Äänekoski biorefinery

A case study

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Innovation:	**Biorefinery**
Intervention:	**Äänekoski bioproduct mill**
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Methodology:	2 interviews, desktop research. Limited/incomplete case study due to actors withdrawing from participation.
Case Study Overview	
Sector(s):	Paper
Value Chain Stage(s):	Resource and production
Type of Intervention:	Technical
Date & Duration:	Planning started in 2013, construction was initiated in April 2015, and the bioproduct mill came into operation in August 2017 with a one-year ramp-up, reaching full production in August 2018. In October 2018 the construction of a textile fibre demo plant was initiated, to be finished by late 2019.
Location:	Äänekoski, Finland
Initiating Actors:	Metsä Fibre
Actor Constellation:	Sweco (general engineering consultant), Andritz and Valmet (pulping technology suppliers), EcoEnergy (biogas plant), Itochu (textile fibre partner), Metsä Spring (venture capital and innovation firm within Metsä) and a network of research and innovation partners.
Short Description of Intervention:	The Äänekoski bioproduct mill is a replacement for an old pulp mill in Äänekoski by Metsä Fibre and is the largest pulp mill in Europe. When planning to renew production at the Äänekoski mill, the decision was made to expand significantly, become independent of fossil resources for the operations, and create a biorefinery ecosystem around the mill open for diversification in collaboration with partners or through joint ventures. The bioproduct mill uses wood (mainly softwood) to produce kraft pulp (1.3 million tpa), and a range of byproducts – some of which have been produced in pulp mills previously, e.g. turpentine (3 200 tpa), tall oil (46 000 tpa), and electricity (1 TWh), and some less conventional products, e.g. biogas and sulphuric acid. State-of-the-art technologies were acquired from traditional pulp and paper process technology suppliers Andritz and Valmet. On-site operations (cranes, trucks etc.) are automated and electrified, the lime kiln uses producer gas from a wood gasifier, sulphuric acid is produced on-site, the waste water sludge is used for biogas production by a partner, new wood based textile fibre production is being developed in a joint venture with a partner company. Most technological solutions are not new, but the scale and application domain for several of them (e.g. bark gasification and sulphuric acid production) are, as well as their combination. The aim is further to expand the product portfolio with new products, of which textile fibres from kraft pulp is first in line with a demo plant currently under construction in a joint venture.
Research Theme Summaries	
1. Innovation History & Dynamics:	In 2013 the planning started for revamping and expanding the Äänekoski pulp mill in a small group within Metsä who focused on developing the plant towards a biorefinery, i.e. diversifying the product portfolio towards non-pulp products, and to do this through collaborations rather than developing all side processes and streams within Metsä. A significant risk and barrier was the scale of the application for many of the technologies used, most of which had previously been tested in similar applications but at a smaller scale. The scale also decreased the willingness to take risks, e.g. in making choices for even more innovative technologies. Main drivers for the project were perceived necessity of going into a direction of product portfolio diversification, while simultaneously going against many competitors and not investing in biofuel production processes.
2. Governance Arrangements & Agents of Change:	The main technologies for the conventional pulp production were acquired from the major technology suppliers Andritz and Valmet, aiming for state-of-the art solutions regarding energy efficiency and pushing for non-conventional solutions, e.g. sulphuric acid production from off-gases. The mill has been opened for other firms to invest in processes using available resources, such as biogas from waste water sludge by EcoEnergy, and joint ventures have been formed to market other new products, e.g. textile fibres through a

	joint venture with Itochu. The development of the fibre production process came out of a previous collaborative research project called Future Biorefinery. A significant share of the 1.2 billion EUR investment – the largest investment in Finish forest industry ever – was secured internally in Metsä, while the majority was loans from EIB (200 MEUR), the EFSI (75 MEUR), and other European Banks. A 32 MEUR investment support was granted by the Finish state for renewable energy and efficiency measures.
3. Transformative Capacities:	Building capacity through networks and acting as an "orchestra conductor" has been an important strategy for Metsä, a strategy which although it can be slow and tedious has reportedly been successful in building up a broader capacity than would otherwise have been possible. Regarding the new textile fibre production, partnering with Itochu was reportedly primarily for reasons of downstream market knowledge and access, as this is a market of which Metsä has little knowledge. The bioproduct mill builds on the competences and resources of the forest and pulp industry that has a long and strong tradition in Scandinavia. The availability of biomass resources in the form of forests – the growth rates of which are increasing – is a significant driver for the industry to develop new products from wood in a carbon-constrained world. Simultaneously, an increasing harvest rate has been challenged as this reduces the carbon sink provided by the forests. Stricter regulations on forest management could hamper the expansion of forest-based bioproducts, a concern raised by the actors.
4. Assessment & Evaluation:	The assessments and evaluations focus on energy efficiency rather than decarbonisation, as the previous mill was already (as most pulp mills) almost fossil-free. Compared to conventional pulp mills where the non-pulp products may correspond to 10% of the revenue, the Äänekoski bioproduct mill earns 20% from other products, the main one being electricity produced from biomass residues (the mill produces 140% more electricity than it uses, compared to a conventional mill that may produce around 50% more than its demand).
5. Uptake & Consequences:	The biorefinery is a widely diffused concept in the pulp industry, where many firms have focused on liquid biofuels as the main new product category. Metsä on the other hand have excluded fuels from the product portfolio and focused their work on structural products, e.g. biocomposites and textile fibres, while using residual resources for energy. Regarding some of the more specific technological solutions scaled up and implemented in the Äänekoski bioproduct mill it remains to be seen to what degree these diffuse within the sector, which will take time as major reconfigurations of mills happen only every few decades.
Conclusion & Outlook	
Key Learnings:	The Äänekoski bioproduct mill is an example of the biorefinery development pathway that has become prominent in the discussion about the future for pulp mill development. It shows that portfolio diversification is still a minor activity, but it receives much attention and interest. A network governance model for innovation breaks the traditional sectoral boundary constraints and has seemingly been successful in this case. As the literature has reported many complications for other actors aiming to move towards biorefineries through collaborations, following the developments in Äänekoski over time will be relevant for better understanding such network dynamics. However, the main part of the bioproduct mill is a traditional pulp mill which is fully controlled by Metsä and thus the novelty of the approach and implementation should thus not be overestimated.
Open Questions & Further Research Requirements:	

For Europe to achieve its long-term climate objectives, carbon-intensive industries have to reduce their emissions.

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To gain a broader understanding of the possibilities of transition, entire value chains of the industries are studied. This includes non-technical factors such as supply chains, financing, trade, and social and economic impacts. Together with forward-looking industry leaders and policy-makers, we explore potentials and capabilities for making transitions in these resource-intensive industries.

PARTICIPANTS & FUNDING

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