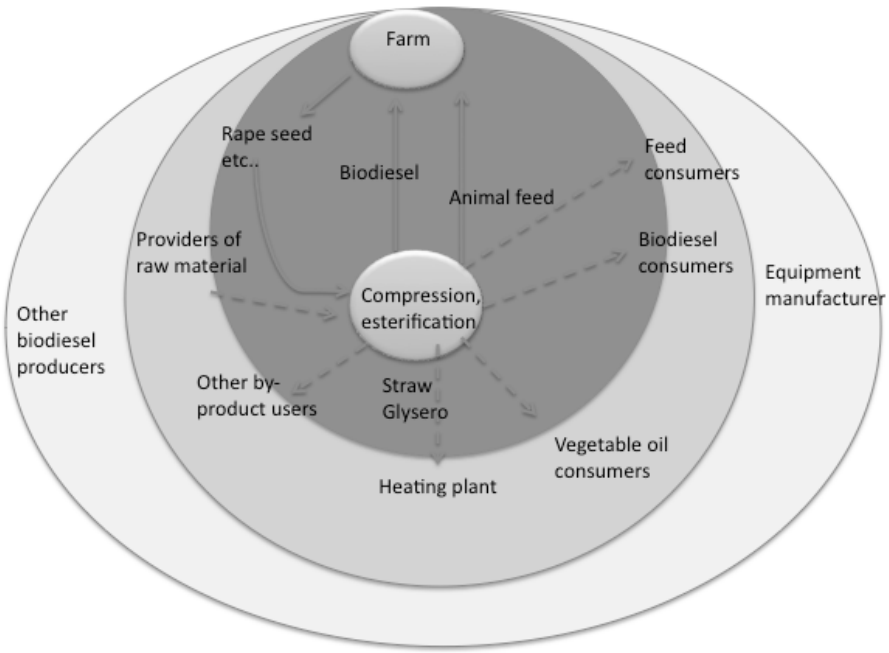

Figure 3. Production model for biodiesel production from the poin of view of the producer.

Despite the many by-products, biodiesel production is not significantly economically profitable for the farmers. In some cases the production costs more than it produces, in some cases the costs and income are even and some expect the profitability to improve in the near future. Still, even in these farms the biodiesel production is more just a hobby and a nice addition to other activities in the farm. Biodiesel production is time-consuming, but it provides an interesting project and thing to study and develop oneself at. Similarly to biogas production the obtained new skills can be useful outside the agricultural sector if ever needed. Some biodiesel producers have taken part to development projects, which have enabled them other interesting projects and contacts.

Many biodiesel producers have started the production with hopes of self-sufficiency in traffic and machinery fuels. Some have also considered possibilities for heat and electricity production. They feel certain pride in driving on fuel produced in their own farm and thus the appreciation of own work is strong. Another important factor is the environmental friendliness of the fuel and thus improving quality of the environment. In general the producers have high hopes for the future regarding both, their own biodiesel production activities, and the importance of biodiesel production in Finnish fuel palette as well as a means to reduce the need to import protein-rich animal feed. On the other hand, as the biodiesel production currently is more a hobby than a business, the producers don't rely their children's future or the regional development solely on biodiesel. More importantly, they see the by-products and the networking as means to gain profitability, and give hope for the future benefits.

Similar to biogas production, also biodiesel production has been labelled as curiosity and the producers have heard doubting comments regarding the possibilities of biodiesel. However recently, also biodiesel production has gained more credibility and people have become interested of the production and more positive towards its potential. This has strengthened the producers' faith in their action and its' future potential

Similarities and differences in social sustainability

The presented different models of bioenergy production in Finnish farms represent different kid of social sustainability, at least according to the bioenergy-producing farmers. The various characteristics of social sustainability related to each bioenergy production model are presented in Table 2 according to the framework of analysis. It seems clear that heat entrepreneurship produces most factors reinforcing social sustainability both regionally, in the future and at the producer's current life. The way these factors are perceivable in different heat entrepreneurships varies depending on the form of the enterprise and role of the particular entrepreneur, but in general social sustainability is reinforced by heat entrepreneurship in all cases.

Regarding heat entrepreneurship, this study reinforces the results represented in previous studies regarding the observation that heat entrepreneurship increases the capabilities of producers and fortifies their abilities to adjust to changes (e.g. Leskinen et al. 2006). Social networks that are formed by the production and their reinforcement is central cornerstone in this process (Åkerman and Jänis 2005) and partially it also ameliorates attractiveness and social cohesion at the local area.

Locally heat entrepreneurship also ameliorates the economic situation. Local forests are more efficiently used, new employment is created and in some cases also small scale local industrial activity emerges. In addition, the availability of energy in the local area ameliorates compared to earlier oil-based energy use. Usually also energy is cheaper for the end user.

Table 2. Common points and differences of bioenergy production on the social sustainability framework

	Heat entrepreneurship	Biogas production	Biodiesel production
1. Energy producer's own life	• Extra income from energy production and forests • Better availability of energy, own energy production	• Own energy production and following positive economic effects • Investment costs economically restricting	• Own fuel and following positive economic effects • Expensive investment, partly also utilisation is expensive
	• Resilience in income opportunities • Possible financial investment and commitment constricts other options • Own image as producer of domestic energy. "Real work" opposed to farming • Increase of knowledge	• Waste management and energy production enable more resilience in the future • Being prepared for tightening manure management demands • Financial commitment restricts other options • Increase of knowledge, own importance	• Possibly more resilience in the future, currently more of an economic burden. • Increase of knowledge, own importance
	• Reinforcing relationships in production related networks • Interesting hobby • Forests in better condition	• Interesting hobby • Time consuming • Some new contacts • Less odour from manure – better environment	• Interesting hobby • New contacts • Time consuming
2. Farm and it's future	• Good opportunity for the next generation • Benefits the rural area and makes it more attractive as a living environment	• Possible business for the next generation • Part of the future of farms, benefits rural areas	• Possibly important in the future
3. Local area	• Employs in many phases, mostly under-employed people • Income from forests • Small scale local industry emerges • Local energy	• Possible financial effects from buying raw-material and selling biogas • Possible employment • Waste management • Local energy	• Financial effects from selling and buying by-products from and raw materials for biodiesel production • Local energy
	• Prejudices at firs, now widely supported	• At first a curiosity, now more accepted and interesting	• At first a curiosity, now more accepted and interesting
	• More dealing among local people • Dependency on business partners • Trust • Increased participation by own energy production in the community	• Less odours from manure – better relationships to neighbours • A very small amount of co-operation or no co-operation at all	• Co-operation related to biodiesel production
	• Local image is enhanced by wood energy • Industrial development • Tourists	• Small industrial development • Tourists	• Small industrial development • Tourists

Biogas and biodiesel production appear quite similar in the framework. Both are rather new activities for the producer and the community, and thus they are related with some amount of insecurities and also financial risk. At the early stage it seems that biodiesel and biogas production rather diminish the capabilities of the farmers by demanding heavy investments and commitment. At longer time period however, the investment can prove to be very profitable as the skills and networks of the farmers ameliorate.

At the local level biogas and biodiesel production are weaker in their ability to create social sustainability when compared to heat entrepreneurship. Especially in biogas production, the producer seems to be quite alone and without a supporting network in the local area. In biodiesel production the situation better, due to various by-products. However, it should be emphasised that both lines of production are still young and not all of the networking and forms of action are fully developed yet, nor are there ready copyable models for these as there are in heat entrepreneurship. In addition, the suspicions and prejudges at the early stage might also have slowed down the farmer's interest in co-operation with these people. Heat entrepreneurship has been actively developed for more than ten years by various projects and instances. They also have a nation wide network of advisors. It is probable, that these measures have reflected to the formation of social sustainability.

In the all three forms of bioenergy production the producers consider it as an enriching element in their lives; as providing new skills and as improving the appreciation of their own work. These can be regarded as the most important aspects of social sustainability in farm scale bioenergy production at the personal level and they clearly show how the different production models can promote social sustainability even at the moment. (Cf. Jokinen et al. 2008)

This study also shows what kind of multifunctionality farm scale energy production can promote from the social sustainability's point of view. In such a way the farm-based energy production interestingly becomes part of the discussion on rural development and the different related visions (Jokinen and Järvelä 2008). Will energy production become central part of sustainable rurality and more importantly, can it help to promote the process of sustainability in the rural areas? In this case the assessment must include ecological, economic, as well as cultural dimensions of sustainable development, which were not included in this study.

Conclusions

There are various new types of bioenergy production, which have evolved along farm activities in Finland. The effects of these productions are still quirt unstudied. In this research, the farm-based bioenergy production was examined in relation to social sustainability, using a framework of analysis created specifically for the purpose. The framework proved to be a successful tool in analysing social sustainability. Based on this study, farm-based energy production can significantly promote social sustainability in the rural areas especially by widening the capabilities of the producers. However, especially the rather new types of energy production, biogas and biodiesel production contain also risks and are very demanding. Thus a lot of development work is still needed in order for these productions to become secure and care should be taken while promoting these for the farmers in order to avoid false hopes and disappointments. Biogas and biodiesel production is still unstabilised and many issues related to social sustainability still start with the word "potentially".

References

Akerman, M. Kaljonen, M. and Peltola, T. 2005. Integrating environmental policies into local practices: The politics of agri-environmental and energy policies in Rural Finland. Local Environment 10(6):595-611.

Akerman, M. and Peltola, T. 2006. Constituting the space for decision making—Conflicting calculations in a dispute over fuel choice at a local heating plant. Geoforum 37:779-789.

Alanen, Veli-Matti 2007: Lämpöyrittäjätoiminta 2006. TTS Tutkimuksen tiedote, metsäsarja nro 715. Työtehoseura.

Bergmann, Ariel –Colombo, Sergio –Hanley, Nick 2008: Rural versus urban preferences for renewable energy developments. Ecological Economics. 65:616-625.

Bucholz, Thomas S. –Volk, Timothy A. – Luzadis, Valerie A. 2007: A participatory systems approach to modeling social, economic, and ecological components of bioenergy. Energy Policy. 35:6084-6094.

Connelly, Steve 2007: Mapping sustainable development as a contested concept. Local Environment. 12(3):259-278.

DfID, 2008: www.livelihoods.org

Domac, J. –Richards, K. -Risovic S. 2005: Socio-economic drivers in implementing bioenergy projects. Biomass and Bioenergy. 28: 97-106.

Dryzek, John S. 2005: The politics of the earth. Environmental discourses. Second edition. Oxford University Press. Oxford.

Elghali, Lucia –Clift, Roland –Sinclair, Philip –Panoutsou, Calliope –Bauen, Ausilio 2007: Developing a sustainability framework for the assessment of bioenergy systems. Energy Policy 35:6075-6083.

Elliott, David 2000: Renewable energy and sustainable futures. Futures 32:261-274.

Elliott, Jennifer A. 2005: An introduction to sustainable development. Third edition. Earthscan. London.

Hyttinen, Timo 2005. Valoa pimeässä. Kohti energiaomavaraisuutta maaseudulla. Vaasan yliopiston Levón instituutin julkaisu 116.

Illsley, Barbara –Jackson, Tony –Lynch, Bill 2007: Addressing Scottish rural fuel poverty through a regional industrial symbiosis strategy for the Scottish forest industries sector. Geoforum 38:21-32.

Jokinen, Pekka – Järvelä, Marja 2008: Ruuan tuotanto ja maaseudun kehityksen visiot. Futura 28(3) 71-75.

Juurola, Muru -Karppinen, Heimo 2003: Sosiaalinen kestävyys ja metsien käyttö. Metsätieteen aikakausikirja 2/2003: 129-142.

Järvelä, Marja – Jokinen, Pekka – Huttunen, Suvi – Puupponen, Antti. 2009: Alternatives of farm entrepreneurship and rural sustainability in Finland. (in press)

Kemmler, Andreas – Spreng, Daniel 2007: Energy indicators for tracking sustainability in developing countries. Energy Policy 35(4) 2466-2480.

Kuittinen, Ville -Huttunen, Markku J. –Leinonen, Simo 2007: Suomen biokaasulaitosrekisteri n:o 10. Tiedot vuodelta 2006. Joensuun yliopisto, Ekologian tutkimusinstituutin raportteja no 3.

Lampinen, Ari – Jokinen, Erja 2006: Suomen maatilojen energiantuotantopotentiaalit. Ekologinen perspektiivi. Jyväskylän yliopiston Bio- ja ympäristötieteiden laitoksen tiedonantoja 84.

Leskinen, Leena A. –Peltola, Taru –Åkerman, Maria 2006: Puuenergia, metsätalouden toimintakentän muutos ja sosiaalinen kestävyys. Metsätieteen aikakausikirja 2/2006: 293-304.

Marsden, Terry 2003: The condition of rural sustainability. Van Gorgum.

Marsden, Terry – Sonnino, Roberta 2008: Rural development and the regional state: Denying multifunctionals agriculture in the UK. Journal of Rural Studies. (in press)

Meadowcrodt, James 2000: Sustainable development: A New(ish) idea for a new century? Political Studies. 48:370-387

Mol, Arthur P. J. 2007: Boundless biofuels? Between environmental sustainability and vulnerability. Sociologia Ruralis. 47(4):297-315.

Peltola, Taru 2007: Business on the margin: local practices and the politics of forests in Finland. Ethics, Place and Environment. 10(1):29-47.

Rannikko, Pertti 1999: Combining social and ecological sustainability in the Nordic forest periphery. Sociologia Ruralis. 39(3):394-410.

Rantala, Tapio –Hakkarainen, Juha –Karppinen, Heimo –Korhonen-Salapuro, Pirjo 2006: Metsien käytön sosiaalisen kestävyyden tulevaisuuden haasteet. Saastamoinen ym. (toim.) Näkökulmia metsäalan sosiaaliseen kestävyyteen ja sen tulevaisuuteen. Joensuun yliopisto, Metsätieteellinen tiedekunta, Tiedonantoja 168:11-52.

Rikkonen, P. and Tapio, P. 2009.

del Río, P. –Burguillo, M. 2008: Assessing the impact of renewable energy deployment on local sustainability: Towards a theoretical framework. Renewable and Sustainable Energy Reviews. 12:1325-1344.

Saastamoinen, Olli -Donner-Amnell, Jakob –Rantala, Tapio (toim.)2006: Näkökulmia metsäalan sosiaaliseen kestävyyteen ja sen tulevaisuuteen. Joensuun yliopisto, Metsätieteellinen tiedekunta. Tiedonantoja 168.

Sen, Amartya 1999: Development as freedom. Oxford University Press.

Scoones, I. 1998: Sustainable rural livelihoods: a framework for analysis. Working paper 72. Institute of Development Studies , Brighton.

Singh, Rajes Kumar –Murty, H. R. – Gupta, S. K. –Dikshit, A. K. 2009: An overview of sustainability assessment methodologies. Ecological Indicators. 9(2) 189-212.

Tykkyläinen, Markku 1995: Asutustoiminnan taloudelliset vaikutukset. Teoksessa Laitinen, Erkki (toim.) Rintamalta raivioille. Sodanjälkeinen asutustoiminta 50 vuotta. Atena kustannus. p. 139-158.

WCED 1987: Our common future. Oxford University Press.

Wilson, Geoff 2008: From ”weak” to ”strong” multifunctionality: Conceptualising farm-level multifunctional transition pathways. Journal of Rural Studies 24(3) 367-383.

Åkerman, Maria –Jänis, Laura 2005: Lähienergiaa puusta – maatalouden ja energiantuotannon synergiaeduista voimaa maaseudun kehitykseen. Maaseudun Uusi Aika (13) 3: 41-48.

[i] There has also been discussion on other agriculture related ways of producing bioenergy, for example willow cultivation. However, these alternatives have not yet been realised in Finland.

[ii] Certainly, there have been valuable attempts to find encompassing lists of sustainable development indicators. The problem is that these lists tend to become unpractically long and there is also significant difficulty in putting social sustainability in measurable terms. (e.g.. Singh et al. 2009)

[iii] The focus on Central Finland with the choice of interviewed heat entrepreneurs is based on this study being part of a larger project called funded by the Academy of Finland (number 115786). The project focuses on new business opportunities of farms in Central Finland in the form of energy entrepreneurship and production of local food. Biogas and biodiesel on the other hand are produced in so few farms that concentration on Central Finland was not practical.