NORTH KARELIAN SMART FOREST BIOECONOMY STRATEGY

BIO4ECO
Interreg Europe
European Union
European Regional
Development Fund

REGIONAL COUNCIL OF
North Karelia

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Contents

What is Smart Forest Bioeconomy Strategy?

North Karelia has recognised "New solutions in forest bioeconomy" as an international-level expertise area for economic development and Forest bioeconomy is one of the choices for North Karelian Smart Specialisation. Smart Forest Bioeconomy takes into account North Karelia's ambitious climate and energy targets.

The aim of this strategy is to bind the regional Climate and Energy Programme and the Forest Bioeconomy Foci of the RIS3 strategy with the experiences gained in this project into a regional bioeconomy strategy that combines the aspects of environmental sustainability and increases the region´s competiveness by concentrating on its strengths. The target year of this strategy is 2025.

Bio4Eco aims to *"emerge the Climate and Energy Programme and the Forest Bioeconomy Foci of the RIS3 strategy into a regional bioeconomy strategy that would combine aspects of environmental sustainability and increase in region´s competiveness."* This smart forest bioeconomy strategy combines regional climate and energy issues with the RIS3 foci forest bioeconomy.

1. INTRODUCTION

1.1 North Karelia's bioeconomy is based on forests

North Karelia is the easternmost region of continental Europe and shares an almost 300 km common border with Russia. The total population of North Karelia is approximately 164 000, and the total area of the region is 21 585 km^2, of which approximately 89% is covered by forests.

North Karelia is considered the bioeconomy capital of the Europe. The competence-based growth industries of the future, such as the forest bioeconomy, and new technologies and materials are the key elements in North Karelia's development due to the active research being carried out at the University of Eastern Finland, Natural Resources Institute (Joensuu office) and the Karelia University of Applied Sciences. In addition to the research cluster, North Karelia has comprehensive education possibilities at every educational level ranging from the doctoral level at the university to harvester and timber truck driver education provided by the North Karelia Municipal Education and Training Consortium RIVERIA. The above-mentioned organisations and public authorities, together with regional development organisations like Joensuu Science Park, Regional business development agencies from three sub-regions of North Karelia (Josek Ltd, Pikes Ltd, LieKe Ltd and KETI Ltd), the Finnish Forest Centre, the Finnish Environment Institute and the European Forest Institute, form a regional bioeconomy cluster.

The region´s undisputable strength is the forest bioeconomy. More than 500 companies with operations involving the forest bioeconomy can be found in the region: the turnover of these companies is nearly €2 billion, and they employ more than 6000 people. In addition, the bioeconomy employs more than 600 experts in the region: researchers, developers, trainers and administrative employees. The region includes strong leading companies as well as promising growth companies that focus on global export markets. The forest bioeconomy sector is strongly collaborative in nature. The experts in the field also have strong networks both at home and abroad.

1.2 Forest bioeconomy in regional development

The Regional Council of North Karelia is a regional, politically guided, municipal coalition for developing and overseeing interests in the region. It is responsible for regional planning and general coordination of regional development programmes related to national and EU structural funds. The Regional Council of North Karelia oversees the interests of the people, municipalities, organisations and enterprises and speaks on their behalf regarding both national and international questions. The work of the Regional Council is intersectoral in nature; it cooperates with different administrative sectors, organisations, business life and local inhabitants. It outlines regional development targets and key projects and measures through the regional planning system, which consists of the regional development plan, the regional strategic programme and the regional land use plan. The Regional Council is also in charge of international activities of the region in its fields of activities.

The highest decision-making body of the regional administration is the Regional Council Assembly, which is elected by a meeting of delegates consisting of the members of each municipality. Executive functions are carried out by the Administrative Board, which is elected by the Assembly. This system of elected representatives ensures that the inhabitants and local authorities have their own say in regional issues and decision-making. Currently, the region is undergoing a regional reform and the final form and tasks of the regional bodies are under development.

The Regional Council of North Karelia has long-term experience in strategic development work, clustering and quadruple-helix participatory processes. The forest bioeconomy has an essential role in the region's Regional Strategic Programme 2018–2021 (POKAT2021), Smart Specialisation Strategy, Climate and Energy Programme and Regional Forest Programme. The Roadmap towards Fossil Oil-Free and Low-Carbon Region 2040 works as an implementation plan for the Climate and Energy Programme of North Karelia 2020.

In addition to energy and climate aspects, it also takes aspects of the bio and circular economy into

the account. The aim of the roadmap is to define the concrete steps needed to achieve the regional climate and energy goals in which the forest bioeconomy plays an important role.

1.3 Bio4Eco project aims to improve bioeconomy on a strategic level

BIO4ECO — sustainable regional bioenergy policies: a game changer — aims to improve regional and national policy processes and policy implementation and delivery while addressing the transition to a low-carbon economy in relation with renewable energy use, energy efficiency of buildings and forest and agricultural biomass. In North Karelia, the project concentrates on achieving the targets of our climate and energy programme and binding the climate and energy programme to our RIS3 strategy, especially in the forest bioeconomy sector.

The BIO4ECO project is based on learning processes at the local and international level. The project has organised interregional and local meetings, thematic workshops, study visits and workshops to facilitate the learning process and to gain a greater integration among the lessons learned.

Figure 1. a) Study visit to Sirkkala Energy Park in Joensuu; b) Dahlia company in Romania used wood to heat greenhouses.

The main expected outcomes of the project are to:

- increase the share of renewable energy in the overall energy mix;
- take into account bioenergy and bioeconomy in all planning and decision-making; and
- lay the groundwork for future integrated strategies and programmes for the regional bioeconomy and carbon neutrality.

The concrete outputs of the project in North Karelia are an analysis of the current state of the forest bioeconomy in the region, this regional smart forest bioeconomy strategy and an action plan for the next two years being used to facilitate the implementation of our forest bioeconomy strategies and programmes. In addition, Bio4Eco has participated actively in the preparation of our new regional strategic programme (POKAT2021) for 2018–2021 in order to take aspects of the low-carbon economy as well as ideas gained from international project meetings into the account in the programme and future development of the region. Bio4Eco also had an important role in formulating the "Roadmap towards Fossil Oil-Free and Low-Carbon North Karelia", which presents concrete steps for the implementation of North Karelia's Climate and Energy Strategy. Some best practices and topics discussed in the international workshops inspired the actions listed in the Roadmap.

A concrete self-defined indicator set for the Bio4Eco project is a 20% reduction in fossil oil used for heating from the level of 2012 by the year 2020.

According to the project plan of Bio4Eco: *"It would be useful to emerge the Climate and Energy Programme and the Forest Bioeconomy Foci of the RIS3 strategy into a regional bioeconomy strategy that would combine aspects of environmental sustainability and increase in region´s competiveness."* This smart forest bioeconomy strategy combines regional climate and energy issues with the RIS3 foci forest bioeconomy.

2. THE BACKGROUND STRATEGIES AND THE CURRENT SITUATION OF FOREST BIOECONOMY IN THE REGION

2.1 Forest bioeconomy is North Karelia's smart specialisation choice

Smart specialisation is part of the EU's cohesion policy and the Europe 2020 strategy, which focuses on each region's strengths and the activities supporting these strengths. At the regional level, smart specialisation can be understood as representing part of a regional innovation policy that guides and focuses resources on the themes that contain the most potential for the future of the region. The goal of smart specialisation is to facilitate the creation of products, services and solutions that will stimulate the region's growth. The smart specialisation strategy helps development organisations and other forest bioeconomy actors to prioritise resources and investments towards those sectors with the greatest potential for new innovations and business on a global scale.

The core of North Karelia's smart specialisation is comprised of two essential elements (Fig. 2):

1. New solutions for the forest bioeconomy; and
2. Technologies and materials as enablers of growth.

These two foci of the smart specialisation strategy, the forest bioeconomy and technology and materials, are both strong fields in the region. The foci are mainly interlinked and should not be developed separately, but in close collaboration with each other, and by using the interfaces of these elements. For example, forest technology and logging logistics are connected with metal and engineering products and harvesters use ICT applications and precision technology and can also utilise the information provided by photonics through forest resource data. New bio-based products are strongly linked with chemistry-related material expertise and extractive industry processing expertise. Networks, internationality, entrepreneurship, education, resource wisdom, innovation and digitalisation are cross-cutting themes of our smart specialisation choices (Fig. 2).

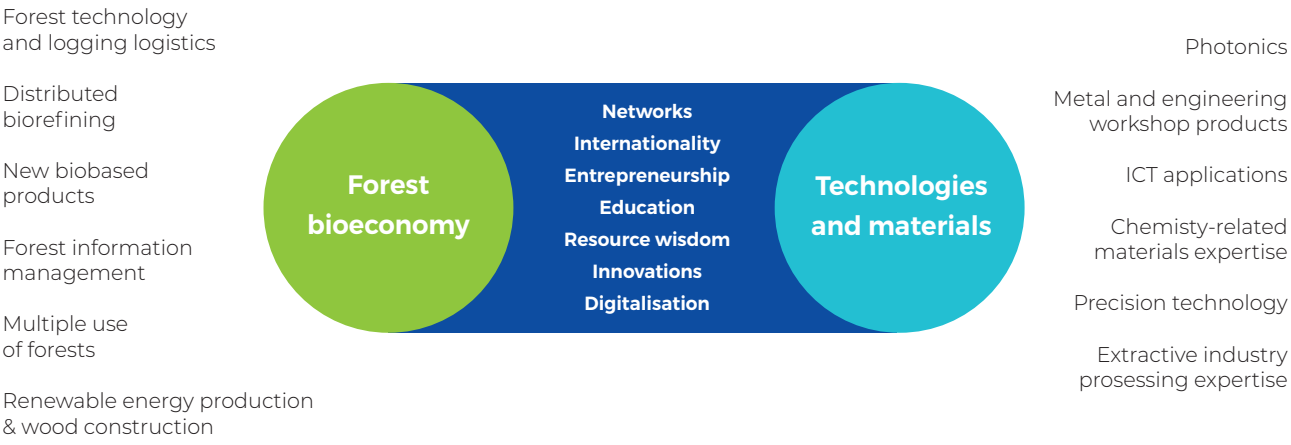


Figure 2. Smart specialisation choices of North Karelia (Smart Specialisation in North Karelia 2018).

Forest bioeconomy is divided into six thematic areas of expertise, which are presented in Figure 3. According to the smart specialisation strategy, the challenges of the forest bioeconomy sector include the transfer of expertise and research knowledge and their application for the needs of business life as well as an entrepreneurial angle in the sector's development work. The forest industry has not traditionally been a hotbed of new entrepreneurial activities, e.g. start-ups. The challenge of the forest bioeconomy sector is in creating products and services that contain an exceptionally high level of added value. The mobility and transfer of experts from research institutes and educational organisations to companies should be increased and used to create a spill-over effect for the entire industry. A more detailed description of the topic can be found in the publication Smart Specialisation in North Karelia 2018.

The Region's Areas Of Expertise For The Forest Bioeconomy:

Forest technology and logging logistics Forest machinery manufacturing, utilisation of logging methods and techniques	**Distributed bio-refining** Raw material chains for distributed biorefining, utilisation of side streams and the refinement technologies and growth of value chains
New bio-based products Bio-based, high added value products, materials and production technology	**Forest information solutions and digitalisation** Service activities that are based on electronic forest information and other wide-ranging utilisation of databanks
Multiple use of forests The refinement of the material and immaterial value of forests and the matching of their different forms of use	**Renewable energy production and wood construction** Distributed energy production and hybrid solutions that are based on renewable energy sources, knowledge environments and demonstration targets for wood construction

Figure 3. The region's areas of expertise for the forest bioeconomy according to the smart specialisation strategy (Smart Specialisation in North Karelia 2018).

2.2 Locally – Renewably – Efficiently - Climate and Energy Programme of North Karelia 2020

The Climate and Energy Programme of North Karelia presents a plan of action for climate change mitigation and adaptation for the region. The programme implements the climate targets set out by the European Union and Finland. The visions and targets presented in the programme aim far beyond the target year of 2020. In terms of energy self-sufficiency and the share of renewable energy, North Karelia already exceeds the climate targets of the EU and national level.

The programme focuses on the sectors of energy production and consumption, transport, community structure and land use planning, construction, waste management, agriculture and forestry. The climate and energy programme is taken into account in the ulterior regional strategies and programmes as well as in the regional smart specialisation strategy.

Based on the vision of an oil-free North Karelia, the region:

- is a carbon-neutral and over self-sufficient region in renewable energy production where fossil oil is not used in energy production;
- takes advantage of and develops the possibilities of the bioeconomy and is an international actor in the climate and energy sector;
- is known for sustainable development solutions that enhance the well-being of people and the environment; and
- is a region where municipalities, communities, companies and residents are aware of the climate change and mitigation actions and who are conscious of their responsibilities and possibilities in terms of climate issues.

According to the climate and energy programme the most significant impacts of climate change on forests are an increase in growth, changes in the tree species composition and the northward movement of southern tree species. Droughts, forest fires and the increase in storm and snow damage will possibly also result in an increase in insect damage and fungal diseases. The changes in the growth rhythm are believed to expose trees to frost damage. The forests of North Karelia are a large carbon sink, and the role of forests in the carbon balance of the region is important. Maintaining the current forest area is crucial for the reduction of greenhouse gas emissions in the region.

Climate change mitigation targets for forestry for 2020 according to the climate and energy programme:

- forests as carbon sinks – with good forest management, the growth of forests, the wood stock and options for utilising wood are enhanced;
- forests as a source of energy – the share of renewable energy from total energy production and use is growing rapidly and exports will increase; and
- the detrimental extreme events caused by climate change can be prepared for.

2.3 The current situation of forest bioeconomy and energy consumption in North Karelia

In North Karelia, the annual growth of forests is greater than the annual forest removals; the overall growth has risen to 9.3 million cubic metres. The annual roundwood loggings (Fig. 4) were 5.9 million cubic metres in 2016, which consisted mainly of pulp wood (57–59%) (Luke Statistical Services). Significantly lower logging volumes compared to growth of forests make it possible to increase the use of wood without compromising the economical sustainability of wood production. However, the scenario analysis produced for the Bio4Eco project by Luke points out a risk to the ecological sustainability of forests ecosystems and the carbon stocks of forests if the planned increase in wood utilisation will be realised.

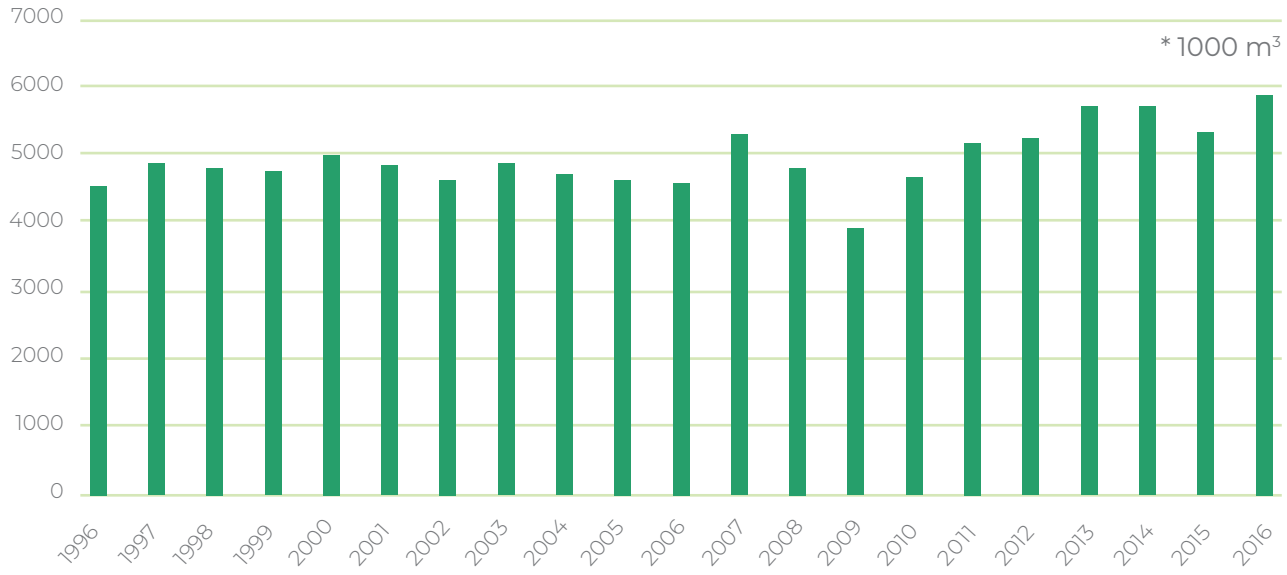


Figure 4. Roundwood removals in North Karelia during the last few decades (Luke Statistical Services).

Primary energy consumption in North Karelia in 2016 was approximately 11 800 GWh, which is a bit less than during the previous study done in 2014 (Itä-Suomen Energiatilasto 2016). The region is a pioneer in the use of renewable energy and, in particular, bioenergy: renewable energy accounts for 64 percent (2016) of the total energy consumption, which is high even on an international scale (Fig. 6). North Karelia is also a model region in energy self-sufficiency; approximately 62% of the energy consumed in 2016 was produced in the region. Wood energy accounts for the largest share of the region's primary energy consumption (Fig. 5).

The share of renewable energy sources from primary energy consumption declined by approximately two percentage points between 2014 and 2016 (Fig. 6). The reduction in fossil oil used for heating continued and was 505 GWh in 2016. Likewise, the use of wood energy declined slightly; its share in 2016 was 48%. Practically all of the municipal centres and the largest population centres in the region are heated by decentralised district heat that is mainly generated by wood energy.

The carbon footprint of North Karelian persons has decreased by approximately 2 tonnes CO_2 eqv during the last few years and it is smaller than that of the average Finn (Finnish Environment Institute, Hinku forum).

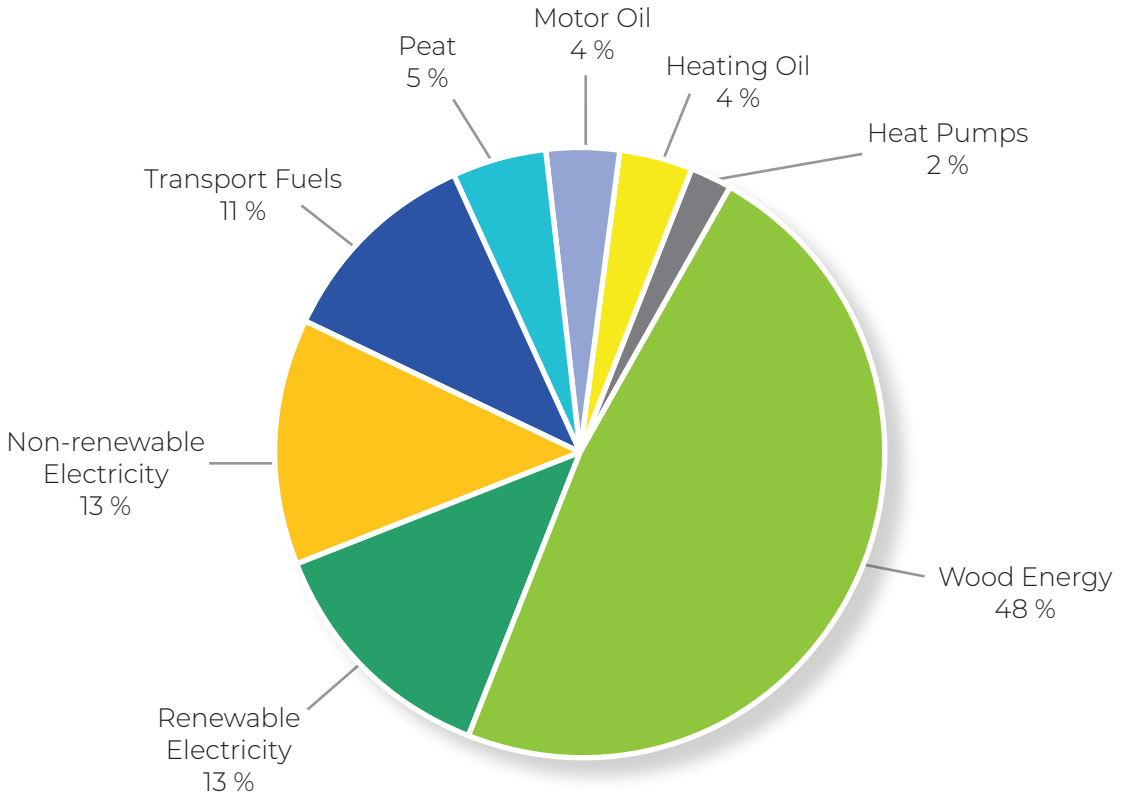


Figure 5. Consumption of primary energy in North Karelia 2016 (Itä-Suomen energiatilasto 2016).

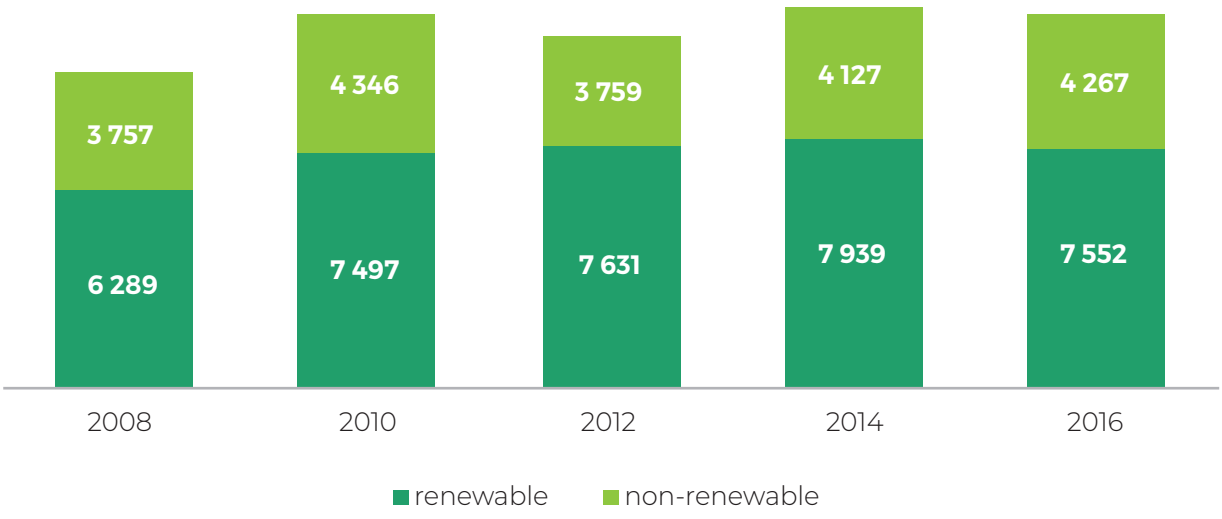


Figure 6. The share of renewable energy sources from total primary energy (GWh) in 2016 (Itä-Suomen energiatilasto 2016).

Finland's long-term goal is to be a carbon-neutral society and to reduce greenhouse gas emissions by at least 80% by 2050. The aims are, e.g. to increase the share of renewable energy up to 50%, to abandon the use of fossil coal, to halve the use of exported heating oil and to increase the share of renewable transportation fuels up to 40%. Eighty percent of Finland's greenhouse gas emissions are mainly from energy production and consumption (including transport).

North Karelia aims to be a fossil-oil-free region by 2030, and it is the first region in Finland to become a member of the Carbon Neutral Municipalities (HINKU) network. Nine out of thirteen municipalities in North Karelia have committed themselves to reducing greenhouse gas emissions by 80% before the year 2030 within their municipal borders. HINKU is a network for local climate actions where municipalities, business life, residents, research institutes and experts are looking for solutions to rapidly reduce greenhouse gas emissions. Greenhouse gas emissions in North Karelia have altogether reduced by 27% between 2007 and 2015, while the use of fossil fuels has been reduced by 34% (Fig. 7). North Karelia is characterised by decentralised community structures and long distances, which sets challenges for the decarbonisation of the transport sector because the transportation of goods and passengers is mainly conducted via road transport. The average age of North Karelia's vehicle fleet is over 13 years, and it modernizes slowly.

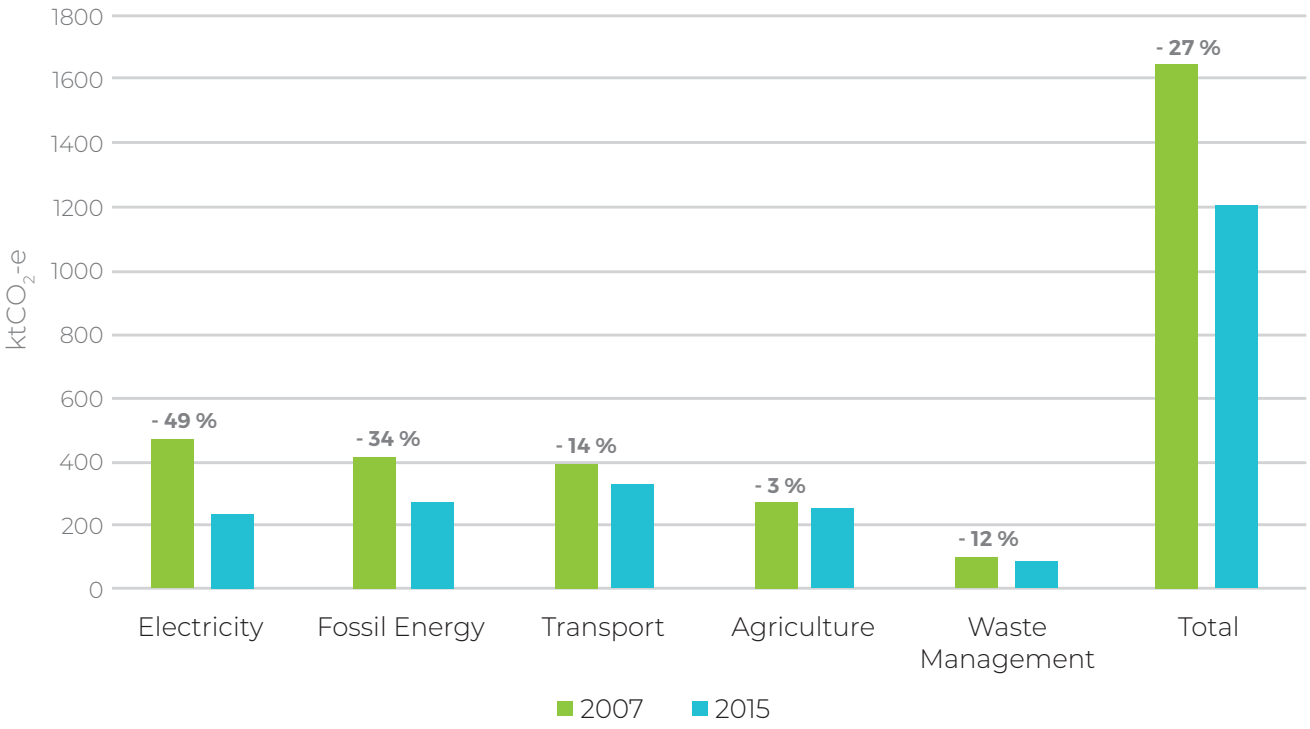


Figure 7. Greenhouse gas emissions in North Karelia, 2007–2015 (Finnish Environment Institute).

The latest follow up on greenhouse gas emissions and oil usage indicate that the actions taken to replace fossil oil in district heating and in separate oil heating boilers have been successful, but when it comes to transport and machinery (tractors, forest machines, cranes, etc.) there has not been sufficient progress (Fig 8). Thus, achieving these ambitious goals is dependent especially on these sectors.

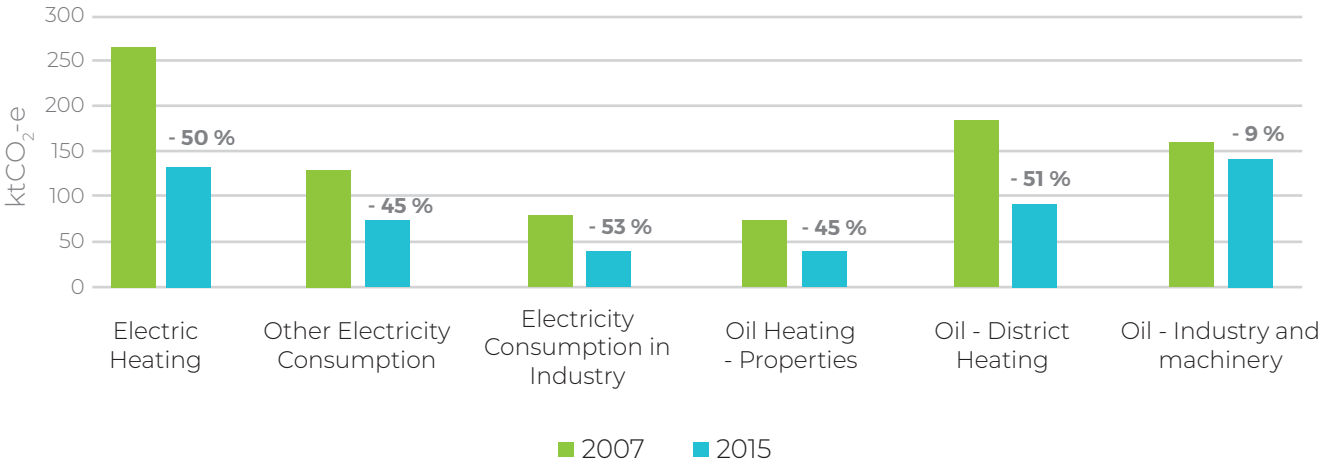


Figure 8. Greenhouse gas emissions from energy consumption in North Karelia, 2007–2015 (Finnish Environment Institute).

The Regional Council of North Karelia, together with the Finnish Environment Institute, has offered tailored support for municipalities and SMEs in North Karelia regarding energy efficiency, renewable energy or low-carbon solutions through the North Karelia towards Oil-Free and Low-Carbon Region project. The project has functioned as a coordinator of climate and energy-related projects and for energy and climate-related actions taken in North Karelia, and it was primarily responsible for the discovery process of the Roadmap towards Oil-Free and Low-Carbon North Karelia. Municipalities in North Karelia have invested in renewable energy production and in energy efficiency actions, for example in their district heating plants and in public buildings. The project has planned and organised two joint purchases of solar power units, which were addressed to residents of the North Karelian HINKU municipalities and private companies. The concept has spread to other areas in Finland, too, and it was chosen as one of the good examples for the S3 Platform on Energy.

2.4 Analysis of the current regional policies' pointed challenges in biodiversity

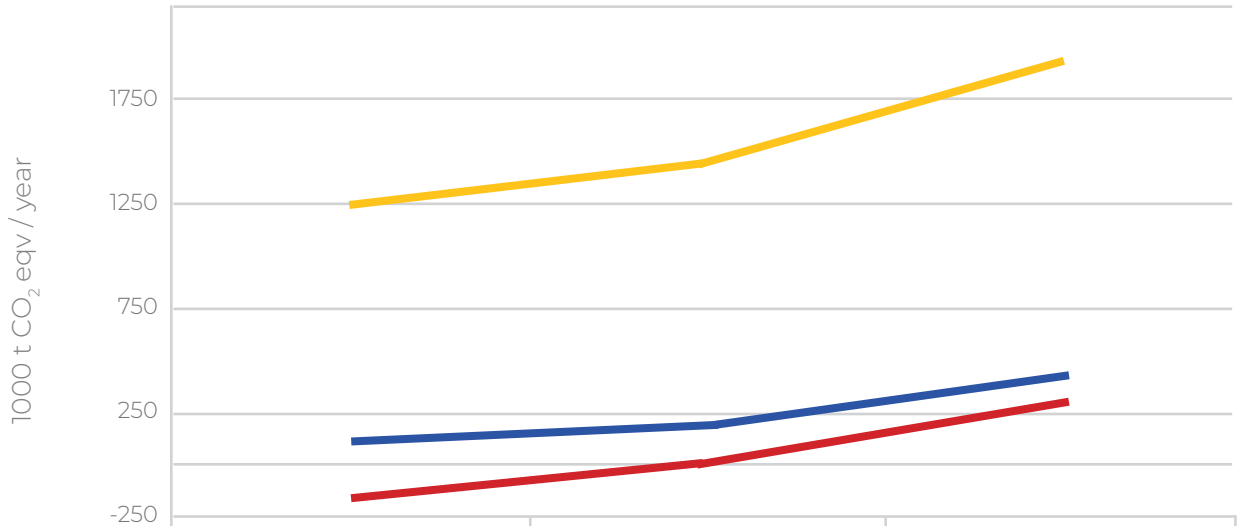
An analysis of the current regional policy instruments concerning forest bioeconomy in the region indicated that the biggest challenge towards increasing wood harvesting volumes in order to supply the raw material for forest based bioeconomy and achieve the goals for renewable energy had to do with combining the increasing harvesting volumes, ecological sustainability and biodiversity. In order to maintain the acceptability of wood procurement and the smart and positive image of the forest bioeconomy, a scenario analysis on how the increasing harvesting volumes affect biodiversity and the carbon stocks of the forests was made. The Natural Resources Institute Luke was selected to implement the scenario study.

The increase in the logging volumes (+1 million cubic metres/ year) used in the scenario analysis was based on the previous regional forest programme, which was also used on the basis of the Bio4Eco project plan. However, the current regional forest programme (2016–2020) aims to increase the harvesting volumes even more (+1.6 million cubic metres/ year), and the impacts on forests will thus be even greater than the scenario analysis suggests. Increased harvesting volumes are needed to secure material for the forest bioeconomy's current and upcoming needs. According to the calculations, increased harvesting volumes will not threaten the sustainability of the wood supply in the region (regional forest programme of North Karelia, Luke Statistical Services).

Many indicators used in the scenario analysis pointed out that increased harvesting volumes do decrease biodiversity (Fig. 9) and the carbon stocks (Fig. 10) of the forests compared to a situation where the harvesting volumes would remain at the same level as in recent years, at least for the next few decades. Bilberry is a so-called key species, one which indicates the success of many other species. The scenario analysis indicated that increased harvesting volumes reduce the bilberry crops and, thus, biodiversity (Fig. 9). By careful planning and selection of harvesting areas, the negative effects of increasing harvesting volumes on biodiversity can be minimised.

	VMI11	2016	2026	2036	2046
Other	6664				
Private	6209				
Current		12872	13451	13973	14174
Optimal		12264	11400	10454	9717
50/50		12381	11899	11363	11166

Figure 9. Bilberry yields during the next few decades in North Karelia. The column indicates bilberry crops divided by forest ownership in the region (private forest owners/ other forest owners). Yellow line = the current logging volumes, blue line = 1 million cubic meters increase in loggings, with loggings selected optimally, and red line (50/50) = 1 million cubic meters increase in loggings, of which 50% is log wood and 50% pulp wood.



	2016-2025	2026-2035	2036-2045
Current	1241,6	1442,8	1922,6
Optimal	116,9	185,1	429,7
50/50	-151,6	11,3	309,9

Figure 10. Carbon stocks in North Karelian forests during the next few decades. Yellow line = the current logging volumes, blue line = 1 million cubic meters increase in loggings, with loggings selected optimally, and red line (50/50) = 1 million cubic meters increase in loggings, of which 50% is log wood and 50% pulp wood.

3. THE VISION OF SMART FOREST BIOECONOMY STRATEGY

Vision of smart forest bioeconomy in North Karelia by 2025

Climate change aspects are taken into account in all development activities. North Karelia is an internationally recognised pioneer in smart forest bioeconomy, where wood and its side streams, non-wood products and ecosystem services of the forests are used and combined innovatively and efficiently, concentrating on decentralised bio-refining, wood-based renewable energy production and hybrid solutions. Resources from the region's forests are processed to make a wide range of high added-value bio-products and services for domestic and export markets. The region is an open and secure environment for industrial piloting.

Silviculture in the region is smart; it keeps the forests diverse, vital and healthy in order to adapt them to climate change and minimise its negative effects. Silviculture enhances efficient wood production, non-wood products, ecosystem services and carbon sinks while simultaneously maintaining and preserving biodiversity.

Energy consumption decreases due to the improvements in energy efficiency, while at the same time the share of decentralised renewable energy is increasing and its sources have diversified. Carbon is stored in wood products, and the region is a pioneer in wood construction.

Interfacial solutions and innovative co-operation models and networks strengthen the forest bioeconomy sector. Knowledge and research information is applied for the needs of business life, and the mobility and transfer of experts has increased. Digital forest data is collected and utilised innovatively. Education of forestry experts is secured at each educational level.

4. ACTIONS TO ACHIEVE THE GOALS

The actions to achieve the vision of the smart forest bioeconomy strategy in North Karelia by 2025 are classified and presented according to the region's areas of expertise with respect to the forest bioeconomy (Fig. 11) and the cross-cutting themes of the expertise areas (Fig. 12) based on the Regional Smart Specialisation in North Karelia (2018).

The Development Needs For The Region's Areas Of Expertise:

Forest technology and logging logistics

Local expertise is utilised to develop forestry machinery suitable for changing conditions.
Harvesting methods and machines are being developed for continuous cover silviculture.
Development and repair of the road and wood terminal network, utilising the possibilities of water-way transportation.

Forest information solutions and digitalisation

Innovative utilisation, collecting and further development of forest information and digital data and electronic materials, e.g. for different predictions, scenarios and climate change effect analysis.

Education for utilisation of digital data banks.

Multiple use of forests

Sustainability and innovative combining and utilisation of different forms of forest use, including ecosystem services. Preparing for climate change by keeping the forests diverse, health and vital; alternative forest management practices to secure ecological sustainability and multiple use of the forests.
Minimisation of environmental impacts in development activities.

Renewable energy production and wood construction

Promoting decentralised, renewable energy production. Developing and implementing hybrid solutions.
Promoting the wood industry, especially diverse wood construction.

Developing the energy efficiency of processes and buildings.
Developing the distribution network of renewable transportation fuels.

Distributed bio-refining

Investments to decentralised bio-refining.

Investments and development in small and medium size units.

New bio-based products

Developing forest-based transportation fuels.
Increasing the added value and diversification of wood products.

Wider utilisation and productisation of forest-based materials.
Developing natural products and their markets.

Figure 11. The actions classified according to the regions areas of expertise for the forest bioeconomy.

The Development Needs of Cross-border Solutions For The Forest Bioeconomy:

Networks & internationalisation

Internationalisation and promoting of networking operation models.

Transferring and applying knowledge and research information for the needs of business life; binding climate change knowledge to practical work solutions.

Increasing the mobility and transfer of experts from research institutes and educational organisations to companies.

Interfacial solutions

Innovative utilisation of the potential provided by interfaces offered by forest, photonics, cleantech and ICT know-how solutions.

Development of industrial symbiosis and co-operation between different operators in the forest bioeconomy field.

Deeper co-operation with business life, the public sector and the third sector.

Resource wisdom

Developing forest-based circular economy and its business models.

Investing in recycling, utilisation of side streams and sustainable use of natural resources (resource efficiency and waste minimisation).

Innovations

Developing references and innovation and service platforms, open testing environments, laboratory infrastructures and equipment for the forest bioeconomy.

Securing the operational preconditions of the RD&I cluster.
Developing and supporting innovation ecosystems.

The public sector as a platform for experimentation and growth.

Education and image

Securing the availability of skilled labour in the forest bioeconomy sector while taking the needs of business life into account.

Securing the positive image of bioeconomy by taking climate and nature values into account in wood utilisation. Emphasising the excellence of the forest bioeconomy cluster in the region.

Entrepreneurship

Climate change and its challenges as a possibility for innovations and new business opportunities.

Promoting heat entrepreneurship, favoring local wood fuel.

Taking the challenges of industrial development into account.

Figure 12. The actions classified according to the cross-cutting themes of the two areas of expertise of smart specialisation.

5. FOLLOW UP

Follow up for the smart forest bioeconomy strategy is linked to:

- the follow up on greenhouse gas emissions, which is performed by the Finnish Environment Institute's HINKU network;
- follow up on energy consumption, production and its distribution to different energy consumers and energy sources performed every two years (Itä-Suomen energiatilasto); and
- follow up on the Regional strategic programme – POKAT 2021.

Also, the following indicators for smart specialisation delivery in the region can be used for a smart forest bioeconomy strategy:

- turnover and exports of companies;
- knowledge-intensive new business generation;
- amount of external RDI funding; and
- RDI intensity in the region.

REFERENCES AND BACKGROUND MATERIAL:

Climate and energy programme of North Karelia: Pohjois-Karjalan ilmasto- ja energiaohjelma 2020- Paikallisesti – Uusiutuvasti – Vietävän tehokkaasti. 2011. Pohjois-Karjalan maakuntaliiton julkaisu 145.

Hinku – forum; Finnish Environment Institute: http://www.hinku-foorumi.fi/fi-FI

Itä-Suomen energiatilasto 2016. https://www.pohjois-savo.fi/media/liitetiedostot/julkaisut/ita-suomen-energiatilasto-2016-final.pdf

Luke Statistical Services 2018: http://stat.luke.fi/

Regional forest programme of North Karelia: Pohjois-Karjalan metsäohjelma 2016–2020. Suomen metsäkeskus. 2016.

Regional Stretegic programme: Pohjois-Karjalan maakuntaohjelma POKAT 2018–2021. 2017. Pohjois-Karjalan maakuntaliiton julkaisu 187.

Roadmap towards Oil-free and Low-carbon North Karelia by 2040: Tiekartta öljyvapaaseen ja vähähiiliseen Pohjois-Karjalaan 2040 - Paikallisesti – Uusiutuvasti – Innovatiivisesti. Pohjois-Karjalan maakuntaliitto. 2018.

Smart Specialisation in North Karelia. 2018. Regional council of North Karelia.

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