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**The
Bioeconomy
Research
Programme
2018–2020**

March 2017

About this proposal

This proposal is intended to focus the customer interaction process. We encourage any feed-back and suggestions for improvement or suggestions for areas that you would like to include in the programme proposal. The Application-oriented research projects are meant to be finalized after an intense “market-pull” with our customers and some of them are briefly described. However, in some proposals there has already been an intense discussion and they are a bit more detailed but that is not to prevent more interaction.

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Timetable 2017

- Customer feed-back meetings: late March–early May
- Revised proposal to customers: June 7
- Answer on interest from customers: September 15
- Consortium building: October–November
- Priority meeting with Steering Boards: late November–December



The bioeconomy is on the rise

Using research to navigate into the bioeconomy

A new economy is on the rise – a bioeconomy. Its birth was caused by climate change and unsustainable exploitation of the planet's resources and its maturation holds a remarkable opportunity for the biomass industry.

At RISE, we believe that renewable raw material can replace many fossil-based raw materials in the future. Our role is to navigate and explore the routes of this transformation through knowledge and research. New technology requires optimization, especially when it is competing with a hundred years spent on fossil-based technology. That is why we consider industry collaboration as an essential step in the transformation process.

The Bioeconomy Research Programme 2018–2020 is RISE's contribution. It is a research-based accelerator for industrial transformation to the new bioeconomy.

A multi-client research programme

Our multi-client programme offers a unique business network, a meeting place for discussion and plenty of headspace for challenging ideas. The research topics based on industrial needs, global trends and market drivers will continuously be reviewed, refined and ranked

“We consider industry collaboration as an essential step in the transformation process.”

throughout the programme. The projects within the programme are designed to achieve client benefit and to create value in new technologies. Our experts and project managers will lead the research with the entire RISE infrastructure at their disposal. The outcome of the conducted research is shared between the participating parties.

Will you be a part of it?

Together, we will navigate the abundance of new technology while devotedly optimizing and improving current technology.

Together, we will share the risk of exploring new biomaterials and processes and continuously steer our efforts to find the best-practice methods with consideration of energy, technical feasibility and material properties.

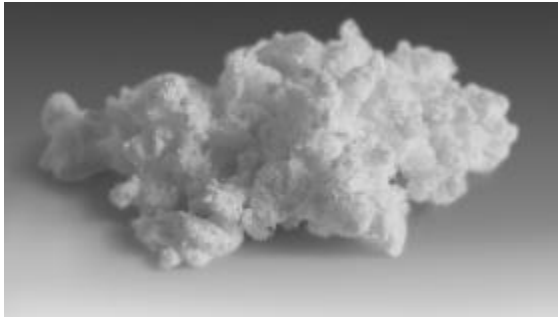
Together, we will implement new technology in an existing infrastructure to equip businesses for a future in which consumer demands for natural, recyclable, premium and safe products are paramount.

The programme areas

The proposal for The Bioeconomy Research Programme 2018–2020 consists of a number of programme areas containing a variety of research topics. The programme areas each

address mutual questions and opportunities of great interest to a consortium of RISE customers. All programme areas are planned for three years.

PULP & CELLULOSE



The modern kraft pulp mill

The kraft pulp mills of today face challenges when they are expected to further improve an already efficient process, while simultaneously adding flexibility to produce customised pulp. We will address process monitoring and guidelines for optimisation of the whole kraft pulp process, as well as problems related to non-process elements and extractives, which have gained importance recently. Studies on cellulose structure, chemistry and properties for customised pulp and novel materials will also be conducted.

LIGNIN



Lignin refining for high value applications

Different types of lignin originating from kraft pulp mills, sulphite pulp mills, ethanol production plants and agricultural waste all have unique characteristics. To understand which applications they are best suited for, we will include studies on separation techniques, tailoring of properties, and material development. The target products are carbonised lignin applications such as carbon fibres, energy storage and emission control, where lignin represents an affordable and sustainable alternative to current fossil-based components. Non-carbonised lignin applications, for example, adhesives, coatings and sealants will also be studied and techno-economically evaluated.

NANOCELLULOSE



Nanocellulose processes and materials

The nanocellulose field is expanding and the development of new applications is accelerating. Yet, some applications have not been realised largely due to uncertainties regarding the best starting material and conditions, and the processing of nanocellulose into various materials. These uncertainties will be addressed and elucidated using characterisation as a key ingredient, further accelerating nanocellulose applications.

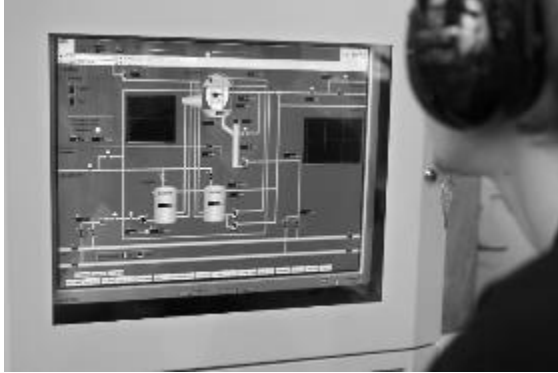
PAPERMAKING



Processes for board, printing and packaging paper

Paper and board production remains a cornerstone of the forest industry and, although a mature technology, the quest for competitiveness and sustainability is never-ending. We will deliver new insights and novel cost-effective solutions to reduce raw material and energy usage in papermaking, as well as enhanced property space for printing paper, sack, highly stretchable and board grades. In general, the focus will be on concepts that can be readily implemented on typical paper machines without large capital investment.

PAPERMAKING



Process analysis and product variability in papermaking

Paper and board makers need to deliver a consistent product quality. Competitiveness also requires maximum machine efficiency with minimum production losses due to unwanted interruptions and grade changes. Tools that allow the entire production to be monitored online will be developed. Combined with advanced analysis methods and complementary studies, these tools will provide a better understanding of the causes for process and product variability, and how they can be reduced and controlled. This increased digitalisation of the production process and the quality control will increase the product uniformity and the efficiency of the production process and raw material usage.

TISSUE



Tissue and fluff production

The most important product properties for many tissue and fluff products are strength, wet resiliency, absorbency, and haptic properties. In some cases, these properties conflict with each other or with the efficiency and runnability of the production process. We will cover uncertainties in the relationship between fibre types, production process and properties of the final product using standard and unique characterisation methods as well as unique laboratory equipment, pilot-scale trials and full-scale implementation.

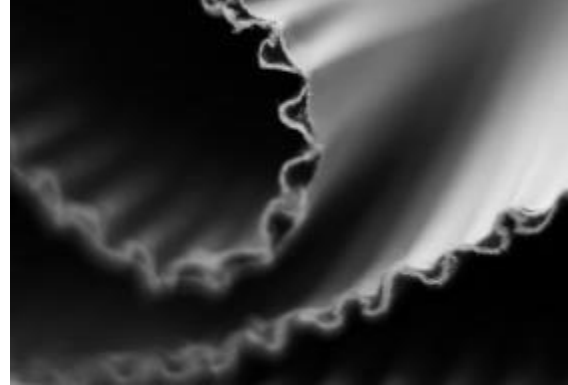
PACKAGING



Boosting convertibility and printability of packaging

An understanding of how material properties and operations contribute to package performance may have a substantial economic impact. We will address development of test, measurement and simulation methods that provide insights into printability and convertibility of packaging in order to predict the performance of a package. The most important deliverables will be the test and measurement methods, theoretical models and numerical tools that can be used in the industry.

PACKAGING



Improving corrugated board performance

The market position of corrugated board, as well as for paper-based packaging in general, can be strengthened and expanded by eliminating the weaknesses of these products. Weaknesses include their sensitivity to moisture, limitations in print quality and the deterioration of liner and fluting. We will address these weaknesses by developing new process solutions for the base papers and relevant testing methods for packaging paper, packaging and print properties combined with testing their relevance for conformity to various transportation standards.

BIOPLASTICS & BARRIERS



Renewable polymers and barriers

Environmental drivers for renewable materials present an opportunity for forest- and plant-derived plastics. The focus will be on using renewable sources as the raw materials for polymers and thermoplastics. Application techniques and manufacturing techniques for both thermoplastic melts and dispersions will be studied from lab to pilot scale. The goal is to develop high performance materials competitive in relation to their fossil-based or other unrenovable counterparts.

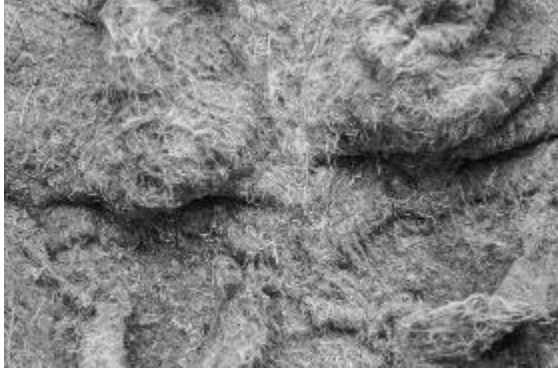
BIOCOMPOSITES



Cellulose reinforced materials

The European Union has set goals for 2020 that deposition of waste (landfills) is to be abandoned, incineration is to be limited to materials that cannot be reused and material recycling of a high quality is to be secured. For this reason, we will develop advanced zero waste cellulose reinforced materials for applications within the building, automotive, household appliance and packaging industries. The approach is to combine knowledge in various fields, such as chemistry, materials science, micro-mechanics, polymer processing, fibre network processing and psychology, to create a toolbox that will enable rapid material development optimized for specific in-service performance and recycling.

TEXTILES



The textile waste material refinery

The need for textile recycling options opens up possibilities for a unique holistic approach, which may also enable new business cases for the textile, recycling and forest industries. We will review and enable the potential of integrating the used textile fractions with the existing recycling schemes, in particular the sectors of plastics and paper/packaging, if these are looked upon with a molecular view. The new products from the so-called material refinery should be of the same quality as virgin material and based on a resource-efficient route benefiting from the existing streams within plastics and paper recycling.

BIOENERGY, FUELS AND CHEMICALS



Bioenergy and co-production of transportation fuels and chemicals

Bioenergy and bio-based chemicals and transportation fuels are high on the political agenda today as a way to reduce emissions of fossil-based CO₂, increase the use of renewable materials and utilize local resources. Bioenergy conversion technologies need to increase profitability by utilizing cheap fuels and decrease emissions. We will address bioenergy conversion, as well as process and feedstock selection and optimization for bio-based transportation fuels. Emphasis will also be on identification of co-production routes to produce chemicals in order to improve profitability and facilitate commercial introduction.

DIGITALIZATION



Digitalization opportunities in the bioeconomy

Digitalization as a new important concept for industry has escalated lately and there are large possibilities to increase competitiveness for the companies who act. We will develop a digitalization pilot where companies can explore and test the basis for moving business from “product by volume” towards “service of functions” in a more sustainable digitalized society.

The bioeconomy ecosystem

Is “biobased” always more sustainable than “fossil-based”? Can consumers really throw biodegradable items anywhere? Will they understand that they cannot? When should we use hardwood and when should we use soft-wood fibres?

As a new addition to the research programme,

“As a new addition to the research programme, we propose a forum across the programme areas.”

we propose a forum across the programme areas in which we will discuss the duality and complexity of sustainability, bioeconomy and circularity from a technical point of view. In workshops and seminars, we will put new technology and products in a system perspective in order to understand where it fits in a circular bioeconomy and what future environmental threats it might cause. We will discuss how businesses can push sustainable solutions through activism and how environmentally conscious consumers pull them through their purchases. The forum will also include surveillance of legislation, policies and market drivers.

Together, we will navigate the abundance of new technology and its potential in an ecosystem of suppliers, converters, brand owners and markets.

We urge your input on this proposal!



The impact on sustainability

The Bioeconomy Research Programme 2018–2020 has embarked on the first stage of its sustainability journey with both economic and environmental sustainability goals. Efficiency of renewable resources, production processes and renewable materials, chemicals and fuels constitute the solid foundation of the bio-economy and will thus permeate the entire programme. A circular economy is a sustainable economy, but it entails new societal needs

“Both economic and environmental sustainability goals”

and industrial challenges that we strive to meet in collaboration with like-minded partners.

Together, we will take the lead in the transition to a sustainable society.



Minimize cost and environmental impact through efficient use of energy and biomass resources

At a production site, minimization of the used energy and raw materials and exploitation of the total resource potential are parts of sustainable solutions. With regard to recirculation of resources, however, the overall energy and raw materials utilization is important to avoid sub-optimization along the value chain and to ensure a holistic sustainable approach. Both scenarios are handled in several programme areas.



Maximize volume and quality through production efficiency and runnability

Improvement of production efficiency and runnability enables more production time and a higher quality. This can result in larger production volumes and opens up possibilities to produce other materials and products. Development of production processes for efficient conversion of biomass into materials, products and energy targets at robust economic sustainability. This, in turn, translates into direct environmental benefits. Up-scaling in order to demonstrate and evaluate the potential of new process solutions prior industrial implementation is a distinctive programme proposal that promotes informed and sustainable decision-making.



Meet societal needs with products made from forest biomass

There are new possibilities for biobased materials with system thinking in mind. While older materials are not always optimal for societal needs – materials may contain unwanted chemicals, which diminish their value or have limited functionality – our competitive advantage is in development of smart biobased materials that are sustainable and recyclable by design.



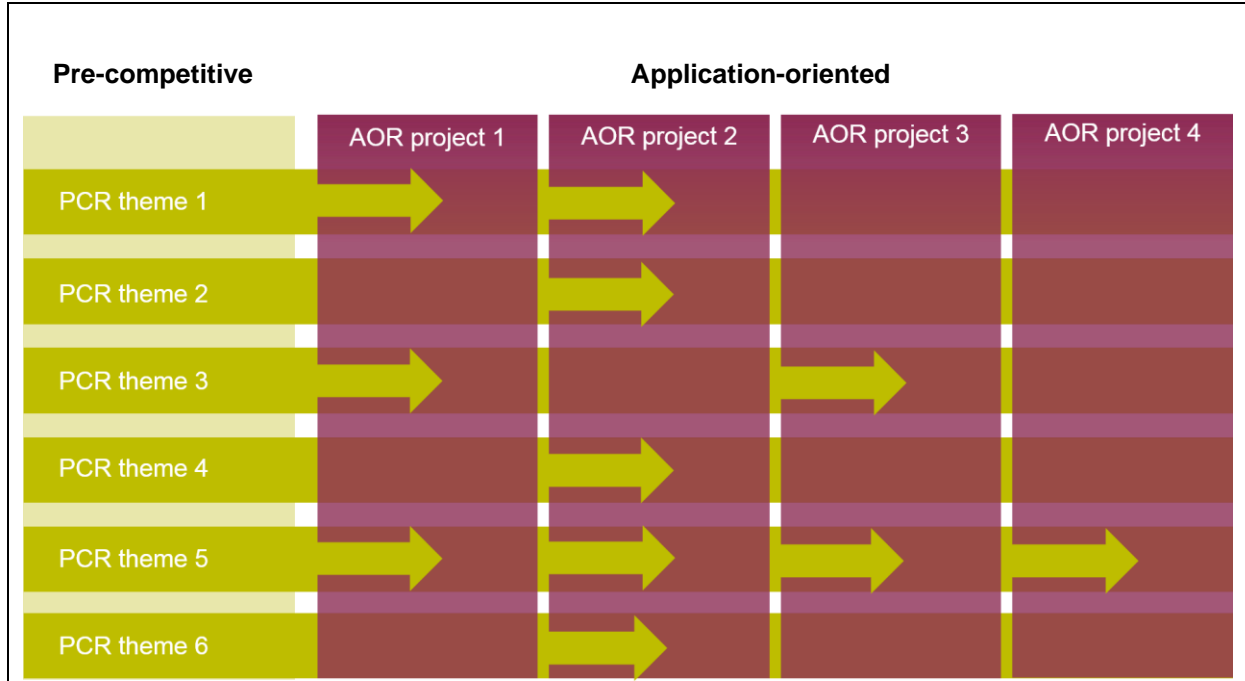
Enable circular economy through key technologies and business models

The circularity of material- and energy flows enables sustainable benefits at production facilities, along a value chain, and through synergies between value chains, with the overall mission of delivering more value to the customer and doing it in a lucrative way. To enable such circular business models, value chain actors need a common meeting ground to discover optimal benefits and find a win-win concept that stands up economically, creates environmental benefit and involves the user. The role of RISE is to provide such meeting grounds and tackle technological obstacles for the biobased circular economy.

What do we mean when we communicate about “Bioeconomy” and “Circular economy”?

- A bioeconomy is about generating economic value based on efficient production and utilization of biomass.
- A circular economy is one that is regenerative and restorative by design and that aims to keep products, components and material at their highest utility and value at all times.

The successful programme model



Each programme area is divided into a pre-competitive research (PCR) part with a number of research themes, and an Application-Oriented Research (AOR) part that consists of a number of projects.

From pre-competitive to application-oriented research

We believe that it is by returning to the fundamental questions we can develop novel production processes and materials. Examples include cellulose-water interaction, and the relation between raw material and product properties. We also believe that a good toolbox will always come in handy. For us, a good toolbox contains new analysis and testing methods, generic modelling and simulation tools which can be applied throughout a value chain. In order to know which questions are important and which are merely interesting, we take a bird's eye perspective of the research area through our market and research surveillance tool.

Within each research area, activities related to the fundamentals, the toolbox and a “look around the world” are gathered in the Pre-Competitive Research (PCR). These activities are grouped into a number of research themes that will support the Application-Oriented Research (AOR).

The knowledge platform generated from the pre-competitive research can be used for new technical solutions and applications in one or several multi-client Application-oriented Research (AOR) projects. Application-oriented research projects may also be run as bi-lateral projects.

The results from these projects may afterwards be developed further to industrial reality together with customers through bi-lateral projects.

The demonstration economy

It is a high priority in the Research Programme to demonstrate the manner in which the programme is a research-based accelerator for industrial transformation to the new bio-economy. In other words, research efforts will be communicated and evaluated as e.g. prototypes and pilot runs with client benefit as a performance indicator.



Our portfolio of testbeds and demo plants includes transportable nanocellulose pilot, the LignoBoost Demo plant, FEX paper machine, and plants in Örnsköldsvik, Piteå, Södertälje and Trondheim among many others. Commercialization and large scale manufacturing will be addressed in new and high-risk research projects in order to better understand the requirements of a potential pilot scale production.

Technology Readiness Levels (TRL)

Throughout the descriptions of the bioeconomy research programme, we use TRL as defined by the European Commission in the Horizon 2020 Work Programme:

- TRL 1 – Basic principles observed
- TRL 2 – Technology concept formulated
- TRL 3 – Experimental proof of concept
- TRL 4 – Technology validated in lab
- TRL 5 – Technology validated in relevant environment
- TRL 6 – Technology demonstrated in relevant environment
- TRL 7 – System prototype demonstration in operational environment
- TRL 8 – System complete and qualified
- TRL 9 – Actual system proven in operational environment

Intellectual property rights

The pre-competitive research (PCR) is partly supported by public funding and therefore the results will be owned and published by RISE. A publication can be delayed if a base patent application is preferable to secure RISE's and the programme partners' right to continue to do research or use it in applications. All parties in a Programme area will of course have a non-exclusive free right to use the results.

The application-oriented research (AOR) projects are kept separate from each other as regards Intellectual Property Rights, and other confidentiality matters. Only customers joining the consortium behind a specific application-oriented research project have access to all its results. The customers can choose to co-own a patent if this is applied for during the agreement period.

Pre-competitive research (PCR)

- Programme area manager from RISE
- Advisory committee from the financing customers.
- Publish rather than patent
- Leveraged by public funding
- Base patent can be applied to secure continued R&D and use
- RISE owns IPR

Application-oriented research (AOR)

- Project manager from RISE
- Project steering board with representatives from the financing customers and RISE
- Select modules in model agreement upfront
- Publish later
- If patenting is decided a model for Joint ownership agreement can be used
- Public funding can be applied for if agreed upon
- Possible to run as bi-lateral projects



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