

Feasibility study of lignin side-flow applications in Kainuu, summary of results and recommendations

**BRIDGES, 7th IPL
PP2, Regional Council of Kainuu
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Lignin feasibility study summary



- **Purpose:** to identify cost efficient lignin-based investments for Kainuu region.
- **Optimisation question:** to identify optimal types of lignin applications aligned with the supply and quality potential of (primarily) Kainuu lignin suppliers & Finnish users (i.e. large businesses operating in Finland and utilising lignin).
- **Findings:** The recommendations are organised into short term and medium term options. The short term options focus on lignin production and processing investments, and the longer term options relate more to development projects. The latter includes also research and training of entrepreneurs and sector-experts. For detailed review of the recommendations.
- **Period of implementation of the feasibility study:** 1.10.2017 deciding the focus & study expectations – 30.4.2018, delivery of the final feasibility study
- **Good practice (-s) reference:** 1) Centre of Expertise Biobased Economy (COEBBE), Netherlands and 2) The Bioeconomy Science Center (BioSC), Germany.
- **Funding / financing:** Structural funds, regional funds, private funds.
- **Action plan take up:** 1) Agree lignin operator in Kainuu (lignin processing) and investment terms (include FDI options); 2) Agree lignin supplier investments concept and criteria for nation-wide calls; 3) Agree the concepts of the development projects and the associated criteria and budgets, to include into the action plan (coordinator of this multi actor project will be Kainuun Etu).
- **Acceptance of the feasibility study (RSK session):**

Lignin FS, Next steps

- 1) Selection, which ones of the recommendations we accept, where we shall put efforts including funds and financing

- 2) Way (-s) to realise the selection: investment and project partnerships identified and discussed; listing of possible resources, regional, national, and further

- 3) Objective: by end of August a plan (what, who, how, how much, when) to be outlined and key partnerships agreed.

- 4) Challenges we anticipate.

The lignin challenge

Figure 1 Current lignin types, the most potential applications, and their values are shown [Gosselink 2011].

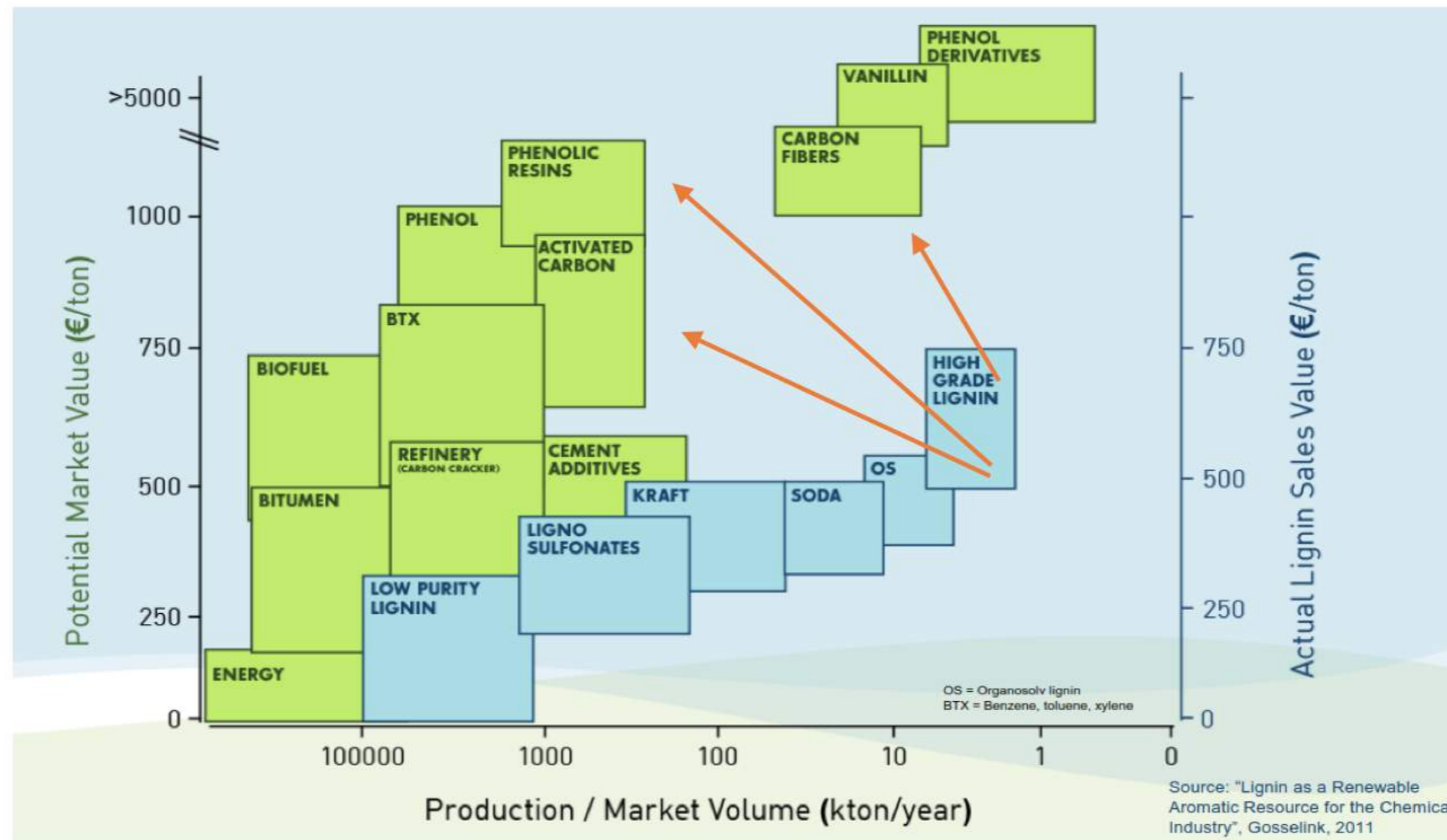


Figure 1 Lignin types and possible products. Blue boxes indicate lignin types and green boxes possible products [Gosselink 2011]. The most potential applications for high quality lignin (relevant to Kainuu) are *activated carbon, phenolic resins, especially adhesives and carbon fibers* (arrows with orange in Figure 1).

1) Lignin in the world

2) Lignin in Kainuu

The most potential lignin applications for Kainuu are resins (especially adhesives), activated carbon and carbon fibers. However, there are no products yet which have been completely made from lignin. Some research and testing is still needed. Only immediate utilisable application for lignin is still energy production.

Key challenges of the lignin markets

The development of lignin markets and applications faces several challenges. The challenges with new material are greater than the challenges with a new product. They must be well understood so that they can be overcome.

1. Proof of concept: Does the material do what it is supposed to do? Is there enough test data to demonstrate performance results?

2. Economics: Is there a real business case, a solid value proposition?

3. Funding challenges: Much R&D is needed, and R&D is expensive and time consuming. Besides lab-scale research, long-term piloting is needed to get evidence of concept. From where will the funding come? Who is willing to invest?

4. Market development: Market is still limited for the most of applications. For lignosulfonate, a range of applications are pretty well-developed, with 1 million tons of commercial lignin. However, for kraft and biorefinery lignins, considerable work needs to be done in applications testing and development.

5. Scale upping: The amount of investment going from lab scale to commercial scale, increasing production in e.g. 100 times, is clearly greater than the investment needed to get initial lab output. Scale-up issues apply not only to production, but also to applications. This requires further investment. The same can apply further down the value stream. It is rarely a "drop in" product that simply replaces another material with no change to the customer process.

6. Competitive materials: Novel materials may seem to be unique specialties, not having direct competition. However, there are always competitive materials. The potential applications for lignin and lignin-based materials are currently being satisfied by other materials. For customers to switch to a new material, and possibly invest capital to adjust their process, the business case must be attractive.

Lignin knowledge resources in Finland

Expertise and infrastructure related to bio-economy is available at many universities and research institutes in Finland. Lignin utilization is closely linked with bio-economy concept. Some of the recognized faculties/research units in this application area are as follows:

- Aalto University, School of chemical engineering, Department of Bioproducts and Biosystems;
- University of Oulu, Faculty of technology, Environmental and Chemical Engineering research unit, Fibre and Particle Engineering research unit, Sustainable Chemistry research unit;
- University of Eastern Finland, School of forest sciences, Wood science and technology research
- Tampere University of Technology, Chemistry and Bioengineering, Bio and Circular Economy

VTT technical research centre of Finland Ltd is leading lignin related research institute in Finland. VTT is developing bio-based adhesives based on lignin and new lignin dispersions and colloids which are useful in material applications. In addition, VTT is actively studying thermoplastic lignin composites. VTT is engaged in various national and international lignin related research programmes. Luke (Natural Resources Institute Finland) is strongly associated with bioeconomy research. Luke's one research programme is the Boreal Green Bioeconomy. The research programme aims to create new bio-based products and business opportunities.

Lignin users in Finland

Table 4. Big Finnish companies that may have an interest in lignin utilisation.

Companies	
UPM (1,2,3)	Pöyry (5)
Stora Enso (1,2,3)	Andritz (4)
Metsä Group (1,2,3)	Borealis (3)
Metsä Fibre (1,2,3)	Fortum (2)
Kotkamills (1,2,3)	Tikkurila (2)
St1 (1,2,3)	Neste (2,3)
VAPO (1,3)	Neste Jacobs (2,3)
Valmet (4)	Kemira (2,3)

Investment recommendations

Table 5 Investment recommendations for lignin (prioritised order).

Short term investments for lignin - investment type	Possible lignin suppliers	Size of investment – cost estimate/ maturity level	Competence needed
1.(White) pellet production -new/ extension/ modifying investment depending on the existing facilities	St1; Local energy producing companies, e.g. Kainuun Voima; Local pellet manufacturers e.g. M- Pelletti in Kuhmo, Finnish Pellet Group Kajaani Ltd; Vapo; in the longer run: biorefinery (Kaicell Fibers)	- 5000 tpy - Less than 1 million euro for capacity of 5000 tpy (1) - business plan for the biorefinery needed	No special training/ education needed to adopt technology if pellet producers involved
Medium term investments for lignin (within 3 years)- investment type	Possible lignin suppliers	Size of investment - cost estimate/ maturity level	Competence needed
1.Technical carbon, especially activated carbon production -new investment	St1; Other lignin producers in Finland; Vapo; Activated carbon producers in Europe e.g. Jacobi Carbons, activated carbon utilizers e.g. Kemira	Lab scale testing going on, cost estimate around 10 million euro for capacity of 5 tpd (2)	Skilled labor is needed to operate actions
1.Phenolic resins (adhesives) production -new investment	St1; Adhesive manufacturing companies in Europe (e.g. Henkel)	Lab scale testing going on, no cost estimate yet	Skilled labor is needed to operate actions

Development project recommendations

Development project recommendations- type of project	Possible partners/actors, lignin suppliers and users	Duration/cost	Expertise/Education needed
1.High quality lignin utilization as macromolecule (especially as an adhesive)- Research project	St1; Lignin producing companies in Finland; VTT; LUKE; relevant research units at universities, adhesive manufacturers, adhesive users (e.g. CrossLam Ltd in Kuhmo), Resin manufacturers, e.g. Momentive Specialty Chemicals Ltd in Kitee, Kaicell Fibers	1 year, 100-300 k€ (Costs are dependent on amount of applications) - business plan for the biorefinery needed	Scientific expertise needed, Several projects going on at VTT and at many universities Transfer of competences to local businesses, additional projects can be organised.
1.High quality lignin based activated carbon development project - Research project	St1; Lignin producers in Finland; VAPO; Relevant research units at universities (e.g. chemical and environmental engineering unit at UO); Activated carbon manufacturers/utilizers	1 year,around 300 k€ (Costs are dependent on workload and number of partners)	Scientific expertise needed, activated carbon related research is going on at many universities. Introduction of the uses of high quality lignin locally and transfer of competences to local businesses, additional projects can be organised.
1.High quality lignin-based carbon fiber development project- Research project	St1; Lignin producing companies in Finland; VTT; relevant research units at universities	1-3 years, around million euro	Scientific expertise needed, VTT is a strong player in lignin-based carbon fiber research in Finland, involved in several projects Introduction of the uses of high quality lignin locally and transfer of competences to local businesses, additional projects can be organised.
1.Black pellet production -Business development project	St1; Technology licensors e.g. Valmet, Arbaflame, Zilhka, Solvay; Energy producing companies, e.g. Kainuun Voima, Fortum; Local pellet manufacturers e.g. M-Pelletti in Kuhmo, Finnish Pellet Group Kajaani Ltd; Vapo	Pilot scale testing going on, costs expected to be more than in the case of white pellets	Minor training/ education is needed to adopt technology Introduction of the uses of high quality lignin locally and transfer of competences to local businesses, additional projects can be organised.

Berry renewal feasibility study

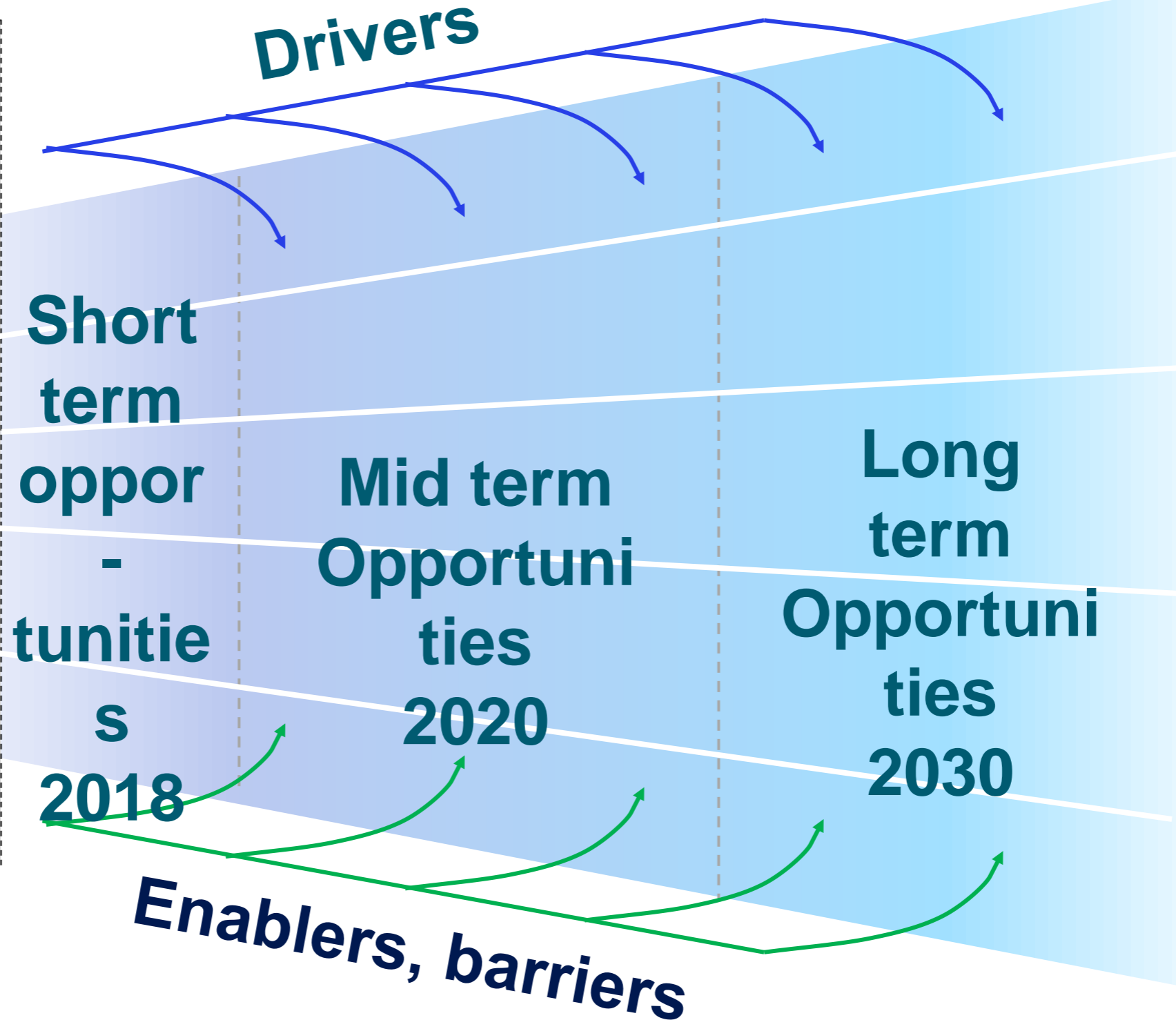
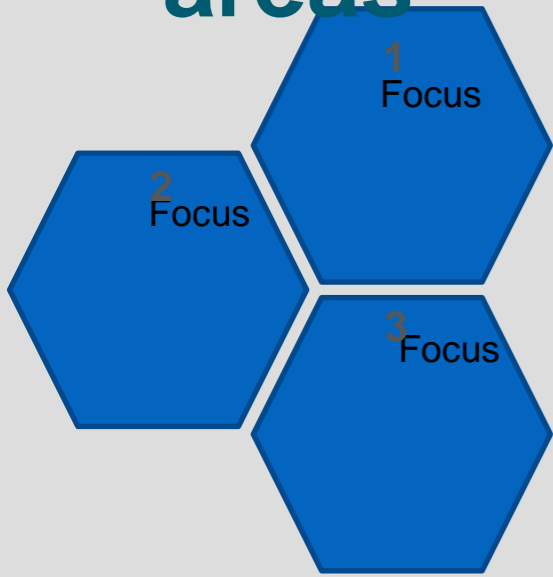
- **Purpose:** to renew the berry industry of Kainuu towards
- **Optimisation question:** Expanding regional economic base to the potential of a new industry with strong research & innovation potential.
- **Kainuu challenge:** strong resources, considerable knowledge base, weak productive base.
- **Strategy we selected:** The focus is on two actions, two components: investments & the BERRY+ industrial modernisation S3 platform
- **Findings:** In process; we had delayed start for reasons beyond our control, now the process has re-started
- **Period of implementation of the feasibility study:** June- July 2018
- **Good practice (-s) reference:** S3 platform
- **Funding / financing:**
- **Action plan take up:**
- **Acceptance of the feasibility study (RSK session):**

Berry industry renewal FS, Next steps

- **Berry industry investments:** types of investments and / or entrepreneurship initiatives that will be finally recommended.
 - **Mapping of potential:** questionnaire & desk research
 - **Discussions with businesses**
 - **First round of findings:** Mid June 2018
- **BERRY+:** Application to the S3 Industrial modernisation platform
 - **Interregional partnership:** To make the application we need three countries (Member States) at least are required. We have now confirmed two (both from BRIDGES) and we are negotiating with four more (all of them outside the BRIDGES partnership).
 - **Process:** the S3P concept will be clarified (first round of data collection on going, KE) and the industrial modernisation platform will have a predominant theme; the expert (LUKE) will formulate the BERRY+ theme; letters of commitment to be signed by regions and organisations within the regions.
 - **Deadline:** the application will need to be submitted by 30.9.2018

Feasibility study on berries

3 Focus areas



Willing and Able to Grow! Kainuu Region is a good place to live in and attractive to visit (Kainuu RS 2018 -2021)



Enterprises and Know-how

Tourism, technology industry, bio economy, sustainable mining



Improving Accessibility with new Transport Solutions

Room to breathe

Effective cooperation on regional, national and international levels



Well-being Deriving from Work, Health, Nature and Community

Easy everyday life



Enjoying a Positive Reputation

The regions' strengths result in the amount of investments, tourists and new inhabitants

Sustainable growth

Know-how

Digitalisation

Internationality

Equality

Values: Positivity and encouragement

Optimising the possibilities throughout the region

SMART SPECIALISATION (*RIS3*) CHOICES OF KAINUU REGION 2018-2021

TECHNOLOGY INDUSTRY INNOVATIONS:

1. Measurement technology
2. Games & simulators
3. Metal industry innovations

BIO ECONOMY & MINING INNOVATIONS:

1. Process and environmental monitoring of industry
2. Forest & blue bio economy & food

HEALTH & WELBEING INNOVATIONS

1. Activity tourism
2. Health, physical training and sports

CROSS-CUTTING THEMES AND GOALS ON ALL RIS3 PRIORITIES:

1. Developing Key Enabling Technologies (KETs)

2. Utilisation of robotics, automation, data centres, data analysis, artificial intelligence & virtual reality

3. New solutions and applications of circular economy

4. Innovations in resource efficiency, decarbonisation and climate change mitigation & adaptation



**INVESTMENTS, NEW ENTERPRISES, KNOW-HOW AND TECHNOLOGY TO THE REGION,
INCREASING VOLUME AND ADDED VALUE OF PRODUCTION AND EXPORT**



Kainuu RIS3 2018 - 2021

- The approach of Kainuu Smart Specialisation strategy differs from the traditional development activities of regional spearheads of economic activities by its choice to emphasize high level of know-how, as well as research and innovations and the supporting educational activities. The spearhead fields in general are developed as an entity covering everything from the basic know-how needed to excellence and the infrastructure related to activities.



- **Quadruple Helix** cooperation
- **Cluster-based development** (wood industry is developing to industrial cluster, mining industry will be formulated to industrial cluster etc.): formulation of business ecosystems where companies & research units have potential for RDI co-operation



“Bridges Model” of fostering RIS3 implementation:

- FS studies (forest bio-economy: wood industry, chemical forest industry, berries) – business models for production side-flows & commercial trends utilisation
- Recommendations for Bridges Action Plan implementation and also to AP of regional strategy of Kainuu 2018 – 2021
- Modelling the research-to-business approach, 1) collect industry-related excellence, 2) pre-assessment of industry absorptiveness (regional stakeholder sub group), 3) express the optimisation question = feasibility study concept, 4) implement the feasibility



Kainuu RIS3 2018 – 2021 implementation

- Fostering implementation via active participation to Commission thematic RIS3 platforms:
 - ClusSport (Kainuu is partner region in ClusSport platform – sport related RDI & innovations & business growth: Partnership's Vision statement "The Sport Partnership aims to support EU regions committed to generate a pipeline of business investment projects in the sport sector" Partnership's Rationale statement: "Following a bottom-up approach - implemented through interregional cooperation, cluster participation and business involvement as well as aligning specialization profiles of the partner regions" see: <http://s3platform.jrc.ec.europa.eu/sport>)
 - NSPA regions initiative for an arctic RIS3 platform
 - S3 Platform for bioenergy (Bioenergy & renewable energy partnership)
 - S3 Platform for berry industry on planning stage



- **Pilot Action on Industrial Transition in North East Finland**

Main elements:

- National or regional authorities (NUTS 1 or 2) willing to work on the basis of their respective S3 in order to promote broad-based innovation to address the challenges of industrial transition
- Focus on more developed and transition regions
- 12 regions/countries selected (2 calls); coordinated by Lapland

Objectives:

- Develop a comprehensive strategy for regional economic transformation building on their smart specialisation strategy, clusters and digitisation of industry plans
- Identify where possible collaboration and funding opportunities at European, national and regional level
- Link with other regions in regional and cluster partnerships
- Focus on mutual learning and sharing of good practices in innovation policy implementation, governance and monitoring
- Test new approaches in industrial transition and provide evidence to underpin post-2020 policies and programmes



- Business ecosystems are built around leading companies or other industry leaders
- In the field of forest bioeconomy:
 - **Kantola Woodpolis industrial area and cluster in Kuhmo (wood products industry):**

Turnover approx. 100 M€, 12 companies and approx. 250 jobs.
By 2020, the goal is to create 50-70 more jobs and increase the turnover by 70-100M€ and start 4 new companies.
 - **Renforsin Ranta Business Park in Kajaani** (approx. 30 industrial and service companies and companies in growth industries like forest bioeconomy, data centre ecosystems and services/operating environment, with 600 jobs).

Noteworthy investments are made at Renforsin Ranta related to mechanical wood processing and the forest bioeconomy business ecosystem is developed around ST1. The professorship and research group related to modern bio refining/ Kajaani University Consortium MITY unit.
 - The future bio refinery investment in **Paltamo (KaiCell Fibers)** will from the start adopt a BioFutureFactory™ business ecosystem model, in which utilising side flows is essential.
 - The business ecosystems of forest bioeconomy aim at creating new business and comprehensive RDI cooperation to the whole Kainuu region (**The Kainuu Forest Bioeconomy Business Ecosystem**)