Next-Generation Textile Fibre

Innovation & Technology

2019-2020 Progress Report

Contents

RGE Group of Cellulosic Fibre Companies

An Integral Part of the Textile Value Chain

RGE is a group of resource-based manufacturing companies with global operations. Founded in 1973, our purpose is to improve lives by developing resources sustainably.

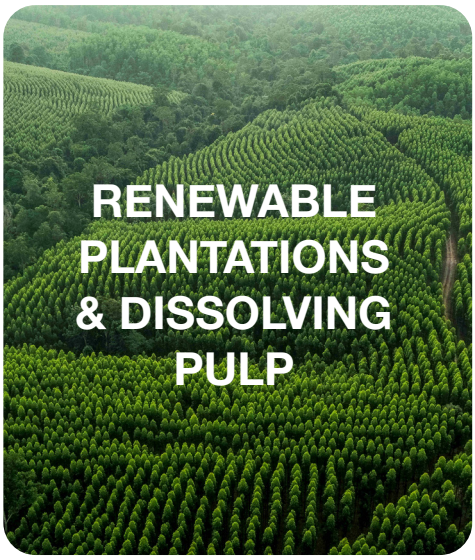
As a supplier of cellulosic fibres, our fibre-related businesses are integrated vertically from sustainable plantation management to textile fibre and yarn production.

We are the world's largest producer of viscose fibre with strong presence in Asia where textile demand growth intersects with the textile production hub, presenting a real opportunity to drive change.

Our deep expertise in the cellulosic fibre business and integrated capabilities allow us to have full control over product quality, accelerate scalable innovation through practical industry collaboration, and mitigate supply chain risks.

APRIL Group is one of the world's largest, most productive and efficient producers of fibre, pulp and paper with plantations and manufacturing operations in Riau, Indonesia. APRIL manages over 440,000 hectares of renewable plantations and operates the world's largest single-site pulp mill at 2.8 million tonnes of pulp annually.

www.aprilasia.com

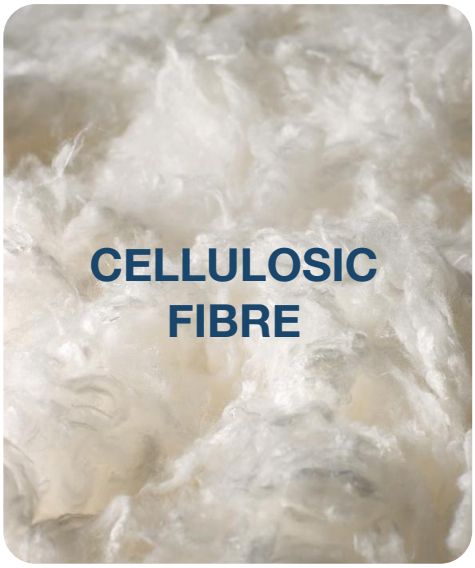


Bracell is a leading manufacturer of dissolving pulp and specialty cellulose. From its eucalyptus plantations in Brazil, Bracell's mills in Bahia and Lençóis Paulista produce a combined 750,000 tonnes of pulp a year. It is currently embarking on an expansion project that will boost its overall dissolving pulp production capacity to 2.0 million tonnes.

www.bracell.com

Asia Pacific Rayon (APR) is the first fully integrated viscose staple fibre producer in Asia from forest plantations to viscose. Its 240,000-tonne mill, which is co-located with APRIL in Riau, Indonesia, uses the latest production technology to produce high-quality viscose fibres to meet textile needs.

www.aprayon.com



Sateri is the world's largest producer of viscose fibre, a natural and sustainable raw material found in everyday items like textiles, baby wipes and personal hygiene products. Its five mills in China produce about 1.4 million metric tonnes of viscose fibre yearly. It also operates Linz yarn spinning mill in Nanjing, and a 20,000-tonne Lyocell facility in Shandong.

www.sateri.com

Asia Pacific Yarn (APY) is a fully integrated viscose staple fibre yarn manufacturer, located in Riau, Indonesia alongside APR. APY applies the latest yarn spinning technology to produce an annual capacity of 7,560 metric tonnes of high-quality yarn products or equivalent to a total converted capacity of 32,000 spindles with open-end-rotors, ring spindles and vortex positions.

Linz (Nanjing) is a maker of high-quality viscose yarn products that are exported worldwide. Set up in 2007 and acquired by Sateri in May 2016 as part of its strategy to be closer to customers and improve quality, the advanced mill has open-end, vortex and compact Siro spinning technologies with a total converted capacity of 50,000 spindles.

Vice Chairman Message

At RGE, we're in the business of resource-based manufacturing. What does that mean? From nature's resources, we manufacture raw materials that can be found in essential items used by millions around the world each day: paper, clothing, medication, wet wipes, margarine, shampoo, and many more.

We pride ourselves on the fact that the virgin resources we draw on to make these important products possible are renewable. But that does not mean we rest on our laurels. In fact, we are taking our sustainability commitment to the next level by exploring how waste can also be used as a resource to generate new materials and give rise to a circular economy.

We formalised this approach in October 2019 at the Textile Exchange Sustainability Conference in Vancouver, when we announced a commitment of US$200 million into next-generation textile fibre innovation over the next 10 years, split across three areas: 70% towards scaling up proven clean technology in fibre manufacturing, 20% towards bringing pilot-scale production to commercial scale, and 10% towards R&D in emerging frontier solutions.

This report covers how we have accelerated our R&D and innovation efforts to drive the development of ground-breaking solutions in alternative cellulosic feedstock and clean manufacturing technology in the 12 months since we announced our commitment to invest. Some of the more notable developments include the launch of recycled fibre FINEX™, inaugural production of Lycocell, and new R&D facilities in China and Indonesia.

In addition to pursuing greater environmental outcomes through our integrated upstream operations, we are taking a comprehensive approach to achieving circularity. We are investing in our own R&D to help innovate new concepts and technologies that address the fashion industry's waste loop. Our R&D team has embarked on research into cotton textile waste recycling.

At the same time, a concerted effort across the industry is needed to effect systemic change to the way the world produces and consumes. Many of our breakthroughs this year were achieved through collaboration. It is through partnerships like these that we create a multiplier-effect on the innovative capital built up across the industry. We believe this kind of openness to collaborate is needed to help drive real change.

While we have advanced rapidly in a fairly short period, and under challenging conditions of a global pandemic, the work is still far from done. As we enter a new decade, we pledge to hasten our efforts towards next-generation textile fibre solutions.

By 2023, all existing mills of Asia Pacific Rayon (APR) and Sateri will meet the emissions limits set out by EU BAT (European Union Best Available Techniques).

Sateri is set to have a product with 50 per cent recycled content by 2023, and to reach 100 per cent by 2030. It also aims for 20 per cent of its feedstock to contain alternative or recycled materials by 2025. APR will source 20% of its feedstock from alternative or recycled materials by 2030.

We look forward to sharing new milestones with you in the near future.

Bey Soo Khiang

October 2020

US$200 million
into next-generation textile fibre innovation over the next 10 years

20%
pilot-scale production to commercial scale

10%
R&D in emerging frontier solutions

70%
clean technology in fibre manufacturing

Investment Approach

Investing in start-ups

Sourcing ready solutions

In-house R&D capabilities

Milestones 2019-2020

October 2019

Launch of
$200m
Investment Commitment

March 2020

Breakthrough in Commercial Production of Recycled Fibre in Partnership with Södra

April 2020

Commitment to EU-BAT compliance for Sateri's existing viscose mills by 2023

May 2020

Lyocell Production Commences in Shandong, China

Pulp to Viscose Pilot Line Completed in Riau, Indonesia

June 2020

FINEX™ Unveiled as Marquee Brand for Recycled Fibre

August 2020

3 of 5

existing Sateri viscose mills verified EU-BAT Compliant

2 Patents Filed on Conclusion of 3-year Cotton Textile Waste Programme with Donghua University

October 2020

Established progressive targets at product and feedstock levels

September 2020

New R&D Innovation Centre Opens in Shandong, China

Investing In Partnerships & Collaboration

Our Investment Process and Considerations

To support our investment commitment, we complemented our R&D team with a dedicated investment function with personnel recruited from the private equity and venture capital industry.

The investment function supports RGE in sourcing investment and partnership opportunities, facilitating collaboration with innovative technology companies in areas of alternative feedstock and clean manufacturing.

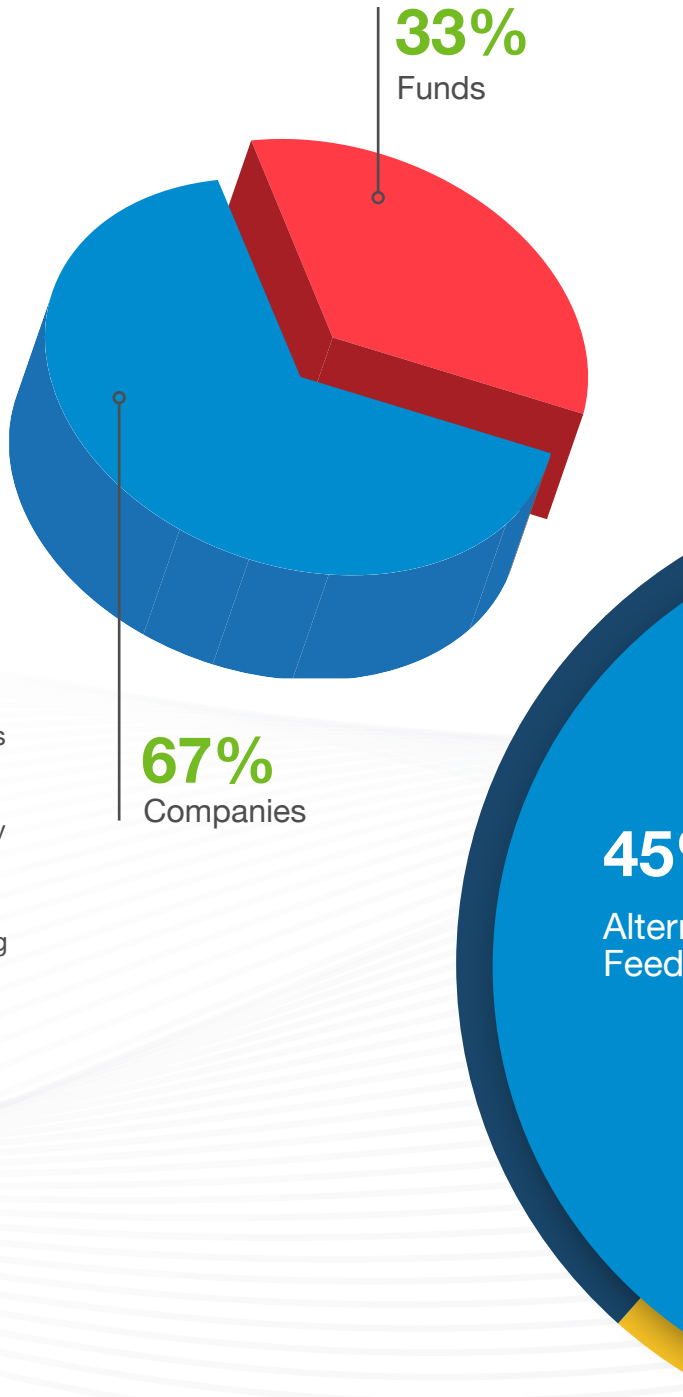
Over the past 12 months, we have explored potential collaboration with about 30 companies and funds that are focused on sustainability in the fashion supply chain. The technologies provide solutions in alternative cellulosic feedstock ranging from textile-textile recycling to microbial and agricultural waste, as well as clean solvents.

We also worked with other investors actively investing in similar technologies to evaluate projects that could benefit from RGE's support. We thank organisations like Fashion for Good and others who have introduced innovators to us.

While we remain committed and optimistic on our innovation journey working with a diverse group of early-stage technology companies, we recognise the complexity, time and capital intensity in scaling up new technologies within our sector. Our goal is singular: achieving commercial scale where possible to be cost-competitive, while maintaining or improving on consistency in quality.

Our investment review process takes into consideration various factors that include founders' vision and mission, pathway to commercialisation, scale-up risks, and overall fit with our existing operations and long-term business model.

The investment process combines investment discipline with our deep industry knowledge that includes a Technology Readiness Level (TRL) framework. This framework provides our team clarity on technical risks, and also informs us how we may support and complement a potential investee and technology partner with our internal know-how.

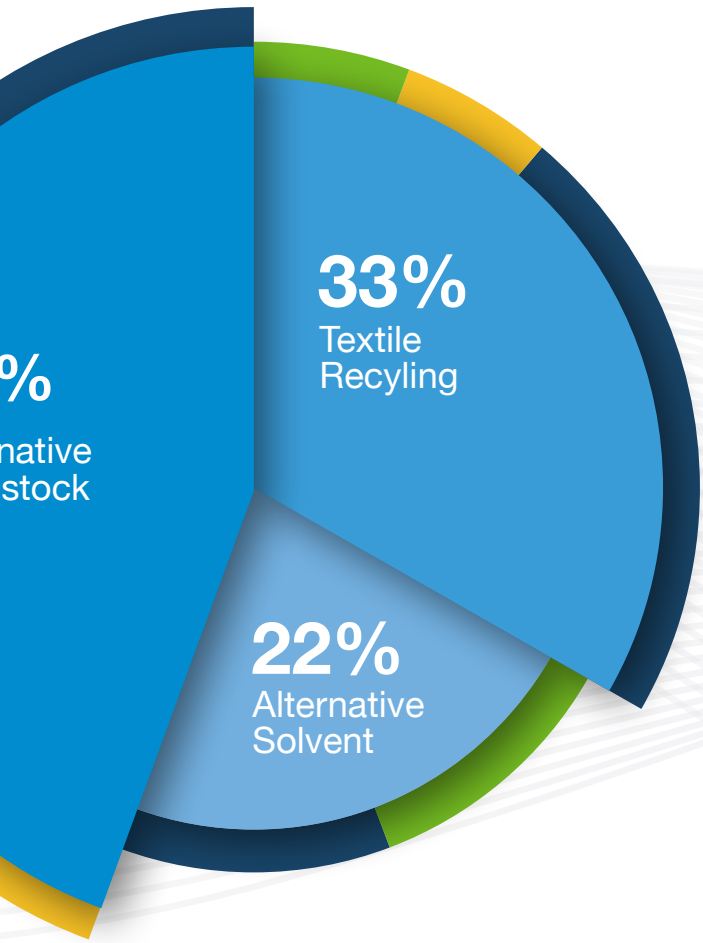


In-depth Discussion + Trials

In-depth Discussion

Engagement Only

Types of Technologies



Impacts of COVID-19

The COVID-19 global pandemic has disrupted the fashion and textile sector, impacting players large and small. Travel restrictions have impaired our ability to conduct face-to-face meetings which are critical for complex technical projects.

For early-stage innovators, the impact is more acute as trials and other collaborations come to a near halt. Their fundraising efforts have also slowed down as private equity investors are cautious in a global economic downturn.

While we believe the pandemic has and will negatively impact our investment and partnership activities, we remain committed to invest financial and human capital to drive toward our sustainability goals in new innovative technologies.

Private Sector

Infinited Fiber Company

RGE joined a group of investors including H&M Group, Virala and Fortum to help Infinited Fiber Company scale up its technology that turns textile waste and other cellulose-based materials into new textile fibres. A strategic cooperation agreement was also signed between RGE and Infinited Fiber Company to commercialise the Finnish startup's technology.

In February 2020, Infinited Fiber Company opened its new pre-commercial 150-tonne per annum plant and customer training centre located in Valkeakoski city, Southern Finland. This is a leap from the 50-tonne per annum pilot plant in Espoo, Finland, that Infinited Fiber Company has operated since early 2018.

Infinited Fiber Company's technology of using recycled feedstock and a green chemistry process in a circular fashion to produce fibres, aligns well with RGE's goals and existing operations.

Following a visit to our pulp and viscose facilities in Kerinci, Riau, Indonesia in February 2020 by Infinited Fiber Company CEO Petri Alava, we have entered into discussions with Infinited Fiber Company on its technology roadmap and fundraising needs for expediting commercialisation. A joint project in China to explore retrofitting viscose production with Infinited Fiber Company's cellulose carbamate technology may materialise in the near term.

Re:newcell

A Memorandum of Understanding with Re:newcell was signed in May 2019 for technical cooperation and trials. Since then, we have trialled Re:newcell's Circulose pulp, recycled from cotton textile waste, in both our viscose mill in China and dissolving pulp mill in Indonesia.

While viscose fibres comprising varying percentages, up to 20%, of Circulose pulp have been successfully produced, trials remain underway with a focus of assuring performance consistency and quality. Discussions with Re:newcell to offtake a sizeable pulp volume from their new commercial plant in 2022 are ongoing.

Södra

Sateri achieved a breakthrough in the commercial production of viscose made from recycled post-consumer textile waste by Swedish company Södra, and other PEFC-certified wood pulp. Södra's OnceMore™ technology is a world first in the separation of blended fabrics and recycling of textiles from post-consumer waste. A senior executive exchange and visit to Södra's mill is planned for after pandemic travel restrictions lift.

Public Sector

Donghua University

Sateri and Donghua University initiated a joint programme in September 2017 to study the optimisation of cotton textile waste as a feedstock in viscose manufacturing. Donghua University, formerly China Textile University, has a rich heritage of research in textile-related disciplines.

The collaboration combines the inherent strengths of Donghua University with Sateri's expertise in viscose production processes. On conclusion after three years in August 2020, the programme had moved from lab trials to pilot testing and resulted in two patents filed jointly.

China Association of Circular Economy

Sateri is in discussion with the China Association of Circular Economy (CACE) to commission a study on the recycling and utilisation of textile waste in China. The study, which will commence in early 2021, will analyse the output, utilisation, demand, investment risks and regulatory landscape of the textile waste industry in hopes that the comprehensive study will inform the industry on strategies to unlock the potential of textile circularity in China.

Aalto University

Under full sponsorship by the company, two of our staff members were accepted by Aalto University in 2019 to pursue their post-doctoral research studies under the tutelage of renowned academic, Dr Herbert Sixta.

The Finnish University is a leader in material science and engineering, including research in frontier technology in developing solvents and green chemistry used in Ioncell and Lyocell fibres. This mutually beneficial collaboration has helped strengthen RGE's in-house R&D capability in clean manufacturing technologies while our staff have contributed to the University's rich body of research work and literature.

VTT Technical Research Centre of Finland

APRIL joined VTT Technical Research Centre of Finland and 51 other companies in a three-year 'Piloting Alternatives for Plastics' project which seeks to accelerate new generation fibre products towards industrial scale production.

Among the piloting targets are fibre-based materials to replace plastics used in textiles, wiping, hygiene and construction materials. The project is backed by EUR6.7 million funding from the European Regional Development Fund (ERDF), VTT and participating companies.

In Conversation with Petri Alava
CEO of Infinited Fiber Company

Where did the inspiration for Infinited Fiber Company and its cellulose carbamate technology come from and what have been the key developments over the past year?

Infinited Fiber Company was founded in 2016 to commercialise a breakthrough technology that enables discarded textiles, used carboard and other cellulose-rich feedstock like agricultural refuse to be regenerated into high-quality textile fibre that has the soft, natural look and feel of cotton. It is biodegradable and can also be recycled over and over again, preserving 100% of the quality. The fibre is very unique given the wide range of possible feedstock options as well as the consistent quality and unique properties, like its very high dye uptake and cotton-like characteristics. The production process is also unique as it is organic solvent-free, making it safe and sustainable. We use urea, a naturally occurring and safe compound, to activate the cellulose fibres of the feedstock and turn them into a cellulose carbamate powder that is then dissolved to a honey-like liquid and spun into new, cotton-like fibre that is ready to be used by the textile industry.

Cellulose carbamate technology as such is not that new – but our patented technology for using it to create

new and totally unique textile fibre from used textiles is revolutionary! Our cofounder Ali Harlin has been researching cellulose for years, and his eureka moment came when he tossed his old jeans into the process.

We've done a lot over the past year! We set up a factory to produce cellulose carbamate powder at a bigger scale. We also ran our pilot production continuously for 72 hours, demonstrating that it is possible to achieve the continuous production of a high-quality fibre with stable characteristics using our process. Our R&D team have been busy, testing various feedstock options and other novel ideas, and also refining our main process and chemistry to prepare for commercial-scale production very soon!

What achievements to date would you like to highlight and what immediate plans or goals do you have going forward?

We are extremely proud that several of the world's biggest yarn and fabric manufacturers and many of the leading global fashion brands have tested our fibres in different types of yarn and textile applications, and found them to meet their brand and consumer performance requirements. This is great news for us, as it validates what we are doing. We are now in a situation where we have more demand for the fibre than we are able to produce in our pilot, so the plan going forward is definitely to boost capacity.

Our technology can be used to retrofit existing pulp-based fibre production lines relatively easily, so this is a cost-effective way for viscose producers like RGE to convert production capacity to cellulose carbamate fibre production. And we see that as an important avenue for boosting production capacity: the licensing of our technology to partners like RGE. At the same time, we are also exploring other potential options for scaling up cellulose carbamate fibre production with a range of potential investors and partners.

What barriers and opportunities do you see to scaling your innovation?

The opportunities are huge. We have the solution to enable the textile industry to live up to its promises and ambitions of circularity and sustainability. We have the technology that enables textile waste to become valuable feedstock rather than a problem at landfills and a contributor to greenhouse gas emissions as incinerated waste. Our technology also eliminates the pressure on virgin fibres like cotton, which use up a lot of agricultural land that could otherwise be used to grow food, water that could otherwise quench thirsts, and pesticides, which pollute land and waterways and are harmful to people. So, the opportunities are huge and inspiring. The barriers, on the other hand, are rather prosaic: we need upfront investments into production lines to scale the technology. While the revenues are expected to be substantial both in real terms as well as in human and environmental gains, it's not easy to change the established processes and investment traditions of an entire industry.

How do investors and industry partners like RGE feature in Infinited Fiber Company's plans and goals?

We cannot revolutionise the textile industry on our own! Our technology enables circularity and acts as one of the major pieces that has thus far been missing from the equation. We already see great interest and high demand for our fibre from global fashion brands, and from yarn and fabric producers. But we need the entire industry's buy-in to truly make a difference. Partners and investors like RGE are hugely important to our plans for scaling production and for establishing Infinited Fiber Company's unique regenerated cellulose carbamate fibre as the number one sustainable choice for consumers. The commitment of our partners and investors to acting on their ambitions of sustainability and committing to the use of sustainable technologies and processes is absolutely crucial. Together we can really make some magic!

Accelerating In-House R&D Capability In Textile Fibre Innovation

RGE has developed strong in-house Research and Development (R&D) capabilities over many years. We have about 730 staff members involved in fibre R&D functions across Brazil, China and Indonesia.

Our R&D efforts have traditionally focussed on enhancing quality and productivity in our operations and products. In forestry management, for example, our research emphasis is on silviculture and intensifying land use and fibre yield. In manufacturing, we focus on projects such as introducing value-added features like anti-bacterial and traceability to enhance our existing products.

Today, we have 99 staff members involved in textile fibre-related industrial R&D, including 11 with PhD and post-doctoral qualifications and 15 with Masters Degrees from various nationalities.

With the commitment to invest in the development of next-generation cellulosic textile fibres that are closed-loop, circular and climate-positive, we have in the past year not only strengthened our in-house R&D infrastructure and other capabilities but also embarked on new R&D projects towards this direction.

Our capabilities in this area are still nascent by industry standards but we are committed to accelerating our learning and journey to success. Our key advantage is the possession of expertise across dissolving pulp, viscose, lyocell and yarn spinning in different parts of our businesses and locations.

The potential and value of integrating our competencies and harnessing synergies are already being unlocked, evidenced by achievements in the past year.

1 PhD	1 PhD	1 Masters	1 PhD 1 Post-doc	1 Masters	1 Masters
4 PhD 4 Masters	1 Post-doc	1 Masters	2 PhD 5 Masters	1 Masters	1 Masters


Lafuma
Lafuma
EcoCosy 依可丝
FINEX

FINEX™

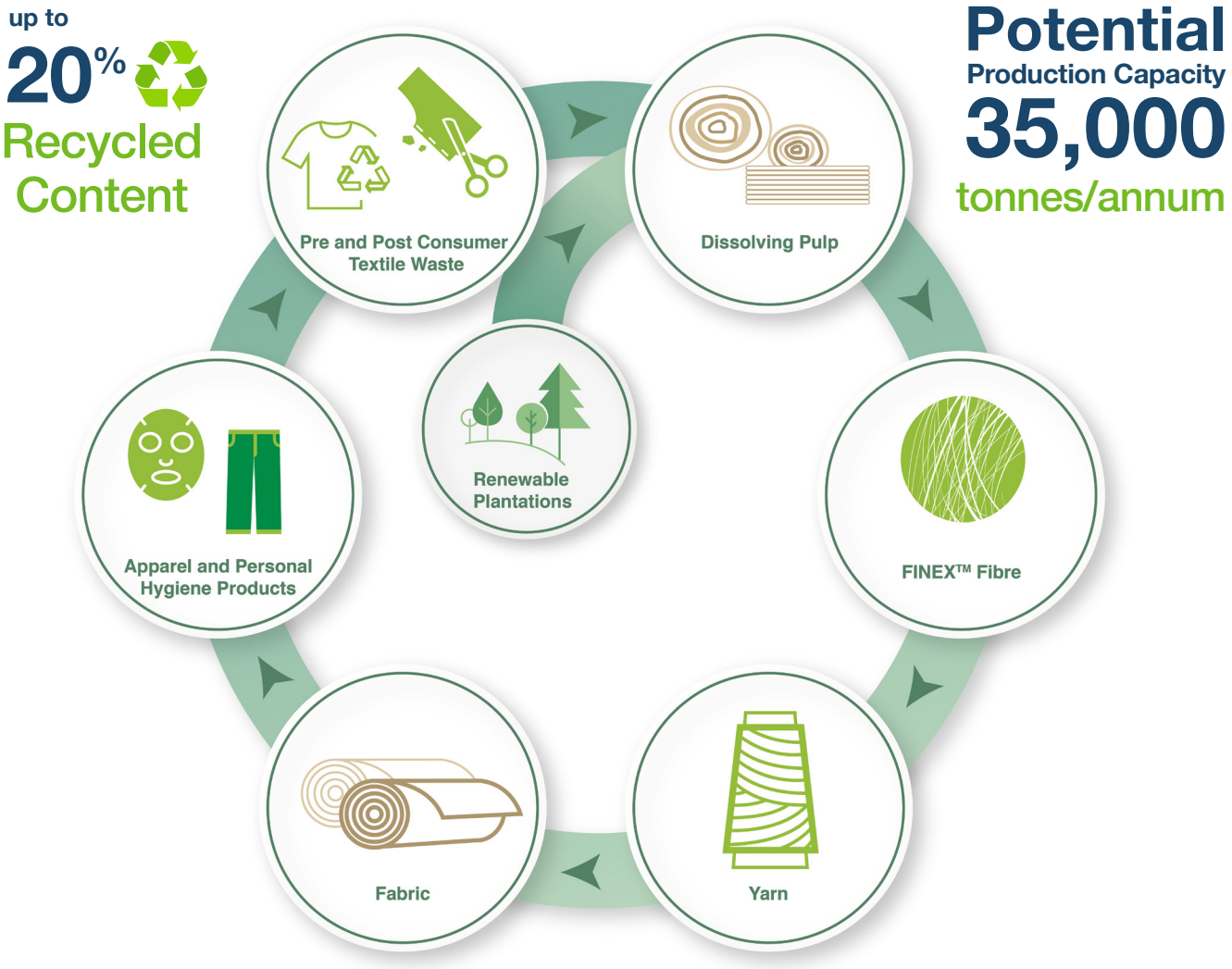
TOGETHER FOR A BETTER NEXT

Sateri introduced FINEX™ as its marquee brand for fibres containing recycled content.

In August 2020, Sateri obtained the Recycled Claim Standard (RCS) certification which provides verification of recycled materials through the supply chain. Sateri has successfully produced FINEX™ viscose fibres with up to 20% recycled content.

FINEX™ was officially launched on the sidelines of the Intertextile Shanghai Apparel Fabrics expo. Our ability to produce FINEX™ using a 35,000-tonne per annum commercial production line means that we are capable of scaling up production to respond to market demand.

Equally notable is the high quality of FINEX™ fibres which are compatible with existing spinning technologies, ensuring stable yarn production without the need to adjust existing processes or parameters, and delivering excellent spinning efficiency, yarn evenness and tenacity.



Lyocell
By Sateri

Our development of Lyocell was planned in anticipation of the expiration of related technology patents in recent years. Over an intensive period spanning nine months, our R&D team researched, acquired production know-how, and planned for the infrastructure to produce Lyocell.

Lyocell is manufactured using closed-loop technology, requiring minimal chemical input during the production process, and utilising an organic solvent that can be almost fully recovered and recycled.

In May 2020, Sateri completed its first 20,000-tonne per annum line and commenced Lyocell production in Rizhao, Shandong, China. We plan to expand Lyocell production in other parts of China over the next two years.

Capacity
20,000
tonnes/annum

New R&D Facilities

We opened a multi-storey R&D Innovation Centre in Shandong China in September 2020 which features a 5,000 ton per annum Lyocell production line dedicated for pilot trials, and other imported state-of-the-art equipment.

The Centre's activities will focus initially on laboratory tests for pulp selection, new and differentiated fibre product development, and quality and productivity improvements in Lyocell production. In the near future, the Centre will undertake projects to explore frontier next-generation textile fibre solutions and other related downstream innovation.

In Kerinci, Riau, Indonesia, we built a new fully automated viscose pilot plant. The plant closely simulates the entire viscose manufacturing production on a much smaller scale, enabling more efficient testing of new products and production techniques.

When operational by end 2020, the pilot line will focus on developing new products from existing raw materials and test out new sources of fibre from recycled textiles and agricultural residuals.

We initiated a cotton textile waste project to help our R&D team better understand the textile-to-textile recycling process.

Alternative Feedstock Projects and Trials

Our R&D teams in China and Indonesia conducted more than 30 trials on non-wood cellulosic feedstock ('alternative feedstock') samples received from external parties. These are in addition to the trials our teams conducted with Infinited Fiber Company, Södra and Re:newcell.

We initiated a cotton textile waste project to help our R&D team better understand the textile-to-textile recycling process.

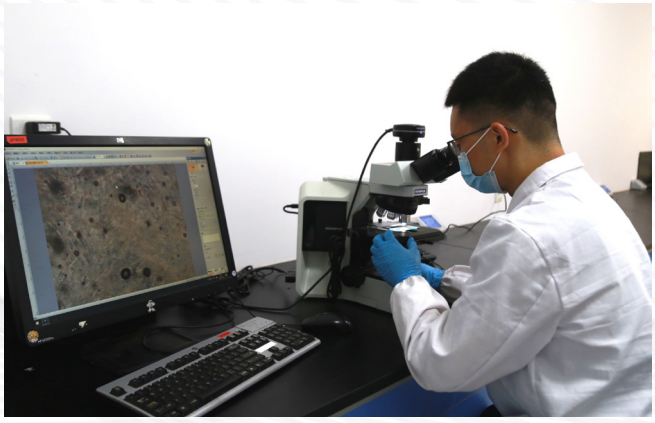
Pre-consumer cotton waste obtained from Indonesia and Singapore have been trialed and the results have been encouraging, with potentially up to 50% recycled content in viscose produced at good quality.

The same investment review process and considerations apply to our in-house projects. While a roadmap to realising a full in-house commercial solution by 2022 is being planned, we anticipate considerable challenges in sourcing sufficient volume of textile waste to scale up production.

Similar to our planned partnership with the China Association of Circular Economy, we are actively seeking interested parties to conduct a comprehensive study of the textile waste landscape in Indonesia to inform strategies in overcoming this challenge.

Through our trials, we have encountered known challenges in textile-to-textile recycling technology such as removal of dyes and separation of blended fibres. There is also the challenge of controlling non-process related elements like silica and metals in viscose production.

Our insistence on quality means we have to consider not just how the pulp performs in our viscose production process, but also how the fibre will be compatible with the processes of our downstream customers.



Driving the Future of Fashion: Where Passion Meets Innovation

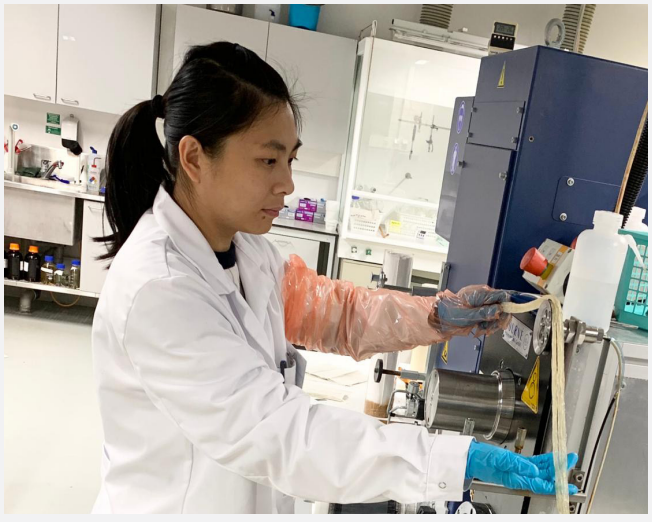
H'ng Yin Ying first joined APRIL in 2017, where she kickstarted her journey with the company as a researcher based in Pangkalan Kerinci, Riau, Indonesia.

She knew she wanted to make a difference, but what she did not expect were the strides she would soon take in advancing the future of fashion. After just two years in Kerinci, Yin Ying found herself in a laboratory in Finland, investigating the application of green chemistry to produce cleaner textile fibres. Together with a Sateri colleague from China, the two young researchers were fully funded by RGE on a year-long post-doctoral research programme at Aalto University.

"I was deeply honoured and surprised that RGE offered me such a huge opportunity to take up a development programme, given it was such a short time since I'd joined the company," Yin Ying said.

Motivated by her belief that cellulosic fibres, with its natural and renewable properties that can enable a closed-loop manufacturing process, will drive the future of fashion, Yin Ying used this opportunity to advance innovation and research in the field through the programme.
She is currently researching advanced textile fibre technology with a focus on cellulosic fibre at Aalto University, under the tutelage of renowned industry expert Dr Herbert Sixta.

"I was deeply honoured and surprised that RGE offered me such a huge opportunity to take up a development programme, given it was such a short time since I'd joined the company," Yin Ying said.



“RGE is evidently prepared to invest significantly in research and development – including investing in its employees to further this goal. I’m happy to support APR’s ‘From Plantation to Fashion’ vision, with textile production processes that are sustainable and constantly innovating.”

“While the market is currently still dominated by fast fashion practices, there is increasing pressure for the industry to be more sustainable, and fibre sustainability and recyclability are the key to this,” Yin Ying added. “RGE is evidently prepared to invest significantly in research and development – including investing in its employees to further this goal. I’m happy to support APR’s ‘From Plantation to Fashion’ vision, with textile production processes that are sustainable and constantly innovating.”

Upon the completion of her Finland stint in October this year, Yin Ying is looking forward to returning to Indonesia to join Asia Pacific Rayon (APR) and apply her technical knowledge. Under Dr Sixta’s supervision, she will continue on her research project exploring the use of clean solvents in textile fibre production through different technology processes like Ioncell and Lyocell.

“My parents and friends don’t understand the complexity of textile production and my research. I explain that everyone knows pork lard is a key ingredient to make the best tasting Char Kway Teow but too much pork lard can choke up your arteries. What I am trying to discover is how to adjust the same ingredients and replace the lard with something healthier so that the best tasting dish is still being served at the same price for all to enjoy!”, she shared.

The insights from the research will contribute to the reimagination of fibre production as we know it, working towards a sustainable yet high quality fashion-forward future. In Pangkalan Kerinci, Yin Ying will have access to a new pilot plant in Kerinci that allows simulation of the entire viscose production process to accelerate her work.

“I really can’t wait to return to work in Kerinci. We have already identified a list of priority projects in next-generation production and product development,” Yin Ying shared. “Needless to say, I feel fortunate right now to be adding to my existing knowledge and studying here in Finland.”

For now, Yin Ying is taking full advantage of her remaining months in Finland to immerse herself into the culture and life in Finland.

“Unfortunately, I don’t think I’ll be able to travel to other parts of Europe due to the ongoing pandemic. I am just thankful I was able to visit Iceland, Austria, Germany, Switzerland and France before Covid-19 while on my year-long stint here.”

Char Kway Teow is a famous fried noodles dish from Malaysia where Yin Ying was born.

Interview with Allen Zhang
President of Sateri

Leading viscose fibre producer Sateri has kept its foot firmly on the gas in recent months, with milestones that include starting production of lyocell fibres in China and launching a new commercial scale viscose fibre made from recycled textile waste – all in the midst of a global pandemic.

This is an excerpt of an in-depth interview with Sateri President Allen Zhang published by just-style in September 2020. Full interview by Beth Wright is available here.

> “Our sustainability focus is in two key areas. First, we ensure we source from sustainably managed plantations that are free from deforestation. Second, we pursue circularity in our manufacturing operations.”

Sustainable Sourcing

As a raw material supplier, Sateri is at the critical start point of a sustainable value chain.

Its viscose fibres are made of wood cellulose from sustainably managed plantations – including fast-growing eucalyptus and acacia trees – which is processed to remove lignin, a glue-like substance that binds fibres together, before being repeatedly filtered and washed to form dissolving wood pulp. This pulp is then dissolved into a viscous liquid and crystallised into regenerated cellulose threads.

"Our sustainability focus is in two key areas. First, we ensure we source from sustainably managed plantations that are free from deforestation. On this front, being part of a group of companies that is vertically integrated from plantation manufacturing to yarn spinning gives us a high level of oversight and influence over the upstream textile value chain.

"Second, we pursue circularity in our manufacturing operations. This requires us to invest not only in best-in-class technology for greenfield projects but also upgrade facilities of our existing and acquired mills to improve the use and recovery of chemicals, water and energy."

The firm, which recently joined the UN Fashion Industry Charter for Climate Action, aims to have all its mills meet the European Union Best Available Techniques (EU BAT) standards by 2023. Its facilities in Jiujiang and Jiangxi were confirmed EU-BAT compliant last month, following verification of its Fujian mill in April. Other achievements include the STeP by Oeko-Tex and Standard 100 by Oeko-Tex certifications, along with the Made In Green by Oeko-Tex product label to verify its viscose products are safe and responsibly produced.

Four of Sateri's five mills have also obtained the Chain of Custody (CoC) certification from the Programme for the Endorsement of Forestry Certification (PEFC), and are certified under ISO 9001 and ISO 14001.

The company also says it is one of the world's first viscose mills to have completed the Higg Facility Environmental Module (FEM) assessment.

Beyond these initiatives, Sateri also works closely with its downstream partners in yarn and garment manufacturing, particularly in carbon reduction. Last year it initiated a Climate

Leadership Programme in collaboration with the China National Textile and Apparel Council (CNTAC) to explore how product innovation at upstream companies can help drive energy conservation and decarbonisation in downstream production processes.

The company also works to communicate sustainability across the entire value chain. Examples include its Tracer initiative, which links producer to consumer by embedding the firm's fibres with a tracer that can be detected through a scanner to give consumers the confidence that they are buying a garment that is authentic, and sustainably sourced and manufactured.

Regenerating Textile Waste

Sateri is also forging ahead to commercialise the production of viscose incorporating post-consumer white cotton textile waste that uses dissolving pulp made by Swedish company Södra and can be processed on existing spinning technologies. The first apparel featuring the new FINEX™ fibre was produced by outdoor brand Lafuma ahead of 618, China's major mid-year online shopping festival.

While Zhang did not divulge the percentage of textile waste that is used, he says Sateri is working towards a higher percentage mix to meet the 5% and 20% required by the Recycled Content (RCS) and Global Recycled (GRS) Standards, respectively in collaboration with Södra and other dissolving pulp suppliers, as well as the development of in-house solutions.

"Even though the technology to recycle cotton is currently the most advanced, we remain agnostic to the type of recycled cellulosic feedstock used in our ongoing efforts to close the loop. We hope our investment in textile fibre innovation and technology will yield a wider range of commercially viable options in the near future, including viscose-to-viscose textile recycling."

When asked about the challenges in regenerating textile waste into new fibres, he highlights two hurdles. "The two main technical challenges for any form of textile-to-textile fibre recycling are colour and fibre separation. Most textiles today are made from a blend of fibres. Even a 100% cotton bed linen, for instance, will have trimmings made from polyester."

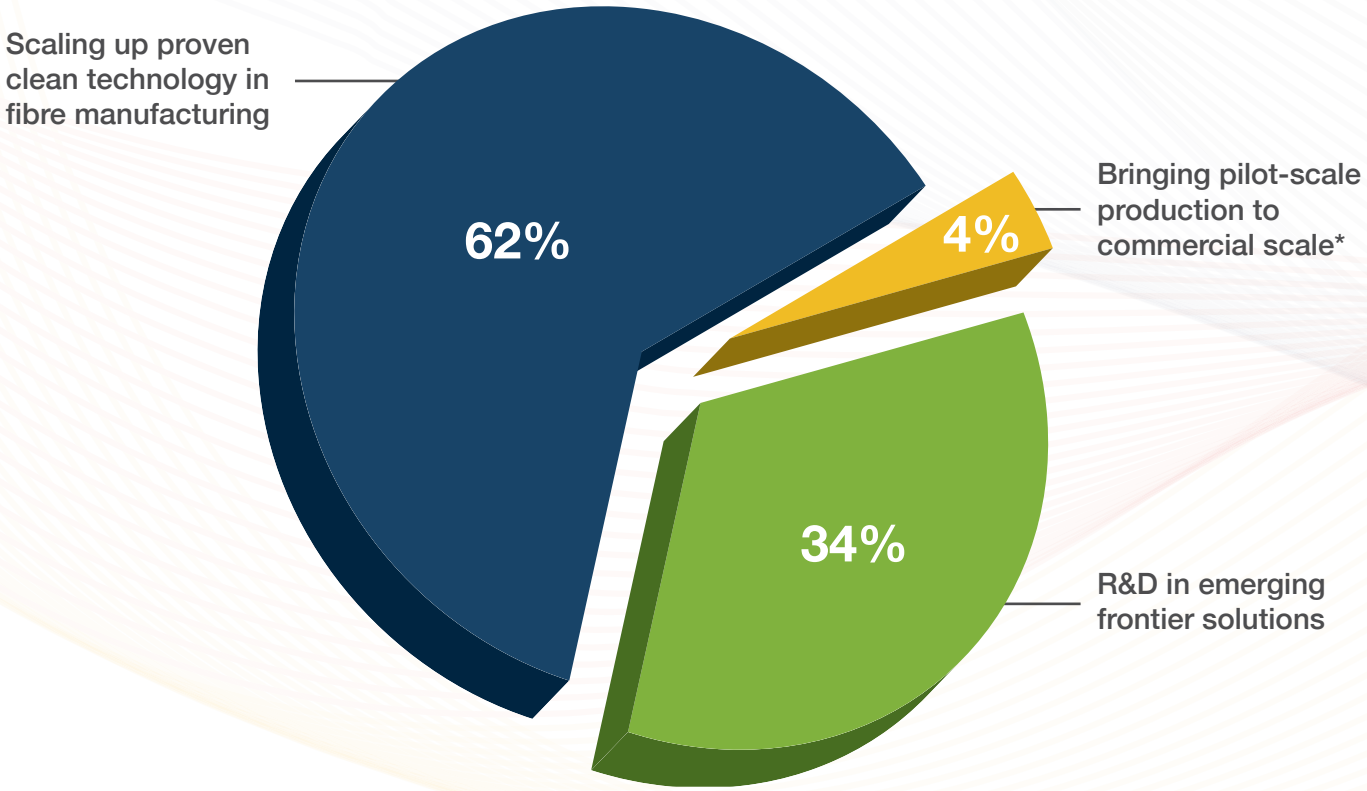
"Our insistence on quality means we have to consider not just how the pulp performs in our viscose production process, but also how the fibre will be compatible with the processes of our downstream customers like yarn spinners. We set high parameters because we believe that we should be upcycling rather than downcycling."

Scale and cost are two further hurdles to ramping up textile-to-textile fibre recycling.

"Consumers, particularly in the mass market segment, are generally reluctant to pay more for eco-friendly products. While there are brand partners who are willing to invest in innovation and share costs, the bulk of the burden rests on manufacturers, so there is long-term risk in financial viability and an ever present need for patient capital. Ultimately, cost is a function of economies of scale. As a large-scale manufacturer, we understand the importance of scaling up production in bringing costs down – our entry into China's lyocell market seeks to do just that."

Other major challenges relate to policy and infrastructure. "In textile waste collection for fibre recycling, for example, there are existing policies that limit or ban textile waste collection import and export. This is a pre-competitive area that industry actors will do well banding together to tackle," Zhang suggests.

Actual Expenditure (2019/2020)



In USD (million)

Scaling up proven clean technology in fibre manufacturing	
Lyocell 20,000 ton production line	**25.9**
Bringing pilot-scale production to commercial scale*	
FINEX™	**1.6**
R&D in emerging frontier solutions	
Sateri R&D Innovation Centre and 5,000 ton pilot line	**11.8**
Kerinci viscose pilot plant	**1.4**
2 x post-doc research sponsorship	**0.8**
Piloting alternatives for plastics research project	**0.02**
TOTAL	**41.52**

**Investment amount in Infinited Fiber Company is bound by agreement confidentiality.*

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