

Lime kiln conversion

A case study

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Innovation:	Lime kiln fired with biofuel
Intervention:	New lime kiln at SCA Östrand (Bioloop)
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Methodology:	4 interviews with a total of 5 people. Background information from the internet (e.g., press releases) and on lime kilns in kraft pulp mills.
<i>Case Study Overview</i>	
Sector(s):	Paper
Value Chain Stage(s):	Primary pulp production
Type of Intervention:	Technical intervention
Date & Duration:	Project announced 2009 and kiln in operation 2011
Location:	Sweden
Initiating Actors:	SCA
Actor Constellation:	SCA and equipment supplier Andritz. SCA had clear criteria and demands to which Andritz offered a solution in competition with Valmet.
Short Description of Intervention:	<p>The intervention consists of SCA's investment (500 MSEK) in a new wood powder-fired lime kiln at Östrand kraft pulp mill in Timrå. The new powder-fired lime kiln at SCA Östrand replaced two oil-fired lime kilns. The lime kiln is primarily fuelled by wood powder from ground pellets, but also uses gases from the mill (that need to be dealt with anyway), and has oil as back-up in case of problems, upstarts, etc. The pellets are supplied by SCA's wood pellet factory BioNorr in Härnösand, which is only 40 km away. The equipment was supplied by Andritz.</p> <p>Lime kilns are a key process step in the chemical recovery system in kraft pulping. In the lime kiln, calcium carbonate (lime mud) is converted to calcium oxide (re-burned lime mud) via calcination. The lime kiln receives lime mud from the causticizers which prepare the cooking chemicals (white liquor) and then returns calcium oxide to the white liquor preparation. The kiln is a long rotary kiln typically fired by oil or gas to provide a high and stable temperature for the reaction.</p>
<i>Research Theme Summaries</i>	
1. Innovation History & Dynamics:	<p>At the time of deciding to invest in a new lime kiln there were two plants in Sweden that had partial wood/bark-powder firing in converted kilns (Södra's pulp mill in Mönsterås and Kappa Kraftliner in Piteå). However, Östrand was the first ever new-build and new investment for near 100 % wood powder firing. The innovation built on the research on wood powder fired boilers in Sweden and elsewhere, which goes back to the 1980s, and the installation of a number of wood powder burners in converted boilers and CHP plants that previously fired coal. Nevertheless, firing basically 100 % wood powder in a new large lime kiln meant pushing the technical development since there is a chemical process in the kiln and the re-burned lime mud must meet certain quality requirements. Hence, new burners had to be designed and fine-tuned in order to ensure good heat distribution in the kiln, the right flame temperatures and shapes, etc. Excessive temperatures cause refractory damage and over-burned slow reacting lime product. Andritz, who put together the system with lime kiln, grinders, fuel feed, etc., had good theoretical knowledge of wood powder burners, but no previous practical experience of powder burners in rotary lime kilns. SCA had experience of producing and handling wood pellets.</p> <p>An important challenge for this intervention was the handling of large amounts of pellets and powder (about 11.5 ton/h) including explosion risks. However, to secure a stable supply of wood pellets was not a challenge in this case since SCA has a wood pellet factory at a relatively nearby site. Moreover, the logistics were already in place with trucks delivering sawdust to the pellet factory from sawmills close to the pulp mill and then going back empty. These could now transport pellets on the way back. As a consequence of the intervention, the wood pellet factory now had a customer with a stable all-year demand totalling 55,000 t/yr (the capacity is 160,000 t/yr) and can thus avoid seasonal storage. The pellet market is otherwise driven by the seasonal demand for space heating.</p>

	<p>A minor institutional barrier to this intervention concerned the required renewal of the environmental permit for the pulp mill as a result of the lime kiln investment, a process in which the increased NO_x emissions were challenged by the authorities (the NO_x emissions are higher for wood powder burners than oil-fired burners).</p> <p>Based on the good experiences from Östrand, SCA made a decision in 2012 to also invest (490 MSEK) in a wood powder lime kiln at Munksund pulp mill. This time it was together with Valmet who were keen on doing it and getting a show-case/reference. Also Södra decided to invest in a wood powder fired lime kiln at Värö pulp mill in 2012, which was in operation 2015. However, no other investments in wood powder fired lime kilns have been identified apart from Östrand, Munksund and Värö. At the moment, there appears to be greater interest in biogas fired lime kilns where the biogas is produced via thermal gasification.</p>
<p>2. Governance Arrangements & Agents of Change:</p>	<p>The key actors in this intervention are SCA, Andritz and Valmet. Andritz and Valmet (the only two suppliers in the European market) made competing bids for the project. Andritz was chosen primarily because they provided guarantees for the technology. The arrangement was a pretty normal project procurement except both SCA and Andritz were prepared to push technical development. At Andritz the project was managed and carried out by Andritz Finland which appears to be relatively autonomous from the mother company and to have had large degrees of freedom in this project.</p> <p>The investment decision at SCA aligned with their long-term investment strategy and of maintaining a green profile. Some years earlier, plans had been made to expand the mill but the 2008-2009 recession made investments a challenge. In an effort to proceed with expansion plans the lime kiln was identified as the most interesting and profitable investment (the oil-fired lime kilns were unreliable and a bottle neck at the time). The oil price was fairly high at the time and the price of wood pellets was expected to be favourable to oil in the long-term. The synergy to buy wood pellets from the sister company was also recognised. Particular government policies, including the EU ETS, were not important for the investment decision.</p> <p>The financing of the intervention could not be determined from the interviews but SCA is a financially strong company. At both SCA and Andritz, new knowledge and training were required for the handling of wood pellets and powder, which involves explosion risks.</p> <p>The use of wood pellets at the pulp mill entailed new business between sister companies and highlighted the opportunity for synergies within the SCA group. The intervention strengthened the green profile of SCA and provided a stable demand for wood pellets for the wood pellet factory.</p>
<p>3. Transformative Capacities:</p>	<p>The intervention builds on previous skills in SCA (e.g., in producing and handling pellets) and in Andritz (e.g., theoretical background in wood powder burners) but also required new skills to be developed. Although wood and bark powder burners in lime kilns already existed, this was the first ever 100 % full-scale wood powder fired kiln. In particular, the pellet and powder handling required new skills, including in dealing with explosion risks. Although it involved technical challenges, these were judged to be small enough for Andritz to make an offer aligned with the SCA demands for very high availability in what was jokingly referred to as “a full scale pilot”.</p> <p>A key reason for going ahead with the project was that it was profitable with the relatively high oil prices that prevailed at the time, but it was also very much aligned with SCA corporate strategy to be an environmental leader. Both companies see themselves as innovative forerunners. The project was never challenged or questioned from corporate headquarters. The project itself has not been used for marketing or branding. For this purpose, environmental goals and emission trends are reported on a more aggregate level.</p>
<p>4. Assessment & Evaluation:</p>	<p>The emission reductions are easy to calculate through the avoided use of oil (17 000 m³ of oil per year is about 46 kt of carbon dioxide). It is considered a successful project by SCA and Andritz but it has not been evaluated by external actors. The carbon reductions and sustainability are also dependent on sustainable forestry.</p>
<p>5. Uptake & Consequences:</p>	<p>Being or striving to become fossil-free appears to be a strong norm in the Swedish paper industry. This is not the case in other parts of the world. Reducing oil dependence has</p>

	<p>been on the agenda for decades. The pellet market started mainly for space heating and small boilers. The project increased pellet demand with likely effects on the pellet market and regional bioenergy development. The mill expansion as a whole was expected to generate 600-700 new jobs but mainly upstream and downstream and only a few jobs at the mill itself. The projects at Munksund and Värö may have had similar effects. The project is aligned with and may have strengthened corporate strategy and image as an environmental leader. Forestry effects on biodiversity are always an issue but it is not possible to attribute effects to a single project.</p>
<i>Conclusion & Outlook</i>	
Key Learnings:	<p>The case illustrates the importance of the mill context (e.g., expansion plans), including material and geographical factors (proximity of pellets), path dependency (e.g., pellets market for space heating), and trust between actors in the choice of technical solution.</p> <p>Alternatives to wood powder include gas from gasification, tall oil and bark powder. Mills with less direct access to pellets seem to prefer gasification. Tall oil goes to transport fuels due to strong policy induced demand. Bark powder is slightly more technically challenging than wood powder.</p> <p>Getting away from oil, and doing so profitably, was a key driver and going ahead with decarbonisation has been part and parcel of corporate strategy for a long time. Overall strategy and future expectations are key to strategic investment decisions, and EU-ETS played a very small role in motivating the investment.</p> <p>The innovation may spread to kraft pulp mills in other parts of the world but it is of less relevance to paper mills in Europe. Here, a key option is electrification to replace natural gas used primarily in steam generation for heating and drying. Investments must be profitable to be made – this motivates policy to change relative fuel and electricity prices.</p>
Open Questions & Further Research Requirements:	<p>Electrification options for the paper industry need further research. Electric boilers may be easily installed but more energy efficient options (e.g., high temperature heat pumps and process heat integration) should be pursued.</p>

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