Forest bioeconomy in Joensuu region, Finland

The Bioeconomy term refers to the sustainable production and conversion of biomass into a range of food, health, fiber and industrial products and energy. There are diverse definitions of bioeconomy, but in every possible definition there is always a bio-based raw material to be used. It can be any biological material coming from forest resources (wood and non-wood resources), agriculture crops and its residues, and animal-based (including fish) as a product in itself or to be used as raw material. Bioeconomy includes the concept of circular economy where the materials loop is closed and wastes will be used to obtain energy or other products in order to achieve a high material efficiency. Also, at the end of the product life-time it should be possible to reuse it again to produce something else or used as energy source.

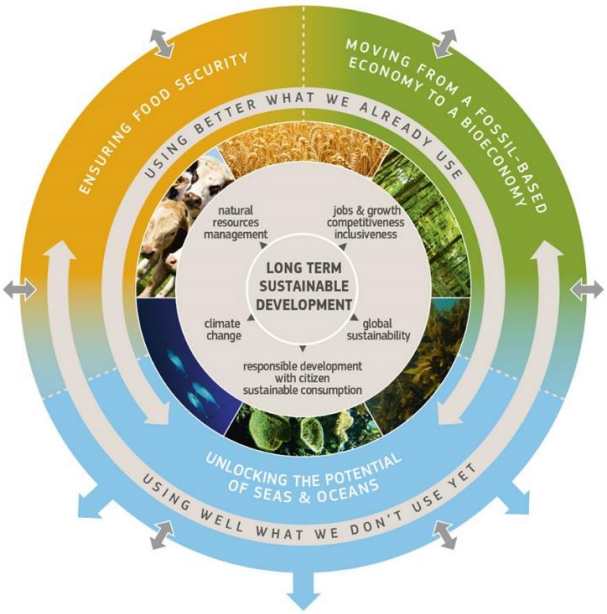

Figure 1: Bioeconomy. Source: European Commission

It is a movement from a linear economy based on fossil fuels to a circular economy developed under the renewable limits of the planet. This paradigm shift requires that economic growth does not have a negative impact on the environment, entire opposing, that nature and biological renewable resources are the engine and the main source of wealth in the economy. There are different fields addressed within the bioeconomy: green bioeconomy (forest), blue bioeconomy (water and fisheries), yellow (agriculture and farms), and bioenergy. Finland has strong foundation on forest-based bioeconomy as 80% of the land is covered with forests and has been a strong sector for its country economy.

The forest-bioeconomy is the sustainable utilization of forests in order to create products and services that allow economies to replace fossil-based raw materials for bio-based ones. It is the linkage between the whole forest value chain (including the management and use of natural resources) to the delivery of products and services while maintaining the sustainable use of forests and its biodiversity. European forests are the main providers of raw materials (wood and non-wood), bioenergy and cultural ecosystem services such as recreation activities and nature tourism.

The increasing population forecasts say that by 2030 the global demand of food, energy, and water will increase significantly. The sustainable solution to fulfill it seems that it will be the bioeconomy, as we are using many non-renewable materials in an unsustainable way such as oil, gas, minerals and so on.

Finnish bioeconomy goals

The Finnish Bioeconomy Strategy was adopted by the Government on May 8, 2014. One of Finland's purposes is to became a low-carbon, energy-efficient society, based on the use of renewable natural resources and recycled materials. The aim is to generate new economic growth (100 billion euros) and create new jobs (100000 new jobs) by 2025 in the different bioeconomy businesses, providing new high added value products and services while maintaining the sustainable use of natural resources.

In that way, the main strategic goals of the Bioeconomy Strategy are: to create a competitive operating environment, establishment of new business, a strong competence base related to bioeconomy, and accessibility and sustainability of biomasses.

However, the development of bioeconomy is a hot topic nowadays. For example, land use, land-use change and forestry regulation of European Union might affect the utilization of forest biomass as a feedstock under bioeconomy, which is crucial for Finland.

North Karelia Region, unique hub of natural resources expertise

The total population of the North Karelia region is 165 258 in 2014.
The number of municipalities is 13, of which 5 are towns. The regional capital is Joensuu, known as the European Forest Capital. Many forest related institutions are established in the city (European Forest Institute, Natural Resources Institute Finland). It is also known as University city, with the campuses of University of Eastern Finland and North Karelia University of Applied Sciences.

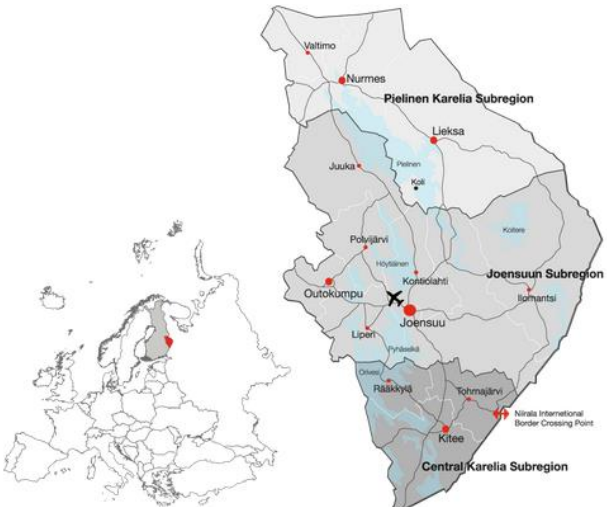

Figure 2: North Karelia Region map. Source: pohjois-karjala.fi

The region is known for its natural resources. The total area is 21,585 km^2, of which forests represents 70 % (15,000 km^2). The main tree species are pine, spruce and birch. The stock volume of the different tree species is about 170 million m^3: pine 95 million m^3, spruce 50 million m^3 and hardwoods 25 million m^3. The annual forest growth is approximately 9.15 million m^3 and the use of forests is 4.8 million m^3 annually. There are more than 2,200 lakes in the region, Pielinen being the largest one with an area of 894 km^2.

Forest bioeconomy is the most important sector in the region and employs about 6000 people in 500 different companies. The annual turnover of the companies in the forest sector is € 1.7 billion in 2014, with the goal of an increase in net sales of € 2.7 billion by 2025. Moreover, there are more than 600 experts (researchers, trainers, developers) working in the field of forest bioeconomy in the different related organizations (UEF, EFI, Luke and so on).

There are the ideal conditions to develop the bioeconomy in Joensuu as local authorities give support to the green development with different strategies. The Regional Council of North Karelia has different strategies such as "The Climate and Energy Programme of North Karelia 2020" (to implement the climate targets set out in the European Union and Finland), and Towards oil-free and carbon neutral North Karelia. Joensuu authorities also have a similar programme in the same direction "Carbon neutral Joensuu 2025" to reduce the greenhouse gas emissions, the energy demand by energy-efficiency actions, increase the use of renewable energy and reduce wastes in the city.

Different networks are created between the local and regional authorities, and the learning community of Joensuu area giving support and resources in the pave to develop these programmes. The new knowledge and advances are transferred and used by the companies established in the region to innovate and develop new products and services.

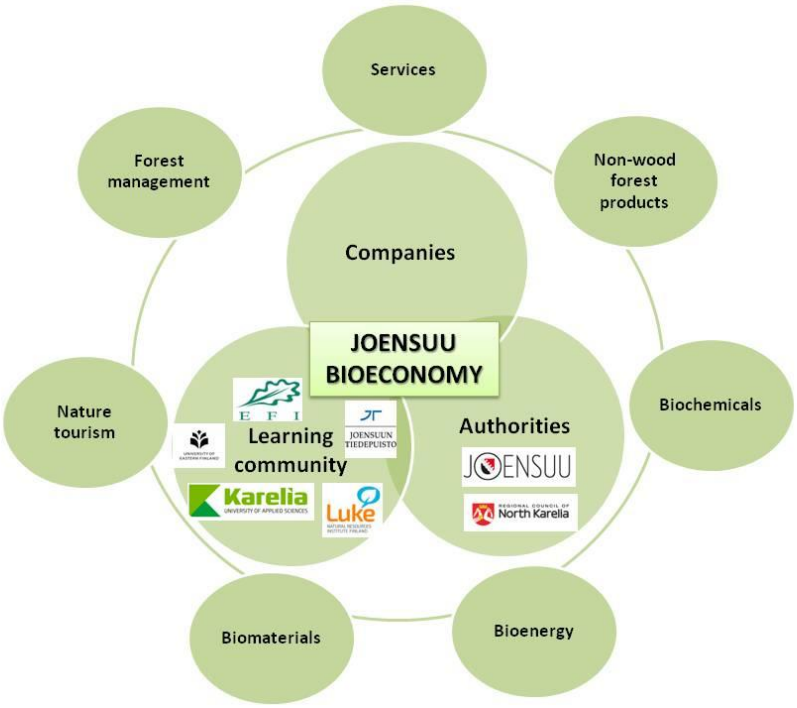

Figure 3: Networks in Joensuu's communtiy.

One example of this shared commitment in the region could be the Green HUB- Open innovation platform:

Green HUB consists of respected experts and experienced actors on forest bioeconomy located in Joensuu. The aim of Green HUB is to bring together experts and companies on forest bioeconomy to boost collaboration and harness newest research knowledge to

utilization of companies. In Green HUB action are involved Joensuu Science Park Oy, University of Eastern Finland, Karelia University of Applied Sciences, Natural Resource Institute Finland, Finnish Environment Institute, European Forest Institute, Finnish Forest Centre and Joensuu Regional Development Company.

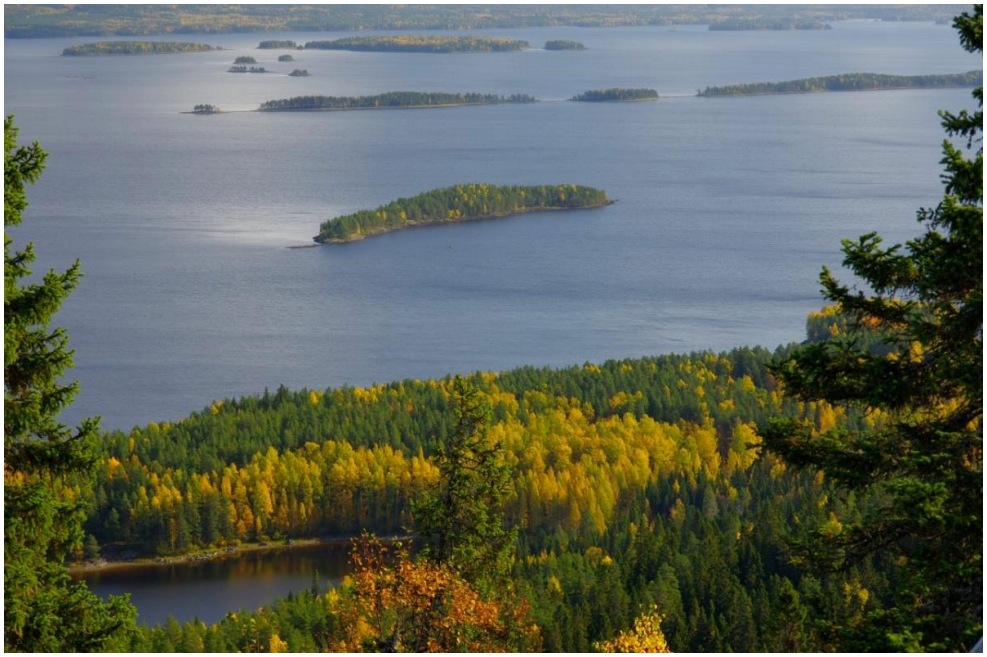

Figure 4: Koli National Park. Source: Wikimedia Commons.

Universities

Joensuu is a hub of expertise in several knowledge domains in Finland. University of Eastern Finland and Karelia University of Applied Sciences have their campuses in the city making it a perfect spot for many national and international students. That allowed the region to be at the forefront of global forest bioeconomy and ICT.

University of Eastern Finland:

From the bioeconomy viewpoint, the main strengths of UEF are the university's true multidisciplinary and the diverse expertise in the forest-and-wood based bioeconomy. Strategically, UEF's bioeconomy focus is on forests, wood and land use; the goal is to make a competence cluster formed in Eastern Finland by UEF and its partners, the most sought-after academic partner in bioeconomy research and education addressing forests, wood and land use in Europe. The goal is to make it as a part of everyone's studies because all the Units of University of Eastern Finland are affected by the bioeconomy somehow.

There are several MSc study programmes that can be considered as bioeconomy studies or are related: MSc in European Forestry, MSc in Finnish-Russian Cross-Border University (CBU), MSc in Environmental Policy and Law, MSc in Environmental Biology, MSc in Tourism Marketing and Management, Finnish University Network for Tourism Studies (FUNTS) and Wood Materials Science (WMS).

Faculty of Science and Forestry

The University of Eastern Finland is composed by four different faculties; one of them is the Faculty of Science and Forestry operating in Joensuu and in Kuopio campuses. The faculty comprises four departments (Physics and Mathematics, Applied Physics, Chemistry, and Environmental & Biological Sciences) and two schools (School of Forest Sciences and School of Computing).

The School of Forest Sciences is globally recognized as one of the important schools related to the study and research of forestry and environmental management. The activities of the School are in collaboration with different forestry-related networks at the national, European and international levels. Cooperation benefits with other institutions are another crucial aspect for the School. That is why there are many joint projects with the European Forest Institute (EFI) and Finnish Natural Resources Institute (Luke) which are very close to the university facilities. The studies offer goes from Bachelor's Degree (BSc in Forest Science), four international Master's Programmes (MSc in European Forestry, MSc in Wood Materials Science, MSc in Forestry and MSc in Translatlantic Forestry) to Doctoral Studies (DSc in Forest and Bioresources).

The main research themes are the ones that deal with forests and their important role in the society, specifically to the ones related on the environment and renewable natural resources. The areas of research are: forest ecology and pathology, forest management and ecosystem services, forest mensuration and planning, forest technology and energy technology, forest economy and politics, and wood science and technology.

Webpage: http://www.uef.fi/web/forest ; http://www.uef.fi//en/web/biotalous

Karelia University of Applied Sciences:

The Karelia University of Applied Sciences is proud to train skilled professionals to be part of the path to a great future, paved with skills and expertise. It offers many Bachelor's Degrees as well as different Master's Programmes and participates in many international programmes such as Erasmus+, Nordplus, FIRST. All students have the opportunity to work closely with local companies and with other educational institutions on exciting research and development projects. In the field of bioeconomy related studies the offer is the BSc in Forestry and MSc in Renewable Energy.

One of the focus areas of research is "Sustainable Energy and Materials" which aims are to give solutions on renewable natural resources and bioeconomy based sustainable energy solutions, and also increase the use of wood in construction and the use of wood based materials. Other aspects to promote are the energy efficiency solutions and nature conserving innovations.

Webpage: http://www.karelia.fi/en/

Science Park

Joensuu Science Park Ltd. was established in 1990 to offer high-quality facility services and business development services to support company growth in an innovative and developing environment. It develops business life in and around Joensuu, employs 24 people with an

annual turnover of EUR 8.2 million with more than 120 companies working in its facilities. There are diverse facilities for meetings and celebrations and facilities for lease. They support the development of different companies in the green sector and facilitate the establishment of new companies with the Start Me Up business idea competition:

Green growth: to encourage the development of green growth in Joensuu region and identify new opportunities. The development of green growth means smaller environmental loads, low-carbon development and resource efficiency. It can already be found in existing fields such as forest bioeconomy, ICT and photonics and there is the need to give support to these companies to help them growing.

Start Me Up business idea competition: the goal of this competition is to find and reward individuals and companies whose business idea has the potential to generate business in North Karelia. Eleven different ideas will receive support money to further develop their business projects. The first prize is EUR 15000 for and facilities in Joensuu Science Park for one year and the others ranges from EUR 1000 to 5000.

Webpage: http://en.tiedepuisto.fi/

Research institutes

- European Forest Institute (EFI)

It is an international organization, established by European States. Headquarters are located in Joensuu (Finland), and it has Regional Officies in Barcelona (Spain), Bordeaux (France), Vienna (Austria), Umeå (Sweden) and Freiburg (Germany). It has 115 member organisations in 36 different countries representing forest research and environmental institutions, industries and forest owners. The aims of EFI are conducting research and provide policy support on issues related to forests.

The Bioeceonmy Programme started in the beginning of 2017 and is the responsible for leading and developing the Bioeconomy Strategic theme. Other relevant units also give support to this theme. The Programme is divided in three main different areas:

- Sustainable bioeconomy: sustainability impact assessments.
- Future markets: study and effects of replacing current products for forest-based products.
- Software tools: to address the role of innovation and digitalization.

The successful development of the European bioeconomy depends on diverse questions as the international policy framework, technological and market developments, the global biomass demand and supply and the sustainable use of forests to preserve its biodiversity.

Another interest aspect for EFI is to study what can be the impacts in the markets when replacing fossil- based products for wood-based products. One example could be how wood construction can reduce environmental degradation. Wood use for construction reduces the

buildings energy consumption and CO_2 emissions of the construction products, avoiding high-energy demand processes such as iron and concrete production. It can also help to increase the material efficiency use and reduce the amount of waste generated while construction because the construction products are ready from the factory.

Webpage: http://www.efi.int/portal/

- Natural Resources Institute Finland (Luke)

Is a research and expert organization with knowledge in renewable natural resources and sustainable food production. One of its aims is to provide innovative solutions for new business opportunities based on natural resources. The institute is the responsible to carries out statutory government work such as monitoring the natural resources, plant production certification, inspection of control agents, storage of genetic resources, the production of data on greenhouse gases emissions and produce Finland's official food and natural resource statistics.

Luke is located throughout all Finland; it has four different regional units (Southern Unit, Eastern Unit, Western Unit and Northern Unit) with different research locations and experimental stations. Joensuu Unit is the central location of the Eastern Unit. There are six focus research areas: forest management planning, silviculture and the impacts of forestry on the environment, wood science and technology, forest technology, forest enterprise economics and international forestry. There are more than 100 employees working in the Unit, almost 70 of them are researchers.

The main topics of research are divided in four different programmes. These ones are the Boreal Green Bioeceonomy, Blue Bioeconomy, Innovative Foodchain and Natural Resources Economy.

The current most important and biggest programme for Luke is the one related to the bioeconomy known as "Boreal green bioeconomy". The aim is to promote the sustainable use of renewable resources in the fast development environment of the society. To achieve it there is the need to create new products, energy and services from the biomass raw material from the forests while maintaining its biodiversity. Its main focus areas are biomass production, resource-smart planning and decision making, harvesting and logistics, biorefineries and industrial symbioses, and bieconomy products, services and value chains. Thus, the focus of research is on what happens in the forests, the harvesting methods and how to improve all the related processes before the biomass arrive to the industrial production sites.

Webpage: https://www.luke.fi/en/luke-3/

Examples of bioeconomy companies

Bioenergy companies

- **Eno energy co-operative, district heating from local renewable forest resources**

Eno energy co-operative is a community-based enterprise located in Eno (North Karelia, Finland), it was established in 1999 by 12 local forest owners.

The owners of the co-operative are different local forest owners (54 at the moment). The main aim is to produce heating energy by providing wood chips for the district heating plants using local energy wood. Members provide about 20-30% of energy wood and the other 70-80% is acquired from different providers. One example, they have an agreement with Joensuu municipality to get some fell city trees that are suitable for obtaining wood chips. The raw materials used are small trees by manual felling (15%), by multi-tree processing (70%) and logging residues (15%).

The most distinguishable characteristic of the co-operative is the local approach which is always the central view of all its activities. It is a *win-win* approach for everyone, not just for its members but also in terms of energy wood procurement and other related services. There are many local benefits such as, inexpensive heat for customers (municipality building and private customers had saved without taxes about 4.1 M € during 15 years compared to light fuel oil), local forest owners are able to receive income from their wood, wood harvesting companies receive orders from forest owners to manage the growth of too dense small-diameter young forests, net carbon dioxide emissions are reduced because imported oil is substituted by renewable forest chips (5 M kg annually) and local networks are created. In addition, all employment effects of using the forest chips at this consumption rate are between 7-10 man-years.

The co-operative is responsible to run three heating plants: Alakylä (bio boilers 1.2 MW_{th} + 0.8 MW_{th}), Yläkylä (0.8 MW_{th}) and Uimaharju (1 MW_{th} + 1 MW_{th}), and about 11 km long district heat distribution network to satisfy the customers demand in the local community. The annual turnover is around 1,2 million euro. Next summer they will add a 15 KW solar panels system to cover part of electricity demand of the heating plant of Alakylä.

Webpage: http://enonenergia.fi/node/6

Services companies

- **Forestland Investment Finland Ltd.**

Forestland Investment Finland Ltd. (i.e. Suomen sijoitusmetsät Oy) was established in 2013 to offer consultant services for investors in the forest procurement, as a leading expertise company in the acquisition, management and valuation of forest properties in Finland. There are seven employees working in the company and the annual turnover was roughly 1 million € in 2016 with around 200 forestland property purchases by their clients. In the beginning, the business activity was only focused in North Karelia Region but quickly expanded its business activity to the whole country.

Its market price prediction tool based on the sales comparison approach is used to compare the price of the target forestland property to the purchase prices of its comparables in different parts of the country (Southern Finland, Central Finland, Northern Finland and Lapland). The comparables for the target property are selected using different characteristics such as volume of timber, development classes, percentage of peat lands and fertility of soil, to name of few. Different broker sites are monitored by the company to collect the new properties available in the market, and currently more than 1600 new properties per annum are added to the data base based on a systematic collection and analysis of sold forestland properties. Only properties with the forestland area of 10 ha or more are accepted for the database. It already has more than 4500 sold properties added to the data base, and of these properties almost 2600 forestland properties are classified as representative for the sales comparison and estimation of parameters of the market price prediction model.

The goal is to provide easy, secure and profitable investment in the forest sector as the interest in forest placement has grown steadily in recent years. Unsteady stock prices and low interest rates increase institutional investments in real property. The average annual real rate of return for forestland investments is between 3.5 and 4 % even though some investors are willing to reach 5 %. Forestland Investment Finland Ltd. manages on behalf of the investor a choice of space for all the objectives from the selection to holistic asset management. The services offered will depend on the client's needs and can include the procurement, management, valuation and information production services.

Webpage: http://www.sijoitusmetsat.fi/

Forest management companies

Vallius forestry

Vallius Forestry was established in 2015, but it already had customers using their products for longer while, being very satisfied. Sells and commercialises innovations and technology for the forestry and bioeconomy branches and provide expert services in business management. At the moment, there are 5 people working in the company, and big amount of people supporting them. In addition, the production is outsourced in North Karelia so there are dozens of more people. The aim is to increase sales dramatically heading into millions of Euros in coming years. The clients so far are in Finland, Sweden, United Kingdom, Ireland and Germany but many more to come in near future.

The product offer is meant to improve dramatically the work in forestry, using the most reliable materials in the market to increase the efficiency and reduce the time needed for forestry works.

Cutlink was originally developed for forestry thinning and preparations before harvesting but soon it was noticed that it is also very useful additional option as swing damper. The slowly rotating screws, Cutlink motors and other parts do not suffer of heavy usage which extends clearly the lifetime. Slow rotation (does not throw rocks to the machine the operator is using) also means safety and silence: good to be used in municipalities and it is also a really good solution for long lines such as road and railroad sides, power lines, even some plantations and wet areas such as river sides and damps.

Flowlink is used for harvesting and material handling much faster thanks to the stable movements with the automatic brake control system. Loading the truck can be made 20-40 % faster compared to other solutions. It is possible to use in any forestry machine or application that uses the same link.

The future plans are bringing new features to both products and Finnish state is strongly supporting it in these development projects.

Webpage: https://valliusforestry.com/

Biomaterials companies

- **Kupilka, eco dishware & knives**

Plasthill Oy, the manufacturer of ecological Kupilka® products, was established in 1996 in the forests of Pyytivaara, Eastern Finland. Since the beginning, environmental values have been a cornerstone for the company, being applied in all their products and production processes. In fact, Plasthill was the very first Finnish company to start using green electricity in all its production in 1998. There are currently eleven employees working in the company and the annual turnover is around 1 million €.

The company manufactures its own standard and customised biomaterials with wood-based cellulose fibres coming from the certified Finnish forests. Kareline® biomaterials are being used to give the special qualities also for Kupilka® products, consisting of 50% wood-based cellulose fibres and 50% polypropylene. The products are sold worldwide and the target for the upcoming years is to increase the presence in markets like Japan, USA, Canada, Sweden and Germany.

The head designer of the Kupilka® range is Finnish industrial designer Heikki Koivurova. The options go from Kupilka® outdoor dishware such as cups, bowls, plates and cutlery to Kaarna® service trays, which are the perfect choice for serving bread, fruits and cheeses. Kupilka® products are available in four different colours. The products are eco-friendly, long lasting and at the end of their life span they can be recycled, burnt or returned to the manufacturer for re-use.

Innovating and constantly improving is a sign of identity for the company, and the next commitment is to increase the bio-based content of Kupilka® products to 80 % by 2050, replacing part of the oil-based materials used nowadays. The newest product available in the market is a bigger special edition cup celebrating the centenary of Finland's independence.

Webpage: http://kupilka.fi/en

Other companies in the region

Sector	Company	Main activity	Webpage
Forest management	Arbonaut Oy	Provides highly tailored service and product solutions. GIS, remote sensing, spatial information to fulfil the clients' needs.	https://www.arbonaut.com/en/
	John Deere Forestry Oy	Forest machinery and harvesters to facilitate the forestry works	https://www.deere.fi/fi_FI/regional_home.page
	Kesla Oyj	Is a manufacturing corporation specializing in the design, marketing and manufacture of forest technology.	http://www.kesla.fi/frontpage/
Biomaterials	Stora Enso Enocell Oy	Produces softwood pulp (pine and spruce) and dissolving pulp from birch. The dissolving pulp is mostly sold for textile applications.	http://biomaterials.storaenso.com/about-us/enocell-mill
	UPM Joensuu Plywood Mill	Birch plywood for the transportation and distribution industry	http://www.wisaplywood.com/Pages/default.aspx
	Arcadia Oy	Wood construction	http://www.arcadia.fi/
	Aatelitalot Oy	Log houses construction. House packages are tailor-made to suit your needs	http://aatelitalo.fi/
	Liperin Ikkuna Ky	Produce custom made windows and door products with your desired dimensions, colors and accessories.	http://liperinikkuna.fi/
	Iivari Mononen Group	Customer-oriented provider of product and service solutions for electricity and telecommunications networks.	http://www.iivarimononen.fi/en/
	Lunawood Ltd	Lunawood thermowood, wood material produced by using heat and steam. Thermal modification improves the wood's properties.	http://www.lunawood.com/thermowood/
	Flaxwood Guitars	Flaxwood is an innovative new tone material. Created by breaking the grain structure of natural wood and injection-molding it into shape together with an acoustically sensitive binding agent.	http://www.flaxwood.com/home/

Sector	Company	Main activity	Webpage
Non-wood forest products	Nordic Koivu Ltd	Produces high-quality birch sap and research on utilising it as a raw material for the food, drink, and cosmetics industries.	http://www.nordickoivu.com/index.html
	Hermanni Winery	Produce high quality sparkling wines, wines, liqueurs and spirits made of natural and aromatics Finnish berries.	http://hermannin.fi/en/home:language/en
Bioenergy	Vapo Oy	High-quality wood pellets suited for use in smaller properties as well as large combined heat and power plants	https://www.vapo.com/en
Biochemicals	Fortum	Produce advanced high value lignocellulosic fuels, such as transportation fuels or higher value bio liquids	https://www.fortum.com/frontpage/com/en/?from=irene
Services	Sisu Auto Oy	Product development and production of trucks	http://sisuauto.com/
	Kolo Design Oy	Design and manufacture stylishly practical products for real needs. Ecological Finnish design.	https://www.kolodesign.fi/
	Total Design Oy	Finnish design for many products. Both commercially and technically innovative product or services.	http://totaldesign.fi/
Nature tourism	Koli Activ Oy	A versatile firm that produces nature, activity, café and restaurant services	http://www.koliactiv.fi/english