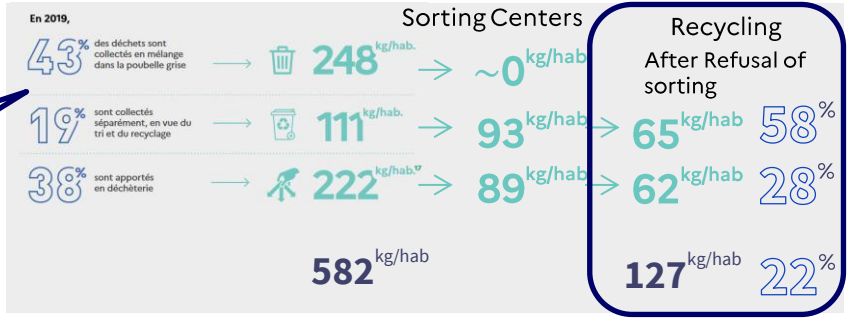
FRANCE 2030
PROGRAMME DE RECHERCHE
RECYCLAGE

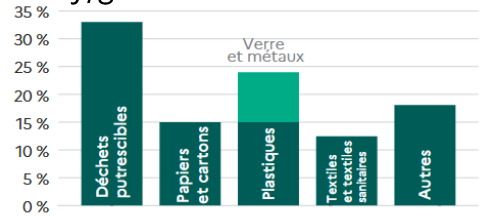
Axe Household waste
PEPR RECYCLAGE

CONTEXT

Household Waste



Grey/green bin : Residual household waste



Sources ADEME -Déchets chiffres-clés - L'essentiel 2021 -

OBJECTIVES

The project aims to acquire the knowledge needed to improve household waste recycling along the entire value chain:

- ✓ identify **the key issues** to be resolved **for an effective recycling/reuse strategy**
- ✓ Propose **innovative technologies** to improve waste recycling and recyclability
- ✓ Identify **socio-economic and regulatory obstacles**
- ✓ **Modeling, evaluate and optimize** scenarios and strategies

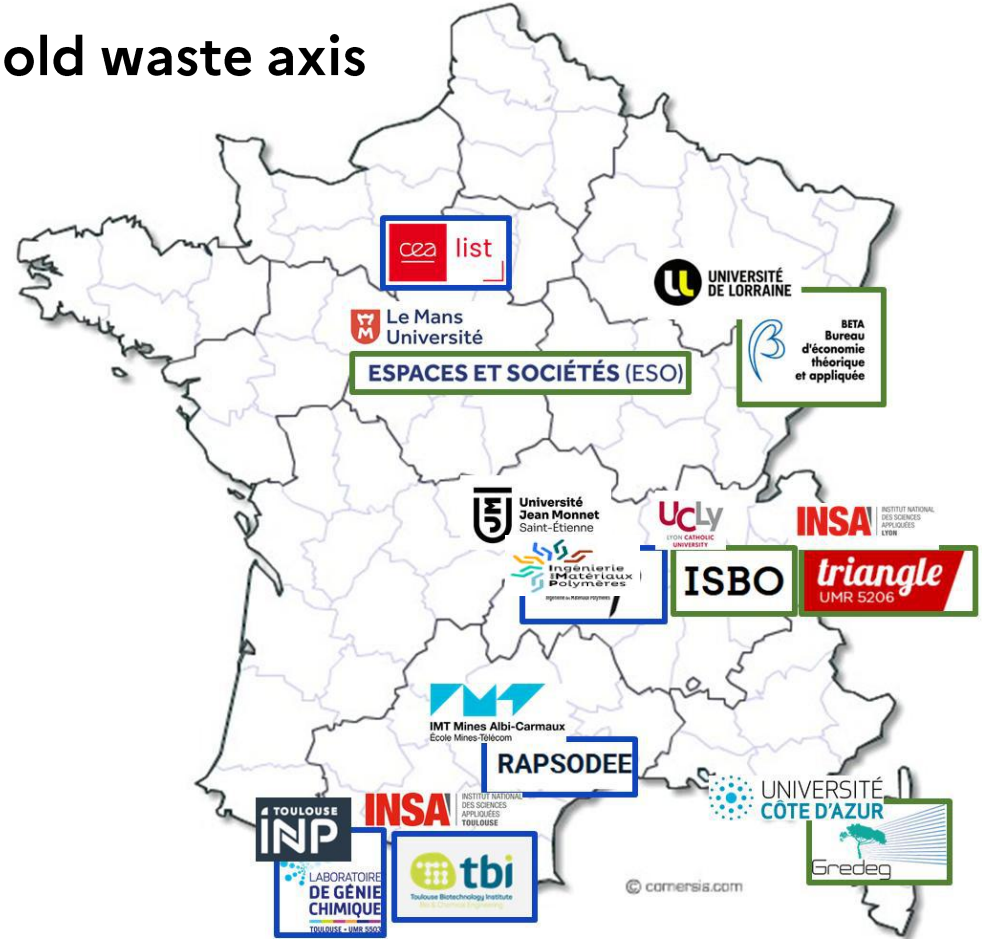
General presentation of Household waste axis

Household waste – System analysis

10 partners
Interdisciplinarity

Start date: 30/03/2023

Post-doc (foreseen/recruited): 9 (138 mois) /7



Topic 1. Innovative sorting for optimum separation of materials

Coordination:
Sandrine Bacconnier et Mathieu Durand, ESO CNRS, Le Mans Université; Adrien Stolidi, CEA List

ESO-CNRS team

Socio-ecological inequalities and waste

- Post-doc 18 months **Nathalie Buchot**: Philo-rudo workshops to understand socio-cultural differences in relation to waste and sorting.
- Rudologist students to map inequalities in relation to waste in the Ile de France region
- Contract teacher-researcher Le Mans Université (Nathalie Buchot) to extend the project in September 2025

CEA List team

Optimising sorting and AI

Post-doc 12 months, **Pierre-Jean Bénard**, started in May 2025: Algorithmic development in multi-view X-ray spectral imaging dedicated to waste sorting and recovery

Topic 1. Innovative sorting for optimum separation of materials

Sandrine Bacconnier et Mathieu Durand, ESO CNRS, Le Mans Université; Adrien Stolidi, CEA List

ESO-CNRS team
Socio-ecological inequalities and waste

Méthodology

Quantitative data collection to examine the domestic waste space and on waste production to analyse inequalities in production: a critical look at social-rudological apriori

Results

- No social group neglects the act of sorting
- All waste must be considered

Observed reality

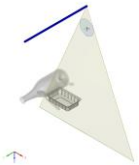
- People living in working-class neighborhoods may produce more residual household waste (RHW)... ...but less total municipal waste (TMW).
- More affluent populations have a greater environmental impact.

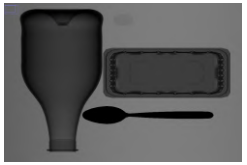
Post-doc 18 months **Nathalie Buchot**

CEA List team
Optimising sorting and AI

Algorithmic development in multi-view X-ray spectral imaging dedicated to waste sorting and recovery

1. ✔ Imaging system modelling
2. ✔ Use-case and simulation
3. ✘ Algorithmic development and performance evaluation on synthetic images
4. ✘ Experimental comparison and specifications





Post-doc 12 months, **Pierre-Jean Bénard**, started in May 2025:

Li, Y., & Zhang, X. (2024). Relation-aware graph convolutional network for waste battery inspection based on X-ray images. *Sustainable Energy Technologies and Assessments*.

Topic 2. Innovative preparation for a wide reuse of materials

WP managers: Y. CHALAMET – IMP –

IMP – Université Jean Monnet – Y. Chalamet RAPSODEE IMT Mines –Albi - Alain de Ryck

Task 2.1 - Preparation and characterization of household waste for recovery :
Post-doc Reda Aboulayt May 2025

Task 2.2 - Decontamination and bleaching of fabrics :
Post-Doc 18 months Jennifer Villamil Jimenez Oct 2023- March 2025

Task 2. Innovative preparation for a wide reuse of materials
Task 2.2:

Methodology

Bibliography

Choice of the system

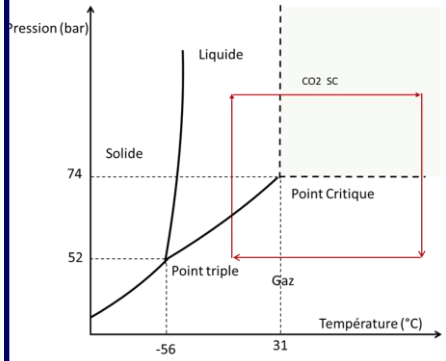
Purification of dyes

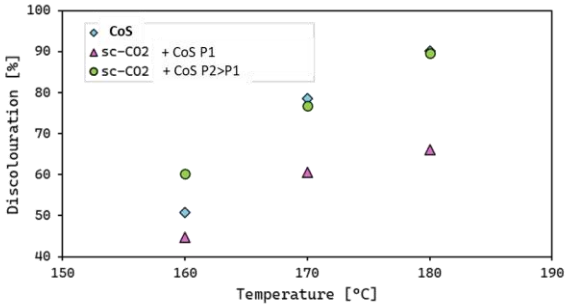
Solubility of dyes in a co-solvent

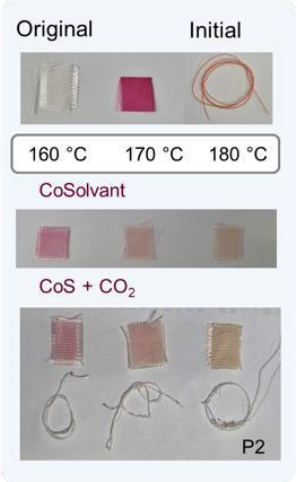
Coloring of Polyamide

Bleaching with co-solvent/CO2

CO2 treatment for bleaching fabrics







- ✓ CO2 alone is not very effective
- ✓ CO2 with CoS is very effective even with a small amount of CoS
- ✓ No CoS residue after treatment
- ✓ Easy dye/CoS separation: CoS is recyclable in a loop

Production of 1 scientific article, and 1 patent in progress

Topic 3. Modeling and system analysis

Responsable WP: Pascal Guiraud, TBI

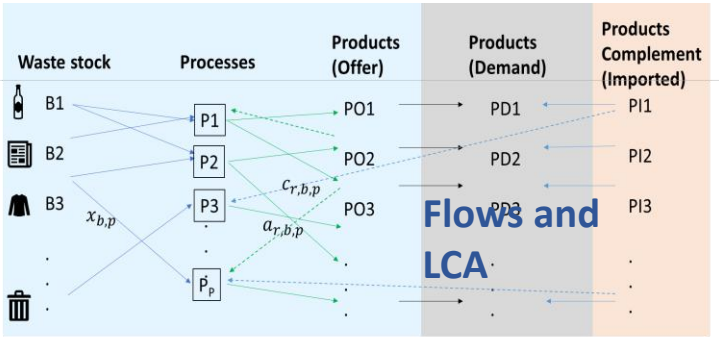
Partners: LGC (Catherine Azzaro-Pantel), TBI (Ligia Barna; Pascal Guiraud)

3.1. Multiobjective optimization of supply chains for household waste management
LGC

Modeling of waste collection, economic and environmental optimization
- The methodology was adopted
- Case study identified in the territory

Post-doc 2025 : recruitment ongoing (2 years)

3.2. Assessment of recycling strategies on the territory : The objective is to identify the most relevant valuations from the point of environmental impacts.
TBI



Postdoc 22 months, recruitment ongoing 2025

Topic 3. Modeling and system analysis

Work done

Plastic waste recycling from shopping malls
Thèse en cotutelle avec U Chulalongkorn Thailande – fond propres

Scenarios

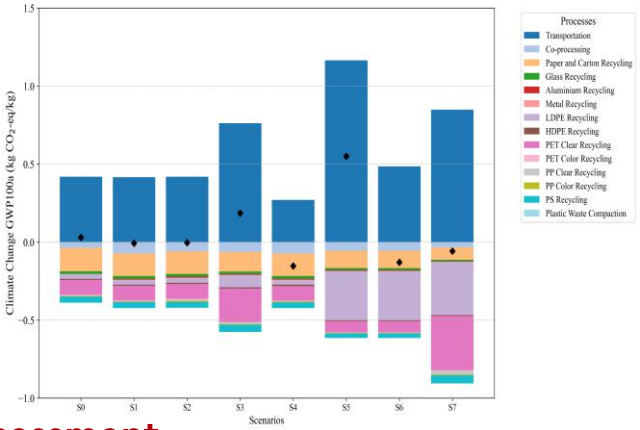
- BAU : Current situation
- Nudge : an ergonomic bin was proposed to facilitate sorting
- Responsability of companies
- Compacting

All actions (double the recycled quantity)

Climate change

effects of transport

effects of recycling



Life Cycle Assessment

Management of 1 kg household waste

Topic 4. Dynamics of actors and organizations

Axe 4.1 : Ludovic Montastruc, LGC

4.1 Defining the concept of CE and its associated indicators in the territory

Post-doc **Lea van Werf**, 18 month + 12-month post-doc financed by Occitanie

The circular economy can be apprehended:

- at the nano level (that of the process),
- at the micro level (that of an organization, a company, a hospital or a university),
- at the meso level (that of a group of players interacting in an industrial field...)
- at the macro level (that of a national economy).

4.2. Actors' behavior towards recycling - BETA, GREDEG, TRIANGLE

Post-doc **S. van Driessche**

Objective

Under what conditions can the level of acceptance of **unit-based pricing (IP)(** like weight-based pricing) be increased?

- Methods of implementing incentive pricing (IP)
- Preferences for incentive pricing within households

Topic 4. Dynamics of actors and organizations

4.2. Actors' behavior towards recycling - BETA, GREDEG, TRIANGLE

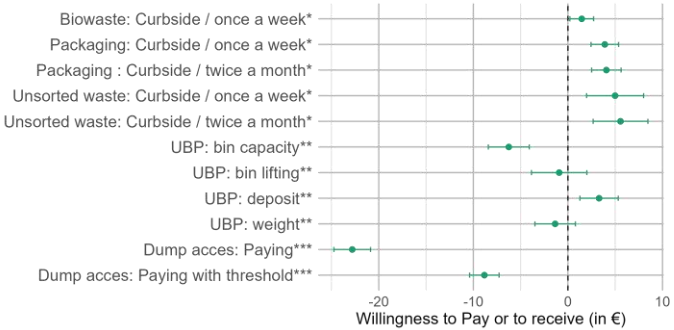
Lesly Cassin, BETA, Nathalie Lazaric, GREDEG, Olivier Brette, TRIANGLE

Methodology :

Discrete choice Experiment : Online survey conducted by a polling company

- Socio-economic questions + questions about current waste management services to establish the status quo for each respondent
- Choice of **waste management services** with different characteristics (scenarios)

Preliminary results: scenario analysis, heterogeneity analysis (population clases)



Preferences to pay for waste management :

- Respondents are willing to pay more to improve certain aspects of the service.
- Bin disposal is preferred over other methods (+€5 to €6/year willingness to pay)
- Unit pricing should include:
  - The number of collections,
  - A deposit system,
  - Or bin capacity.

Topic 5. Regulation and standardiza

Nathalie Lazaric Michele Pezzoni Marie Sciaccitano Olivier Brette Nabila Arfaoui

5.1. Regulation as a potential driver for innovation and sustainability

GREDEG, ISBO, TRIANGLE / Mars 2023 - oct. 2025

Objectives:

(1) Identify and quantify **plastic-related eco-innovations that serve a circular objective** and assess the **impact of regulation** on these dynamics.

(2) **Measure the impact** of **plastic-related eco-innovations** on **plastic waste generation.**

Postdoctoral researcher (20 months): **Marie Sciaccitano**

5.2. Impact of regulation/standardization on innovation in the field of plastics

GREDEG, BETA, ISBO, TRIANGLE / Oct. 2025 - mars 2027

Objective:

Simulate the **effects of public policies** on the **development** of **plastic-related eco-innovations.**

Postdoctoral researcher (18 months): **Marie Sciaccitano**

Topic 5. Regulation and standardization

5.1. Regulation as a potential driver for innovation and sustainability

GREDEG, ISBO, TRIANGLE

Methodology - Based on the PATSTAT (v.Spring 2024) patent database, we perform several textual analyses on patent titles and abstracts to identify and quantify plastic-related eco-innovations.

-focus on Reduction (R1) and Recycling (R3) eco-innovations.

Results : The trade-off between Reducing and Recycling innovations

- ***Path dependency:*** A firm with prior patenting experience in **Reduction (R1)** (**Recycling (R3**) is **more likely** to continue innovating in **Reduction (R1)** (**Recycling (R3**) technologies.
- ***Technological lock-in and trade-off:*** A firm experienced in **Reduction (R1)** (**Recycling (R3**) is **less likely** to engage in innovation related to **Recycling (R3) Reduction (R1**).
- Firms with **extensive patenting experience** are **less likely** to innovate circular technologies.
- **Collaborations** between different types of actors, e.g. firms and universities, **are more likely than firms to develop Recycling (R3) technologies,** whereas **Reduction (R1)** innovations remain mostly patented by **firms.**

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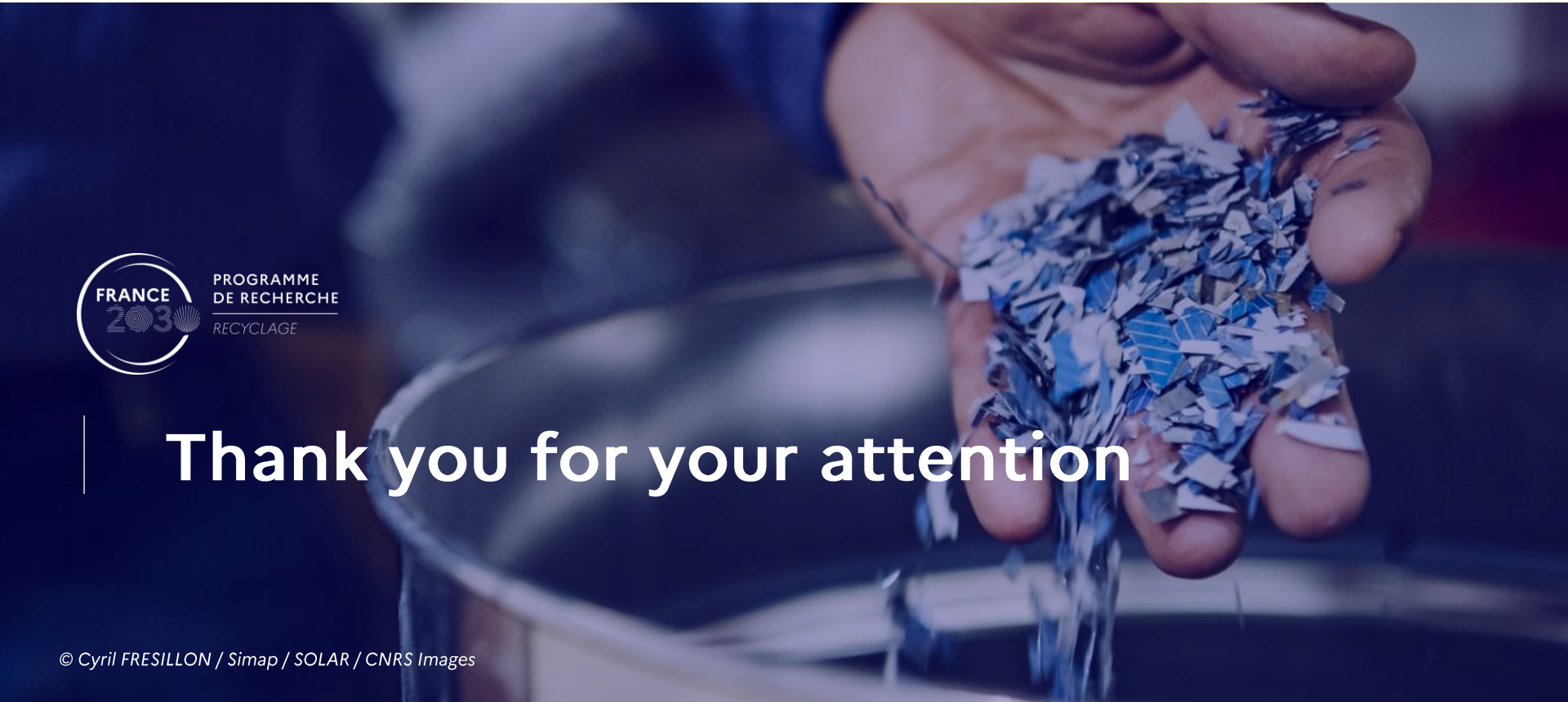

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Thank you for your attention

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