

*Embeddedness in local
farm-scale bioenergy production*

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Abstract: Local bioenergy production is a new branch of farming related entrepreneurship in rural areas. In Finland, rural bioenergy production consists mainly of heat production using wood based fuels (heat entrepreneurship), but there are also farmers producing liquid biofuels, or heat and electricity from biogas. Local bioenergy production systems involve networks of various actors, and they can be analysed in terms of sustainable rural development and multifunctionality. However, in order to gain a deeper understanding about the formation and functioning of bioenergy production systems, an exploration into the concept of embeddedness is useful.

Local energy production systems can be considered more embedded in the locality, whereas large, centralised energy production systems might be more disembedded in nature. Embeddedness offers an insight into the role of relationships, personal ties, values and traditions that are essential in local energy production. The purpose of this article is to explore embeddedness in local bioenergy production from the perspective of energy producing farmers. This is accomplished by focusing on the multidimensional nature of embeddedness on horizontal and vertical levels. The key question to consider is: what kind of embeddedness can be observed in local bioenergy production systems, and how is it acknowledged and used among energy producers? The study is based on qualitative interviews of 31 energy producing farmers in Finland.

Keywords: Bioenergy, embeddedness, sustainable rural development, Finland

Integración (embeddedness) en la producción bioenergética a escala local

Resumen: La producción local de bioenergía es una nueva actividad emprendedora en zonas rurales. En Finlandia, la producción rural de bioenergía consiste principalmente en producción de calor usando combustibles de origen vegetal (empresas de calor), pero también hay granjeros que producen biocombustibles líquidos, o calor y electricidad a partir de biogases. Los sistemas de producción de bioenergía local incluyen redes de varios actores, y pueden ser analizados en términos de desarrollo rural sostenible y multifuncionalidad. Sin embargo, para alcanzar una comprensión más profunda acerca de la formación y funcionamiento de los sistemas de producción bioenergética, es muy útil introducirse en el concepto de integración (*embeddedness*). Los sistemas locales de producción de energía pueden considerarse más arraigados en el entorno, mientras que los grandes sistemas centralizados de producción de energía serían más ajenos a la naturaleza. La integración (*embeddedness*) ofrece una precisión dentro del papel de las relaciones, lazos personales, valores y tradiciones, que son esenciales en la producción local de bioenergía. El propósito de este artículo es explorar la integración (*embeddedness*) en la producción bioenergética local desde el punto de vista de los productores. Para conseguirlo nos hemos centrado en las múltiples dimensiones de ese concepto en los niveles horizontal y vertical. La pregunta clave a considerar es: ¿qué tipo de integración (*embeddedness*) puede observarse en los sistemas locales de producción de bioenergía, y cómo es reconocido y usado entre los productores de energía? El estudio está basado en entrevistas cualitativas a 31 productores campesinos de energía en Finlandia.

Palabras clave: Bioenergía, *embeddedness*, desarrollo rural sostenible, Finlandia

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Introduction

Renewable energy produced in rural areas together with traditional farming practices has become increasingly popular during the past five years. In addition to the most apparent drivers; climate change mitigation and the development of new energy sources (Flavin 2008), local energy production can have significant consequences for rural development. It has the potential to increase rural sustainability, and may even provide a representative model for sustainable rural development (see Marsden 2003, 2009).

Local energy production in this context refers to energy created from local resources, with locally based consumption, and represents a distributed energy production pathway that is rooted in the "soft energy path" proposed by Amory Lovins in the 1970's (Lovins 1977). Currently, it can be paralleled with various new rural productions, including local food, agro-tourism and small-scale industries that increase multifunctionality on farms and challenge the mere food-based, raw material production function of farms (van der Ploeg et al. 2000). As such, these productions can be seen as representing a new path in rural development, but exactly how are they contributing, and by what conditions do they emerge? These questions require further examination.

This study focuses on farm based local bioenergy production in Finland within the context of embeddedness - an interesting concept that provides an insight into the spe-

cial characteristics of local economic activity and its prerequisites. The main questions in this article are: what kind of embeddedness can be observed in local bioenergy production, and how is it acknowledged, applied and also formed among energy producers?

The article is structured as follows: first, an introduction derived from local food studies is provided on the concept of embeddedness. Next, the aspects of locality and quality are examined more closely. A Finnish case study is then presented, and followed by the analysis. In the final chapter, conclusions concerning the appearance and practicality of embeddedness in local bioenergy production are drawn.

Embeddedness, locality and quality

The concept of embeddedness can be traced back to Karl Polanyi's (1944) concept, further developed by Granovetter (1985). The main ideas to consider are the social relations inherently included in economic activities, but often neglected in economic analyses. Embeddedness has been placed in social networks characterised by "positive, respectful and non-instrumental social relations" (Hinrichs 2000) and it can refer to geographical, as well as cultural conditions, where geographical embeddedness implies spatial proximity that facilitates communication and collaboration, and cultural embeddedness refers more to immaterial issues such as mutual knowledge and practices (Floysand and Sjøholt 2007).

Embeddedness via local food studies

Embeddedness has become a popular concept for analysing rural development in local food production, as it clearly enunciates special characteristics inherent in local economic interactions, including mutual knowledge, personal ties and trust, which are often absent in the impersonal, global food market (Sage 2003, Hinrichs 2000). It is closely related to the so-called quality turn in food production and consumption, and to alternative food networks defined by quality, transparency, and locality (Goodman 2003, Sonnino and Marsden 2006). Embeddedness can incorporate sustainability into the food production process, enable viability in remote areas by the use of endogenous resources and offer a competitive advantage in special markets

(Kirwan 2004). In this context, embeddedness is viewed as a larger entity including not only social embeddedness, but embeddedness in local ecological processes as well (Murdoch et al. 2000). This embeddedness in natural processes refers to the assumed quality and related ecological compatibility in local food production, and its association to shorter production chains (Murdoch et al. 2000). Thus, embeddedness can be considered crucial to the new sustainable paradigm of rural development (van der Ploeg et al. 2000, Goodman 2004).

The utilisation of the concept of embeddedness has been accused of being overly simplistic in local food studies. Almost automatically, quality production, ecological sustainability, local food and embeddedness are combined, and placed in opposition of global food-chains, which are labelled as disembodied and undesirable (Winter 2003, Goodman 2004). However, local food production is not necessarily more embedded in the local ecology or social networks than conventional food production, nor is it necessarily more sustainable (Goodman 2004). Wide criticism has been preceded by attempts to elaborate on embeddedness further, and to make it more relevant analytically.

To develop the utilisation of embeddedness further, Sonnino and Marsden (2006) have suggested a more holistic understanding of embeddedness, where the focus is upon how a system becomes embedded and how the embeddedness itself is understood as involving the active utilisation and reconstruction of space, social economy and nature to create the embedded systems (see also Sonnino 2007). In order to facilitate the analysis of embeddedness, Sonnino and Marsden (2006) have separated it into horizontal and vertical components. Horizontal embeddedness involves local actors, producers, consumers, their associations and communication – the local context. Vertical embeddedness refers to the wider institutional, political, and regulatory context. This separation allows a deeper analysis of the different forms of embeddedness potentially present. This analytical distinction, and the more holistic view of embeddedness are used in this article.

Embeddedness and energy - locality and quality?

What could embeddedness contribute to local energy production? Based on local food studies, it seems that there are two especially important concepts to consider in regards to embeddedness: locality and quality (e.g. Sonnino 2007). On the energy side, Elliott (2000) has separated two energy paradigms: the conventional,

usually fossil fuel or nuclear-based centralised production, and a new paradigm, based on decentralised, small-scale renewable energy production. This divide can be compared with the opposition to quality turn in conventional food production, as both divisions are based on the re-localisation of production activities with a greater emphasis on quality and the effects of production. Thus, quality and locality appear as central issues in the energy context as well.

What role does localisation have in the context of energy production? Basically, energy can be produced as heat, electricity, or fuels that are then further refined into diesel for example (or heat, or electricity). In modern societies, with electrical grids encompassing almost every corner, the source of the electricity becomes irrelevant, since it ultimately arrives from the same grid. Thus, to speak of local electricity seems impossible. However, when considering summer cottages without grid connection, for example, or wider security of supply and reliability issues related to grid problems, or problems in centralised production units, locality, or at least the region of electrical production becomes relevant (see Alanne and Saari 2006). In heat and fuel production, energy most often is produced relatively near the consumption site. The source of the fuel can then be questioned: is it wood collected from local forest or gas from local landfill, or is it imported oil or coal? Alas, the locality issue becomes important once more. Here, local energy production is regarded to be energy produced near the consumption site, using locally available energy sources, and usually produced on a small-scale. This obviously leads to the question: what is near enough to be considered local?

Local energy production can contribute to increased local viability in the form of employment, social cohesion and new income sources (Peltola 2007, Huttunen 2009). It also creates new types of utilisation for local natural resources, or utilisation of previously unutilised natural resources. The potential that local energy production has in boosting rural or regional development has even been recognised in many national, rural and energy policies, where supporting local renewable energy production is often based on rural development with hopes of boosting the rural economy and reducing poverty, improving infrastructure and enhancing the quality of environment (e.g. Hillring 2002, van der Horst 2005).

Re-localisation and the shift towards distributed energy production is explored in Table 1, using a divide similar to the one proposed by Sonnino and Marsden (2006) for local food production. The Table represents an energy production division into two opposite poles, and it is important to note that in reality, different kinds of energy production can be situated somewhere between these two poles rather than strictly in one of them. Such is also the case in food production (see Hindrichs 2003).

*Table 1
De-localisation and re-localisation of energy production
and rural space developed from Sonnino and Marsden (2006)
using energy data from this study.*

Type of spatial relationship	De-localisation: Centralised energy production	Re-localisation: Distributed energy production
Producer relations	Large corporations working independently, in competition with one another	Co-operative, locally based production. No competition between regions; only competition within regions.
Consumer relations	Energy has no clear spatial origin and the entire energy production process can be hidden from the consumer.	Energy is consumed near the production site, fuel originates from the same region – consumers can see the entire production process and be familiar with the producers.
Processing and distribution	Large-scale technology, with mostly imported fossil fuels and centralised production far from the consumer. Easily blurs the origin of the energy and reduces it simply to electricity/heat from the plug. Maintenance takes time due to long distances and impersonal service.	Small-scale technology, local fuels, renewable production. Small distribution distances – easily functioning maintenance (due to personal customer relationships).
Institutional frameworks	Regulated system based on centralised production. Producers are highly influential and can efficiently hinder changes. Nationally or internationally based.	Sometimes local authorities and regional development facilitation, but in some cases non-existent or incompatible with the current institutional framework based on centralised energy production.
Associational frameworks	Distance, commercial	Local, relational, trust, networks

The Table 1 uncovers additionally important issues on centralised, distributed, and local energy production, using elements from both horizontal and vertical embeddedness. Local energy production seems to offer benefits in terms of transparency, closer consumer relationships and better quality of services. Whereas global centralised energy production has more negative externalities concerning the processing and distribution of energy. Currently, however, the more dominant, centralised form of

production is more compatible with existing institutional structures. In order to be successful and realised, decentralised production units may need assistance by way of changes in legislation, new standards and updated institutional practices, as observed by Alanne and Saari (2006).

Although many locality-related issues arise when the quality of energy production is discussed, quality itself deserves some focus. In alternative food networks, quality is understood in broad terms and it encompasses aspects such as origin, aesthetic attributes, taste, health and safety and environmental friendliness (Murdoch et al. 2000, Sonnino and Marsden 2006). Quality also seems to be socially constructed and negotiated into the product, and the criteria used to judge quality, like taste, obviously leave room for negotiation. This social construction of quality can also be regarded as part of the embeddedness of local food (Kirwan 2006, Ibery and Kneafsey 2000).

In energy production, quality can be determined partially from attributes similar to those used to judge the quality of food. The supply of energy should be constant and adequate, there should be electricity and heat available in desired amounts, with no breaks in supply, and fuel should cause no maintenance problems. These criteria are largely met by conventional energy production. Sometimes, breaks in the electrical supply are restored slowly in remote areas, and this is where local production can offer better quality.

In local food production, the difference in quality is created via production conditions and external benefits that are attainable by local production. They summarise the potential quality effect of locality – where the "local" label has been an indicator of quality in some local food studies (e.g. Kirwan 2006, Sonnino 2007)¹. It is much more difficult to create local brands for energy than it is for food. In energy production, the ultimate end product is always the same: electricity, heat or fuel and considering the quality in the end, the production process is unimportant. Thus, the only way to manifest quality is to interest consumers in the production process and its effects socially, economically and environmentally. When speaking of local energy production, and environmental impacts, for example, customers must be willing to see the big picture and be prepared to suffer small-scale, local effects in order to avoid larger, global consequences (Jobert et al. 2007, Wolsink 2007). Again, locality itself

1 • By this I don't mean that local production automatically translates to quality production, but rather that the locality aspect has potential to bring some specific quality to the product.

does not necessarily indicate a superior production process, although it usually seems to be the case.

When viewed critically, locality and quality appear as marketable concepts when capturing embeddedness in energy production. However, to delve deeper into the character of embeddedness, the examination of its horizontal and vertical components are necessary. They help widen the analysis and avoid oversimplifications.

The Finnish case study

In Finland, bioenergy production on farms has traditionally consisted of heat production using wood fuels, produced merely to meet the farm's own requirements. This practice is closely related to other forestry practices performed in Finnish farms as many farms include important areas of forest². Increasingly, bioenergy production on farms has also consisted of the production of wood-based heat for retail purposes, thus forming an additional source of income for the farm. In Finland this practice is called "heat entrepreneurship". Heat entrepreneurship began in Finland in the beginning of the 1990's, and the number of heat entrepreneurs has risen rapidly, especially during the 2000's. By the end of 2008, heat entrepreneurs were operating about 420 heat plants. The majority of heat entrepreneurs are farmers (Solmio and Alanen 2009). They can operate independently, but usually they form co-operatives of 2 to 4 persons. Up to 30 entrepreneurs can work together to perform different activities within the heating business. Their customer base commonly consists of local municipalities, and they provide heat for one or several large municipal buildings, like schools. Sometimes they can operate the entire municipality's district-heating network. Fuel from forest residues are mainly acquired from the entrepreneur's own forests, or from other forests within the locality. Saw-mill residues, pellets, or other woody material readily available in the region can also be used to produce fuel.

Bioenergy production on farms can also include biogas or biodiesel production and their utilisation as heat, electricity and traffic fuel. Biogas can be produced from cow or pig manure, thus, manure management problems on farms are also reduced.

2• In Finland, about 60% of forests are owned by private individuals and families and about half of these are based on farms.

Sometimes also other types of biowaste materials available within the region are used, and it is also possible to use cultivated crops for biodiesel production. Biodiesel is mainly produced from rapeseed cultivated on farms.

In Finland, both biogas and biodiesel production are still relatively uncommon when compared to other European countries, like Germany, Austria and Denmark in the case of biogas (EurObserv'er 2008) or Germany and France in the case of biodiesel (EurObserv'er 2009). In Finland, there were 8 farms producing biogas and 4 farms in the process of building biogas reactor at the time of the interviews in 2006. In 2009 the number of biogas producing farms had increased to 10 and about 10 plants were on the building process (Kuittinen et al. 2010). The oldest of these plants was built in the 1980's, but most of them are quite recent and have been built during the last eight years or so. Although there are currently no statistics available on the number of farms producing biodiesel, approximately about 20 to 50 farms can be estimated to be involved in its production. The production of biogas or biodiesel on farms can seldom be considered an auxiliary production line. Rather, it is an addition to food production that reduces the need to purchase energy and makes the farm more multifunctional (see also Huttunen 2009). Biogas and biodiesel production is mostly accomplished on a single farm basis.

The data consists of 31 interviews of bioenergy producing rural entrepreneurs. 29 of them were full, or part-time farmers engaged in dairy, beef or crop production, or a combination of these. Two of the subjects were not farmers, but were engaged in forestry in other ways. The part-time farmers had additional jobs 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 Finland³, 10 biogas producers and 6 biodiesel producers. Some of the interviewees were participants in the same energy production co-operatives or consortiums or were co-operating in other ways. Farming, and especially farming-related energy production is typically a male occupation in Finland, thus due to the lack of female farmers, all the interviewees were male.

3• The focus on Central Finland in the choice of interviewed heat entrepreneurs is based on this study being a part of a larger project called "Sustainable small-scale rural entrepreneurship," funded by the Academy of Finland (number 115786). The project focuses on new business opportunities on farms in Central Finland in the form of energy entrepreneurship and the production of local food. As biogas and biodiesel are produced on so few farms, the concentration on Central Finland was not practical.

The interviews were carried out between fall 2006 and fall 2007 at the interviewees' homes or at the energy production plant. A list of questions was structured into four themes, but the order of the questions varied from one interview to another, and additional questions were also asked, depending on the issues that emerged during each interview. The themes covered included: 1) farm and energy production in practice 2) drivers and barriers for energy production 3) possibilities for energy production at farms, in general and 4) the relationship between energy and the environment. The interviewees' were also asked to draw an operational diagram of their energy production activities.

Since the interviews were conducted on farmers alone, this study provides an examination on embeddedness based upon the farmer's viewpoint. In the analysis, heat entrepreneurship is examined more closely, since it is the most established form of local energy production and the only one that clearly has and maintains a customer base.

Embeddedness and local energy

The assessment of embeddedness in the local bioenergy production case is divided into two parts. First, bioenergy production is examined in terms of locality and quality, to determine how the energy producers relate these two terms to their production activity and whether locality and quality are important to them. Second, horizontal and vertical embeddedness in bioenergy production is assessed further. Typical citations and examples obtained from the interviews are used to illustrate the origins of the analyses and to allow the farmers' voices to be heard.

Locality and quality

The three relevant types of bioenergy production here vary slightly in their relationship to locality and quality. As heat entrepreneurship is an established form of energy production (Solmio and Alanen 2009), the public is already familiar with it. Heat production using wood fuels, in particular, is common in Finland, and it has generally been well accepted. Therefore, heat entrepreneurs usually have a good

starting point for production. More than ten years ago, however, entrepreneurs, had to work diligently to establish a quality image for heat production. Their skills, technology and the scale of production stirred doubts in the minds of municipal decision makers and local customers. One heat entrepreneur recalled the scepticism: "*They (municipal officials) were enormously suspicious about heat entrepreneurship, and they could not believe that farmers could heat an entire school building properly.*"

Heat entrepreneurs construct quality by effectively using the locality aspect inherent in the production. This is accomplished by emphasising the employment and income opportunities that local heat production and fuel collection brings to the municipality and local area. One heat entrepreneur stated it: "*Forests in the own municipality produce energy and activity and employment stays here.*" Also, the price of locally produced heat is often lower than heat produced from imported fuels.

Locality is a part of the quality assurance offered by the management services of local heat production. Heat entrepreneurs are recognised members of the community, thus, they must offer quality service in the heating business if they wish to continue as respected members of the community and avoid conflicts. They simply need to be trustworthy, even if it means leaving Christmas dinner for maintenance duties, or spending the entire night in freezing temperatures to assure that their plant is working properly.

Another important factor derives from good forest management practices. For the most part, heat entrepreneurs use residues from the management of young forests, and thus provide an efficient use for the woody material. The process, in turn, enhances the management of the young forests, as recommended by the Finnish forestry authorities. In the heat entrepreneur's opinion, the process contributes to a "*nicer looking landscape,*" with fewer bushes, and thus a more aesthetic environment (see also Peltola 2007). The producers also claim to be careful in avoiding unnecessary smog emissions from escaping their heating plants, but generally, the producers do not appeal to the renewability, or carbon neutrality of the energy they produce, which may potentially be valued by their customers (as, for example, in farmers markets, Kirwan 2006). In brief, quality in heat production, as constructed by the producers comes via local viability, trustworthy management and environmental benefits.

In biodiesel and biogas production, the producers face much ignorance from officials and from members of the community, concerning their energy production activities. These forms of energy production are rare and can result in scepticism from the community and from Finnish society as a whole. As a result, the producers have

sometimes felt like *"the village idiot,"* or *"clowns,"* although during recent years there has been more interest in, and understanding about biogas and biodiesel production.

Currently in biogas production, the majority of the producers do not require a customer base, as the energy they produce is consumed for their own purposes. For these producers, isolation and public ignorance is of little concern. At farms that actually sell the energy they produce, the farmers must make clear efforts to break their curious image, and some biogas producers also actively promote production to the entirety of Finnish society. Credibility for biogas production is built using such benefits as its compatibility with and utilisation of natural processes and the cleanliness of the energy produced. This also aids in constructing a quality image for their product. One biogas producer described: *"...related to manure management and energy (in biogas production), there are only environmentally positive issues and this is what I think will be a strength at (biogas producing) farms in the future, due to methane utilisation, odour (minimization) and energy production, and better utilisation of nutrients."* Additionally, scientific experts can be used to gain credibility as another biogas producer noted: *"... as a private person I would have no position to fight for this (biogas production), had I not scientific experts to support me."*

As biogas production becomes more common in local communities, biogas producers may incorporate their neighbours and other local contacts into their production, by experimenting with new raw materials, for example. Another aspect of locality in biogas production arises from manure management. The farmer gains an efficient manure management system with biogas production, and this seems to be an important factor when planning the establishment of a biogas system. The production uses natural processes and actually enhances the closed material cycle on farms by collecting methane. As such, biogas production is embedded in both farm processes, and the environment.

Locality is seldom directly associated to quality among biogas producers, as it is among heat entrepreneurs. The energy is produced locally instead of being imported, but it is not really marketed as a local brand. The spatial benefits relate to the entirety of Finland, and it seems that the location of the production is unimportant, as long as it is *"domestic."* This ignorance surrounding the locality aspect can relate to the seeming locality neutral character of electricity as discussed earlier and to the fact that consumers purchasing biogas as traffic fuel can visit any station to fill their tanks. The clearest issue, where locality can be interpreted as contributing to the quality of the energy being produced arises from the environmental friendliness of the mentioned material cycle of the farm.

Biodiesel producers do not actively need to seek customers out. Rather, the customers seek out the producers and are thus already convinced about the quality and attributes of the product. The producers maintain environmentally beneficial, vehicle and motor friendly fuel and strongly emphasise the locality of their product. One biodiesel producer reasoned that, "... *some (biodiesel customers) are just interested in it, some want to use biodiesel to save their car's engine, and others are so green (environmentalist), that they want to use it.*" Another biodiesel producer explained: "*it's nice to drive with own fuel and it doesn't produce bad emissions.*"

Interestingly, the locality label for biodiesel arises from the fact that the producers have manufactured the fuel themselves and that it functions well. Many are aiming for energy self-sufficiency, which was common even among biogas producers. This can be interpreted as some form of micro-locality connected to quality. With such self-sufficient energy production, the producers have complete quality control over their product and they are independent over fluctuations in energy prices. However, this applies only to the energy-producing farmers themselves.

Another interesting issue related to local energy production and quality is that it is regarded as utilising modern technology. Although the primary vision of heat production using wood is traditional, heat entrepreneurs, as well as biodiesel and biogas producers, have a reputation of being new and modern. In part, this contributes to the image of quality energy that they produce. Thus, the production does not require revisiting familiar technologies or procedures before centralised production, as has been the case in the local food movement, (Kirwan 2006) but rather, the production is viewed as a shift towards something modern.

Horizontal and vertical embeddedness

Horizontal embeddedness is observable within customer relations, the local community and the production network, including all partners required in raw material provisioning, etc. Consumer relationships are not necessarily closer in local bioenergy production compared to conventional energy production, but the consumers do possess a better understanding about the source of their electricity or heat, what processes are required for production, and what the effects on the local environment and community may be. However, this requires conscientious consumers who are interested in such findings.

A more interesting issue concerns the local production network. In heat entrepreneurship, energy production is essentially a group effort and the establishment of a producer network, including all persons required for wood collection, fuel production and in formal business management. These networks are built upon existing friendships and family-ties, but also on a more general understanding of trust within the community and knowing which individuals can offer suitable skills and machinery. One heat entrepreneur explained the formation of the co-operative: "*Everybody (people in heat entrepreneur co-operative) is from here (the same village). We have known each other beforehand...almost everybody has lived their entire lives here. One has to be careful who to take along, and one needs knowledge about people's histories.*" When managing fuel procurement, it is important to know suitable forest owners and to have a good reputation, so that they might actively offer their forests for production.

Knowledge about the production locality and local contacts are essential in developing a heating business. New fuel crops, like reed canary grass, have been discovered by the suggestions of familiar farmers with an excess supply of such materials. Auxiliary heating plants have also been established due to an entrepreneur's knowledge of suitable targets in the community. The networks have also increased social activities among the entrepreneurs and created new friendships. For farmers who have often felt alone in the past, the networks have become welcome opportunities to collaborate. One heat entrepreneur describes the importance of collaboration: "*There are people to lean on to when making decisions.*"

Thus, it appears that in heat entrepreneurship, the horizontally embedded relationships are more between the co-operating producers and their partners, than between producers and consumers. In local food production, studies concentrate mostly on the relationships between producers and consumers and reveal little about the producer networks and their embeddedness (e.g. Sage 2003, Hinrichs 2000). However, Chiffolleau (2009) has advocated reinforcing the ties between producers and allowing them to valorise and utilise one another's knowledge and skills, in a manner similar to heat entrepreneurs. This also relates to the creation of collective capabilities enabled by embeddedness as suggested by Floysand and Sjøholt (2007).

In biogas and biodiesel production, the producer networks are weaker, if they exist at all. If they do exist, their construction and functioning occurs in very much the same way as in heat entrepreneurship: based on existing ties, trust and local knowledge. One biodiesel producer tells about his deal on esterification with another biodiesel producer: "*We don't have any formal contracts, it just works this way.*"

Vertical embeddedness seems more problematic. Biogas and biodiesel producers have problems complying to the existing governmental systems of energy production and farming. The legislation does not adequately recognise these production types, and the producers have not yet managed to create new systems or change existing ones to better suit their needs, despite the general political will to promote these activities in Finland. One biogas producer describes the response when he was trying to find out what permits etc. he would need for his biogas plant: "... *It just this that nobody knows, it is such a familiar answer from the officials that nobody knows.*"

The slow adjustment to changes in legislation may be partially attributed to the relatively lonely position of many producers, who often lack power to efficiently influence society. With a higher degree of networking, and embedding the production activities horizontally at the local level instead of at the farm level alone, the situation could be different. The one co-operative biogas producer showing clear horizontal embeddedness seems to have managed to fit its activities into the waste management systems, and is also gaining momentum in selling gas. This can be interpreted as an intertwining of horizontal and vertical embeddedness.

Heat entrepreneurs are a part of a special national system whose activity has been promoted by officials for 15 years. Many supporting bodies and management procedures are in place to support them, and they have managed to incorporate their activities into official forest management schemes (see also Peltola 2007). In some cases they have also turned local politics in their favour, as Åkerman and Peltola have observed (2006). This structure makes it easy for heat entrepreneurs to establish their activity and secure it within the community's services. It is also important to note that once a heating plant has been built, it is difficult for the municipality to change the wood fuel back to oil without significant investment costs and usually, as owners of the local wood fuel base and equipment, the local heat entrepreneurs are strongly established in their positions as heat suppliers.

Conclusions

Embeddedness in farm based energy production in Finland was analysed using the concepts of locality and quality as essential elements of embeddedness and separating horizontal and vertical embeddedness. Locality and quality were partly overlapping

from the energy producers' perspective as locality often was used synonymous to quality; quality of the produced energy was directly derived from the fact that it was locally produced. The following Tables 2 and 3 summarise the observations concerning embeddedness in farm-related bioenergy production as analysed in this study.

*Table 2
Heat entrepreneurs' perspectives on their production activity analysed in terms of embeddedness*

Locality	Quality
<ul style="list-style-type: none"> • Viability of the community 	<ul style="list-style-type: none"> • High technology
<ul style="list-style-type: none"> • Better service, trustworthy management • Better environment → Clearly constructing "our local energy" 	
Horizontal embeddedness	Vertical embeddedness
<ul style="list-style-type: none"> • Rather high: Observable in producer and supplier networks as trust, local knowledge, personal relationships 	<ul style="list-style-type: none"> • Rather high: Good support systems, compatibility with legislation, advisory bodies etc.

*Table 3
Biogas and biodiesel producers' perspectives on their production activity analysed in terms of embeddedness*

Locality	Quality
<ul style="list-style-type: none"> • Micro-locality in potential self-sufficiency as well as in compatibility with natural and farming processes 	<ul style="list-style-type: none"> • High technology • Friendliness for motors (biodiesel)
<ul style="list-style-type: none"> • Better environment both locally and globally → No clear local energy, just energy with benefits, or "my energy" 	
Horizontal embeddedness	Vertical embeddedness
<ul style="list-style-type: none"> • Mostly low: Observable in network building with business associates and customers 	<ul style="list-style-type: none"> • Poor, clear problems

Heat entrepreneurs constructed quality for their energy production using the locality aspect efficiently. This came about by trustworthy management, thus better service and by better local environment. Locality of the energy production also meant increased viability of the community. By entwining locality and quality heat entrepreneurs clearly constructed "our local energy"-brand. Heat entrepreneurship was both, horizontally and vertically embedded. Horizontal embeddedness was manifested in the producer and supplier networks in the way they worked and were formed, emphasising the importance of trust, local knowledge and personal relationships. Horizontal embeddedness was mainly demonstrated in the producer networks rather than between producers and consumers. Vertical embeddedness was manifested through the existing administrative and support systems as well as compatibility with the traditional energy production system in Finland.

Biogas and biodiesel producers have little use of locality for the quality of their product. The importance of locality comes about in a micro-scale as farm-level self sufficiency in energy. This, especially in the case of biogas, includes the compatibility with natural and farming processes. However, the micro-local energy is not branded as local energy, it is rather "my energy", reflecting also the fact that these producers are not necessarily aiming at selling their energy. Embeddedness in biogas and biodiesel production is quite low. At horizontal level, there is network building with business associates and also customers, but it is at an early stage. Vertical embeddedness is lacking and this is causing problems for the energy production activities.

This study illustrates how embeddedness can be important to the establishment of local economic activity in energy production. Heat entrepreneurs have a competitive advantage based on the horizontal and vertical embeddedness of their production activity. They have also managed to create quality and value for their production activity, based on the notion of locality. Biogas and biodiesel producers have in Finland not yet managed to embed their activity socially, but at least biogas production is embedded in the natural and farm production system. If they do manage to embed their activity socially, they could permanently establish their form of energy production in rural Finland, following the example given by heat entrepreneurs.

It actually appears that all energy producers could more effectively embed their activity into the local community horizontally, and utilise the natural embeddedness clearly present in their production. It seems they have a basic understanding about embeddedness-related issues; they just need to make these issues work more efficiently to advance their energy production and the more conventional farming activities in food production. Branding their farms as special local energy farms could even have positive effects on the local area, as it would become something special for the area.

As vertical lack of compatibility with the current energy production system and power structures was a problem for biogas and biodiesel producers, the enhanced horizontal embeddedness could work to ameliorate the vertical embeddedness. This could be accomplished by promoting local biogas production as something worth supporting.

At the moment, the potential of embeddedness is most visible in the case of heat entrepreneurship. The embeddedness in heat entrepreneurship shows how new economic activities based on locality and sustainability can be formed in rural areas alongside farming. The case represents farm-scale multifunctionality comparable to Sonnino's (2007) saffron case. Additionally, it provides evidence for the potential of a new sustainable rural development paradigm (van der Ploeg et al. 2000, Marsden 2009) in local energy production. It also suggests ways to tackle local vulnerabilities and provides a valuable example of the possibilities of local energy production, and how to avoid, at least in part, the pitfalls of global bioenergy production and trade (Mol 2007), and even tackle local vulnerabilities.

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