The research leading to these results has received funding from the European Community's Seventh Framework Programme under grant agreement n° 604187.

Co-funded by the European Union

REFFIBRE NEWSLETTER DECEMBER 2016

REFFIBRE: Maximising the value from paper for recycling

The REFFIBRE project has aimed at developing tools and knowledge that are necessary for eco-designing resource-efficient paper and board production processes. The focus was on paper for recycling (PfR) as the main raw material in paper and board production. In the multiple-output mill concept novel bio-based products -along with traditional paper and board- are produced from side streams taken out of the main production line. New processes have been proposed and demonstrated in cooperation with the REFFIBRE industrial partners, and newly developed tools have been proposed for informing resource efficiency-oriented decision making in the paper and board industry.

Work Package 1: Value Chain

WP1 has focused on determining the value chain-level impacts of the optimised use of PfR. This was done by defining and verifying a number of environmental and resource efficiency indicators, calculated with the use of LCA methodology, that are applicable at product and at process level. Calculating these can use input from other Work Packages (2 and 3), where process models and paper characteristics models have been used in tandem so as to generate information about energy and material use changes under various scenarios, e.g. increasing rejects in deinking flotation, provided that useful applications exist for the additional amounts of side streams generated. The value of such indicators lies in finding areas of maximum potential for energy and material savings, determining the overall impact of changes performed at the process level, as well as in their use as a communication tool in the field of environmental awareness. Economic indicators have also been defined within WP1, which can clarify what the economic effects of a decision may be, as well as what the investment possibilities are. The verification of the applicability of the indicators can be found at http://reffibre.eu/publications.

A mass flow model for fibres used within the CEPI region for six product segments (newsprint, other graphic papers, case materials, other packaging, sanitary & household, and other paper & board) has also been developed within WP1. This model serves as the basis for an innovative way to calculate the Mean Fibre Age (MFA) and Mean Number of Future Material Uses (MNU) for complex realistic recycling systems with multiple loops (http://reffibre.eu/publications). A demonstration tool for calculating these factors is now available for use via www.ptspaper.de/reffibre/src/reffibreMain.php. ISO/TS 14067 is the most appropriate LCA method for use by the paper industry, provided that further guidance regarding the calculation of the allocation factors is available. MFA and MNU have been important pieces of a new allocation methodology proposed within WP1 for treating recycling in LCA studies. The mass fibre flow model also provides the calculation of the recycling rate R, defined by CEPI (2014) as "utilisation of paper for recycling + net trade of paper for recycling compared to paper & board consumption". The results for different paper and board grades are summarized in Table 1. Please note that the MFA and MNU values depend solely on the mass balance that was derived from data reported by the national associations to CEPI. Some additional assumptions had to be made to fill gaps where no information was available. However, due to inconsistencies these assumptions need further research and can lead to changes in the MFA and MNU values.

Table 1. MFA, MNU and R for different product segments in the CEPI region

Product	MFA	MNU	MFA+MNU-1	R
Newsprint (NP)	2	4.2	5.2	0.89
Other graphic papers (OGP)	1.14	3.01	3.15	0.75
Case Materials (CM)	3.02	3.09	5.11	0.87
Carton Board & Other Packaging (OP)	1.85	2.79	3.64	0.90

Thus, results obtained for MFA and MNU allow for fibre age aspects to be included when calculating the allocation factors Ai and Ao for paper products in ISO/TS 14067. The allocation factors for the different products are summarized in the following table.

Table 2. LCA allocation factors for different product segments in the CEPI region, as calculated with the help of MFA and MNU

Product	Ai	Ao
Newsprint (NP)	0.8077	0.6154
Other graphic papers (OGP)	0.9556	0.6381
Case Materials (CM)	0.6047	0.4090
Carton Board & Other Packaging (OP)	0.7665	0.4918

Work Package 2: Production Design

The objective of WP2 has been to develop the tools necessary for modelling the relation between the quality and quantity of PfR components (fibres, fillers) and the quality and quantity of the produced paper and board. Such tools can allow the realisation of optimal pulp compositions for reducing energy and/or material use (eco-design), while keeping paper properties constant. By investigating the relations between pulp characteristics and basic publication and packaging paper properties, useful input can be provided in fields such as predicting energy demand for paper dewatering, moderating paper characteristics by modifying the ratios of different components in pulp, etc. The potential of layered design has also been investigated within the project as a means of developing specific paper properties by reallocating the various pulp fractions within the different layers. A short description of the method can be found at http://reffibre.eu/publications. Finally, the integrity value has been proposed within WP2 as an easy to calculate metric of strength potential in pulp from PfR.

Work Package 3: Process Tools

As already mentioned earlier, WP3 has been partly responsible for developing tools that can supply relevant information for the calculation of the LCA-based indicators defined in WP1. The contribution of WP3 has,

The research leading to these results has received funding from the European Community's Seventh Framework Programme under grant agreement n° 604187.

Co-funded by the European Union

namely, revolved around developing process models for processes such as screening, deinking flotation and dispersing. This modelling work has also been utilised for the development of a software tool –available for demonstration- that is able to calculate indicator values on the basis of data provided by the paper mill. An example of this is the economic assessment of pulp quality, which converts information about pulp composition (fibres, fines, fillers) and the presence of impurities (residual ink, stickies) into a value for the pulp at various process steps.

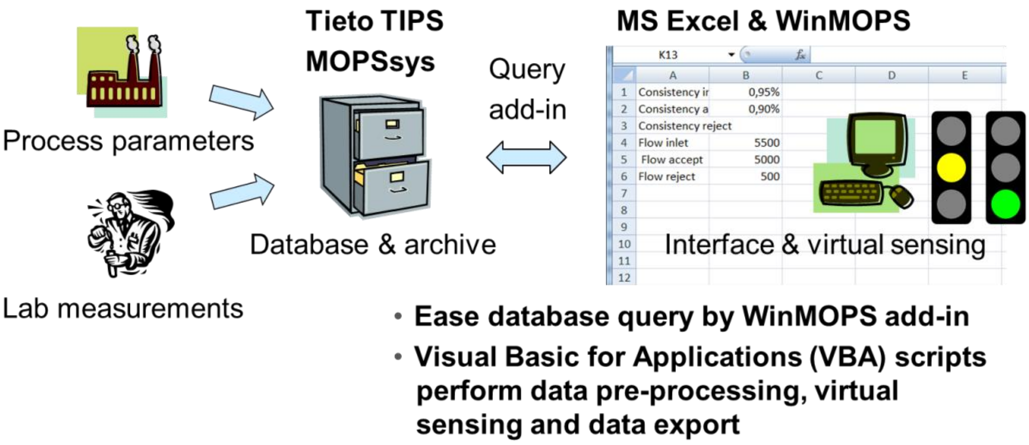

Figure 1. Proposed software interface for allowing the use of process models as "soft" sensors in the papermaking process

Besides process modelling, a systematic assessment of possible side stream applications has also been carried out within WP3, so as to select valorisation routes to be demonstrated within WP5. This systematic assessment has been also made available to the public in the form of a guide to side stream valorisation –to be found at http://reffibre.eu/publications- accompanied by a web-based tool that offers a condensed version of the information in an interactive way (http://reffibre-valorisation-tool.cepi.org/index.html).

Work Package 4: Integration

WP4 has had the role of integrating the models and tools created within WPs 1 (economic and environmental assessment), 2 (eco-design of paper production) and 3 (process modelling) so as to allow them to guide a resource efficiency-based decision making of paper and board producers (http://reffibre.eu/publications). The cornerstone of this is the publication of a guide for the practical implementation of resource efficiency indicators at industry level, which can facilitate the direct use of all developed models and tools by the industry for the optimisation of their products and processes. This includes the introduction of a Balanced Scorecard as a tool for supporting industrial parties that find themselves in complex situations with conflicting objectives.

Work Package 5: Demonstration

A number of demonstration trials have been carried out within WP5, aiming at the practical implementation of innovative technologies for the production of novel products out of streams already available at REFFIBRE industrial partners. These included the following:

- Pyrolysis of sludge streams for the reclamation of inorganic fillers
- Conversion of a variety of streams (sludge, fly ash from sludge and biomass incineration, deinked pulp) into material for the production of composites
- Fractionation of sludge
- Fibre reclamation from fine rejects

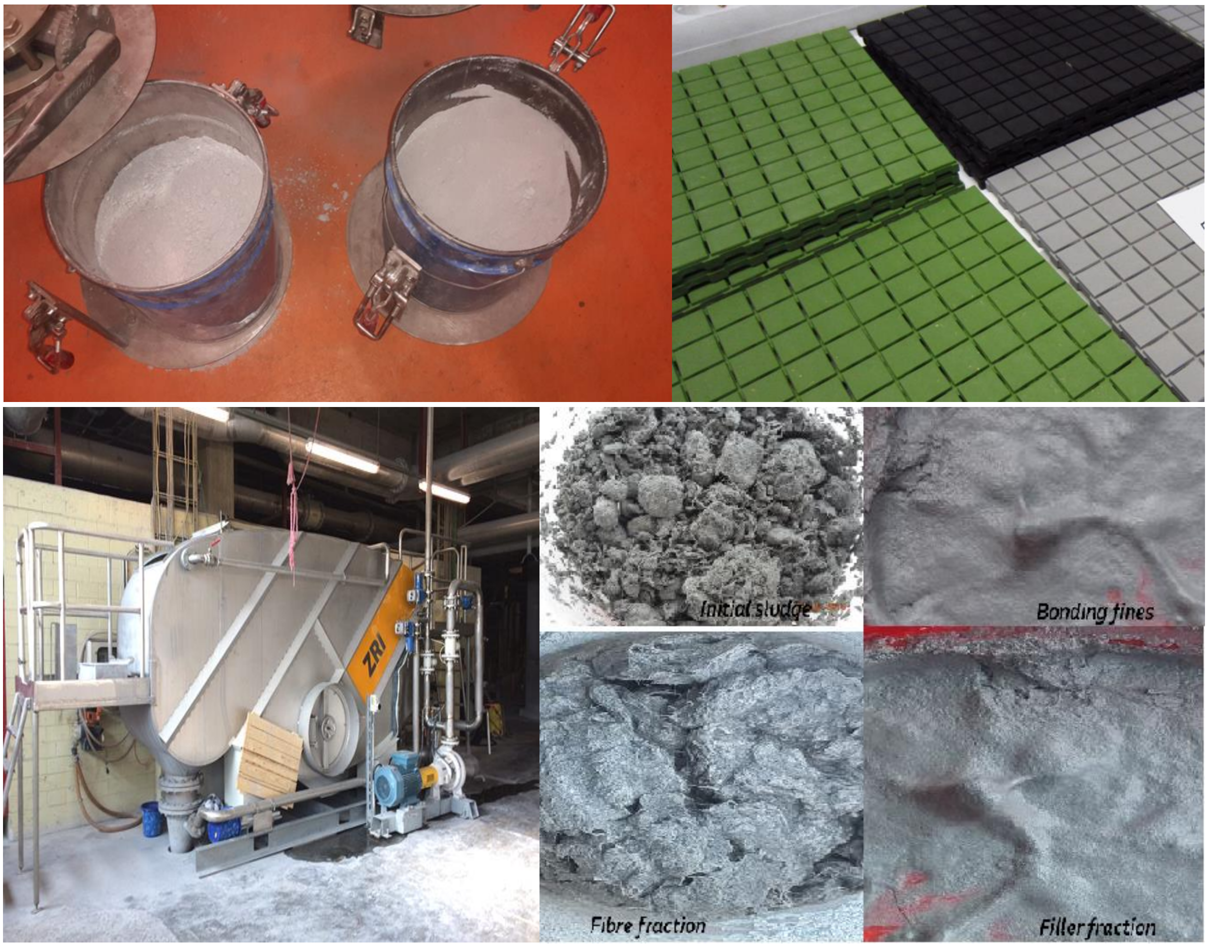

Figure 2. Clockwise from top right corner: Reclaimed mineral fillers from sludge by means of pyrolysis, floor tiles made out of side stream-containing composite materials, fractions generated during sludge fractionation, equipment used for fibre reclamation from fine rejects

Pilot-scale trials with pyrolysis have demonstrated the separation of fillers from paper mill sludge, but the quality of this reclaimed material needs to be further optimised or, alternatively, other end uses for it need to be studied, where impurities will not be as important as in paper production. Demonstration trials for the production of composite materials have indicated that the streams tested can be used in, e.g., injection moulding. Further product development and regulatory approval for the use of side streams are needed. Pilot-scale sludge fractionation showed that it is possible to separate different fractions out of paper industry sludge. The purity of these fractions was, however, worse than anticipated, making the reuse of organic fractions for papermaking a still suboptimal solution. Fibre reclamation from fine screen rejects was demonstrated on industrial scale; a good quality of the pulp stream after the addition of the reclaimed fibres is possible and the installed equipment is in continuous use in the Utzenstorf Papier mill for a longer-term evaluation.

Workpackage 6: Dissemination

The work carried out and the results obtained within the REFFIBRE project have been presented to various audiences, from research organisations to industry and decision makers, using different means ranging from peer-reviewed and professional publications to conference presentations. The REFFIBRE website, which has been the main conduit for information sharing, will remain available for at least five more years, allowing access to newsletters, workshop presentations and the public deliverables of the project.

All of us that have worked on the REFFIBRE project would like to thank you all who have followed our progress by participating in public workshops, visiting our website and reading this newsletter. The project work was concluded on October 31, 2016, but we will be happy to continue the work in cooperation with interested industrial partners and hear how our results can be applied for the optimisation of your activities.