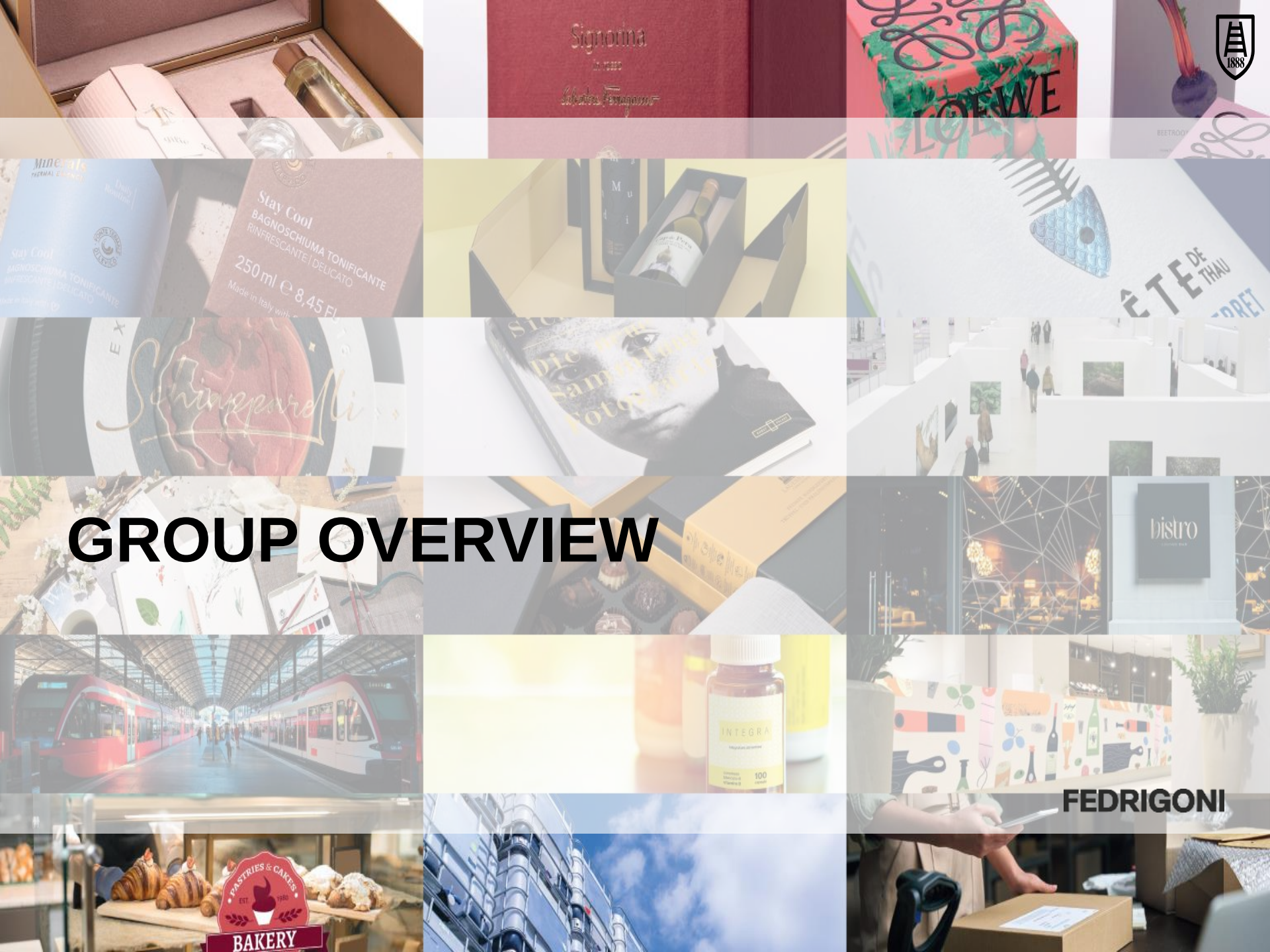
FEDRIGONI

Fabrication d'une électronique écoresponsable en utilisant du papier et des procédés l'électronique imprimée

Gaël DEPRES, Victor THENOT, Juliette SEIGNARD, Blandine JOYARD-PITIOT
Nadège Reverdy-Bruas Grenoble INP-Pagora

12/12/2024



GROUP OVERVIEW

Our organic growth since 1888 has recently been strengthened by numerous acquisitions, which resulted in revenues of approximately **€ 1.8 billion** in 2023.

Today we are the **first global player** in wine labels and high value-added papers for luxury packaging, and the **third largest player** in self-adhesive materials.

Our 2023 Numbers

1.8
Billion € Turnover*

338
Million € Proforma Adjusted EBITDA*

78
Production sites, Slitting and Distribution Centers

6,000
People

Present in **28** Countries

25,000
Products

Sells to **132** Countries

FEDRIGONI

2023 Group Turnover & Business Profile

Source: Financial Statement 2023 (excluded Office business):
Pro Forma Sales Revenues €1.8b
Pro-Forma Adjusted EBITDA: €338m

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Pro Forma Sales Revenues* by geography

49% Europe except Italy
30% Rest of the World
21% Italy

Pro Forma Sales Revenues* by business

60% Self-Adhesives+Tageos
15% Luxury Packaging
19% Creative Solutions
6% Premium fillers

Pro Forma Adjusted EBITDA by segment**

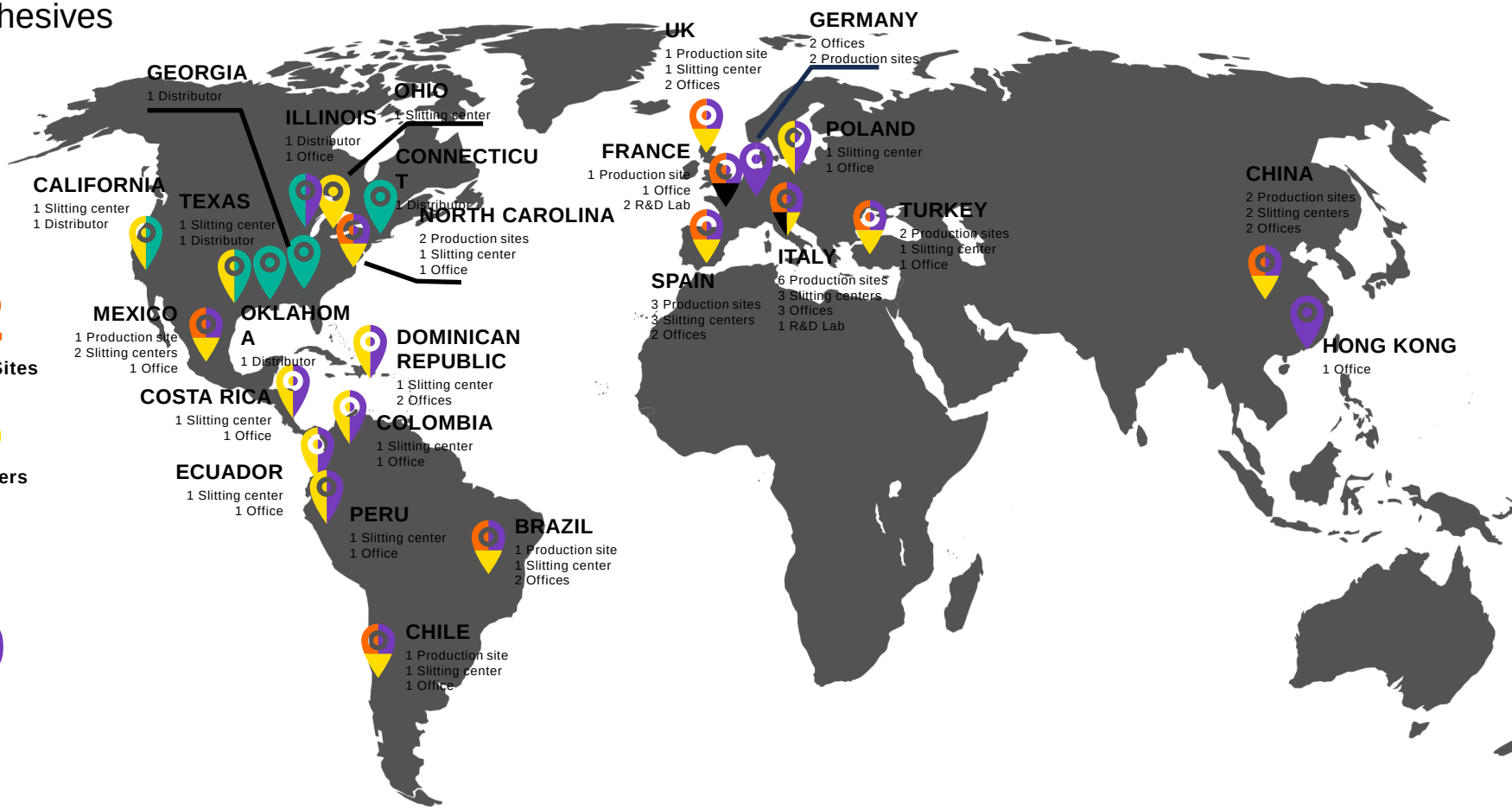
53% Self-Adhesives
47% Special Papers

*Assuming Tageos selling 100% in rest of EU and Arjo in Rest of world

**Adjusted EBITDA by segment includes a managerial adjustment to better reflect the impact of certain energy and pricing elements across the segments.

FEDRIGONI

Where we are
Self-Adhesives



22
Production Sites

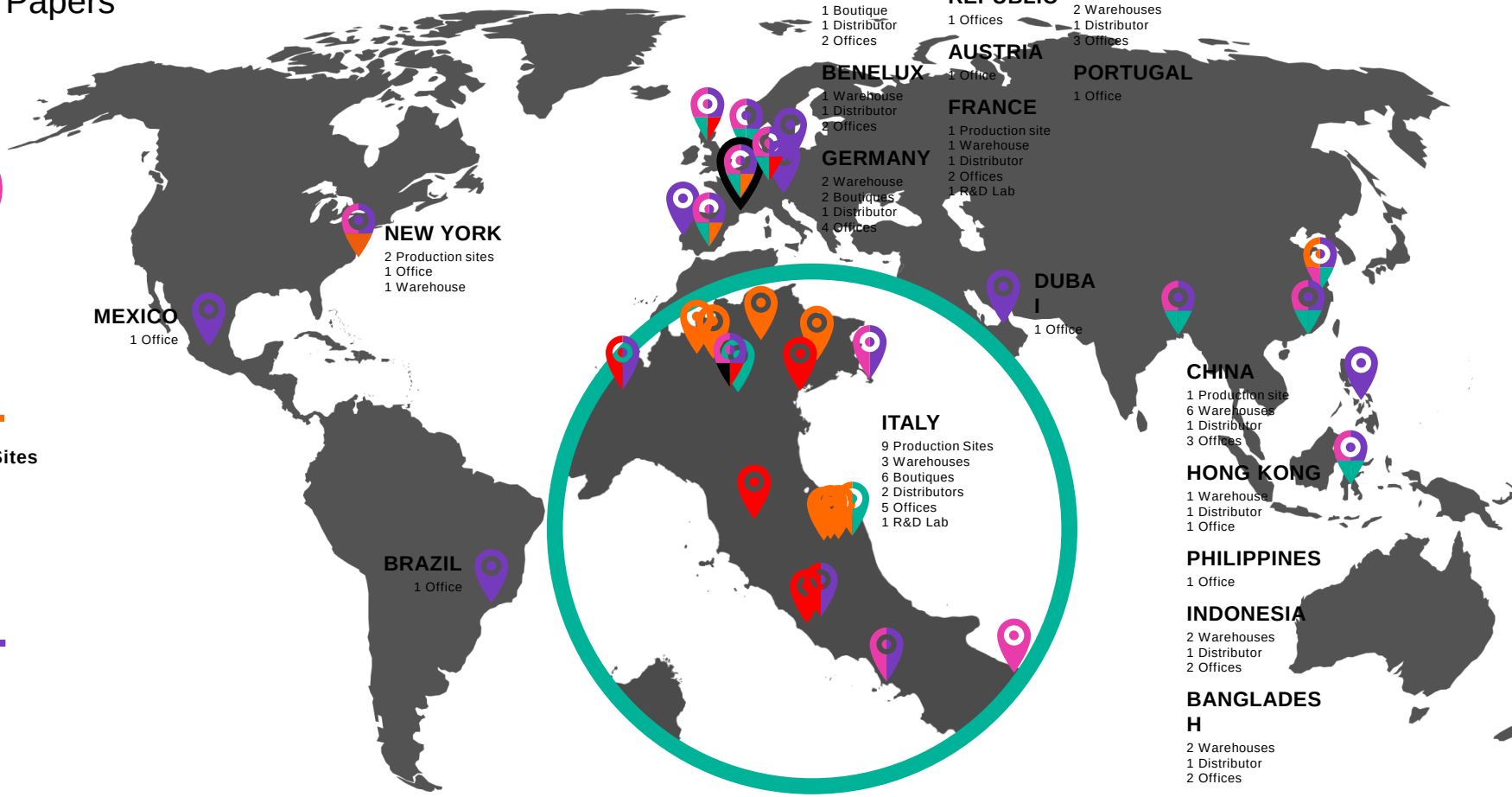
26
Slitting Centers

6
Distributors

29
Offices

2
Innovation Centers

Where we are
Special Papers



20 Warehouses

9 Boutiques

14 Production Sites

11 Distributors

34 Offices

2 Innovation Centers

Plastic in Packaging

- **79 % of plastic waste are accumulated in natural environment** (from Geyer et al , 2017)

Electronic waste

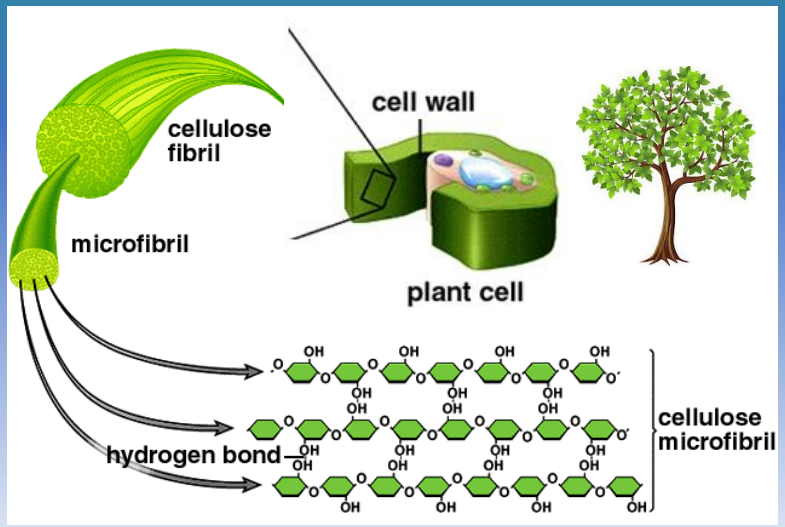
- **50 million tons/year of e-waste in the world!!**

Why paper could be a solution…?

- ✓ Sustainable
- ✓ Biodegradable
- ✓ Renewable
- ✓ Recyclable (80 % of paper is recycled in Europe)
- ✓ Cheap
- ✓ Flexible

- ✓ **Cellulose:** Earth's major biopolymer

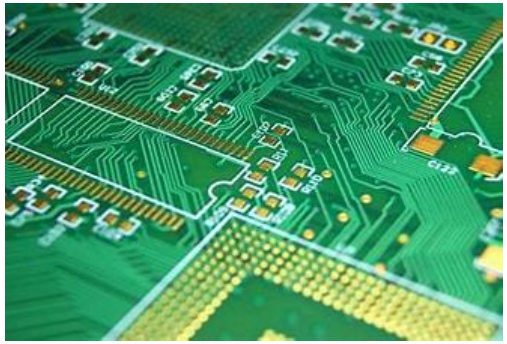
(e.g. 50% in wood; 90% in cotton)

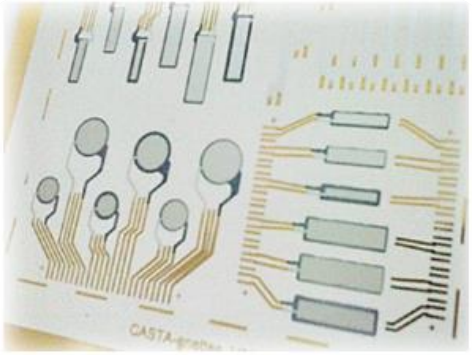


MAIN OBJECTIVES

Use paper as an alternative to plastic (PET) for flexible applications like labels or smart packaging.

Developed an environmentally friendly alternative to FR4 glass epoxy PCB, which are extremely difficult to recycle. The paper will be impregnated with bio-derivated polymer.





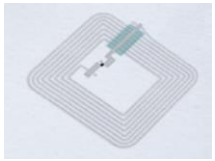
Printed electronics Roadmap

From dedicated paper to active smart Labels

active smart labels

2012 : R&D started paper dedicated to printed electronics

2014 : development of NFC printed tags



2015 : first sales of NFC tags (made by Screen printing)

2018 : Investment in Guarro for flexo machine

Development of sensors (temperature , pressure)

Passive NFC tags with sensors

2021 : Flexo ready for production

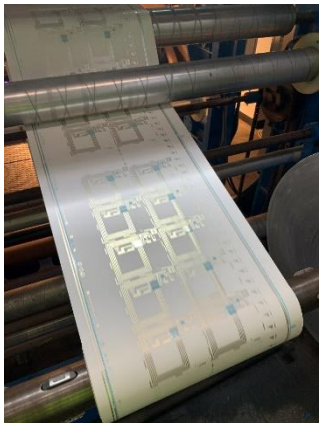
Development of UHF, printed battery and printed display

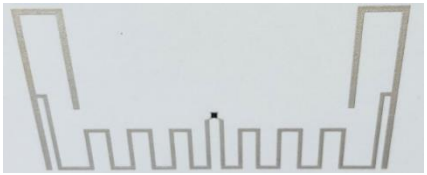
Paper Inlay manufacturing (production stage)

Roll (35 cm of width), printed with 4 heads Flexo machine
with comptetitive prices

NFC tags :

- Different size of antenna : 25 mm, 30 mm, ID1,…
- Different chips : NTAG, Mifare UL, ULC, DESFIRE, DNA,….
- Different chips inductance
- Different position of tags on the roll

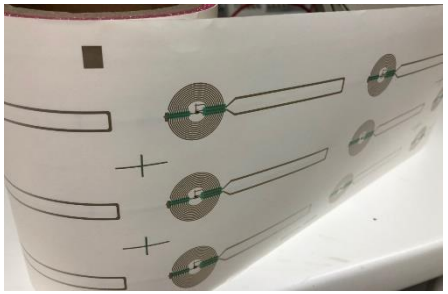


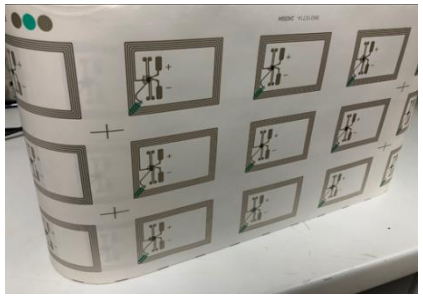


UHF : Different distances of reading
Projects to reduce production cost with bi-materials

Dual NFC/UHF

Passive sensors : Open detection,
temperature

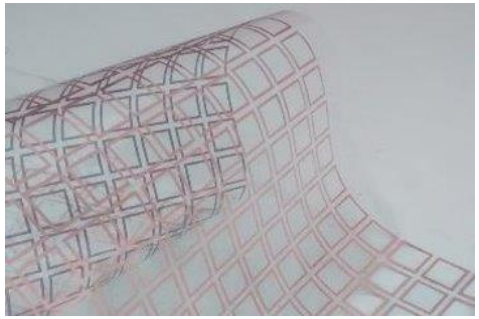




Paper Inlay manufacturing (R&D stage)

At lab and pilot scale (flexo and screen printing)

- Smart cards
- Electrochromic display
- Battery (Zn/MnO2)
- Active temperature sensors
- Other printed sensors :
  - Shock
  - Humidity
  - Ph
- Smart textile
- Selective EM shielding
- Selective EM amplification



High level collaborative projects fundings (mainly EU)

Many collaborative projects with different TRL (Technology Readiness Level) and different objectives :

INNPAPER

2018-2021 : Make real use cases demonstrators (smart labels and Point of Care bioplatforms) using multi-site pilot-lines on paper

MAESTRO
2021-2022 : Paper printed display for anticounterfeiting label

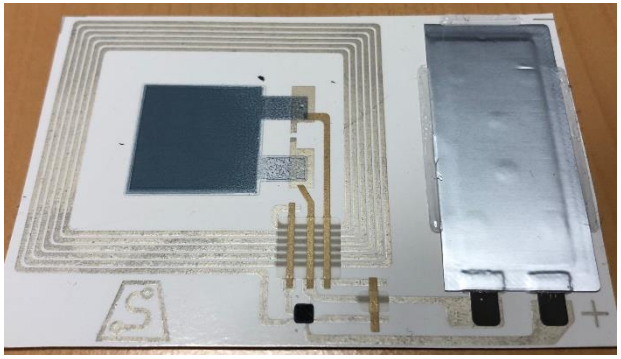
Madras
2020-2023: Nanocellulose foil printed with silver for injection molding objects

InnpressMe
2021-2023 :Pilot printing of smart paper labels including battery and display

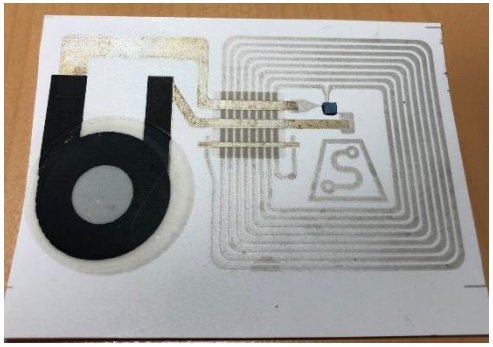
CIRCEL PAPER
2022-2025 : Paper PCB within circular economy

POSEIDON
2023-2024 : Ultra high barrier paper for liquid pouch

Past projects : Smart labels (Supersmart)



Shock detection label (won the OEA price in 2021) with shock sensor and reported battery on paper

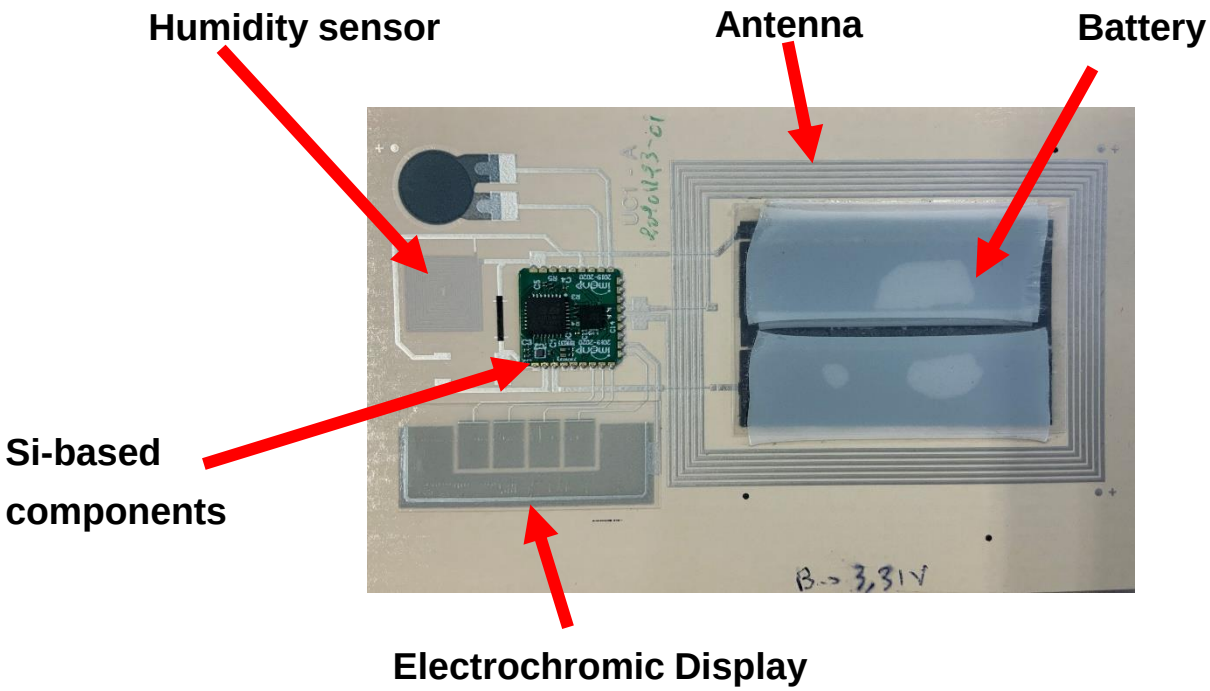


Anticounterfeiting label with printed display (project supersmart) on paper

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

INNPAPER (finished)

- Consortium : Cidetec, CEA, VTT, Arjo, Varta, Ynvisible, Aalto, …
- Developp printed electronics on paper
- Worked on Smart labels and Diagnostic labels (for Virus detection)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 760876

MAESTRO: Objective is to transfer ECD manuf. from S2S screen-printing to R2R flexo

- **Printing of ECD at industrial scale**
  - First trial in Guarro mid january
  - Printing in two passes
  - Very similar performances than lab trials
  - Pilot production in April with NFC antenna
  - Succesful printing but need to reduce switching time

ΔE ≈ 15

Switching time < 10 s

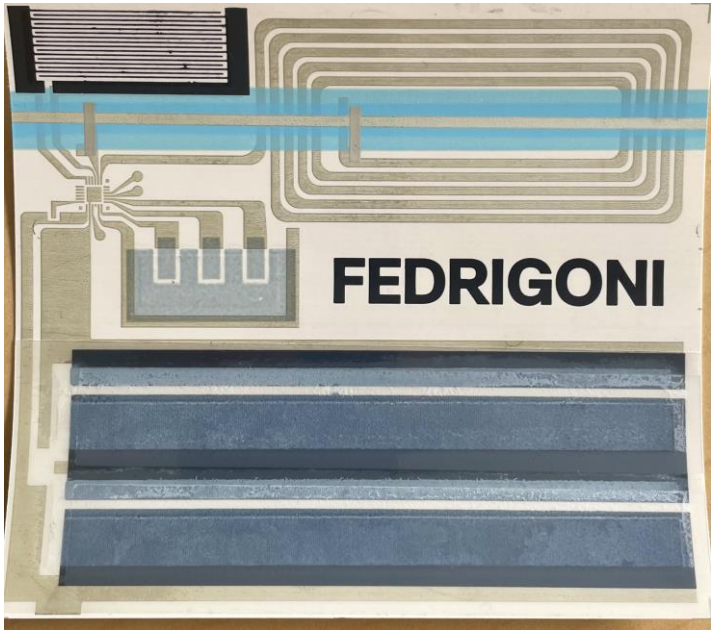
E = 0V

E = -3V

INNPRESSME : VTT, CEA, Cidetec, Rise, Fedrigoni,…

→ Goal : print smart labels (temperature and humidity) with printed NFC antenna, printed battery and printed display.

- Printed humidity sensor (with a nano-cellulose based electrolyte)
- Printed ECD with different electrolyte formulation
- Printed Battery (collaboration with Varta) :
  - Discharge time : 8h @ 100µA
  - Capacity: 1 mAh (need to increase to 5)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°952972

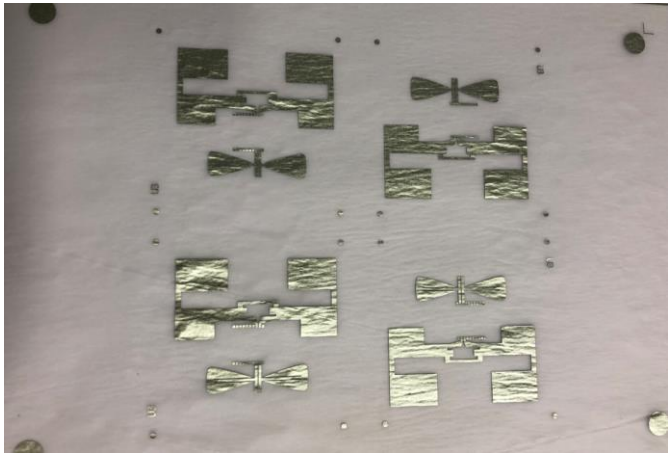
Advanced Materials and Processing in Organic Electronics

Fedrigoni have different tasks :

- Produce high transparency CNF Foils (up to 90 %) using CMC adsorption and phosphorylation

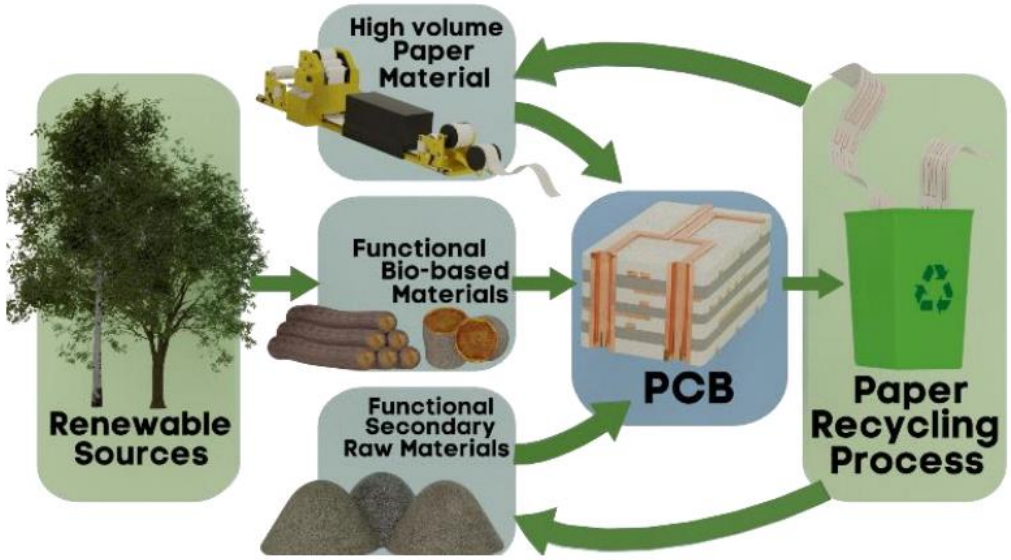
- Upscale it to pilot scale

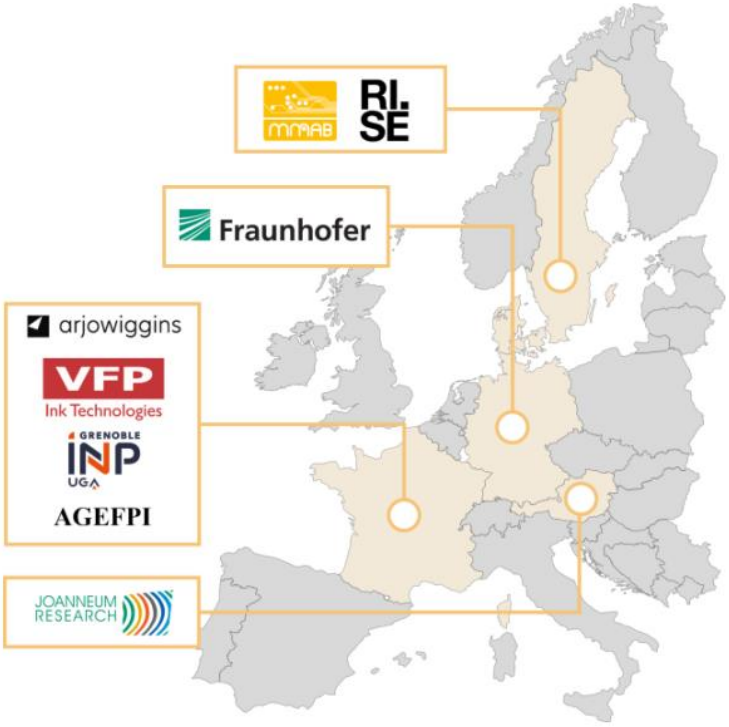
- Print electronics on CNF foils :
  - Antenna (UWB and UHF)
  - Solar cells



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 862492.

CIRCEL PAPER : Circular Economy Applied To Electronic Printed Circuit Boards Based On Paper





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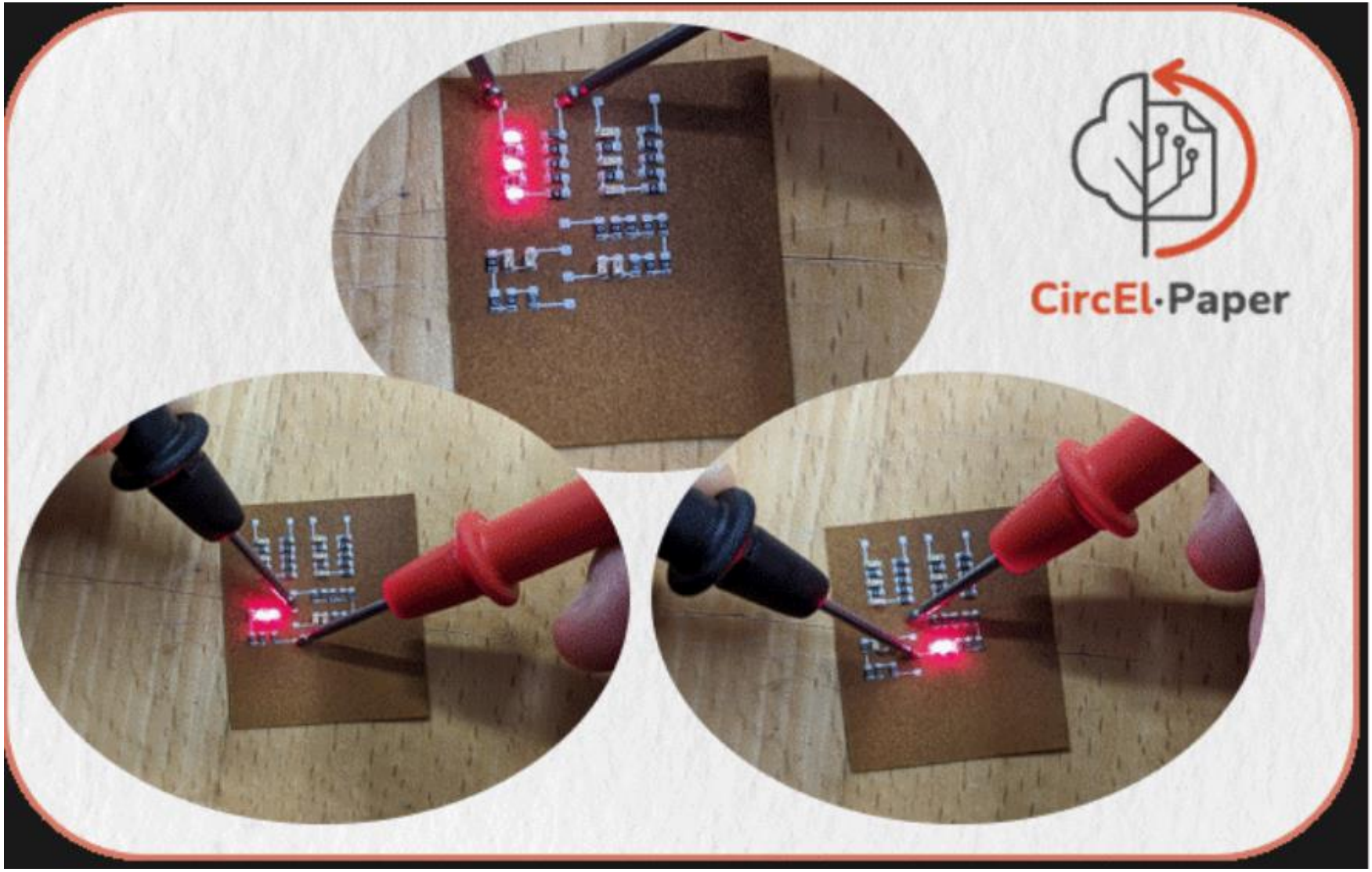
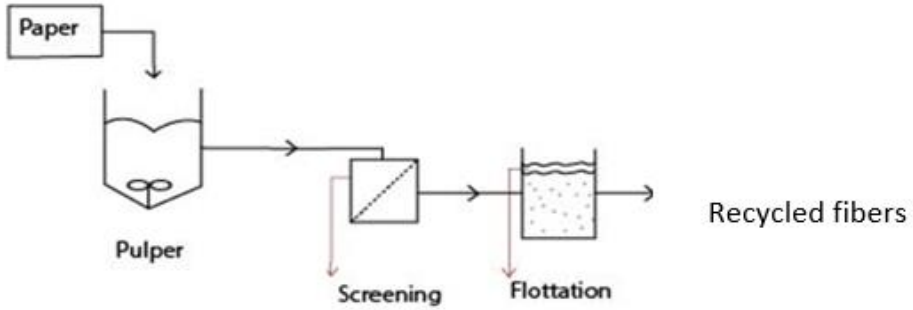
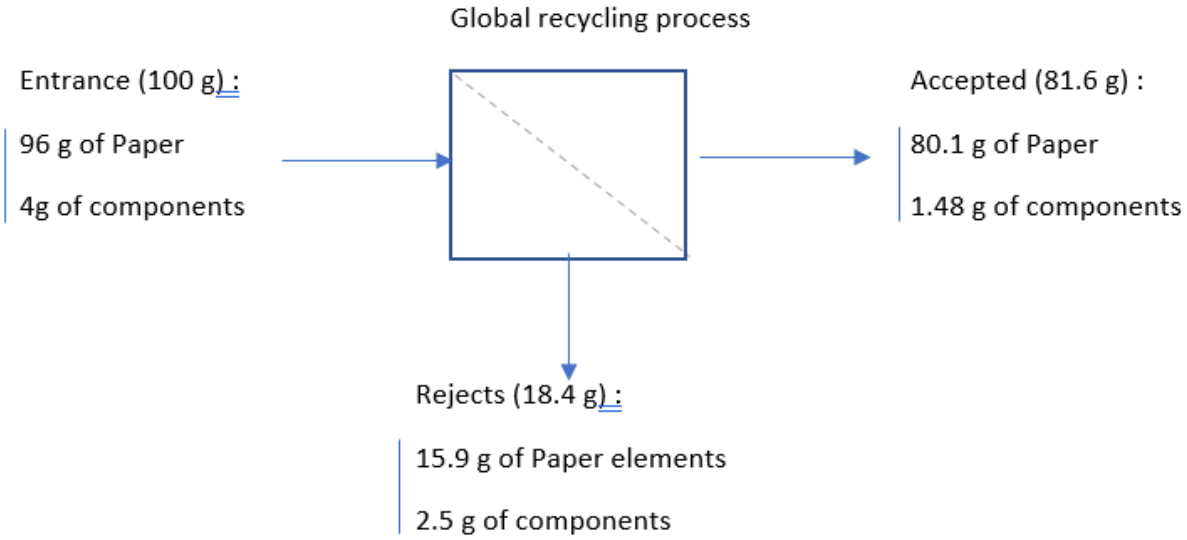

CircEl·Paper

Recyclability of paper electronics



80 % of fibers are recycled
62,5 % of the components are recycled in one cycle



G. Déprès, Victor Thénot; Blandine Joyard Pitiot; Cedric Dumont; Nathalie Marlin; D. Curtil; Nadège Reverdy-Bruas "Recycling of Paper Electronics in Standard Paper and Board Recycling Lines (2022)," in IEEE Journal on Flexible Electronics, vol. 2, no. 1, pp. 18-24, Jan. 2023, doi: 10.1109/JFLEX.2023.3243586.

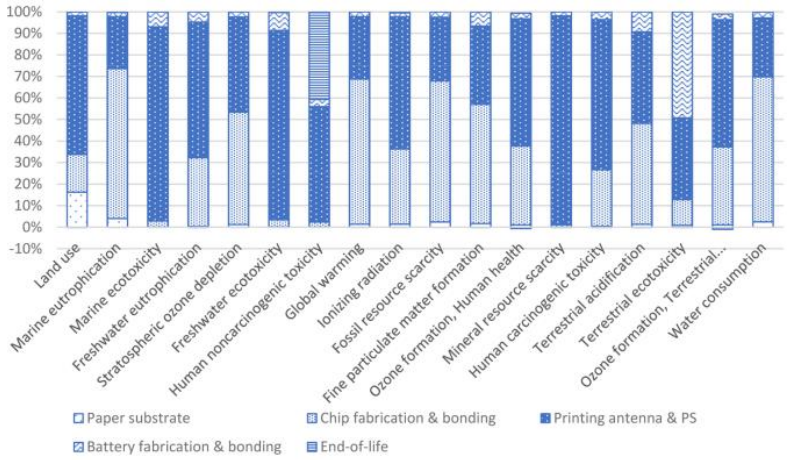
LYFE CYCLE ANALYSIS

2 studies were done on printed electronics on paper :

Shockdetection tag and anticonterfeiting label

2 main contributors on environment :
- Chips
- Silver inks

Paper has a lower impact than plastic

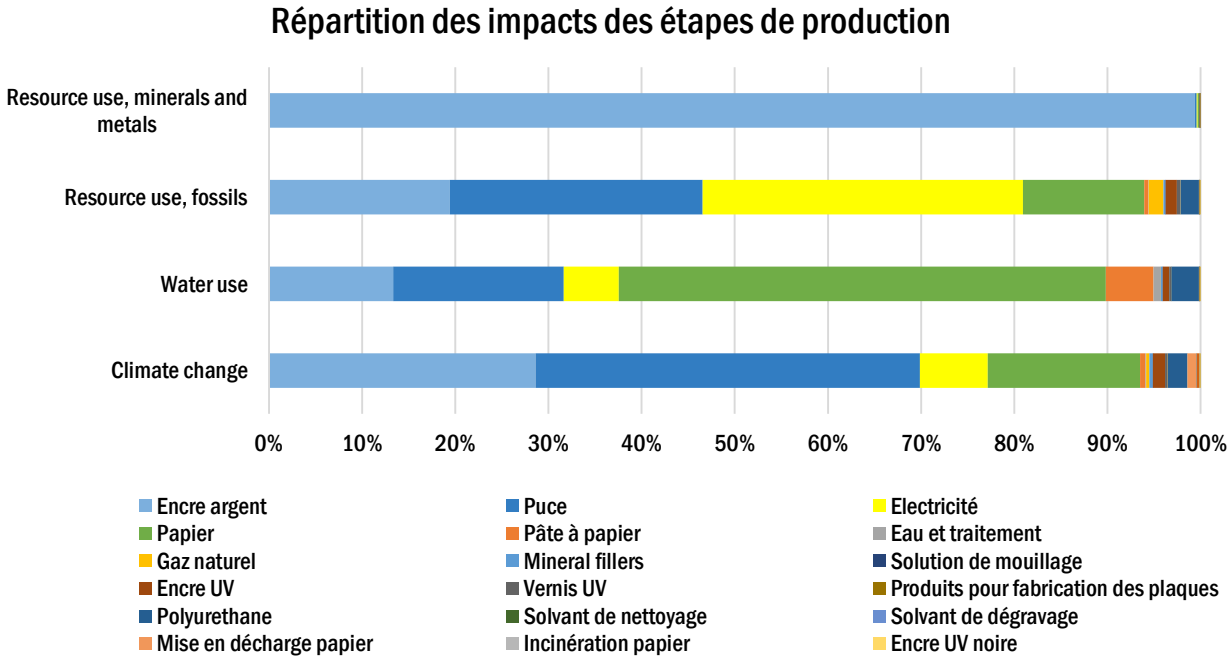


i/ Development of Eco-Efficient Smart Electronics for Anticounterfeiting and Shock Detection Based on Printable Inks
Edis Glogic, Romain Futsch, Victor Thenot, Antoine Iglesias, Blandine Joyard-Pitiot, Gael Depres, Aline Rougier, and Guido Sonnemann
ACS Sustainable Chemistry & Engineering 2021 *9* (35), 11691-11704
DOI: 10.1021/acssuschemeng.1c02348

LYFE CYCLE ANALYSIS

2 studies were done on printed electronics on paper :

ii/ ICARE study done by AFELIM on 2 demonstrators, one on paper NFC cards with printed antenna



Silicon chip and Silver ink are the main contributors of impact on environment

Conclusions

- **Growing need for a more responsible and recyclable electronics industry**
- **FEDRIGONI upgrade an existing industrial flexo machine to build a dedicated tool for printed electronics on Powercoat paper**
  - Roll-to-Roll, high troughput and versatile printing line
  - Ready to produce high quality RFID NFC and UHF antennas
  - Cost effective additive manufacturing

- **FEDRIGONI capabilities going from lab prototyping to mass production through pilot validation**
- **Ongoing R&D work on Smart labels**
  - Printed sensors (T°, RH%, piezo, ...)
  - Printed batteries
  - Electrochromic displays

THANK YOU FOR YOUR ATTENTION

DEPRES Gaël
Senior Innovation & Grenoble R&D Center Manager

FEDRIGONI

FEDRIGONI F1 PAPERS
10 rue Jean Arnaud
38500 VOIRON, France
M +33 632 550 769
gael.depres@fedrigoni.com
www.fedrigoni.com