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Towards inclusive innovation praxis in forest-based bioenergy*

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ABSTRACT

In this paper, we apply grounded innovation platforms (GRIPs) as a tool for inclusive innovation in relation to forest-based bioenergy in Norway. We use cases studied in the Triple Bottom Line Outcomes for Bioenergy Development and Innovation in Rural Norway research project. We review the notion of GRIPs and classify them. We analyse forms of GRIPs and the hypothesis that forms of GRIP affect 'triple bottom line' outcomes of sustainable development. We relate our findings to the debates on inclusive innovation, which we argue is not simply an issue for 'developing countries'. Development, being understood to be different from economic growth, is concerned with inclusion and exclusion, and, in a world of growing inequalities, is a universal issue everywhere.

KEYWORDS

Inclusive innovation; triple bottom line; human rights; bioenergy; grounded innovation platforms; rural communities

1. Introduction

In this paper, we identify characteristics of systems and strategies for bioenergy innovation that may promote environmental, economic and social benefits in rural areas by examining three case studies in forest-based bioenergy in Norway.

In 2008, Norway decided for doubling its use of bioenergy by 2020 (Ministry of Petroleum and Energy 2008), but is, however, a long way from reaching this target. Trømborg (2012) has pointed out that this target seems hard to reach, although the potential is nearly three times today's production with forest biomass representing the greatest[1] (Scarlat et al. 2011). Bioenergy production in Norway is continually inhibited by low electricity prices (partly due to increased precipitation and limited electrical power export possibilities), the channelling of public investments into the petroleum industry, for example, infrastructures, R&D, and incentive mechanisms, low district heating pipe reticulation and occasional local opposition to renewable energy (RE) installations (Ministry of Petroleum and Energy 2012b). However, in certain specific circumstances, local bioenergy production is incentivized by: flexibility needs due to varying hydroelectricity production;

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limited power transmission infrastructure and costs of grid enhancements; needs for alternative heating sources when electricity is channelled into the transport and petroleum sectors or exported; land disturbance caused by other RE sources; and needs for liquid biofuels in the public transport sector (Trømborg 2012; Ministry of Petroleum and Energy 2012b). Because most bioenergy production is located in rural areas based on local assets, it may be an opportunity for rural development. A wide body of research on innovation in renewable energy and its impacts on rural people has questioned the notion that achieving positive economic, social and environmental outcomes can be taken for granted, see, for example, (OECD 2012; Cavicchi, Bryden, and Vittuari 2014). Bioenergy infrastructures may be controversial in rural areas, especially if they are perceived as creating negative externalities while leaving little benefit to communities, for example, external ownership and activities such as land grabbing can reduce local benefits and spur local opposition that subverts implementation of bioenergy plans. Specific forms of bioenergy and related policy and institutional innovation may, nevertheless, improve energy security and flexibility in rural areas, development of rural economies and communities and climate-friendly energy.

Available evidence, for example, Midttun and Kofoed (2005) and OECD (2012) suggests that, to gain legitimacy in RE development and optimize synergies, the development of local and regional innovation systems taking the form of 'triple', 'quadruple' or, less commonly, quintuple helix,[2] is important in easing the adoption and adaptation of bioenergy in rural regions. It is therefore important to examine whether a socially embedded innovation process is necessary for achieving sustainable bioenergy development which can meet economic, social and environmental benefits simultaneously (triple bottom line benefits). Ostrom (1990) and others have argued that such triple bottom line benefits cannot be fostered by markets alone; they require the support of public policies that themselves should be grounded in civil society to produce desirable results. This insight has largely defined the governance models of the Nordic countries, and has been firmly institutionalized in the development of Norway's rural economies since the Second World War (Gezelius 2004; Borgen, Røkholt, and Sørensen 2006; Bryden, Brox, and Riddoch 2015). This paper is based on the TRIBORN (Triple Bottom Line Outcomes for Bioenergy Development and Innovation in Rural Norway) research project funded by Research Council of Norway during 2014–2016 in which we seek to develop knowledge about how one can best utilize this governance tradition for developing bioenergy economies in rural areas, while at the same time safeguarding landscapes and ecosystem services, and satisfying social and political needs for social welfare and local development. The main objective of this paper is to investigate whether innovation platforms (IPs) can mobilize and coordinate local entrepreneurs, policy-makers and stakeholders to promote, to support and to perform innovation within a bioenergy chain; and whether IPs are effective tools for ensuring tangible triple bottom line goals and legitimacy in rural communities.

2. Theoretical and methodological approach

In the case of local bioenergy innovations, the question about inclusion is more than access to affordable energy. It is about whether the needs of those who are deemed to be excluded in the local society, for example, in local decision-making, through lack of access to land or

resources, through receiving negative impacts of bioenergy use or just lack of recognition as a local NGO are addressed in a meaningful way by the local innovation system in question. Indeed, we can appeal to Cozzens et al. (2007) and Lazonick and Mazzucato (2013) in arguing that 'inclusive innovation is associated with reduced inequality' (Heeks, Foster, and Nugroho 2014, 176). In other words, inclusion must be seen as part of the 'social' outcomes, and, we argue, often also in the perspective of 'human rights'.[3] This idea builds not only on the Brundtland Commission report on Sustainable Development of 1994 but importantly on the 'three D's' of the New Manifesto (STEPS 2010), namely direction, distribution and diversity being at the centre of a new agenda for innovation. Direction matters because it shapes the distribution of benefits, costs and risks from innovation. Furthermore, due to marginalization of people and places, the appraisal of innovation needs to consider distribution of benefits and address questions of social differences, equity and justice (STEPS 2010). Finally, a diversity of innovation pathways is needed to resist the processes of concentration and lock-in that disfavour people or places and likewise adapting to different environmental, economic and cultural settings as well as considering social and organizational – as well as technical – dimensions of innovation (STEPS 2010). This implies the following three purposes of innovation, social justice, poverty reduction and environmental sustainability, which as Bryden, Gezelius, and Refsgaard (2013) have noted, bear some resemblance to the 'Triple Bottom Line' (TBL) principle for business accounting (Elkington 1997). The TBL principle proposes that business accounting should go beyond profit measures, to include social and environmental measures. This value triangle is also often referred to as the 3Ps (profit, people and planet) (Slaper and Hall 2011). Bryden and Gezelius (2013, 2015) reflect on the relationship between the 'three Ds' and the 'three Ps' in order to clarify the ethical principles of innovation for sustainable development. Noting that the concern with poverty in the 3Ds, whose origin is in 'development' discourses, when compared with the weaker inclusion of 'social issues' in TBL might at first sight imply that

> TBL might … appear to be the more viable ethical reference-point in modernised economies where absolute poverty has, for the most part, been abolished, whereas the New Manifesto may seem to offer a more precise and forceful imperative in settings where absolute poverty remains widespread.

However, such a conclusion must be challenged by the growing inequality and incidence of poverty in many if not all 'richer' countries (Piketty 2014; Varoufakis, Halevi, and Theocarakis 2014). Most countries are faced with global challenges of 'sustainable development' in the context of modern capitalism, even if national poverty makes it more difficult for poor countries both to face these challenges and to develop their own pathways to solve them. Social inclusion may, of course, relate to issues other than poverty *per se*, such as race, marginalized rural areas, gender and education, but whatever its causes, it must be addressed within the social and economic elements of the three Ps or TBL.

Ethical dimensions become especially sharp where we focus on land-based natural resources and people, neither of which can be regarded as 'commodities'. (Polanyi [1944] 2001; Varoufakis, Halevi, and Theocarakis 2014). Polanyi ([1944] 2001) argues that land, labour and money are fictitious commodities – they are not created for the market because they cannot be reproduced. Land-based natural resources are subject to the constraint of land and are therefore particular in that (a) land is limited in

supply – virtually fixed – and non-reproducible by labour and capital; (b) land is variable in quality, and that quality may be determined by its location, its access to water, its management history. Variable quality and location give rise to locational rents, while general limitation of supply gives rise to monopoly rents to owners; (c) land is essential for human existence, and closely related to the human rights to access to clean and sufficient water, and to food and (d) land has multiple and often competing uses for humans including food, water, shelter, recreation, ecosystems and related services, and renewable bio-based resources in general. In contemporary terms, international recognition of the notion of Human Rights, and its codification in terms of rights to an adequate diet, and sufficient potable water for all, which is also being actively considered for energy, implies that innovations that damage such human rights cannot be acceptable. Thus, for example, to remove land rights from people who depend on the land for their subsistence, and/or access to water, to produce biofuels would, on this argument, be wrong. For these reasons, we follow Bryden and Gezelius (2013, 2015) in arguing that the goals and outcomes of innovation should thus concern a 'Human Rights Based TBL (HR-TBL)'. In this way, HR-TBL serves to bridge the differences between the 'three Ds' and the 'three Ps'.

As to the form that innovation should take, the New Manifesto prescribes explicit inclusion of marginalized groups in innovation in developing economies, and the TBL potentially prescribes a similarly 'inclusive' form for modernized economies, depending on how one defines the social bottom line. The issue is discussed in some depth by Heeks, Foster, and Nugroho (2014) who analyse 'new models of inclusive innovation for development', building on the notion of a 'ladder of inclusive innovation' (Heeks et al. 2013). They distinguish (pp. 177–178) between the following six forms or 'levels' of inclusive innovation (II) in this 'ladder':

- II that simply involves the 'intention … to address the needs or wants of problems of the excluded group'
- II that is inclusive because it is 'adopted and used by the excluded group'
- II that is inclusive because it has 'a positive impact on the livelihoods of the excluded group'
- II that is inclusive because the 'excluded group is involved in the development of the innovation'
- II that is inclusive 'if it is created within a structure that is itself inclusive'
- II that is inclusive because it is 'created within a frame of knowledge and discourse that is itself inclusive'.

2.1. Grounded innovation platforms (GRIPs)

Our approach concerns the first four levels of inclusive innovation discussed above, and with various forms of IP that may or may not involve clusters, producer–consumer interaction, grassroots or frugal innovation in some combination. In particular, we are concerned with the objectives, outcomes and processes of innovation in a Nordic context. In the Nordic countries, 'inclusion' is not only a matter of identifying and including 'excluded groups', where there is a 'universalistic' approach to social welfare issues (Esping-Andersen 1990; Hilson 2008; Bryden, Brox, and Riddoch 2015). This approach

avoids stigmatization of the excluded group that is typical of selective welfare systems using 'means-tested' schemes as opposed to generic schemes as mainly is the norm in the Nordic welfare systems.[4] 'Inclusiveness', however, also applies to innovation goals, processes and outcomes where all relevant groups who can contribute to – and who will be affected by – that process – are included. However, it also ensures an appropriate diversity in formal and informal knowledge contributions, including those concerning the 'right' way to proceed implied in Aristotle's phronesis (Aristotle, 350).

The solution we want to discuss here is the so-called GRIP. This is an IP of the type of 'soft-system' for learning derived from the work Checkland and colleagues from the 1980s, see, for example, Checkland (1981), Checkland and Scholes (1990), and applied by Neils Roling and Janice Jiggins at Wageningen University in the 1990s, see Roling and Jiggins (1998) and Bryden (1994). An IP of this kind gathers actors having different forms of knowledge to tackle a specific problem through a joint learning process. It thus focuses on innovation as a 'learning process' (Lundvall 1992). In our conception at least, such an IP is 'grounded' by the nature of its inclusiveness, power relations, and embeddedness in regional and local contexts (Bryden and Gezelius 2013, 2015). It may also involve a cluster, user–producer interaction, and grassroots or bottom-up processes and action. It can therefore combine different (or all) elements of the range of 'new models' of inclusive innovation discussed in this special issue, and by (Heeks, Foster, and Nugroho 2014), which, we would argue, *are not mutually exclusive*.

When, and to what degree, can we describe an institution as a GRIP? To tackle this problem, we considered two sets of criteria, one dealing with the extent to which the institutional structure, its stakeholders and their relations could be described as an Innovation Platform (IP-ness), the other with the extent to which it could be described as 'Grounded' (GR-ness).

IP-ness criteria are:

- The extent to which the stakeholders have shared goals and objectives;
- The degree to which they have discussed what is and is not known about the ways of meeting that objective (raw materials, finances, skills, technologies, interests, markets, etc.), and so identified such things as financial and material needs, knowledge gaps, opportunities, constraints;
- Whether they have taken steps to fill knowledge gaps, and identified relevant knowledge agents;
- The extent to which they have negotiated raw material supplies and contracts; negotiate markets and contracts; negotiate and plan constitution (coop, company, partnership, non-profit, municipal-owned, etc.) loans, equity, siting, construction, etc.
- Whether they have implemented 'their goals and objectives';
- Whether there are signs of ongoing learning by doing and – through feedback loops (errors recognized and leading to changes) – leading to adjustments, enlargement, new technologies, etc.;
- Do they take a 'triple', 'quadruple', 'quintuple' or 'sextuple' helix form, including foresters and farmers, on the one hand, entrepreneurs, on another, public sector such as municipal authorities, on a third, and knowledge-based organizations like research institutes of universities on a fourth? Are consumers/users and citizens involved, to make a 'quintuple' and finance institutions to create a 'sextuple' helix?

GR-ness criteria are:

- Do the stakeholders have triple bottom line objectives (social objectives including fairness, inclusion, quality of life, good environmental impacts, as well as economic surplus which is often locally recycled in and beyond the business itself)?
- Do they regard it as their moral duty to deliver all of these objectives, and so be concerned with ethical standards, and hence Human Rights (HR) and thus operating towards HR-TBL objectives and outcomes?
- Are they 'embedded' in the local society and economy (having the farmers/foresters involved, the local municipality, local consumers and businesses; linked to previous history of resource use and skills; concern with local markets and impacts).

2.2. Our approach

This theoretical and conceptual basis gives us the means to analyse and categorize our case studies in terms of their 'GRIP-ness', which is our starting point for assessing whether and how the form of a GRIP influences the social, economic and environmental outcomes of innovation in the bioenergy sector.

We start from the hypothetical proposition that any such system must have some or all characteristics of a GRIP, since only a GRIP can ensure that the goals and outcomes have a chance of being socially, economically and environmentally positive. We have undertaken research on three case studies located in Norway in order to explore and test this hypothetical proposition, in particular to understand and categorize the notion of GRIP-ness and what types of GRIP we can observe in the field. The case studies were selected to represent different regional contexts in Norway primarily concerning relative importance of forest ownerships structure, forest biomass utilization in the community, employment opportunities and infrastructure.

To understand the learning processes and other dynamics within the different types of case studies and to assess their economic, social and environmental outcomes we used semi-structured interviews and document analysis to collect data. Several types of actors like bioenergy entrepreneurs, administrative employees in the municipality and representatives from forest commons were interviewed.

We test the four core hypotheses using our case studies and comparative research:

(1) Implementation of Norway's bioenergy targets can be improved by using GRIPs.
(2) GRIPs can mobilize and coordinate local stakeholders such as entrepreneurs, policymakers and stakeholders to promote, to support and to perform innovation including innovation relating to technology, organization, marketing, logistics and policies within a bioenergy chain, but they may take different forms and also transform over time.
(3) GRIPs are effective tools for ensuring that innovation brings tangible TBL benefits to, and legitimacy in, rural communities.
(4) If carried out according to the principles of sustainable forest management,[5] it is possible to reduce any negative impact of bioenergy development on the ecosystem services when developed within a GRIP framework.

Throughout this, the paper aims to 'produce knowledge on how systems and strategies for bioenergy innovation should be designed to promote Triple Bottom Line (TBL) benefits in rural areas and to promote the achievement of national bioenergy targets'.

2.3. National and regional context and institutions

Before turning to the analysis of the three case studies, we describe the national and regional contexts in which they are located. Norway has very variegated geography and climate, which imply different regional and local production specializations and bioenergy sources. However, forest resources represent by far the largest biomass source. Forests cover around 38% of the national territory (approximately 12 million ha). Most of forests are privately owned (80%), but public forests (national, county and municipal) account for 12%, and common forests 4%. The average size of a forest holding is about 50 hectares. Small forest properties, the steep and varying terrain conditions and the varying production possibilities have created great variations in the forest landscape.

Agriculture and forestry are quite central in the Norwegian politics. During the nineteenth and twentieth centuries, the political representation of farmers structured around some specific parties, which still strongly represent farmers' interests in the parliament (Brandal and Bratberg 2015). Therefore, although the country does not have a well-developed bioenergy policy strategy, there are elaborate policies to support agriculture and forestry.

The Ministries of Agriculture and Petroleum and Energy issued the national bioenergy strategy in 2008 aiming to support agriculture and forestry in a period of economic crisis (Ministry of Petroleum and Energy 2008). The goal was to increase bioenergy production by 14TWh by 2020 (starting from 14.5TWh in 2008). A year later (2009), the government implemented the support scheme 'energiflistilskudd' (energy wood chips grant) as a temporary incentive to the use of forest resources for bioenergy production (Agricultural Agency 2013). 'During these five years, NOK 144 million in grants went to wood chips for heat. Overall it produced a wood chips volume of around 3.1 million cubic metres)'. The new government (2013) ended the scheme, and there are currently no other incentives for bioenergy other than the investment grants scheme of ENOVA and Innovation Norway.

ENOVA and Innovation Norway are national agencies within the Ministry of Petroleum and Energy and Agriculture and Food, respectively. They both support investments in renewable energy. Since 2002, ENOVA's grant scheme (through the Energy Fund) supports investments in district heating and, since 2008, local heating plants running on waste and wood products; new energy infrastructures in buildings (e.g. waterborne heating systems) (since 2002). Innovation Norway's grant scheme (Bioenergy Programme) provides investment support for establishment of facilities for sale of heating, where the upper limit for the heating boiler's output is 2 MW. This assumes that farmers own at least 50% of the plant. Therefore, in Norway, bioenergy policy strategy and instruments are split into farm-based bioenergy supply chain and industrial bioenergy supply chain.

In addition to the national policy instruments and grants, the municipal and county policies and projects (e.g. the 'Grønnvarme' projects in Hedmark, and Bioreg Hadeland) turn out to be important tools for bioenergy development, in the inland forest counties.

Municipalities are found to play a crucial role in supporting bioenergy. They must issue a local climate and energy plan (planning tool) and often become main customers of bioenergy companies for heat supply, in order to phase out fossil fuels from public buildings. Moreover, municipalities can regulate that new buildings must be connected to district heating grids (Ministry of Agriculture and Food 2014; Albrecht 2015). It is worth noting that in Norway, the municipal governments have always been crucial actors in the energy sector. When the hydropower system was firstly developed, municipalities became main owners of energy companies. This contributed to the embeddedness of energy production and supply in local institutional context and resources (Bryden, Brox, and Riddoch 2015).

Norway has adopted the EU RES Directive 2009/28/CE (Ministry of Petroleum and Energy 2012a) with a goal to reach 67.5% of renewable energy share (RES) in gross final energy consumption but a White paper on Norway's Energy Policy has first appeared in 2016 (Ministry of Petroleum and Energy 2016). In 2015, the net domestic consumption reached was totally 213 TWh (Statistics Norway 2015), of which electricity provided the highest share of about 55% while fossil fuels provided about 35%. This implied a RES of 69.2% (Melbye, Rørstad, and Killingsland 2014). The energy system for electricity and heating is almost completely based on hydropower (96.7% in 2012) and the source that supported industrial development in Norway from the late 1800s. Most of energy infrastructure in the country is therefore based on hydropower, especially in private buildings, whereas public buildings still have systems based on natural gas or oil. Norway is also the biggest producer of oil in Europe and has a goal to reduce CO_2 emissions by at least 40% by 2030 (Ministry of Climate and Environment 2015). These framework conditions work against the implementation of a stable and thorough bioenergy strategy in Norway, besides constraining the value-chain development, and provide a stark contrast with Finland and Sweden.

Norway produces 10–12 times more energy than it consumes, but mainly fossil fuel-based. This creates increasing dependency on imported electricity, due to lack of flexibility in our energy distribution systems being dominated by electricity grids. The use of bioenergy in 2015 was only about 8% of the net domestic energy use of Norway while the share of bioenergy in Sweden and Finland is 26% and 30%, respectively. With less than half of the annual increase in growth utilized, this biomass has huge potential for utilization in Norwegian rural communities for heat, for transport and for industry.

3. The case studies

The three case studies that this paper examines are situated in two regions in Norway. The first region, Innlandet, is located in the South-Eastern part of Norway and includes Oppland and Hedmark county. This region is Norway's largest and most important forest region for the economy, welfare and public health according to the regional authority (Fylkesmannen i Hedmark 2012), who sees it as an aim to increase the development of the forest sector. The productive forest in Innlandet is owned by 23,000 forest owners of which individuals own 65% of the land, the public through state and municipalities own 18% and the residual 17% is owned among others by community commons (bygdealmenninger), co-ops (sameier) and shareholder companies. Innlandet has a large share of smaller forest holdings, and up to 75% of the holdings have less than 50 ha of productive

forestland. Norwegian Ministry of Agriculture and Food (2007) argues that there is a potential for increased felling on the smaller forest holdings. In 2011, around 85% of the sawlogging in Innlandet was processed there, while the rest was exported to other counties and Sweden, while for pulpwood, more than 90% is processed outside the region.

The two case studies in the region Innlandet are Hadeland and Land. Hadeland consists of three municipalities that cooperate through the Regional Council for Hadeland. Land consists of the two municipalities Søndre Land and Nordre Land. Case study Hadeland has increasing population while Land has decreasing population and the population density is much higher in Hadeland than in Land. The case studies are rather similar with respect to economies, with forestry being important sectors for landowners and local authorities. A large part of the forest in Hadeland is owned by forest-almenninger (common ownership), while most of the forest in Land is owned by private forest owners.

The third region is Vestlandet, being less forest rich than the eastern part of the country. Furthermore, forest is not as present in local culture and mindset in the same way as in the east partly due to less importance of the forest in the past. However, bioenergy may be an option for use of the wood, due to fewer alternative market opportunities. Larger energy companies have not supported – and in some case even worked against – bioenergy development in this part of the country. As hydropower companies in general have a lot of trust within society, they can be good supporters for new renewable energy sources as well as providing capital.

The case study from Vestlandet is situated in Voss municipality. This municipality is relatively forest rich in a Vestlandet context. The infrastructure close to the sea and Norway's second largest city, Bergen leaves possibilities for easy access to export markets. The mountainous forest is, however, fragmented with poor access and transport infrastructure. In Voss, the forest volume is growing. Voss also has the largest area of natural forest in Vestlandet and large areas with cultivated forest were planted between 1955 and 1975. The forest is mostly owned by private forest owners of which many are organized in the local forest owners association (Voss skogeierlag). The higher quality timber is sold to local sawmills while pine of poorer quality is exported to Sweden and Germany.

4. The case studies – described and compared

In the two regions, the three case studies throughout our analyses were identified as different forms of GRIPs. In Søndre Land (the Southern of the two municipalities in Land) we did not, however, identify any GRIP. We first describe each GRIP separately and then we compare them in terms of Gr-ness and **IP**-ness.

4.1. Voss GRIP-ness

In Voss, much has happened during the last 10 years concerning bioenergy. Important goals have been local utilization of local energy resources to provide cheap and reliable energy while providing local employment and income to the local businesses in the whole value chain. The story started with Voss Bioenergy, a limited bioenergy company, which was initiated and owned by local farmers with forest resources and the local and regional forest owners' cooperative. They produced bioheat for a municipal

care centre. However, Voss Bioenergy experienced several technical and financial problems and they decided to join forces with a municipal waste company and a municipal hydropower company to establish Hordaland Bioenergy limited. Today, this company is owned by the municipal waste company and the municipal hydropower company.

Current customers include Voss municipality, a private hotel and Hordaland County Council. In the near future, they plan to deliver district heating to many private and public customers in the town-centre. The raw material is delivered mainly from forest owners in Voss to a local sawmill which chips the material, although a few loads have come from the eastern part of Norway. There are several formal contracts, and meetings have taken place between Hordaland Bioenergy and their cooperation partners. Voss bioenergy held two public information meeting in its' start up to find shareholders and inform the population in Voss about the bioenergy project. Hordaland Bioenergy has support from the local population.

The entrepreneurs developing the bioenergy plants have gained knowledge by self-studies, study tours to Hadeland and Sweden and use of consultants from the deliverers of equipment. The two companies have, however, faced difficulties regarding access to knowledge. There were very few other bioenergy actors in the nearby that they could share knowledge with and knowledge from other parts of Norway was not always directly usable for Vest-Norway as they have, for example, a more humid climate than other parts of Norway. The manager of Hordaland Bioenergy has partly solved this competence challenge by being an active member in a national local heat forum for sharing of knowledge.

In sum, the actors have shared goals of using local resources, adding local value and providing cheap and reliable heat. Furthermore, there has been an ongoing learning process as well as processes on exchange of knowledge between the actors. They have negotiated formal agreements on their businesses. As such, the IP-ness is relatively strong with a quadruple helix form with the biomass providers, the entrepreneurs, and the local authorities and some users. The resources are locally sourced as well as the capital and the involvement of the local population through two public meetings. However, the moral duty to deliver seems not to be expressed. As such, the GR-ness is average to strong.

4.2. Hadeland GRIP-ness

In Hadeland, bioenergy development has depended very much on local innovators. The history of local collaboration in Hadeland around bioenergy started in 1986 when a bioenergy plan was initiated by diverse types of actors (municipalities, the county governor, forest commons, the local power plant and agriculture and forestry unions). Since the 1990s, a number of businesses have started production of bioenergy and most of them still exist, although a few have closed down (especially those who started in the 1990s). Energigården,[6] a private competence centre for bioenergy located on a forest farm in Hadeland, has been crucial for motivating public entities in the region to facilitate for bioenergy.

Hadeland represents a strong case of public entities (the three municipalities, the county governor and the county authority) working together for a shared goal of increased use of bioenergy and developing Hadeland as a competence region for bioenergy. These objectives are mainly motivated by local industrial development, but also environmental

considerations. The objectives have partly been operationalized through the establishment of several publicly funded bioenergy projects aiming at promoting bioenergy in the region. These projects have been important for putting bioenergy on the agenda. The managers of the plants have challenged administrative units within the municipalities, such as the estate division, to use bioenergy in municipal buildings and the projects have been important for competence building among local politicians, the local municipal administration, and the general public has received newsletters about bioenergy.

There has further been a close collaboration between the municipalities and private bioenergy actors. Private actors like the forest commons in Hadeland have challenged the municipalities and the municipalities have responded by facilitating for bioheat entrepreneurs and by being an important bioenergy customer. The private actors share some of the same bioenergy goals with the public entities. Examples of the goals of the private actors are to contribute to local value creation and the forest commons are motivated by ensuring sale of pure-quality wood and to be part of the entire value chain.

One of the goals of the local public bioenergy projects was to foster cooperation and meeting places for different private bioenergy actors in Hadeland. The projects did, however, not succeed on this goal. One of the actors that was interviewed emphasized : 'Each actor "is busy with his own business" and they have not taken advantage of the cluster situation.'

Concerning knowledge, we observed that one of the goals of the local public bioenergy projects was to foster cooperation between local bioenergy companies and researchers from the national R&D sector. This initiative did, however, not succeed as the local bioenergy entrepreneurs experienced that the national researchers did not pay attention to their needs. To meet their competence needs, the private actors involved owners with complementary knowledge, and they bought consultancy from outside the region. Energigården has been important for competence building among forest owners and local authorities, and generally, the knowledge transfer between private and public actors has been extensive.

The population in Hadeland has not been actively involved in developing the bioenergy industry in Hadeland. The population has, however, at several occasions been informed about bioenergy in the region by the publicly initiated bioenergy projects and school children have visited Energigården. Private bioenergy customers have also been extensively informed about bioenergy by some of the private actors.

Concerning embeddedness, we have observed that supplies of biomass are both local and non-local, while the human labour, the knowledge and the capital are mainly locally sourced. The bioenergy activity is also highly embedded in the regional and the local context, as Hadeland has a long history of utilizing forest resources and the bioenergy activity to a large extent takes place within already existing institutions and with the main actors being local.

In sum, there is an average IP-ness in the Hadeland GRIP. It is mainly a quadruple helix with a strong connection between foresters and farmers and the entrepreneurs, between the local public actors and the private actors as well as between public actors and the local competence centre, Energigården. The local competence centre has been important for foresters and farmers, but not directly for all the private bioenergy entrepreneurs. It is further the case that the cooperation between private actors has been limited. The GR-ness is average to strong with economic, and partly social and environmental objectives, public

emphasis on bioenergy use, locally sourced capital, local actors, and partly locally sourced raw material and knowledge.

4.3. Nordre land GRIP

In Nordre Land, the history of the bioenergy development started already in the 1980s with an eager chief of forestry in the country promoting bioenergy, which at that time due to low hydropower prices did not take off. In 1985, Nordre Land municipality made a plan for district heating in the local centre and in 1991, there was a municipal decision to go for waterborne heating systems in municipality buildings. Early in the 2000s, the hydropower prices increased and bioenergy became more competitive. The forest owners association were at the same time challenged with increased costs for transport of pulpwood and already having active social relations considering bioenergy was an obvious option. So, in 2005, 13 forest owners established Dokka biovarme. The municipality supported this first initiative by asking for biotechnology using wood chips rather than wood pellets in the knowledge that this would favour local suppliers.[7] The foresters gathered a lot of knowledge about the technical and organizational issues partly from Sweden, partly from suppliers of equipment and from local experts in the Innlandet region including Energigården. In 2006, a new bioheat plant Torpa biovarme was set up by 26 other foresters and with consultancy from Dokka biovarme and with no competition between these two plants. Eventually, bioheat plants were also established by the municipality in former industrial facilities and the wood chips being purchased from the forest owners. In 2011, Dokka fjernvarme was established by the same first 13 forest owners with an addition of 4, as they now had surplus capital to use for new investments. The bioheat plants all supply different municipal buildings, like primary and secondary schools, kindergarten, fire station, warehouse, operation centre, elderly and care centres as well as a local housing area. Wood chips are bought from Dokka biovarme, while the municipality itself does the daily operation. A caretaker drops by once a day to check the plants. Since the municipality built their plants, the electricity prices have dropped. The plants are currently operated with a financial loss. As of today, Nordre Land municipality has biomass heating in 80% of the municipal buildings.

In summary, the bioenergy entrepreneurs now own and run four bioheat plants of which the forest owners have three and the municipality has one. The customers are mainly the municipality and the county using the bioenergy in schools, kindergarten, an elderly centre and local administration buildings. The raw material is based on timber delivered by the shareholders of the bioenergy plants, the chipping and transport being done by locally hired entrepreneurs. Making chips a requirement was a way of securing the work for the local foresters in preference to the inevitable external suppliers of wood pellets.

The initiating forest owners arranged hearings both for potential shareholders, for municipality politicians and administration and for citizens about transport of chips, emissions from the heat plants and so on to gain acceptance and so did the municipality. As a result, the forest owners of Dokka biovarme and Dokka fjernvarme now also function as knowledge sources for other places in Norway and abroad.

In sum, the IP-ness of this GRIP is average to strong with shared goals, shared processes, shared learning, shared implementation and negotiated contracts carried out.

It is mainly a quadruple helix as there is no specific knowledge actor in this helix. The GR-ness is relatively strong with economic, social and environmental objectives for the entrepreneurs and the municipality; however, it is only a group of foresters and not the whole association that is included. The embeddedness in local resources being capital, labour and biomass is strong and so is the moral duty to deliver for the municipality.

4.4. Søndre land

In Søndre Land, there have been some initiatives to establish bioenergy production by local forest actors. These initiatives have generally not succeeded and no GRIP exists. No municipal buildings are heated by bioenergy, while a local sawmill and a market garden use bioenergy. In the 1930s, there was an intense labour conflict between forest owners and forest workers. This conflict is still present and seems to have implied lack of local political benevolence to forest owners and thereby no political emphasis on local business development from forestry. Municipal heating decisions have been taken by the municipal administrative staff and therefore treated as a purely economic issue. Heating pumps have been the results in these decisions. Additional explanations for these decisions are more scattered[8] settlements in Søndre Land than in Nordre Land and preferences for heating pumps among the municipal estate administration.

In Table 1, we have summarized our findings on GR-ness and IP-ness which will be used for the analyses.

5. Analysis

In Figure 1, a stylized example of a GRIP is illustrated – although having variations in structure and components as described in this paper. In these cases, as in the others we have examined in Sweden and Finland, we describe this GRIP structure as a 'Quintuple Helix' because it has five rather than three different groups of interests ('Triple Helix'),

Table 1. Comparison of GR-ness and IP-ness for the GRIPs.

GRIP	IP-ness	GR-ness
HADELAND GRIP	Quadruple Helix with some quintuple Helix features. Shared, mainly local economic and value-chain objectives, but also environmental. Municipal action and action from the locally based competence centre critical.	Locally based actors and ownership that mainly or partly use local resources Information by municipality and private actors for the local population.
NORDRE LAND GRIP	This GRIP has developed over time being a Quadruple or Quintuple Helix. Initiation through forest owners association, and later on also municipality and one more forest owners association. Municipal decisions, support and knowledge crucial.	Very embedded in use of local wood, and via ownership and local use of the heat. Local hearings among citizens by forest owners and municipality.
VOSS GRIP	This GRIP has transformed itself over time, bringing in new partners, as a result of technical problems. It now has a quadruple helix form, with some quintuple helix features. Shared goals of using local resources, local value added and cheap and reliable heat.	Embedded with local wood, local capital. Information meetings for the local population in the beginning.

each bringing different types of knowledge, values, norms and other resources to the learning and action system. However, all the GRIPs do show certain characteristics related to their GRIP-ness both in the process of development and in the established structure.

5.1. Processes of GRIP development

Dependency of local entrepreneurs: The development of bioenergy in all GRIPs has been driven by entrepreneurs and a vast search for competence among the entrepreneurs on the supply side. The lack of national policies and national competence on bioenergy may have spurred this drive.

Facilitation by local authorities: First of all, the municipalities are crucial in creating local markets through licensed obligation and mandatory connection to district heating for industrial and/or housing areas and public buildings. Such facilitation has had little diffusion in Norway. The decisions have involved establishment of infrastructure for heating solutions in public buildings and, in some cases, new building areas for industry or private housing. However, being a more touristic area, Voss also has a hotel with district heating in addition to public buildings. Such infrastructure secures a more long-term demand, which is most probably a condition for generation of bioenergy production on a larger scale. Three factors have been central for these decisions: accounting for the local forest sector, accounting for the municipal economy and employment, and finally, knowledge about alternative solutions and their respective costs.

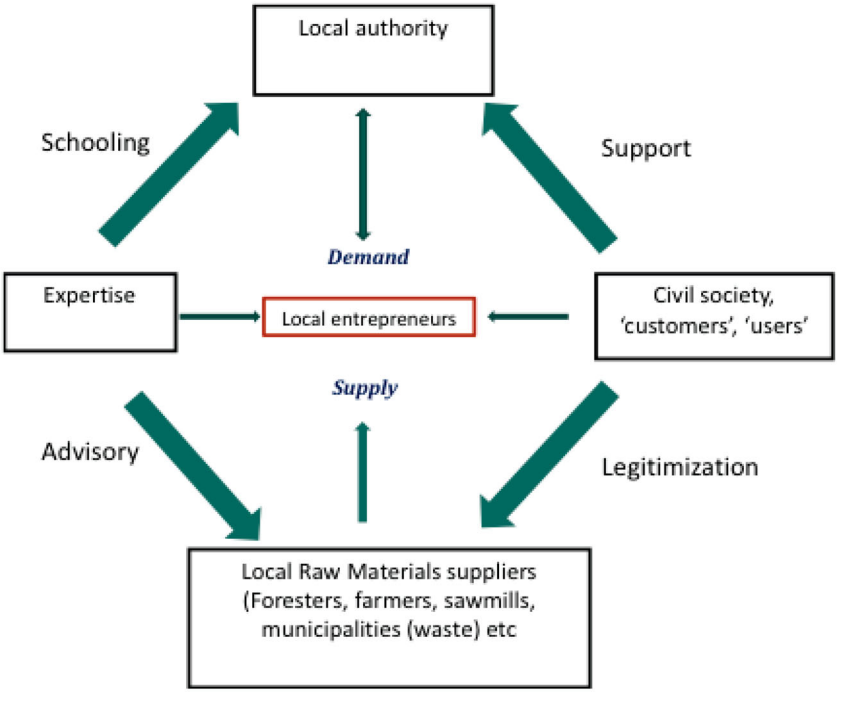

Figure 1. Stylized example of a GRIP, 'The Quintuple Helix'.

Entrepreneurial forest associations: These create opportunities for collective action with low transaction costs and business development, as it is easy to start up new business through access to common capital and using personal networks. Furthermore, there has been a close connection between the forest industry, municipal administration or local politicians in the choice for heat solutions. This was among other things kicked-off by decrease in timber prices and reduced income and employment opportunities in forest businesses as a result of the closure of pulp mills in many areas of Norway.

Dialogue between local entrepreneurs and public decision-makers: The 'alliance' between entrepreneurs and municipal engagement both among politicians and administration on the demand side has been crucial for development. The contact with the civil society to prevent potential conflicts information meetings or relying on solid trust has also been important for trust and acceptance.

Competences: Norwegian entrepreneurs have gathered knowledge partly from local experts and partly outside the area either Sweden or Denmark, and the value of sharing of rather than competing for knowledge is highlighted. Energigården, as a local innovator with its systematic sharing of knowledge and orientation towards collective action, has been an important actor. Energigården itself has links to the university system through the education of its principal and staff, and through its board members, but it is notable that direct links with universities and research institutes are largely absent in the GRIPS examined. Our preliminary impression is that the entrepreneurs and local authorities involved prefer to talk to a knowledge intermediary who is seen as a peer.

Such a dissemination of knowledge seems possible partly because the actors have limited ambitions about expansion outside their own key areas, which has decreased the competition in the NORDRE LAND GRIP. In some cases, such as HADELAND GRIP where the competition has been stronger, the businesses have been more reluctant to share their knowledge. The competence gathering among the entrepreneurs is not a bottleneck as such, however, since they, if entrepreneurial, will manage to find knowledge no matter where it is available. Among municipal administrations, sparse knowledge about bioenergy may be a challenge for the bioenergy development because of their critical importance for the local regulations and market. Also on the demand side with customers buying energy, either as industries or as private houses, knowledge and security about price, delivery and environmental impacts are necessary information to provide.

5.2. Central conditions for GRIPs in bioenergy

An important forest industry with local support: Because customers in HADELAND, NORDRE LAND and VOSS GRIPs – as in the rest of Norway – have access to cheap electricity, price considerations have not been the main motivator for the choice of bioenergy solutions among municipal customers. The relative local importance of the forest industry implies that the interests of this sector have political power in these municipalities and have a say in the choice of local energy solutions. The result is that in Hadeland, since the 1990s, a number of businesses have started production of bioenergy and most of them still exist, although a few have closed down. The importance of local support for local forestry is clearly seen when comparing Nordre Land and Søndre Land municipality, the latter having no GRIP. In Nordre Land, the municipality has gone a long way to adapt the tender for bioheat to suit local providers, while in Søndre Land, historically sensitive

class relations between large forest owners and forest employees seem to have limited the political space for public/private cooperation around heat solutions, leading to choices other than bioheat.

Dense local networks: A small population, ownership through commons, and so on create greater transparency and possibilities for collective action with low transaction costs, and make it easy for the different actors to get in contact with each other. In some cases, the path from business to administration and politics has been short, leaving room for common municipal strategies to combine business and public needs in the choice for heat solutions. This is clearly the case in HADELAND and NORDRE LAND GRIP. However, there is no guarantee that such dense local networks contribute to collective action. The case of Søndre Land shows that class conflicts inherited from the past may also create large obstacles for collective action.

Access to competence: The knowledge base for bioenergy includes technical knowledge about bioenergy, which in general is low in Norway compared to Sweden and Finland. However, both entrepreneurs and innovators seem to be keen enough, and able to gather technical knowledge both locally or abroad through study tours and business consultancies, although municipalities may rely more on local competence. The knowledge about access to raw material, distribution systems with logistics and costs, and how to organize any regulatory issues, is generally adapted to local market conditions, nature, geography and business structure.

Scattered settlement and waterborne heating systems: This limits the bioenergy market for households, and makes public and large industrial buildings the most important potential, although the denser urban settlements are important in some cases.

Land ownership structure: There is a large variation in ownership structure between the three GRIPs and the fourth case study in Søndre Land municipality. Nordre Land municipality is characterized by relatively many and small properties (Nordre Land municipality 2015). In Søndre Land municipality, despite its very similar structure to Nordre land with a vast forest area, economic structure, population and migration, the trials for bioenergy development have been few and failed due to lack of support in the local council, for promoting bioenergy, partly because of conflicts between large forest owners and employees in the 1930s. A recent case of land management shows the different attitudes to local landownership in these two neighbour municipalities. In this case, a large investor not living in the area in 2006 was denied permission to buy forestland in Nordre Land municipality, while Søndre Land municipality right afterwards agreed to sell a large forest area to the investor.

6. Conclusions

All of the GRIPs studied in this paper have quadruple or even quintuple helix features; in other words, they usually have the involvement of:

- Suppliers of raw material, in this case wood chips, wood waste materials and other kinds of fibrous waste;
- Energy suppliers, mainly district heating suppliers of hot water;
- Municipalities, usually as customers, facilitators and regulators;

- Knowledge brokers, not Universities or research institutes in our cases, but either Energigården, consultants, or through study visits abroad especially Sweden;
- Sources of capital, public (ENOVA, Innovation Norway) and private (local savings banks, hydropower companies, etc.)
- Local population, commonly through public information meeting and sometimes also as customers.

However, some are more dominated by one or two kinds of partner, such as the forest owners or local commons or the municipal authority, and others are more balanced. They also commonly have shared goals:

- Foresters and Municipalities want to utilize local timber resources, much of which have lost their former market as pulp and paper mill feedstock, and to add value to that locally;
- Municipalities want low-cost and reliable heat energy;
- Local firms and the local population want low-cost and reliable heat energy;
- Many interests want more local development (employment and incomes).

However, some GRIPs (and some partners in them) are more focused on the utilization of available wood and so providing markets for forest owners, while others are more focused on other goals. In general, there is little expression of environmental goals per se (although reductions in CO_2 gas emissions are sometimes quoted by respondents), or of social goals other than local employment and local value creation. This is probably at least partly because in Norway the universal welfare state and minimum wage regime is generally assumed to be responsible for issues of personal welfare and income distribution. However, primary and secondary schools, kindergarten, and old-folks homes are run by the municipalities in Norway, and they are always connected to the district heating systems in our cases. The high schools, run by the counties, are also commonly served. There is no evidence that specific efforts have been made to 'include' 'excluded' or marginalized groups as such, although the common involvement of municipal authorities may be considered to ensure that the interests of all citizens are considered. However, it may also reflect the nature of power relations, especially the power of the forest owners, in the local political system.

The close relationship of all GRIPs to local forest owners and wood suppliers reflects the dominance of forests as the main bio-resource in the regions studied, as in most of Norway. They are embedded in a long-standing local social system around mainly small-scale forest ownership, forest commons, sawmills and forest owners' cooperatives. The relatively large number of forest owners and the usual involvement of democratically elected municipal councils also reflect a GR-ness which gives the GRIPS local legitimacy and explains the general absence of conflicts – indeed, a positive feeling – around local bioenergy activities. In one case, the municipality chose wood chip technology deliberately to allow local suppliers to compete against larger external pellet manufacturers. However, in one of the cases studied in one of the two regions discussed in this paper, the bioenergy plans failed because of former class conflicts between large-scale forest owners and workers, and consequent lack of support in the local council. The long tradition of forestry in the two regions also means that there is a relevant local knowledge and skills base,

although specific knowledge and skills on bioenergy technology have to be sought either from the local knowledge broker, Energigården, or externally.

The GRIPs are not necessarily formal, or static, entities. The VOSS GRIP shows that they can be radically transformed over time, with new owners, new activities and new technologies, in this case brought on by initial technical and financial problems. In the case in question, however, these transitions were managed by the local actors, and can be regarded as part of the learning process which gave rise to feedbacks.

The technology for bioenergy is fairly well known, and open-source rather than surrounded by heavy patents. It is therefore accessible to local communities and small entrepreneurs. However, in a country with relatively cheap hydro-electrical energy approaching 100% of total electrical energy, it is often marginally competitive, especially in the absence of strong national government supporting policies. It is therefore encouraging to note those bioheat enterprises that have started since the 2000s are mostly still present today. The reason for this has been the ability to create relatively stable local conditions, through the involvement of municipalities. This involvement has been greatest where there is an absence of conflict around forestry, sometimes due to consensual collective forest associations or local commons which are collectively owned and managed, and not only because this favours a forestry presence in the local democratic arena. Such involvement has also been encouraged in situations where the grid infrastructure is relatively weak, or power supplies have for this or other reasons proved unreliable. Equally, the recent weakness in the market for poorer quality timber, which formerly had markets in the Norwegian pulp and paper industry, has prompted foresters to look for alternative markets. In some cases also, municipalities have a goal to brand their areas as 'green' and/or to stimulate economic development, and see bioenergy as one means of assisting with this. Finally, bioenergy has some tireless 'champions' in Norway, including active, persuasive and knowledgeable entrepreneur running Energigården in Hadeland. Without these elements, there seems to be little reason for bioenergy to be a significant element in the Norwegian context. Equally, if bioenergy targets are to be reached, it is through such elements becoming active and motivated in many more regions and municipalities that will surely determine this.

How, then, do the GRIPs studied stand up in terms of 'inclusiveness' or attending to the HR-TBL or 3P goals? First of all, on the environmental side, the outcomes for climate change and indeed biodiversity are generally contested, although this is not a source of conflict in our cases, at least to date. So much depends on specific contexts, management practices and the time-scale being considered (Clarke et al. 2015). In TRIBORN, we are collaborating with environmental and landscape scientists to examine these issues in depth, but at the time of writing, the answers remain unclear. Turning to the 'social' side, the main concerns must be around poverty, exclusion and inclusion. Despite some influence of the neo-liberal tendency since the 1970s, Norway remains a largely universalistic welfare State. The municipal councils provide kindergarten and school places for all, health services children, youth, municipal doctors, and all old folks with elderly homes and care, and 'all', means rich, poor, and everyone else in between – all being provided at no or very low cost and not being means-tested as in many neo-liberal countries like the UK and the USA. Political representation and voting rates are also very high, and municipalities are small (average population 10,000). It can thus be argued that it is the general development of Norway's political institutions that gives some assurances regarding the

representation of poorer and more disadvantaged groups in society. In turn, the fact that kindergarten, schools, clinics, hospitals, municipal buildings and old-folks homes are often the first to be served by district heating schemes based on bioheat gives such groups an interest and an involvement as citizens, as voters and as customers.

It remains to be seen how this plays out in the other countries involved in this study. Equally, our work on HR-TBL outcomes remains incomplete, and will be the subject of future papers.

Notes

1. Norway has one of the highest proportions of unharvested annual forest growth among the Scandinavian countries.
2. A helix is composed of institutions and actors having different functions in any innovation system, and the interactions between these institutions and actors. Traditionally, the innovation literature discusses the 'Triple Helix', but, as argued in the Introduction to this Special issue, there are several reasons why we opted to go beyond the triad.
3. Thus, in many 'green' projects including those related to bioenergy, forests, natural parks and indeed agriculture, poor people are frequently displaced from their land to make way for large-scale projects. See, for example, Geisler (2013) and Geisler and Feldman (2012).
4. In general, the idea that a person or persons should 'represent' a category of people defined by others as 'poor' is extremely problematic from a number of points of view, and seldom adequately discussed in the literature. The building of civil society institutions, with State support, is for many a critical step in securing such representation (Dahl 1990).
5. Forests that are managed according to the IFC or PEFC principles.
6. The Energy farm was established in 1991 and has initiated and taken part in several state-funded bioenergy projects and local bioenergy companies (Energigården 2016).
7. Pellet technology normally needs larger plants and more heavy investments which only larger investors like hydropower companies with no local ties are able to initiate.
8. Scattered settlement makes bioheating less profitable.

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