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# BIOENERGY DEVELOPMENT IN NORTH KARELIA, FINLAND

**DRAFT, 19 June 2017**

*This draft working paper looks into rural bioenergy development in the region of North Karelia in Finland. It aims at identifying the enabling factors behind the relatively successful local bioenergy development and considers how the bioenergy development has impacted sustainable local and regional development in North Karelia.*

*This working paper is a part of the TRIBORN Project, which investigates how to increase the production of bioenergy in ways that promote sustainable development understood as positive economic, social and environmental outcomes - in rural areas. The working paper at hand will be finalised and published online later in 2017.*

*Read more about the TRIBORN Project here:*
*http://www.nibio.no/prosjekter/triborn*

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# Content

## NORTH KARELIA – A RURAL FORERUNNER IN FOREST-BASED BIOENERGY

**North Karelia – sometimes entitled as the forest region of Europe – is one of 19 regions in Finland. It is located in the easternmost part of the country, and shares a 296 km border with Russia. The total population reported is 164,300 (2016) in an area of 21 585 km2 (Statistics Finland, 2016) North Karelia is a predominantly rural region and the region's 164,300 inhabitants are sparsely distributed (7.7 inhabitants per square kilometre).**

**North Karelia is divided in 14 municipalities and three sub regions of Pielinen Karelia, Joensuu and Central Karelia. The main urban centre and economic capital of the region is the city of Joensuu with approximately 30% of the total population. (Statistics Finland, 2016)**

**North Karelia is often considered as a Finnish forerunner in renewable energy, largely thanks to innovations emerging from its robust forestry industry. Renewable energy accounts for 63% of total energy use in North Karelia (28.5% in Finland as a whole), with 82% of this coming from wood-based sources.**

## FOREST INDUSTRY AND BIOENERGY DEVELOPMENT IN NORTH KARELIA

### Motivation arising from local assets

Due to its vast forest resources and accumulated expertise in forestry, a large scope of upstream and downstream activities of forestry value chains is present in North Karelia today.

The region hosts a number of multinational foresty-related industry actors, including e.g. Outokumpu, John Deere, UPM Kymmene, and Stora Enso. A large number of smaller actors are operating around these major actors, providing services and material across the forest industry value chain and also developing businesses stemming from the industry side streams.

For instance, the region specialises in timber construction, and Eastern Finland produces most of the forest machines sold in Europe. The forestry industry also specialises in pulp and biomass as well as the processing and use of ash collected from wood-fired power plants. Additionally, expertise in forest measurement and other aspects of forest development are exported by local companies.

Furthermore, a large portion of the companies that make up North Karelia's forestry industry are locally owned by co-operative private firms, individuals and municipalities. For instance, there are 22 000 non-industrial forest owners and more than 5 000 people working in the forestry supply chain. Thus, the profits and natural resource rents are to a significant extent recycled back into the local economy. (Regional Council of North Karelia, 2016)

Due to the strategic importance of forest industry, the forest industries and local forestry associations have been and still are quick to pinpoint any policies affecting forest activities at the local level and the incentive system for renewable energy is adjusted in a reciprocal manner. Incentives for thinning of the wood and producing renewable energy from forest resources, as well as permitting (with controls) the re-use of wood ash as a forest fertiliser, are deemed beneficial

because they positively impact the wellbeing of forests and the quality of wood derived from the forest.

In North Karelia, the development of bioenergy is happening through formal and informal networks connecting private enterprises and energy co-operatives with the public sector, regional research institutions and consumers in a quadruple-helix manner. According to the estimates by the Regional Council of North Karelia, this network, or a bioeconomy cluster as the Regional Council of North Karelia entitles it, involves around 500 companies, has generated 6 000 jobs and has an approximate turnover of €1,7billion. Simultaneously the cluster constitutes the backbone for the high regional levels of renewable energy consumption, equalling up to a 63% share of renewable energy in the total regional energy mix (with 82% of this coming from wood-based sources), which is well beyond the Finnish and EU average, reaching 29,4% and 12,5% share of renewable energy respectively. In addition, the cluster's approach has contributed to the lowering of the North Karelia's $CO_2$ emissions around 21 % between 2007 – 2012. (Regional Council of North Karelia, 2016)

The Regional Council of North Karelia estimates that at least 120 companies are concentrated in the "bioenergy and renewable energy" sector, which had a turnover of about EUR 200 million in 2010. Between 2004 and 2010, turnover and employment in the renewable energy sector (mostly woody biomass) grew by about 130% (turnover) and 60% (employment). Direct employment in this bioenergy cluster is about 1 300 man-years, and the regional multiplier for employment in the forest supply chain is estimated at 2.3. (OECD 2012)

A profound factor advancing North Karelia's progress in the bieoenergy sector has been the long-term strategic work undertaken by the Regional Council with a focus on the development of local value chains, legitimacy of locally produced renewable energy, R&D and innovation activities and attracting investments. In addition, the local universities and research institutions are strongly linked with business in North Karelia through a substantial regional innovation network. This ensures that research objectives evolve in response to specific needs within the region, which contributes directly to the competitiveness of the forestry industry. Most importantly, these benefits are achieved in a cooperative, consensus-oriented manner between the regional actors and residents, and with a minimal impact to the landscape and environment, which is a vital asset in the region's tourism industry and environmental sustainability. One particular example of a joint learning and innovation is the Wood-Energy Network (WENET) that was an 8-year joint programme for regional bioenergy actors. Once the program was officially ended, the structures and networks carried on and the overall benefits proved sustainable in long term. (Interview)

***"Over 10% of workplaces are in the regional forest bioeconomy…about 25% of our turnover in North Karelia is coming from forest-based bioeconomy, equalling up to 1.7 billion euros."*** Regional Council of North Karelia (Interview)

# Forest bioeconomy sector in NK

**The Forest Bio-economy in North Karelia**

| Sector | Workplaces | The revenue |
|---|---|---|
| Forest Economy | 2000 | 300 M€ |
| **Renewable Energy (mainly Bioenergy)** | **1350** | **160 M€** |
| Wooded products and wood based construction | 1000 | 400 M€ |
| Pulp and board based industry | 350 | 330 M€ |
| Technology industry | 1200 | 400 M€ |
| R&D&E, Management | 400 | 50 M€ |
| Travelling and eco-system services | N/A | 2-5 M€ |
| **Total** | **6300** | **>1600 M€** |

Figure 1. Forest bioeconomy sector in North Karelia 2012 (Regional Council of North Karelia, 2012)

## Long-term strategic work pays back

An important part of the development process of North Karelia's bioenergy and bioeconomy sector is the long-term strategic work undertaken by the regional quadruple helix actors under the coordination of the Regional Council of North Karelia. Building on North Karelia's regional strengths and competitive advantages as a forestry region, including bioenergy deployment, is strongly viewed as a regional development priority administered by a regional policy. This persistent strategy work has paid off in investments, more sustainable energy consumption and additional revenues for local forest owners.

The Regional Council has applied an integrative strategy approach which connects several regional ambitions and policies. A number of bioenergy strategies have been implemented in North Karelia since the 1990s. The current direction of the region is established through a number key documents: Regional Strategy 2030, Regional Programme 2017, Smart Specialisation Strategy, Regional Climate and Environmental Programme 2020 and Regional Land Use Plan 2030. One of the main ambitions guiding the strategy work is the target of North Karelia becoming a completely fossil fuel-free region by 2030. Forest bioeconomy is one of the three spearheads of the Regional Smart Specialisation Strategy of North Karelia, defining this theme as one of the development priorities

***"The municipalities are taking advantage of North Karelia's Regional Strategy, and using it to convince companies to come into the municipalities."***
The Regional Council of North Karelia (Interview)

when the regional authorities allocate national and European regional development funds into the regional projects. (Interview)

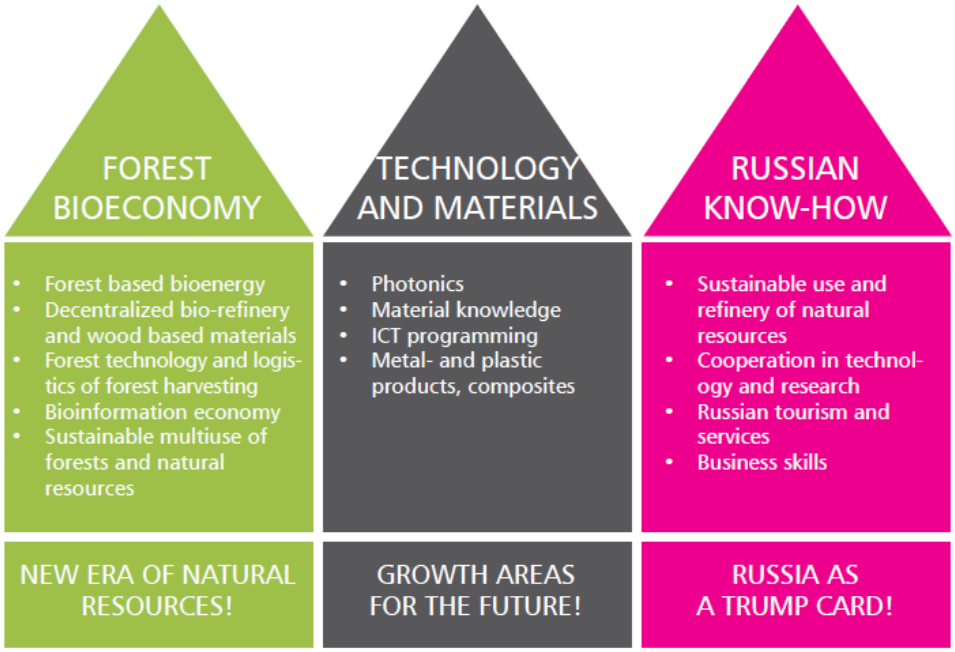


Figure 2. Spearheads of North Karelia's Smart Specialisation Programme (RIS3) (North Karelia's Smart Specialisation Programme 2013)

The regional strategy aims at reducing dependence on oil and replacing it with renewable energy. A specific focus is given to liquid fuels from woody biomass in order to apply the fossil-free thinking also to regional transport and to reduce transportation costs. Moreover, the strategy highlights the importance of forest-based products, biorefining, forest energy technology, improvement of local value chains and strong entrepreneurship as foundations for energy self-sufficiency and ambitious export targets. (OECD, 2012)

Several concrete goals set for North Karelia for 2030 are directly related to the development of the bioenergy industry and request for more innovation, including targets such as increase in the revenue from the bioeconomy by EUR1 billion, net decrease of greenhouse gas emissions by 80% (2007 baseline) and the abandonment of fossil fuels in the region (Climate and Environmental Programme of North Karelia 2020). The efforts for realising a fossil-free region is coordinated by the Regional Council which works in a very practical manner with the regional stakeholders, including businesses and municipalities. This has involved establishing a direct link and continuous dialogue regarding the ambition for and foreseen benefits of a fossil fuel-free region as well as very hands-on work from the Regional Council's side in order to inform, motivate and equip the regional actors to realise their part in the quest for a carbon-neutral region. (Interview)

The capital investments directed to the region's bioenergy and bioeconomy sector have been relatively high between 2013 and 2015, when more than EUR100 million were invested in biogas, bio-oil plants and RDI networks in the region. The success in attracting private investments to North Karelia is denominated both to the long-term regional strategy work and accumulated local expertise in the forestry sector, including the presence of internationally competitive knowledge institutions and supply of skills. Two additional projects with significant investment needs are planned in Nurmes (bio-coal plant) and Lieksa (bio-oil plant). (Regional Council of North Karelia 2016; Interview)

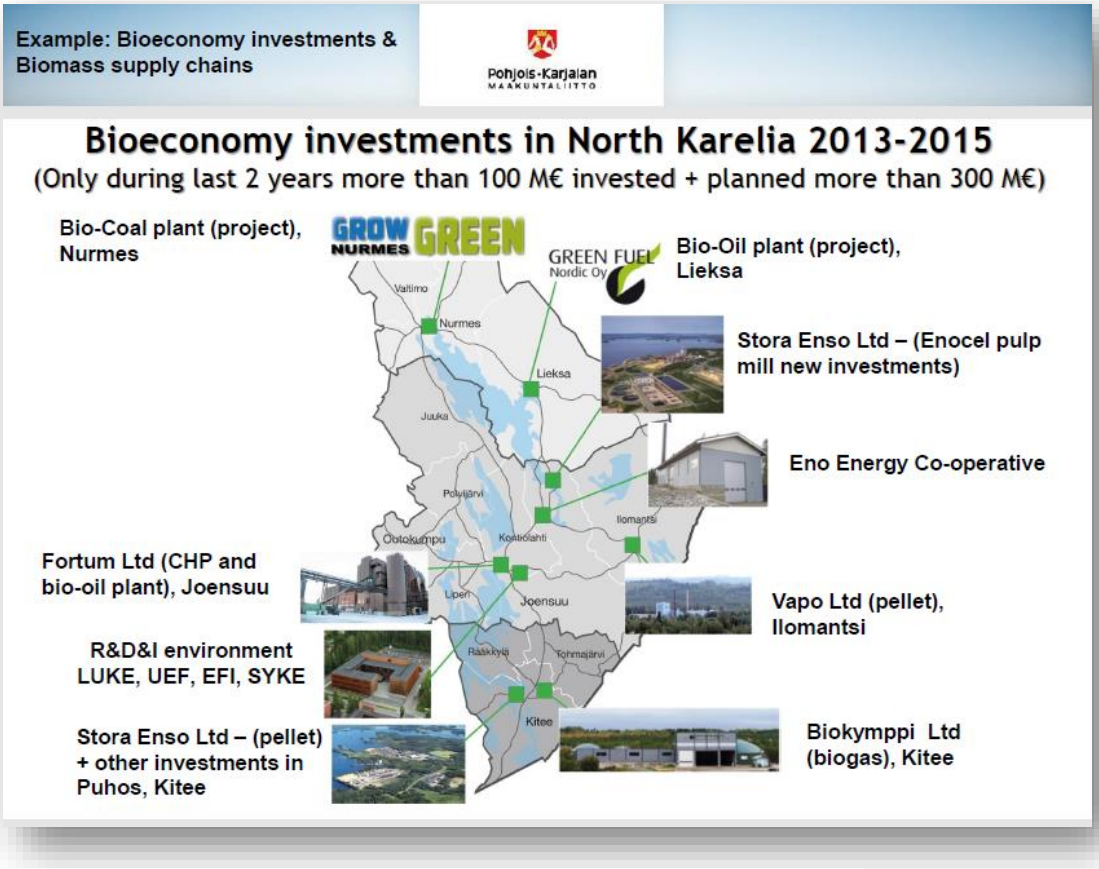


Figure 3. Bioeconomy investments in North Karelia 2013-2015
(Regional Council of North Karelia)

The Climate and Energy Programme 2020 of North Karelia presents a plan of action for the North Karelia region on climate change mitigation and adaptation. The programme was drafted in cooperation with all regional actors under the coordination of the Regional Council and it sets a common vision of the desired future. The programme focuses on the sectors of energy production and consumption, transport, community structure and land use planning, construction, waste management, agriculture and forestry, including regional energy consumption targets for 2020 (see figure 6). As is required from these types of regional development programmes in Finland, the

programme of North Karelia also includes an impact assessment of the programme targets in relation to economic, social and environmental well-being in North Karelia (see figure 10).

Majority of North Karelian households used to be relying heavily on oil heating, but today local bioenergy is proving an effective alternative, reducing heating costs significantly. The Regional Council has even established a call centre which provides information and guidance for local residents wanting to switch from oil heating to the local district heating system. Consequently, the money invested in local renewable energy stays in the region, instead of being used to buy oil which comes outside the region (OECD, 2012). At the same this, this approach is widely considered to contribute to regional energy security and climate change mitigation which has increased the legitimacy of locally produced bioenergy further.

This has enabled North Karelian forest owners to diversify their production by using forest residues as feedstock for district heating systems in local towns and villages. By owning district heating plants, the forest owners and cooperatives of forest owners are able to capture additional revenue from the forest. Although the impact on job creation is not dramatic, the diversification has offered small forest owner co-operatives a new source of revenue. (OECD, 2012).

Regional district heating systems are often based on small-scale installations with a limited impact on the environment and landscape, which is also deemed important for local life quality and maintaining the tourism industry of the region (OECD, 2012).

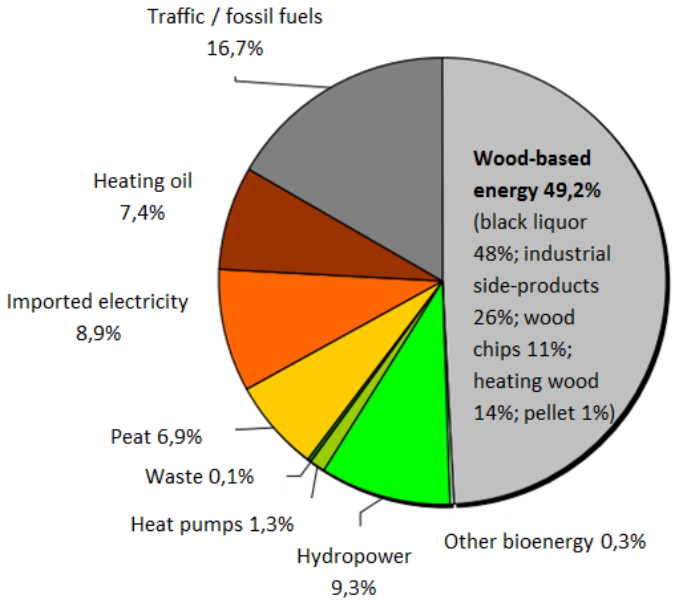


Figure 4. Share of different energy resources by % in North Karelia in 2008 (North Karelia's Climate and Environmental Programme 2020 )

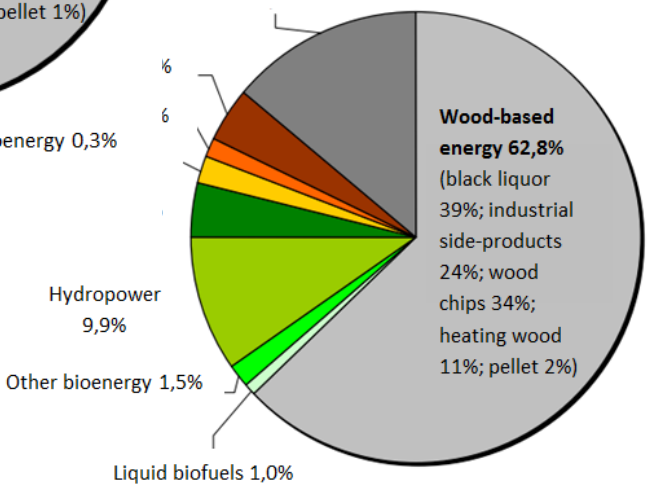


Figure 5. Target lines for the share of different energy resources by % in North Karelia in 2020 (North Karelia's Climate and Environmental Programme 2020 )

| Energy consumption in North-Karelia (GWh) | | |
|---|---|---|
| | Year 2008 | Year 2020 |
| Black liquer | 2400 | 2500 |
| Other industrial by-products | 1300 | 1500 |
| Forest chips | 550 | 1500 |
| Biofuels | | 200 |
| Fire wood | 700 | 720 |
| Pellets | 50 | 150 |
| Field biomass | 17 | 50 |
| Biogas | 14 | 100 |
| Waste | 10 | 150 |
| Hydropower | 940 | 1000 |
| Windpower | | 150 |
| Solar | <1 | 20 |
| Heat pumps | 130 | 400 |
| Geothermic | | 10 |
| Peat | 700 | 300 |
| Oil(traffic) | 1700 | 1400 |
| Oil(heating) | 750 | 0 |
| Import of renewable electricity | 270 | |
| Import of nonrenewable electricity | 630 | |
| Total | 10161 | 10200 |
| Renewables (%) | 62,7 | 80,8 |
| Self sufficiency | 69,7 | 86,2 |

Figure 6. Target lines for energy consumption in North Karelia
(Climate and Environmental Programme of North Karelia 2020)

## CROSS-SECTORAL COOPERATION AS A DRIVER FOR BIOENERGY DEVELOPMENT

The bioenergy network of North Karelia integrates several types of regional and local actors who all collaborate in an effort to work together on the development of regional bioenergy sector and forest industries. The most important actors in the regional bioenergy/bioeconomy network are discussed below.

The **Regional Council of North Karelia** (comprised of 14 municipalities) is responsible for regional planning and coordination of regional development programmes and strategies as well as management of most national and EU Structural Funds at the regional level. The main responsibilities of the Regional Council include fostering cooperation, outlining regional development targets, key projects and measures through the main planning documents as well as undertaking international activities. It is also responsible for regional energy policy and coordinating and implementing the strategy for North Karelia as a 'Fossil-Free Region' by 2030. The highest decision-making body in the regional administration is the Regional Council Assembly, which is elected by delegates from the member local municipalities. Executive functions are carried out by the Administrative Board, which is elected by the Assembly. The work of the Regional Council is further supported by the Regional State Administrative Agency for Eastern Finland and the Centre for Economic Development, Transport and Environment of North Karelia.

The **regional business community** includes several key associates. The region hosts a number of multinational forest-related industry actors, including e.g. Outokumpu, John Deere, UPM Kymmene, and Stora Enso. A large number of smaller actors are operating around these major actors, providing services and material across the forest industry value chain and also developing businesses stemming from the industry side streams. North Karelia has around 22 000 **non-industrial forest owners** and over 500 **companies** in the forest sector. Local **co-operatives,** assembling local forest entrepreneurs, dominate the forest industry and play a key role in bioenergy technology deployment by providing small forest owners with information on the most profitable way to collect and put biomass on the market, and reducing transaction costs and facilitating collective action. Some of these co-operatives have entered the business of district heating systems to take advantage of the woody biomass they produce. (OECD, 2012)

Another important aspect of the co-operatives is their positive impact on social capital. This is mainly because they involve a large number of actors, produce common rules and build trust, thereby facilitating business interactions and reducing transaction costs. They provide the necessary organisation and coordination to collect biomass and organise its sustainable use at a reasonable cost (OECD, 2012).

The connection between regional companies and co-operatives is strong. Organisations such as Kontio-Energia Osuuskunta (Kontio Energy Co-operative, established in 1998), have deployed municipal wood-chip heat plants to produce and sell thermal energy. Kontio Energy co-operative, located in the North Karelian municipality of Kontiolahti, sub-contracts local companies for the required activities like wood harvesting, chipping and transport. Another example is the Eno Energy Group from the Eno municipality, which is a co-operative currently owned by around 50

forest owners. This company also delivers thermal energy derived from wood chips from local producers.

The **regional research system** is comprised of a number of institutions (Figure 7). The research is conducted by a series of bodies and organizations with headquarters or regional offices in North Karelia, which work in close collaboration with the regional businesses, the Regional Council and are also involved in many trans-European and Nordic collaborative projects. The research institutions are strongly linked with business in North Karelia through a substantial regional innovation network. This ensures that research objectives evolve in response to specific needs within the region, contributing directly to the competitiveness of the forestry industry. The regional research network is currently working around areas which could have a decisive impact on future bioenergy, for example liquid fuel from pyrolysis; diesel oil from cellulose; ethanol from cellulose; optimal logistics for biomass flows; measurement of forest resources using lasers; and transport and logistics equipment amongst others. Certain research projects also focus on the social science side of bioenergy and bioeconomy, including topics such as legitimacy, female entrepreneurship, regional innovation systems etc.

***"The change (for bioeconomic thinking) starts from the kids…vocational school might be even too late…it should start from the infancy."*** BIOFEM Project, North Karelia University of Applied (Interview)

| Name of organisation | Type of organisation | Brief Description |
|---|---|---|
| Karelia University of Applied Sciences (NKUAS) | National university | Main areas of focus: renewable energy, wood construction, Russia-competence, precision engineering, multimedia services and competence in aging |
| The European Forest Institute (EFI) | International organisation | Focused on generating information for policy-making on forest and forestry issues.<br>125 member organisations from 37 countries. |
| Natural Resources Institute Finland (LUKE) | Government research institute | Main forest research institution in Finland and one of the biggest in Europe with a goal to "promote, through research, the economical, ecological, and socially sustainable management and use of forests" |
| University of Eastern Finland<br>(incl. e.g. the School of Forest Science) | National university | International PhD program in bioenergy, research projects including forest sciences, environment, energy, social sciences and health |
| North Karelia Municipal Education and Training Consortium | Vocational college | Basic forestry education (drivers and mechanics) |

Figure 7. Key Research and Education Institutions in North Karelia

One of the main benefits the regional research institutions bring about is their capacity to incentivise investors into adopting new technologies. North Karelia's research institutions play an important role in demonstrating and evaluating vanguard technologies and introducing them to interested investors. The perceived risk is a common issue regarding private investments for bioenergy development, especially in terms of novel technologies, and the regional research institutions have a core function in mediating the uncertainty factor. (Interview)

Regions taking up the challenge of bioeconomy transition cannot disregard that the bioeconomy is knowledge intensive and part of the challenge is to build a scientifically skilled labour force in peripheral regions. The regional education institutions of North Karelia, in collaboration with regional companies and the Regional Council, have come to play a key role in providing relevant curricula and also in-service training e.g. for the regional bioenergy entrepreneurs.

**Public development organisations** also play a role in North Karelian innovation platform as they connect and mediate among government authorities, research centers and businesses. These services may be focused on consultancy services and joint facilities, as is the case for Joensuu Science Park (owned by the city of Joensuu and the Regional Council of North Karelia), targeting technology transfer, business development and commercialisation services and scaling up research findings for the benefit of businesses. Three regional development agencies are present in the region: the Joensuu Regional Development Company which is a non-profit association owned by seven North Karelian municipalities; the Pielinen Karelia Development Centre serving the municipalities of Nurmes, Lieksa and Valtimo, located further away from the regional capital; and Central Karelia Development Company, a business promotion and development company owned by three municipalities in Central Karelia: Kitee, Rääkkylä and Tohmajärvi.

***"We have quite a competition for establishing new biorefineries. Almost in every location across the region there is some plan for a biorefinery, which are all competing for the state grants and European grants."*** North Karelia University of Applied Science (Interview)

These intermediate organisations play a major role in coordinating the regional bioenergy development across a larger geographical scope in order to find inter-regional synergies and joint benefits and to gather critical masses.

The function of the **local citizens** in the regional innovation platform comes in the form of valuable consumer and public feedback, setting the local market priorities for the businesses and industry while influencing also the course of regional research priorities and actions of the regional governance. **Local politics** do play a role in the bioenergy development as well, which is well illustrated by different uptake levels of bioenergy and bioeconomy across the municipalities in North Karelia. While certain municipalities, such as Nurmes, are strongly targeting bioeocnomy as a local development strategy, have political prioritisations and scarce resources hampered the development of bioenergy and bioeconomy in some other municipalities.

## The interplay between regional and sub-regional innovation platforms

North Karelia depicts a case of geographically uneven development within the region itself. Whilst a major share of the regional economic development is concentrated in Joensuu, the more rural parts of North Karelia are lagging behind as the spill-overs from the regional capital reach the more peripheral municipalities only in a sub-optimal manner. sub-region concentrates most of the economic development of North Karelia. Consequently, **sub-regions**, such as Pielinen Karelia, and **individual municipalities** are increasing their efforts to attract business and investment into their bioenergy sector in order to mitigate their particular development problems related to demographic challenges and decreasing employment opportunities (Lehtonen & Okkonen 2016).

Municipalities and sub-regions that have taken an active role in developing their own innovation platforms may be analysed as partially independent sub-regional platforms embedded in the major regional platform. One example, the municipality of Nurmes, is discussed in the following section.

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### Case Nurmes

(based on a stakeholder interview)

Nurmes is a municipality in the North Karelian sub-region of Pielinen Karelia. As many other rural regions in Finland, Nurmes is experiencing asymmetrical development compared to more urban regions, facing typical challenges for sparsely-populated rural areas, such as low employment and negative net migration (Lehtonen & Okkonen, 2016).

Since 2000, the population of Nurmes has decreased from 9,781 inhabitants to 7,996. In 2016, the municipal unemployment rate was 18% (the national average in Finland being 13%).

The economic industry structure of Nurmes relies heavily on services (63,6%), with the majority of jobs provided by Nurmes municipality and the Valtimo Health Care Joint Authority. Manufacturing amounts to 20,0% of the local economy, with textile, metal and wood-based companies included. Primary production (15.7%) is focused on wood-harvesting and farm production. (Nurmes municipality ,2016).

In 2014, Nurmes municipality joined the programme of Carbon Neutral Municipalities of Finland (known as the HINKU network), with an aim to reduce their greenhouse gas emission with 80% by 2030 in comparison to 2007 levels. Adhering to the HINKU program was not an isolated action since in 2011 Nurmes municipality has set its strategic focus on developing the bioeconomy industry and increasing the attractiveness of the municipality and Pielinen Karelia region (Lehtonen & Okkonen, 2016). This approach has since become evident through two main drivers: the "green" industrial area development, and the Pielinen Karelia Development Center. The local bioeconomy development is also strongly anchored to the municipal leadership of Nurmes, which is knowledgeable of forest industry and bioeconomy development.

In 2013, 28 hectares of municipal land were set apart for a "green industrial zone"of Nurmes. The industrial area was established as there was a shortage in Nurmes of large industrial plots and the existing plots were scattered. The green industrial plan promotes bioeconomy and relevant upstream and downstream industries by advocating for industrial symbiosis approaches. The area

was named an area of green industry by bioeconomy companies that would be located in the area and according to Nurmes' carbon neutrality objectives. As is indicated by the name, companies that located in the area will follow the principles of sustainable development in their operations in order to produce products and services in a way that is low-emission, resource-efficient and environment-friendly. The area that consists of 28 hectares of land is divided into nine plots, out of which a couple are still available. Plans for the area include a biorefinery, a bioterminal, a CHP plant, a wood dryer, and a loading and unloading site for the railway.

Since 2015, a bioterminal has been operating in the green industrial zone, collecting and selling energy-wood. A maintenance facility for specialised wood transportation is under construction and building of a biorefinery is expected to start in 2017. Investments for the development of local bioeconomy sector in Nurmes have come from multiple sources of funding, i.e. from the local government funds, from the Regional Council of North Karelia and the Finnish Transport Agency.

One of the main enabling conditions that allow the municipality of Nurmes to pursue a sub-regional innovation platform and green industry hub is the presence of foreign investment. International capital is playing a significant role for developing the municipality. However, this also calls for striking the balance between the foreign investments and make sure that the strategic inclusion of the local society in order to ensure that a share of the benefits will be recirculated into the local society and economy.

A critical element in the development trajectory in Nurmes has been the Pielinen Karelia Development Center (PIKES), an intermediate company that is partly owned by the three municipalities that form the sub-region, namely Nurmes, Lieksa and Valtimo, which focuses on business services, project development and monitoring focused on regional development. PIKES brings together various quadruple helix actors around the regional development issues of Pielinen Karelia sub-region, not only the key stakeholders from Pielinen Karelia but also from around the regional capital region of Joensuu. Current projects ran by PIKES cover a broad range of topics, from e.g. food industry modernization to bioenergy technology development and the green industry park in Nurmes.

Although there is a clear inclination of sustainably sound investments taking place in Nurmes at the moment, it is yet too early to feasibly assess the outcomes for societal, economic and environmental sustainability of the local development approach adopted in Nurmes.

***Key learnings from Nurmes***

A key observation that can be drawn from the case of Nurmes is the limitation posed to a grounded innovation platform by geographical distances and concentration of innovation actors in the urban areas and regional capitals. The case of Nurmes and the sub-region of Pielinen Karelia however demonstrate that this issue can be mediated by the establishment a more local, sub-regional, platform for peripheral actors that would otherwise face the risk of being short of the benefits stemming from the major regional innovation hub. In North Karelia, the major innovation platform around Joensuu area and the sub-regional platform of Pielinen Karelia have emerged as mutually supportive and complimentary structures, which are partially intertwined and inseparable. An

important role is played by the different regional and local actors, in this case especially the Pielinen Karelia development center PIKES guarding the interest of the more peripheral municipalities, that facilitate the dialogue and collaboration between the regional capital region and Pielinen Karelia. Simultaneously, this type of an approach is in the interest of the regional developers in the Regional Council as well as it has the potential to further enhance the balanced regional development across the entire region of North Karelia.

***"I think this is the key point: Does the municipality have a strategy? And can the municipality follow its strategy for many years? Not only for one, two or three years, but for a longer period, because getting and demonstrating real results takes time."*** Mayor of Nurmes

Another worthwhile factor in advancing bioenergy development in areas such as Nurmes is the interplay between regional strategies and local-level municipal strategies. A core factor for the successful attraction of investment into the green industrial park of Nurmes, for example, has been a detailed, long-term municipal strategy backed by a strong political and social will in the municipality. Simultaneously, the local strategy is aligned with the regional strategies and committed to the goals and targets set out by the Regional Council of North Karelia, the Carbon Neutral Municipalities of Finland and the programme for a Fossil-Fuel Free Region of North Karelia. This method has contributed to the creation of trust among public and private investors as well as local citizens regarding the green growth plans of Nurmes.

## KEY CHARACTERISTICS OF SUSTAINABLE BIO-INNOVATION IN NORTH KARELIA

Based on the approach applied in the TRIBORN project, an innovation platform can be considered as grounded if the objectives pursued and obtained from this network are aimed towards achieving triple bottom line (TBL) outcomes, referring to environmental, economic and social objectives while acknowledging regional peculiarities and specialising strategically on regional assets. The bioenergy cluster of North Karelia indicates that these three-fold outcomes are achievable.

For example, North Karelia's local energy co-operatives have demonstrated that heat produced from bioenergy is cheaper for the consumer compared to light fuel oil. Switching from oil heating to local renewable energy has generated savings worth EUR 2 million for the local economy while providing an annual additional employment equivalent to 7-10 man years. Simultaneously it prevents the burning of approximately 2 million litres of fossil oil, reducing regional $CO_2$ emissions around 5 million kilos per year. (Regional Council of North Karelia 2016)

The economic impact of the bioenergy cluster on the region is evident: the renewable energy sector alone (mostly forest-based bioenergy) equalled up to 20% of the regional employment and has a share of 10% of the regional revenue. From 2008 to 2012, the turnover of bioenergy sector increased 37% while the number of jobs increased by 25% with the technology and services branch experiencing the largest growth. In addition, the strategy work undertaken by the Regional Council of North Karelia and strong regional knowledge base in forestry and bioenergy-related matters has helped in attracting private investments to the region. (Regional Council of North Karelia 2016)

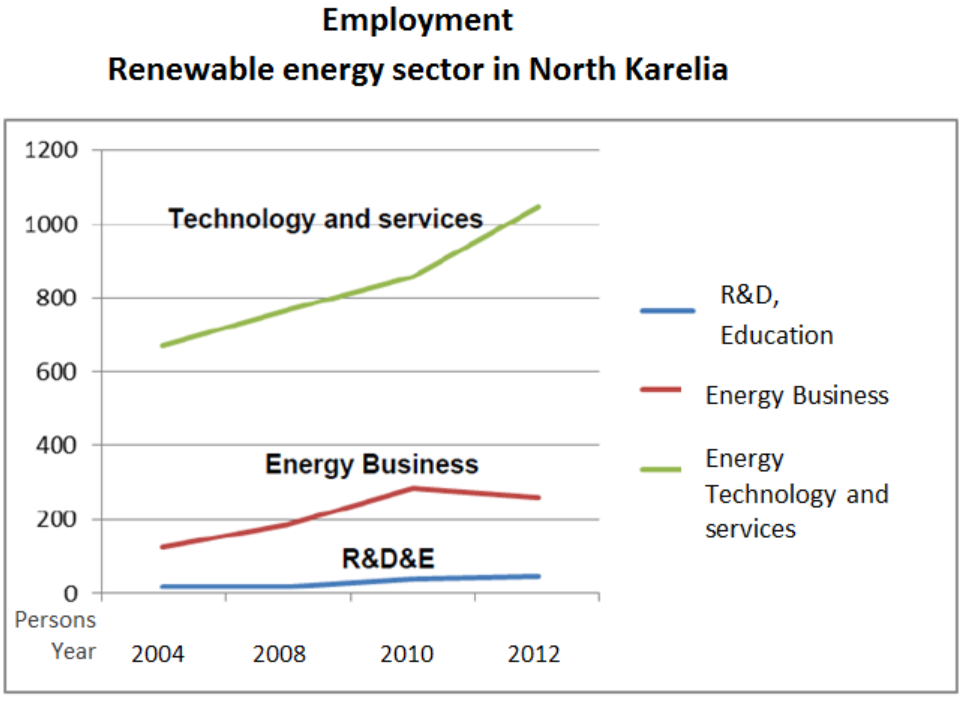


Figure 8. Employment (in persons) of renewable energy sector in North Karelia (Regional Council of North Karelia, 2012)

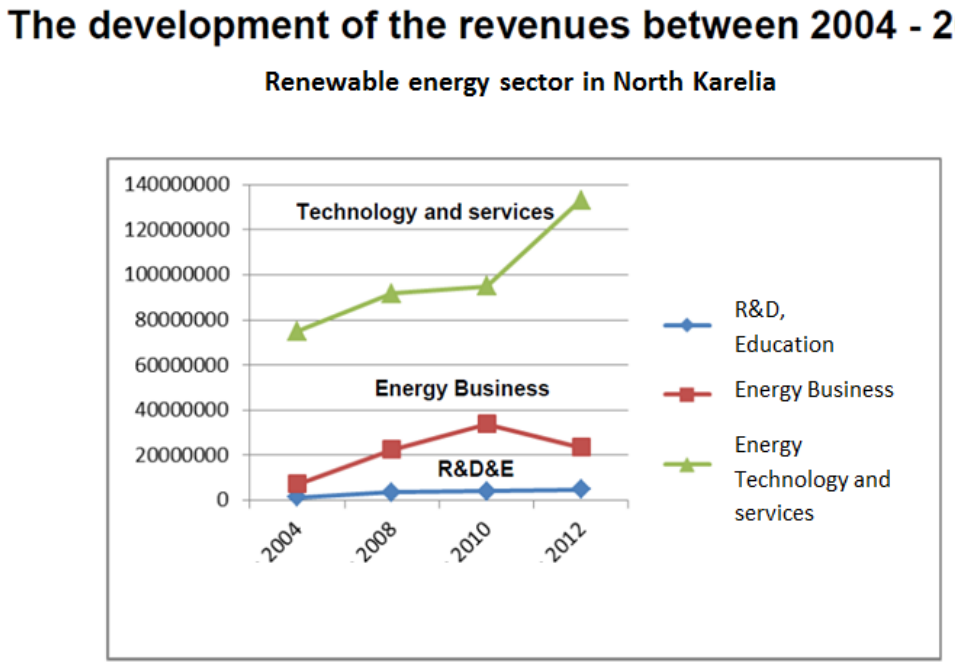


Figure 9. Turnover (€) of renewable energy sector in North Karelia (Regional Council of North Karelia, 2012)

North Karelia has gained several environmental benefits due to its specialisation in bioenergy. In 2012, 63% of the energy consumption [1] came from renewables with 82% of this supply produced by wood-based sources. The regional $CO_2$ emissions have decreased by 21 % between 2007 – 2012 and the carbon footprint of a North Karelian inhabitant is 34 % smaller than the footprint of an average Finn (2012) and the greenhouse gas emission per capita is also lower compared to national average. Simultaneously, the consensus-oriented local method of bioenergy production based on small-scale installations and sustainable forest cutting has does not altered the regional recreational values and nature tourism.

The social benefits of the regional bioenergy development are capitalised in large part because of the high percentage of ownership by the public and private regional actors, and besides job creation the profits and natural resource rents are largely recycled back into the local economy (OECD, 2012). Furthermore, the European Forest Institute (EFI) has indicated that improved use of biomass in North Karelia would have large impacts on the labour market and positive effects in the region due to the reduced imports of fossil fuels. It has been studied, that the impact of renewable energy on employment creation tends to be larger when the energy process depends on a raw material. This applies in the case of biomass, which likely to have higher income and employment

[1] Including heat, power, private households and traffic

benefits than other energy sources where the main input is free (solar, wind, tidal) and/or where the benefits from these inputs are captured by external interests. (OECD, 2012)

The expected social, economic and environmental outcomes of North Karelia's regional strategy and target lines for the further development of the regional forestry bioeconomy cluster and fossil-free region are outlined in the Impact Assessment of North Karelia's Climate and Environmental Programme 2020 (see figure 10). A requirement for assessing the impact of regional development programmes is outlined in the Finnish law. The impact assessment of North Karelia's Climate and Environmental Programme was conducted by a regional committee responsible for assessing the potential impacts of different regional lines of strategy and action in a coherent and streamlined manner. The committee consists of representatives from the Regional Council of North Karelia, The Regional State Administrative Agency for Eastern Finland, The Centre for Economic Development, Transport and Environment of North Karelia and the University of Eastern Finland.

| Impact assessment of North Karelia's Climate and Environmental Programme 2020 | | |
|---|---|---|
| | **Impact**<br>**++ / + / o / - / - -** | **Description** |
| **I Social Impacts** | | |
| Impact on living conditions and their quality | + | Increasing the use of renewable energy sources improves local employment, which has indirect positive impact on people's well-being |
| Impact on health and security | + | Increasing the use of renewable energy sources improves local employment, which has indirect positive impact on people's health |
| Impacts on equality:<br>- Equality between men and women, equality between regions and societal groups | ++ | Increasing the use and production of renewable energy helps to secure balanced regional development and the equality of citizens residing in sparsely-populated rural regions |
| Impacts on citizens' possibilities to influence | o | |
| **II Environmental Impacts** | | |
| Emissions to air, water and land | ++ | Reducing the use of fossil fuels reduces the amount of emissions to air. |
| Impact on natural environment, natural diversity and protected areas | - | Strong increase in the production of bioenergy can have negative impacts on natural diversity |
| Impacts on climate change mitigation and adaptation | ++ | All targets of the programme have a positive impact on climate change mitigation and adaptation |
| Impact on the use of natural resources | | |
| - Increasing the sources of renewable energy | ++ | The programme increases the use of renewable natural resources while decreasing the use of non-renewable (fossil) fuels |
| - Increasing material and energy efficiency | ++ | The programme has positive impacts on energy and material efficiency by e.g. developing low-energy construction |
| Impact on landscape and cultural heritage | o | |
| Impact on the amount and quality of waste | ++ | Reducing waste is one of the core targets in the programme, which can contribute to reducing of greenhouse gas emissions |
| Impact on traffic | | |
| - Forms of transport, public transport | ++ | The programme aims at enhancing the infrastructure and improving the conditions for public transport |
| - Transport – and mobility needs | ++ | By improving the infrastructure and implementing complementary construction different transport needs can be reduced |

| | | |
|---|---|---|
| Impacts on the environmental health | - | The micro particles created by the burning of wood-based fuels have a negative impact on environmental health especially in small-house areas |
| **III Economic Impacts** | | |
| Households | + | The approach presented in the programme increases rural employment which in turn has positive impacts on the household economies |
| Companies | ++ | The programme targets support the creation of new business opportunities, which affects corporate economies positively; e.g. increased use of wood-based energy, development of wood construction and traffic bioefuels |
| Regional Economy | ++ | The programme targets support the creation of new business opportunities, which has a positive impact on regional economy; e.g. increased use of wood-based energy, development of wood construction and traffic bioefuels. |
| **IV Other Impacts** | | |
| Research, development and innovation activities | ++ | The programme goals increase positive impacts on research, development and innovation activities especially through the uptake of renewable energy resources, wood construction and forest research |
| Regional development impacts | | The programme supports regional development on all regional levels |
| - County/regional level: businesses, services, employment | ++ | E.g. Increased turnover and employment for the renewable energy cluster and wood construction sector |
| - Sub-regional level: businesses, services, employment | ++ | |
| - Countryside, rural areas: businesses, services, employment | ++ | E.g. De-centralised and self-sufficient energy production and related fuel maintenance support rural businesses and consequently the vitality of the rural countryside |

Figure 10. The impact assessment of North Karelia's Climate and Environmental Programme 2020

## Lessons learned and ways forward

The sustainable success of bioenergy development and innovation in North Karelia depends also on capacity to engage in a learning process that can transform initial challenges into opportunities. For instance, the use of biomass for renewable energy was not an immediate success in the region. It took time to penetrate the market and convince households to switch from oil to wood-generated energy. Generating trust and collaboration between regional actors and stakeholders has also taken time and required consistent actions and open dialogue from the regional strategists.

> ***Wood-Energy Network (WENET) was 8 years of joint development cooperation between companies and research and development organisations in this region. We had joint projects and also engaged in the promotion of export of local products… Not competing with each other but developing things together."*** North Karelia University of Applied Science (Interview)

Overall, the North Karelian innovation platform has been identified as a constantly evolving concept and as an ongoing learning process that takes time but delivers clear benefits for its participants.

Certain regional conditions such as the presence of a large, managed forest resource, cold temperatures and high-cost energy alternatives provide a strong financial incentive to develop the local bioenergy as a means to increase the local value creation and reduce the cost of energy while at the same time ensuring that the profits generated from energy sales remain in the local economy.

Many favourable institutional factors for regional innovation are in place in North Karelia: strong local government with willingness to act, local ownership of power utilities, presence of strong research institutes and education facilities, tradition of co-operative organization, legitimacy of local bioenergy production and presence of local and regional actors in several stages in the supply chain (OECD, 2012).

One key for successful bioenergy and bioeconomy innovation in North Karelia lies in the embedded-ness of the regional, internationally leading forest science base that is strongly connected to the export industry as well as the local environment and local companies. This can further create 'glocal' opportunities for North Karelian innovation, with the potential of tackling local problems and simultaneously contributing with products and services for global exportation.

Key constraints for development of forest-based bioenergy in North Karelia are unfavorable national and EU-level policies and regulations causing market distortion and unfavourable conditions for the use of forest biomass as energy. Such examples, relevant especially for North Karelia have been wind energy subsidies and policies that favor large-scale installations which fit poorly to the North Karelian setting of de-centralised, small-scale energy production units. Another aspect is balancing the citizens' approval of large projects by considering the landscape of the area and the impact these large projects may have on the tourism industry (OECD, 2012).

Also the profitability issue of harvesting young energy wood remains pertinent. In order to further increase the share of renewable energy from the forest and achieve the regional and national targets of forest chip use (in North Karelia from 550GWh in 2008 to 1500 GWh in 2020), more and more focus will need to be directed towards young forests and small scale wood. Currently, energy wood harvesting from young stands is seldom perceived as profitable from an entrepreneur's point

of view. Main barriers for profitable harvesting are linked to the insecurity of substitutes, small tree size, bad preparation of stand and difficult forest hauling as well as lack of time and funding. From the viewpoint of an energy producer, using forest chip is challenging compared for example to using fossil oil, and a number of quality and delivery issues need to be tackled in this regard as quality of raw material and secure supplies are essential factors for a profitable heat plant. Besides consistent energy policy, forest entrepreneurs in North Karelia have pinpointed better land use and building planning form the authorities as well as more education about accounting, taxing, subsidies and generation change as key actions for improving the status of forest-based bioenergy.(Bioenergy Promotion Project, 2014)

Another of the major aspects hindering the transition towards a stronger bioeconomy in North Karelia is related to access to risk finance and other economic challenges facing especially local small and medium-sized enterprises. SMEs may lack the seed-funding to start their innovation programs which consequently hinders the overall performance of the GRIP. More effective governmental strategies together with more foreign investment and small-scale technology demonstrations may help counter the issue. (Interview)

***"The most challenges are based on just the economy - is it viable? How much money you are going to save? How big risks are you willing to take? Are those risks mostly related to technology?"*** North Karelia University of Applied Science Interview (Interview)

North Karelia is also facing the challenge of ageing population. The question of generation change is a salient issue for many forest and bioenergy entrepreneurs and depends on the profitability of local renewable energy production and silviculture as well as about the perception of bioenergy business in the eyes of the younger generation, especially with regards to the required education and understanding of innovation possibilities within bioenergy and bioeconomy as well as the attractiveness of the sector, including the question of female actors in the field.

One issue is the question of openness of the current innovation platform for innovation and development around other thematic areas than forestry and bioenergy. Despite North Karelia's strategic advantage in these particular areas, it could prove beneficial to explore other potential areas of regional bioeconomy, such as agri-food. The domination of wood-based bioenergy in the regional innovation ecosystem has been pinpointed by several regional actors. (Interview).

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**Interviews:**

| Interviewee | Title | Organisation | Date of interview |
|---|---|---|---|
| Jakob Donner-Amnell | Researcher | University of Eastern Finland, Faculty of Social Sciences | 18 February 2016 |
| Niina Huikuri | Specialist | Pielinen Karelia Development Center PIKES | 17 February 2016 |
| Anniina Kontiokorpi | Project Manager | Regional Council of North Karelia | 18 February 2016 |
| Ville Kuittinen | Development Specialist | North Karelia University of Applies Sciences | 18 February 2016 |
| Jouni Luoma | Business Consultant | Joensuu Regional Development Company JOSEK | 17 February 2016 |
| Ilkka Lukkarinen | Chairperson | Energy co-operative Kontio-Energia Osuuskunta | 17 February 2016 |
| Lasse Okkonen | Bioeconomy coordinator | North Karelia University of Applies Sciences | 18 February 2016 |
| Ari Pappinen | Professor | University of Eastern Finland, School of Forest Sciences | 18 February 2016 |
| Pasi Pitkänen | Regional Planning Manager | Regional Council of North Karelia | 18 February 2016 |
| Helena Puhakka-Tarvainen | Senior Project Manager | North Karelia University of Applies Sciences | 18 February 2016 |
| Asko Saatsi | City Mayor | Nurmes Municipality | 17 February 2016 |
| Harri Välimäki | Development Director | Joensuu Science Park | 18 February 2016 |