Modelling circular economy in the Spanish pulp and paper industry

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INTRODUCTION

- The pulp and paper industry of Spain accounts for 15.236 billion €, which is 4.3% of the total industrial production value (Cámara de Comercio de España, 2018).

- Eucalyptus wood is the source of ~75% of the wood used for the manufacturing of pulp for paper (Aspapel, 2020). However, new regional regulations are limiting the maximum surface that will be available for this type of plantation in the future, affecting the availability of this commodity.

- In 2020, 66.9% of the national paper demand was collected for recycling (4384700 t) and the recycling ratio reached 78.3% (5130400 t) (Aspapel, 2020). The most recent goals have been set in >70% for the collection ratio at the national level by 2023 (Aspapel, 2020) and 76% paper recycling at the European level by 2030 (European Paper Recycling Council, 2022).

- Spain's national TIMES model represents the recycling process linearly and cannot describe the limits, reality and future scenarios of this industry.

CHANGES MADE TO THE MODEL

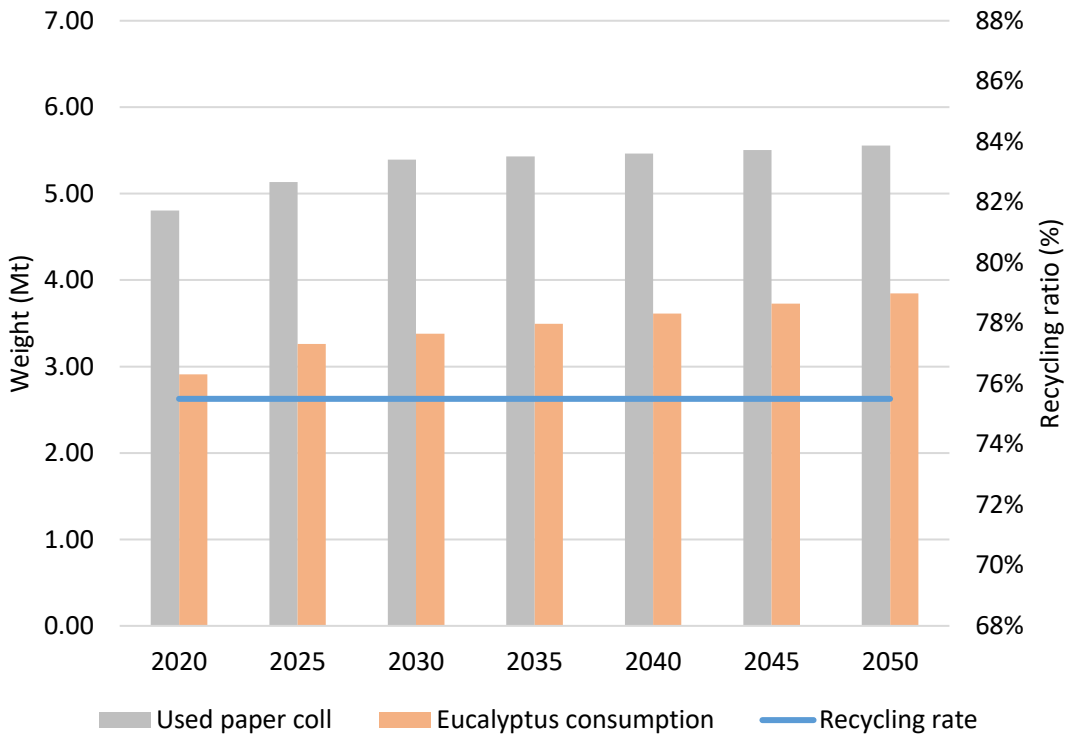
PREVIOUSLY	CURRENTLY
Paper for recycling was produced via a mining process with no upper limits and no correlation with the demand. This resulted in a recycling ratio >100% from 2030 onwards.	A collection ratio has been implemented in order to represent material limits and determining the maximum amount of paper that can be recycled.
Wood for paper pulp manufacturing was modelled as a generic commodity that did not differentiate between species.	Wood for paper pulp manufacturing has been divided into two new commodities: eucalyptus wood and pine wood. Special attention is now given to the eucalyptus wood commodity, allowing for the modelling of different scenarios according to future regulations.
Imports/exports of paper products, paper pulp and used paper for recycling were not modelled.	Imports/exports of paper products, paper pulp and use paper for recycling have been included with the purpose of accounting for all material flows.

SCENARIOS

IPP1

Collection ratio stagnant (66.9%)

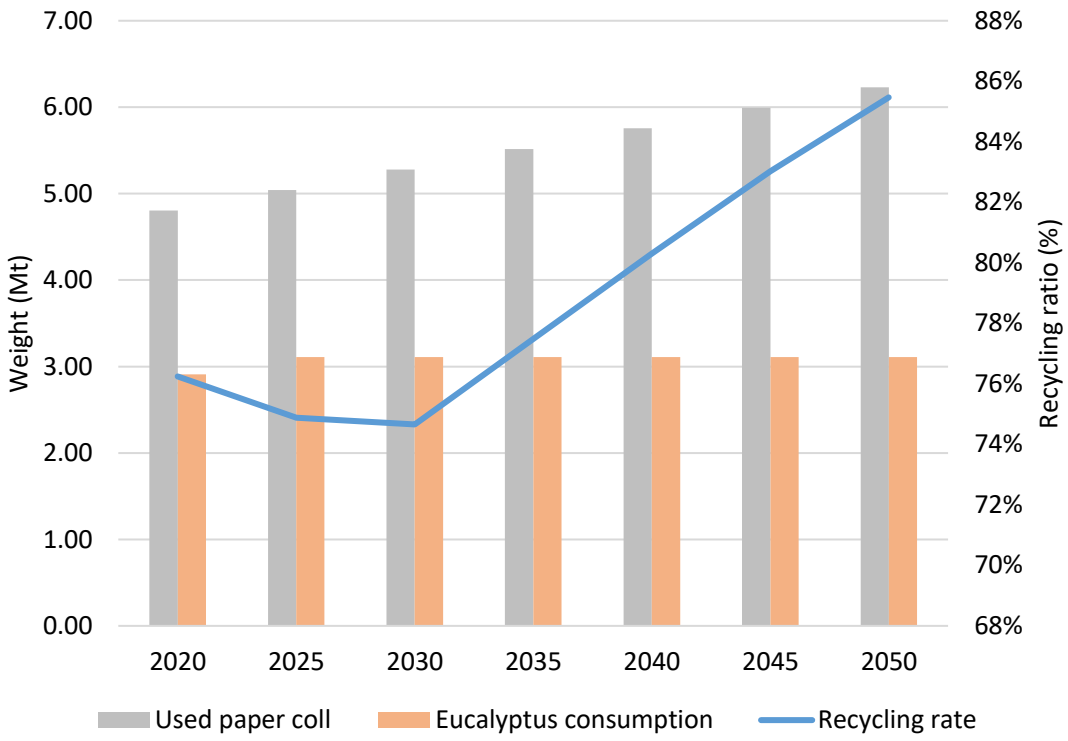
Eucalyptus stock allowed to grow at historical rate



IPP4

Collection ratio increased to 75%

Eucalyptus stock limited to max. historical value



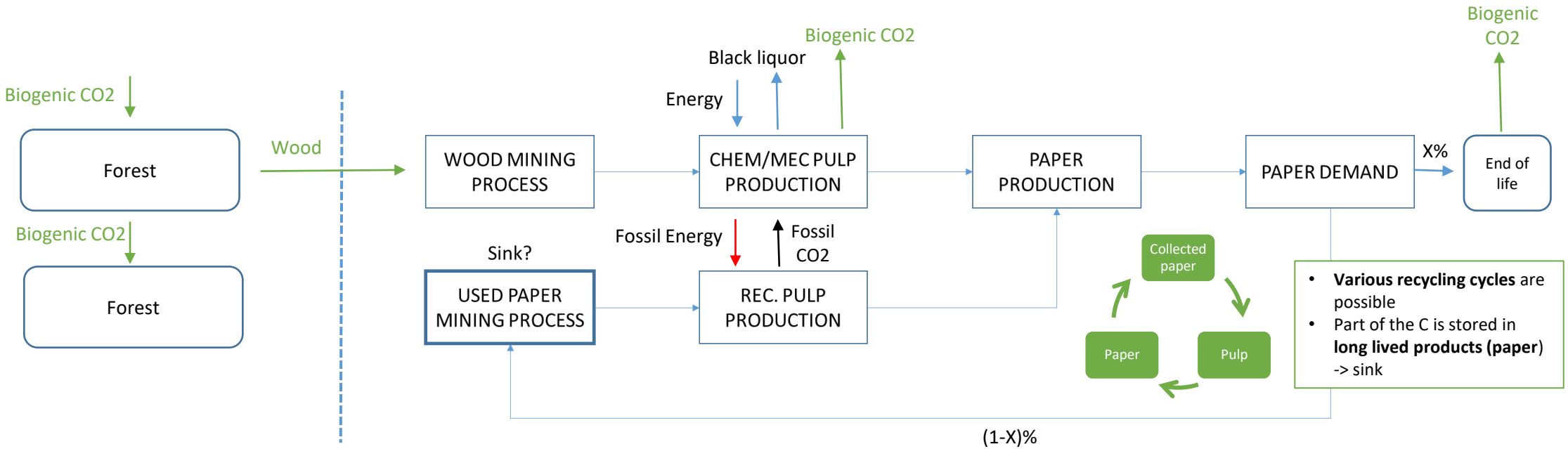
+5% CO_2 emissions

FUTURE CHALLENGES

SOME ISSUES TO CONSIDER

- Recycling is pulling CO2 emissions upwards since virgin pulp production uses the residual black liquor to produce process energy (biogenic CO2), while recycled pulp production uses fossil energy (fossil CO2)
- C contained in recycled paper enters again in the cycle. As various recycling cycles are possible, this C becomes stored in long lasting products and is not released into the atmosphere as C in used paper sent to end of life (landfill, valorization, composting, even second gen biofuels) does.
- The forest area not harvested for wood (due to the use of recycled paper) still keeps the upper ground C stock
- Collection of used paper can have important CO2 emissions due to transport processes

- How can we account for the CO_2 emissions avoided by recycling?



FUTURE CHALLENGES

- What is the best way of measuring circularity for materials in the TIMES family models?

Table 1
Summary of the reviewed circularity indices, including measurement basis and case studies (Env = Environment, Eco = Economy, Soc = Society).

Indices	Source/Developer	Unit	Env.	Eco.	Soc.	Case studies
New Product-level circularity metric	(Linder et al., 2017)	Economic value recirculation	x	x		Starter engines
Circ(T) or Cumulative Service Index	(Pauliuk et al., 2017)	Material recirculation over period of time	x			Steel (Pauliuk et al., 2017) Cr and Ni in Steel (Nakamura et al., 2017)
Material Circularity Indicator (MCI)	(EMF, 2015)	Material recirculation (0-1 index)	x			Unspecified widget (EMF, 2015) Used tires (Lonca et al., 2018) Tidal energy device (Walker et al., 2018) Catalytic converter in heavy off-road vehicles (Saidani et al., 2017)
Circularity index	(Cullen, 2017)	Circularity degree (%)	x			Energy intensive materials
Global circularity metric	(De Wit et al., 2018)	Material recirculation	x			The global economy
Circular Economy Indicator Prototype (CEIP)	(Cayzer et al., 2017)	Circularity degree (%)	x			Leather making (Cayzer et al., 2017) Catalytic converter (Saidani et al., 2017) Tidal energy device (Walker et al., 2018)
Circular economic value (CEV)	(Fogarassy et al., 2017)	Circularity degree (%)	x			Future Budapest 2024 Olympic Games (just a proposal)

Source: Corona, et al. (2019)

REFERENCES

- Cámara de Comercio de España. «*MAPA DEL SECTOR INDUSTRIAL ESPAÑOL*» 2018.

- Asociación Española de Fabricantes de Pasta, Papel y Cartón. «Memoria de Sostenibilidad.» 2021.

- European Paper Recycling Council. «European Declaration on Paper Recycling 2021-2030.» 2020.

- Corona, Blanca, Li Shen, Denise Reike, Jesús Rosales Carreón, and Ernst Worrel. "Towards sustainable development through the circular economy—A review and critical assessment on current circularity metrics." *Resources, Conservation and Recycling*, 2019.