



RE-FACADE GLASS PANELS

made by Construction & Demolition Recycled Glass

P5 Presentation | Isidora Matskidou | 5166187

Supervisors:

Dr. Ir. Faidra Oikonomopoulou: Structural Design & Mechanics | Dr. Ir. Alessandra Luna Navarro: Design of Construction







LET'S BE CLEAR

NOT ALL GLASS CAN GO IN YOUR RECYCLING

When it comes to glass, only glass bottles and jars should go in your local recycling program.

Check with your municipality for information about your local glass recycling programs.



Department of
Environmental
Conservation



#RecycleRightNY

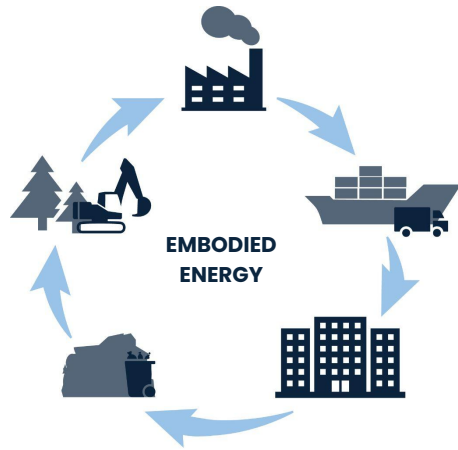
New York State Recycling Glass Flyer



**POST-CONSUMER CONTAINERS
UPCYCLING**



**FLOAT GLASS
DOWNCYCLING**



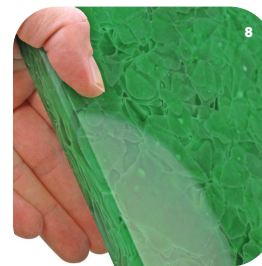
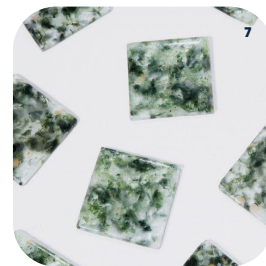
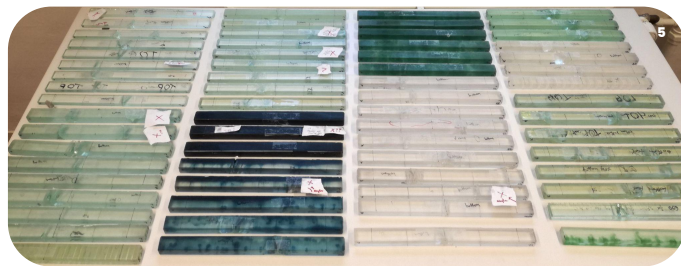
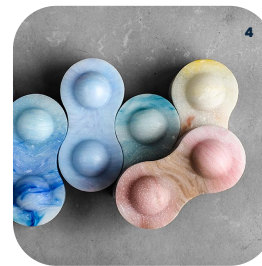
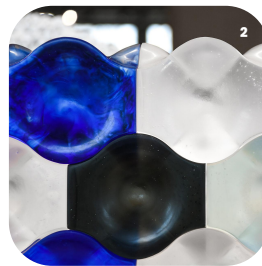
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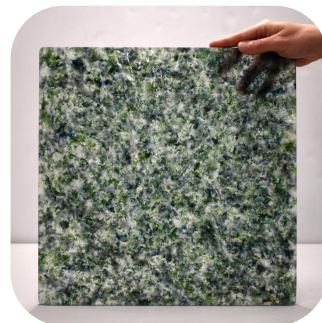
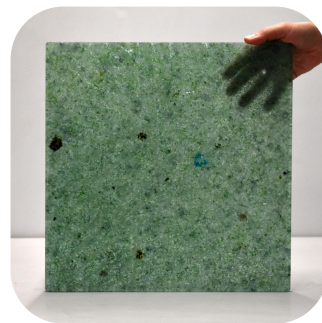
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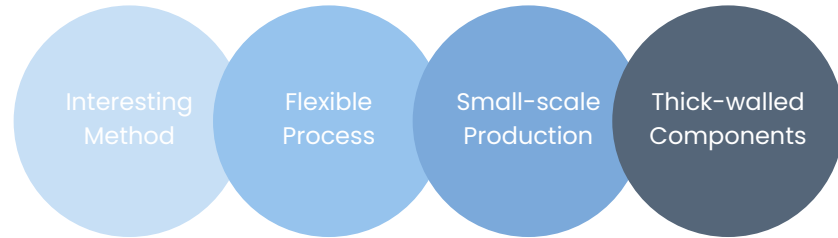
**ECOLOGICAL
FOOTPRINT**



1, 2, 3, 4. Glass samples of RE3 project, made by Faidra Oikonomopoulou et al., 2018.
 5. Glass beams made by Faidra Oikonomopoulou and Telesilla Bristogianni.
 6. Street tiles made by Diana Simpson Hernandez, 2013.
 7. Recycled glass tiles made by Snohetta and Studio Plastique, 2021.
 8. Glass ceramic products made by MAGNA Glaskeramik.



Glass panels made by Telesilla Bristogianni and Faidra Oikonomopoulou.





VS





VS





“ In what ways can we develop a glazed facade panel made by recycled glass, coming from Construction & Demolition cullets, through an upcycling approach and taking into account its life-cycle assessment? ”

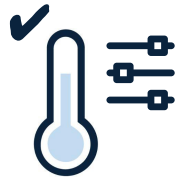


?



VISION





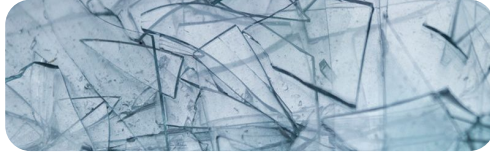
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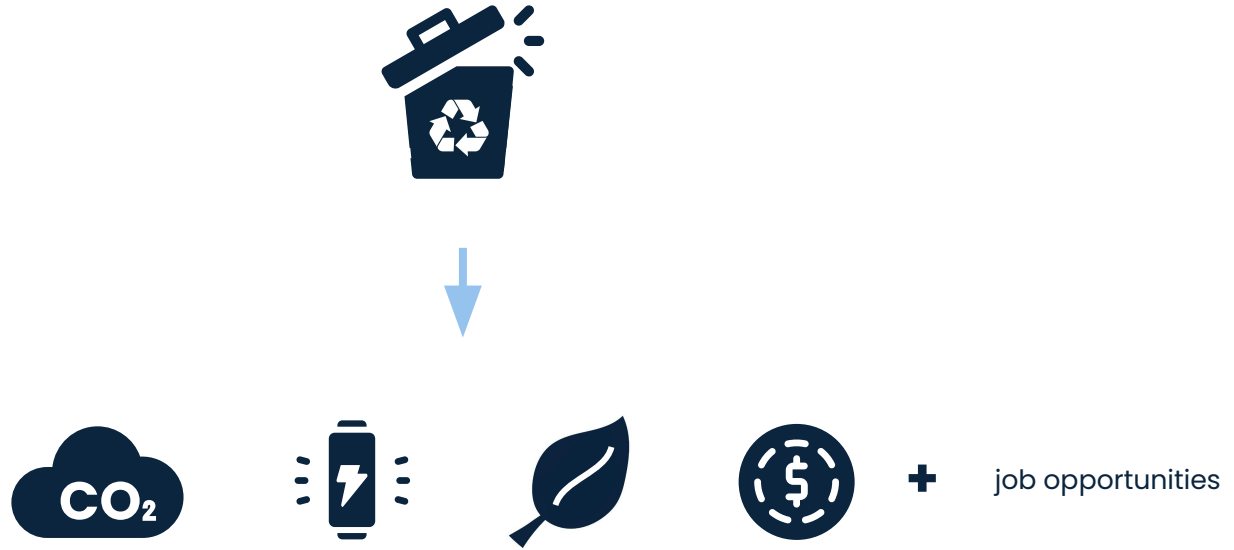
LITERATURE REVIEW



Glass is

100% recyclable

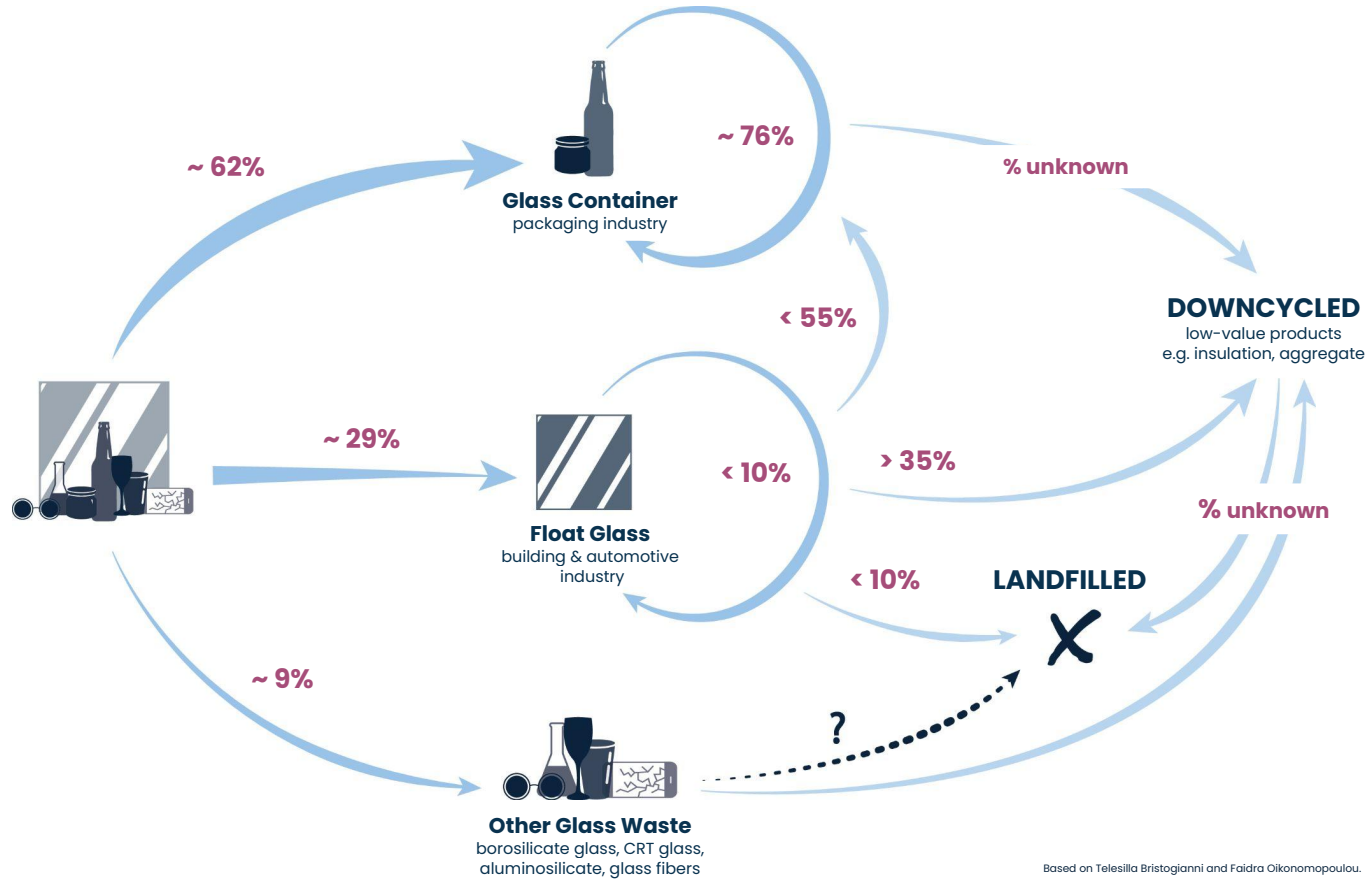
It can be remelted endless number of times without ever reducing its quality.



GLASS PRODUCTION

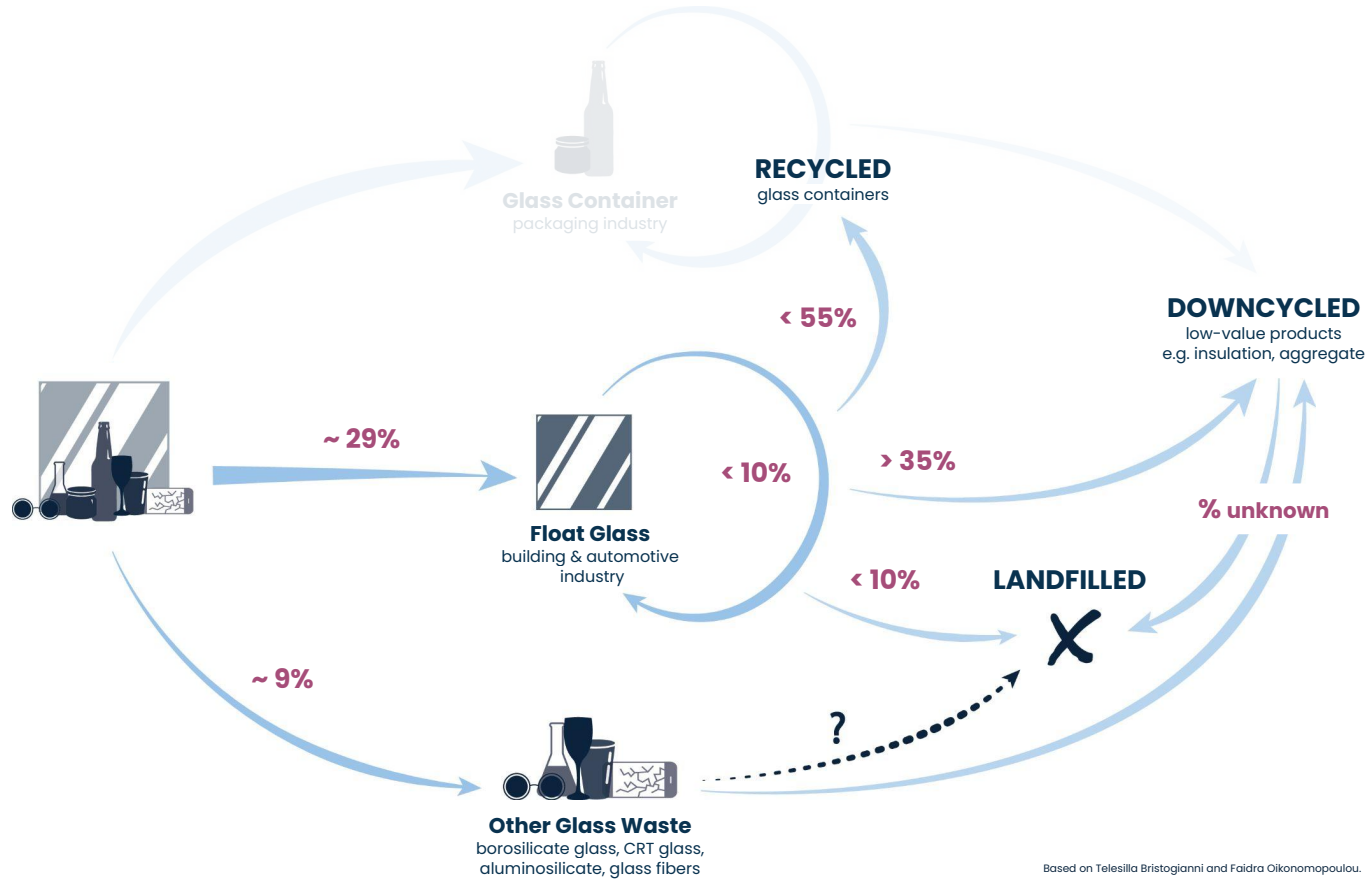


LITERATURE REVIEW



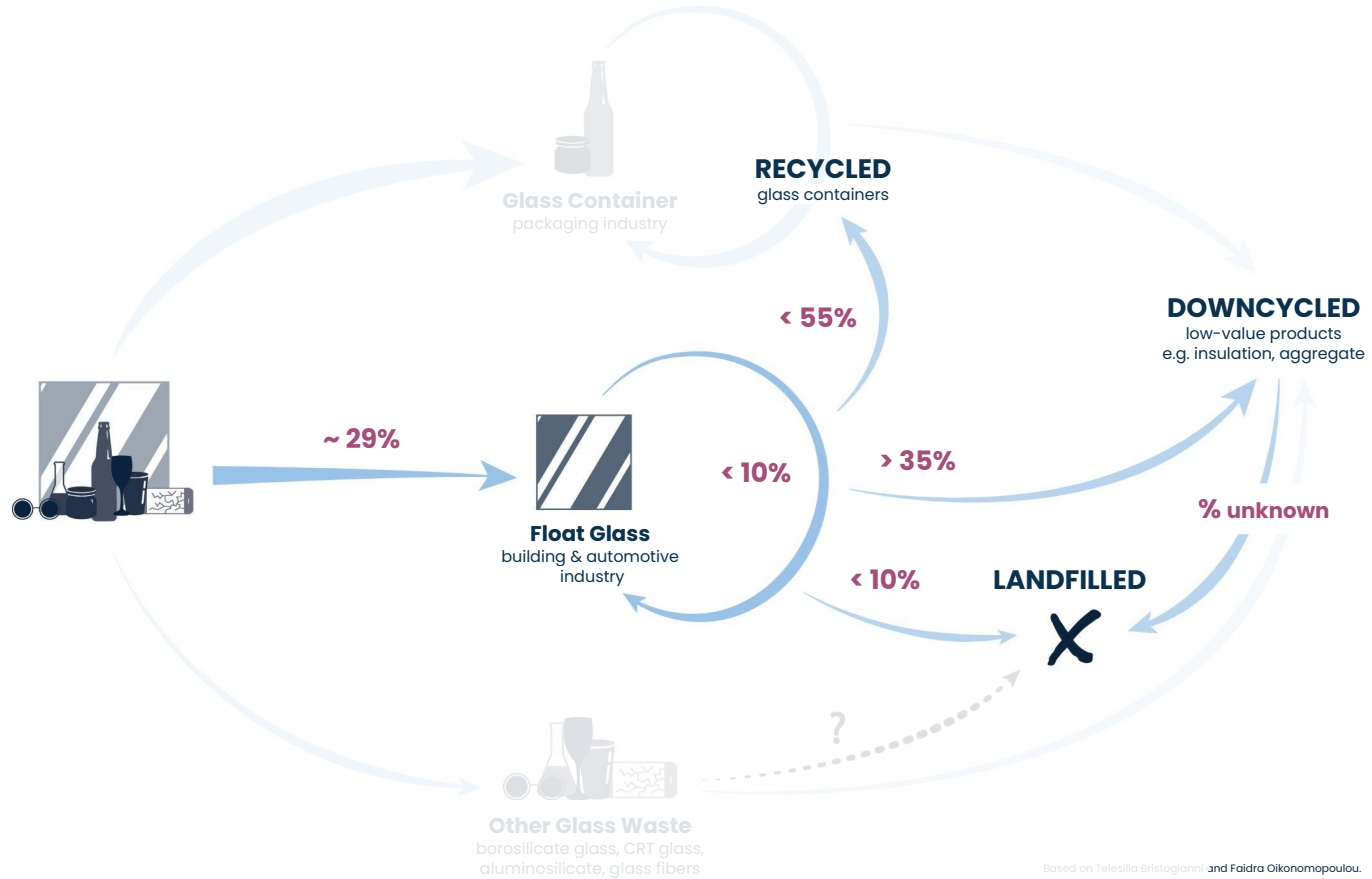
Based on Telesilla Bristogianni and Faidra Oikonomopoulou.

LITERATURE REVIEW



Based on Telesilla Bristogianni and Faidra Oikonomopoulou.

LITERATURE REVIEW



Based on Telesilla Bristogianni and Faidra Oikonomopoulou.



GLASS PACKAGING

VS



FLOAT GLASS

LITERATURE REVIEW



WELL-ORGANISED COLLECTION SYSTEM	✓	✗
MONO-MATERIAL	✓	✗
LOOSE CULLET ACCEPTANCE RULES	✓	✗
EFFORTLESS RECYCLING PROCESSING	✓	✗
COST-EFFICIENT RECYCLING PROCESS	✓	✗
NO DISASSEMBLY	✓	✗



78%

GLASS PACKAGING

vs



<10%

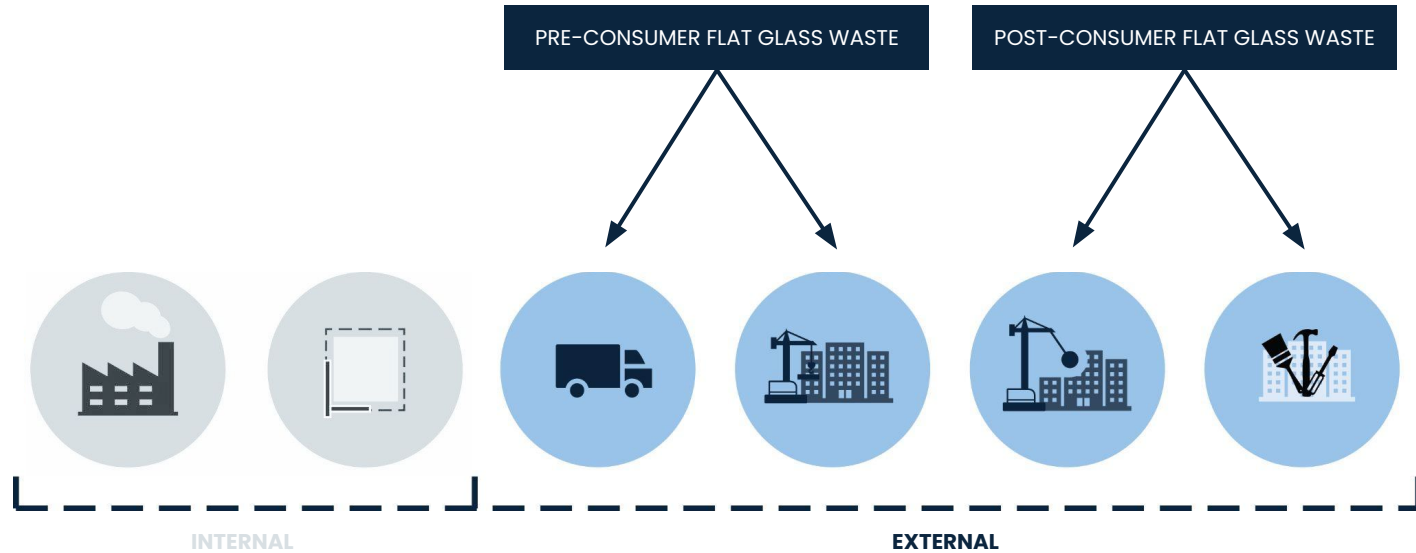
FLOAT GLASS



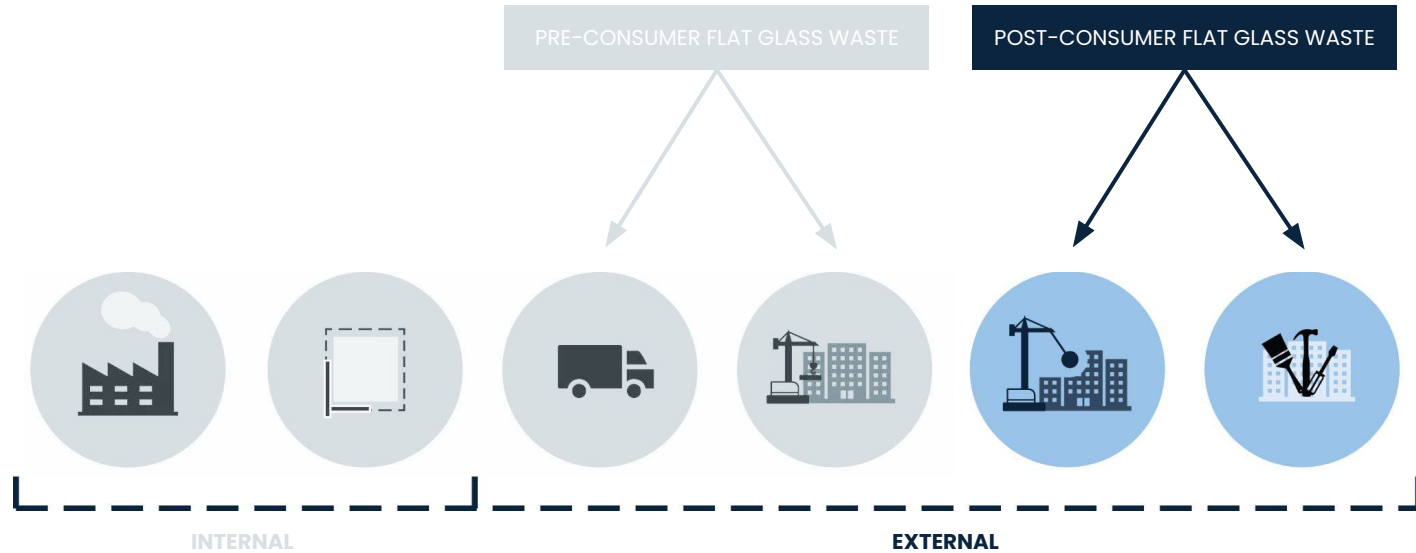
**FLOAT GLASS
DOWNCYCLING**

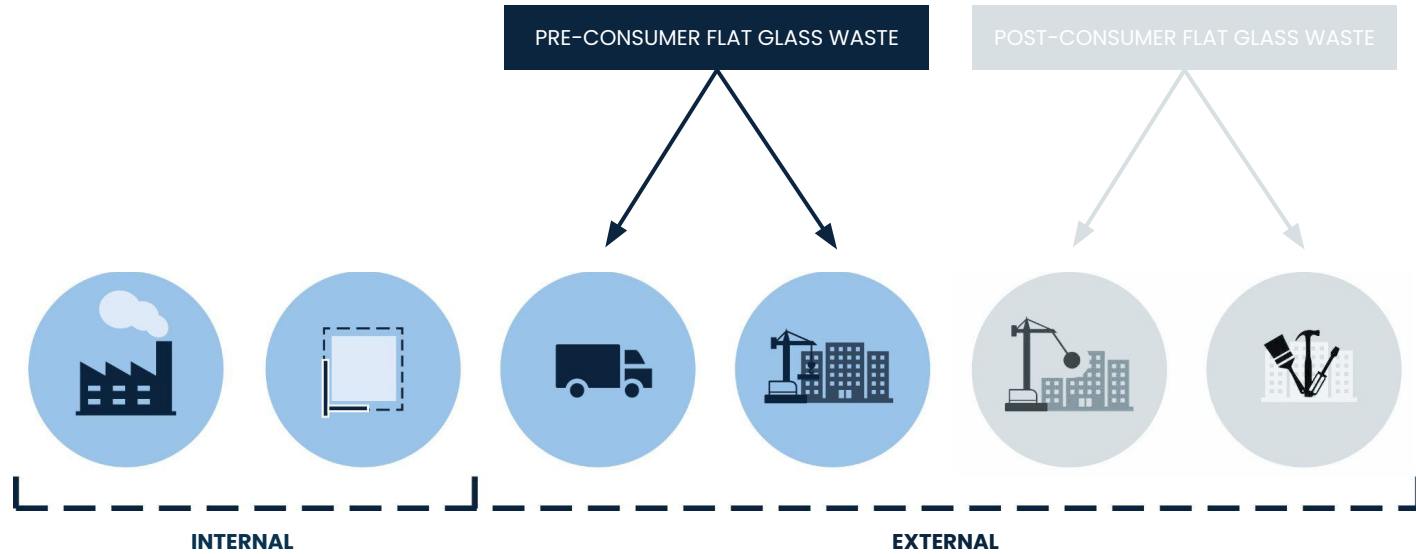
LITERATURE REVIEW

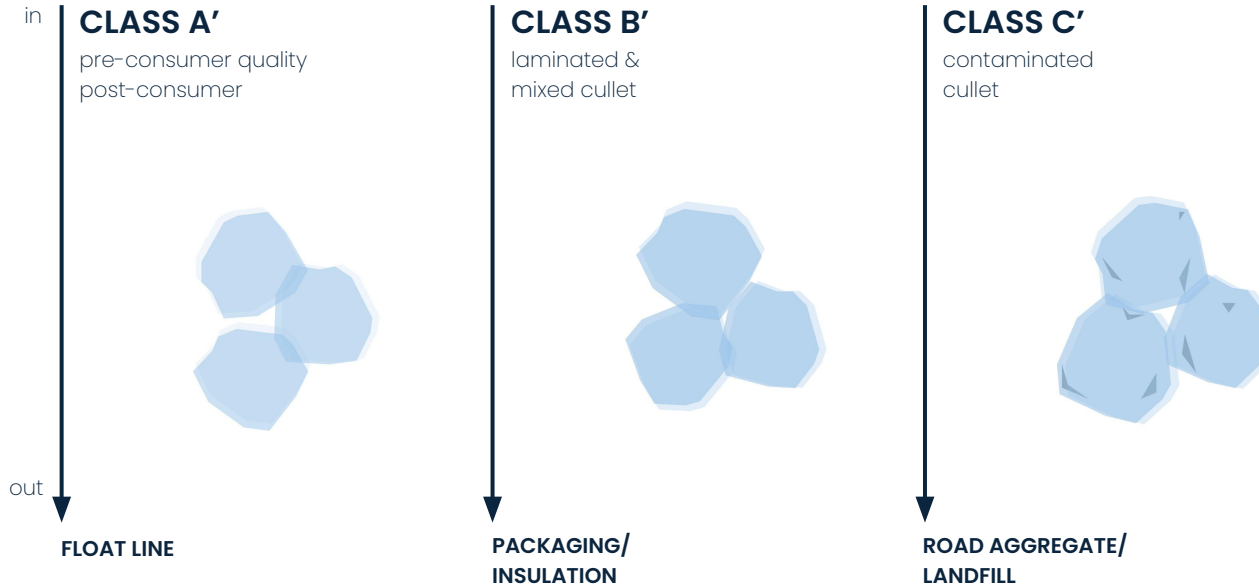




LITERATURE REVIEW







LITERATURE REVIEW

in



Laminated Glass



Insulated Glass Unit



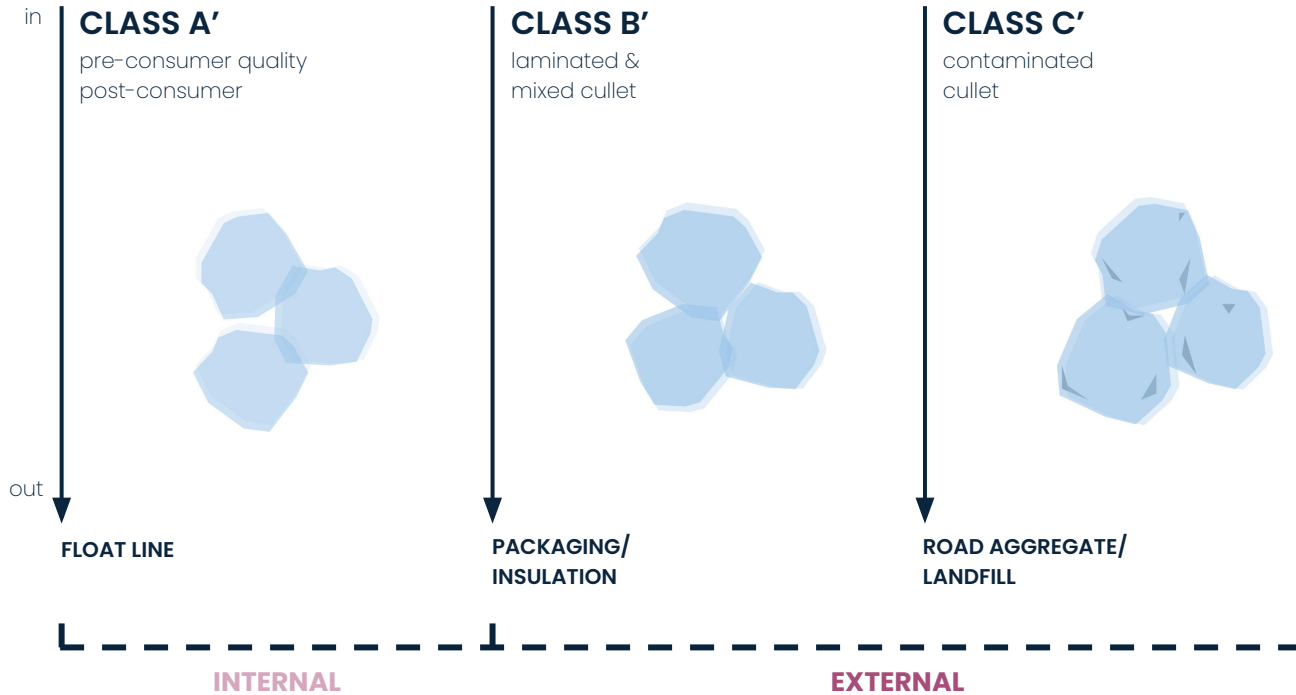
Tinted Glass



Printing

(ARUP)

LITERATURE REVIEW



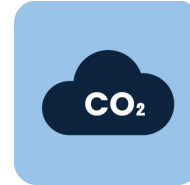
(ARUP)



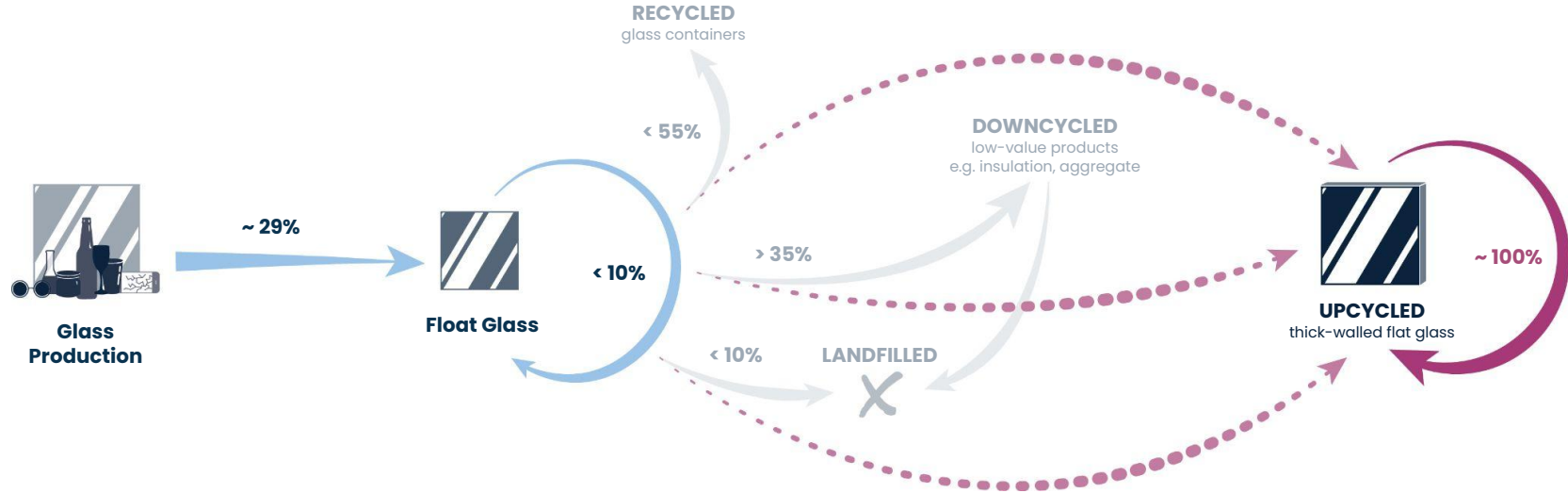
**RISKS TO THE INDUSTRIAL
PROCESS AND FACILITIES**

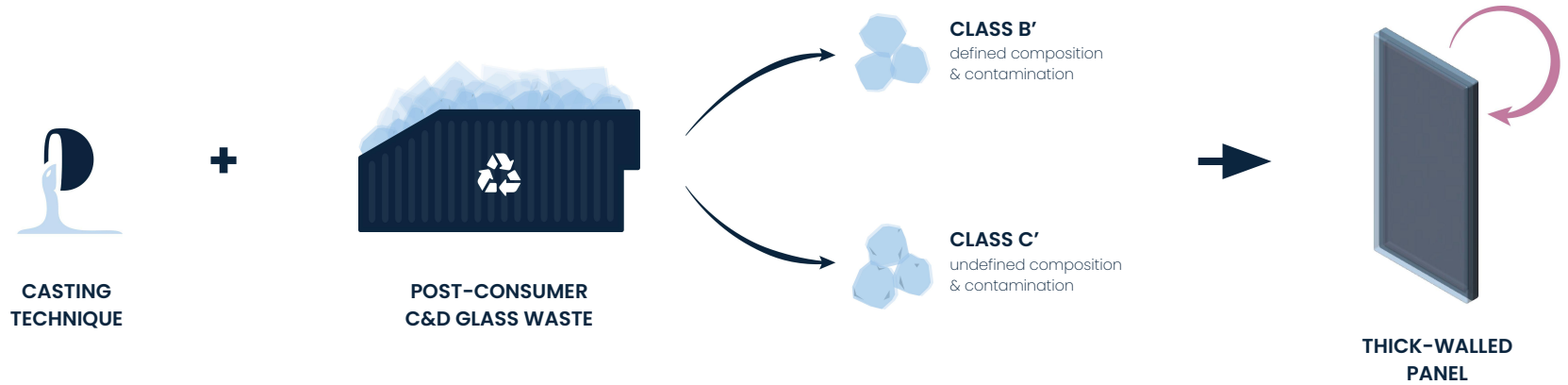


**RISKS TO THE QUALITY OF
THE FINAL GLASS PRODUCT**



**RISKS TO UNWANTED
ATMOSPHERIC EMISSIONS**



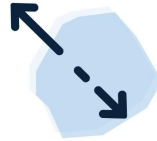


EXPERIMENTAL METHODOLOGY

DESIGN CRITERIA



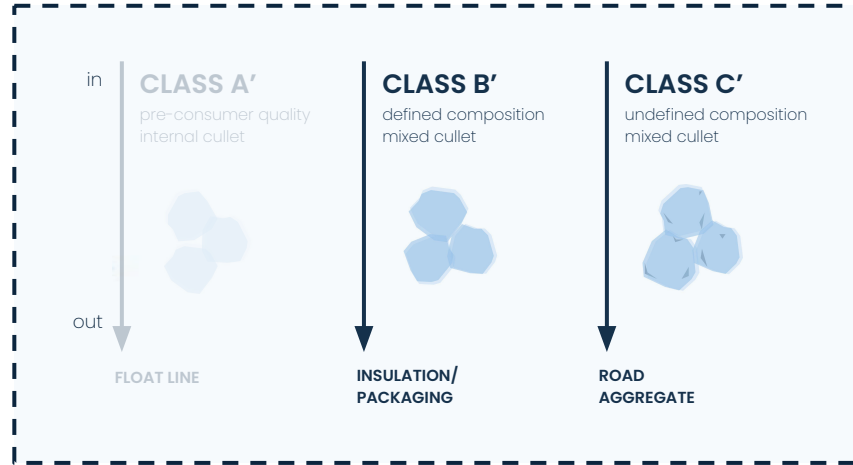
**CONTAMINATION
RATE**

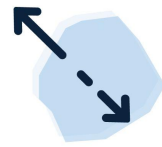


CULLET TYPE



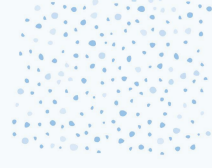
**MELTING - ANNEALING
SCHEDULE**





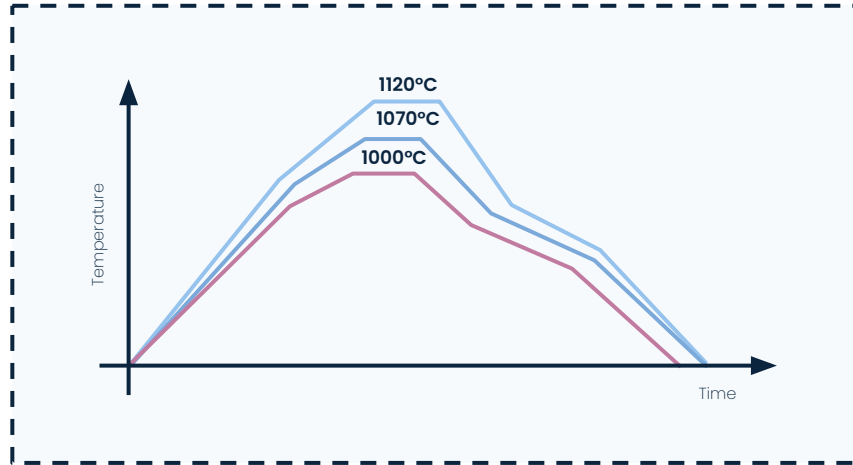
CULLET TYPE



SHARDS	FINE CULLET	COARSE POWDER
		
$C > 10 \text{ mm}$	$1 \text{ mm} \leq C \leq 4 \text{ mm}$	$C \leq 1 \text{ mm}$



MELTING - ANNEALING SCHEDULE





Product Performance



Product Performance



Stress
Observation

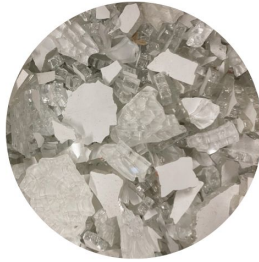
Thermal
Shock

LCA
Assessment

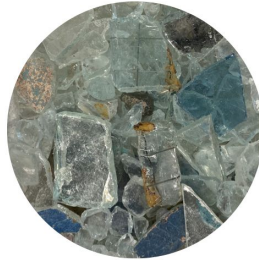
EXPERIMENTAL OVERVIEW

EXPERIMENTAL OVERVIEW

DEFINED
COMPOSITION



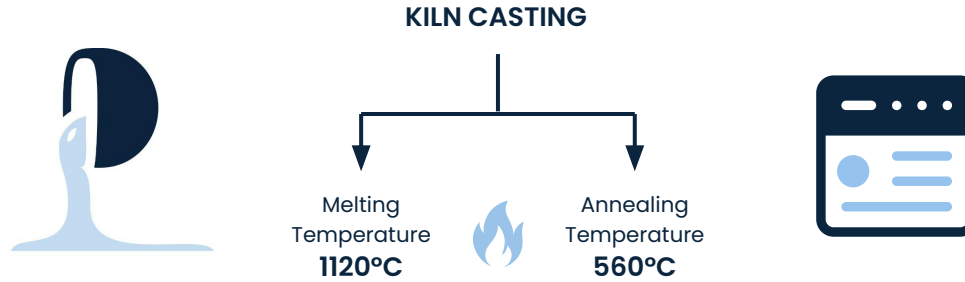
UNDEFINED
COMPOSITION



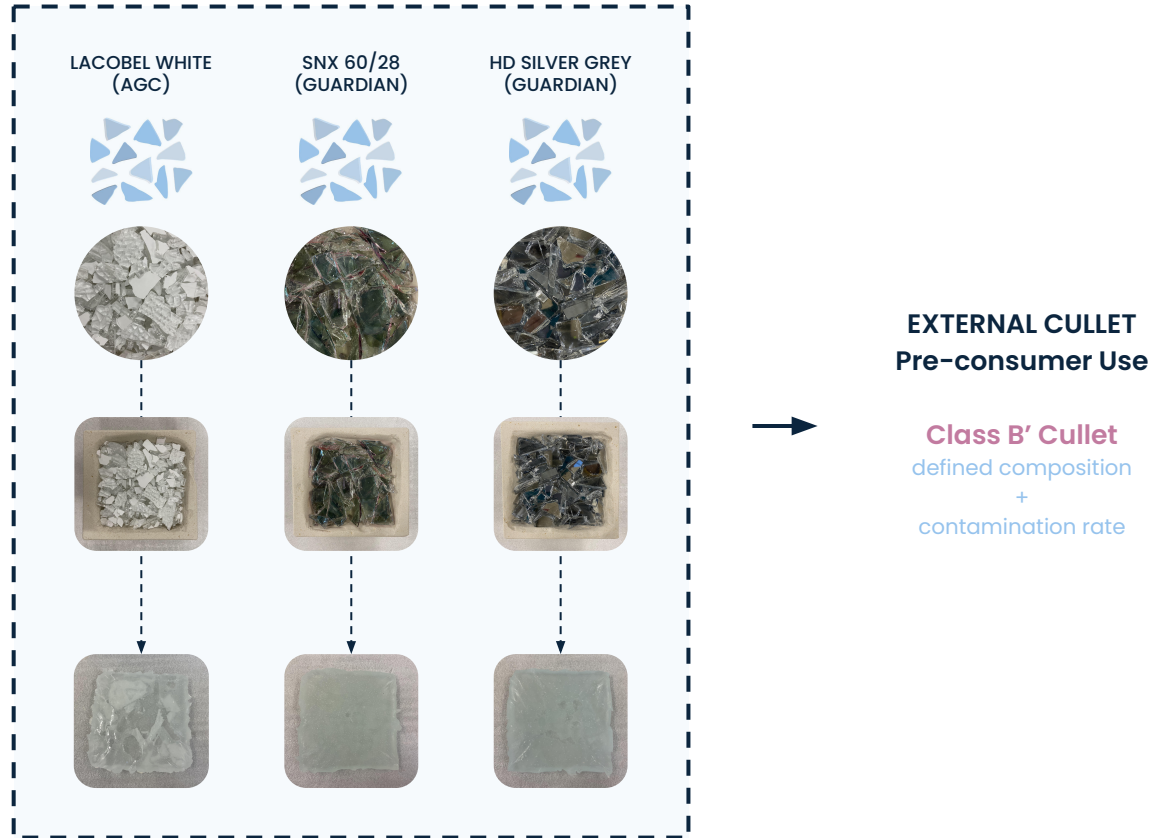
EXPERIMENTAL OVERVIEW



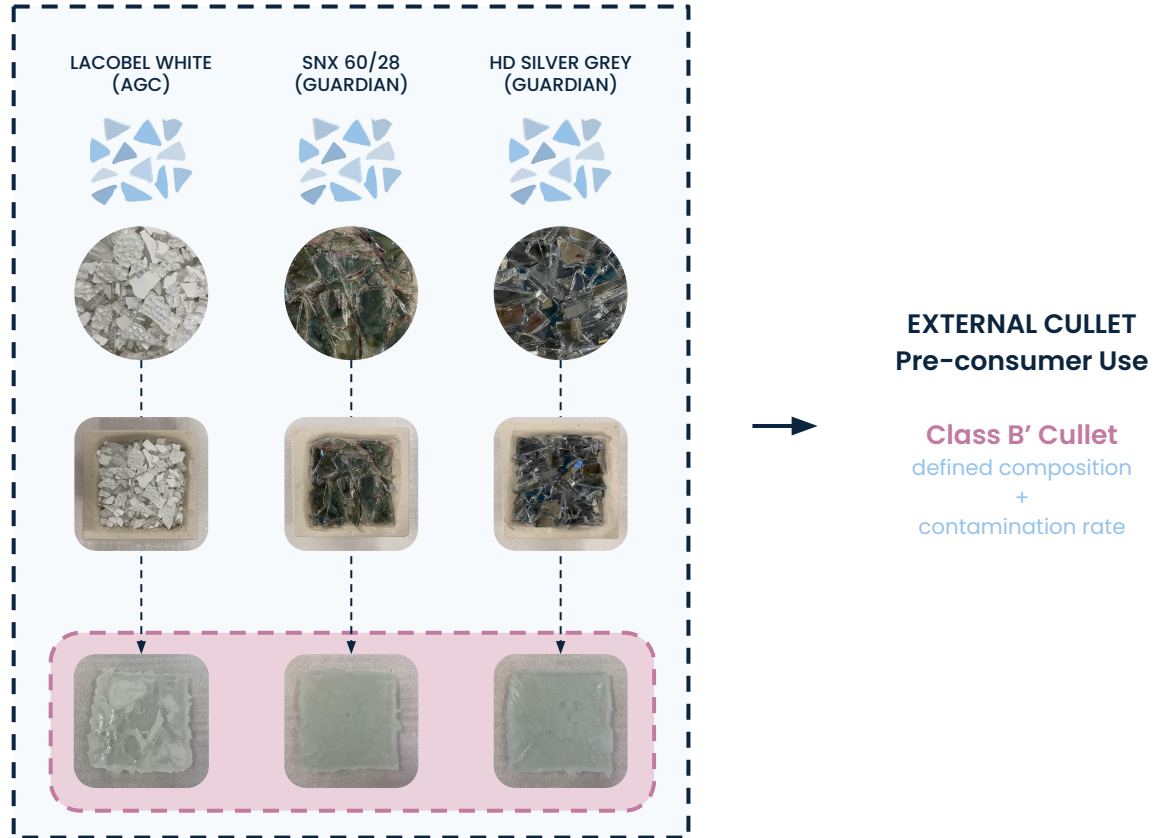
FIRING ROUND I



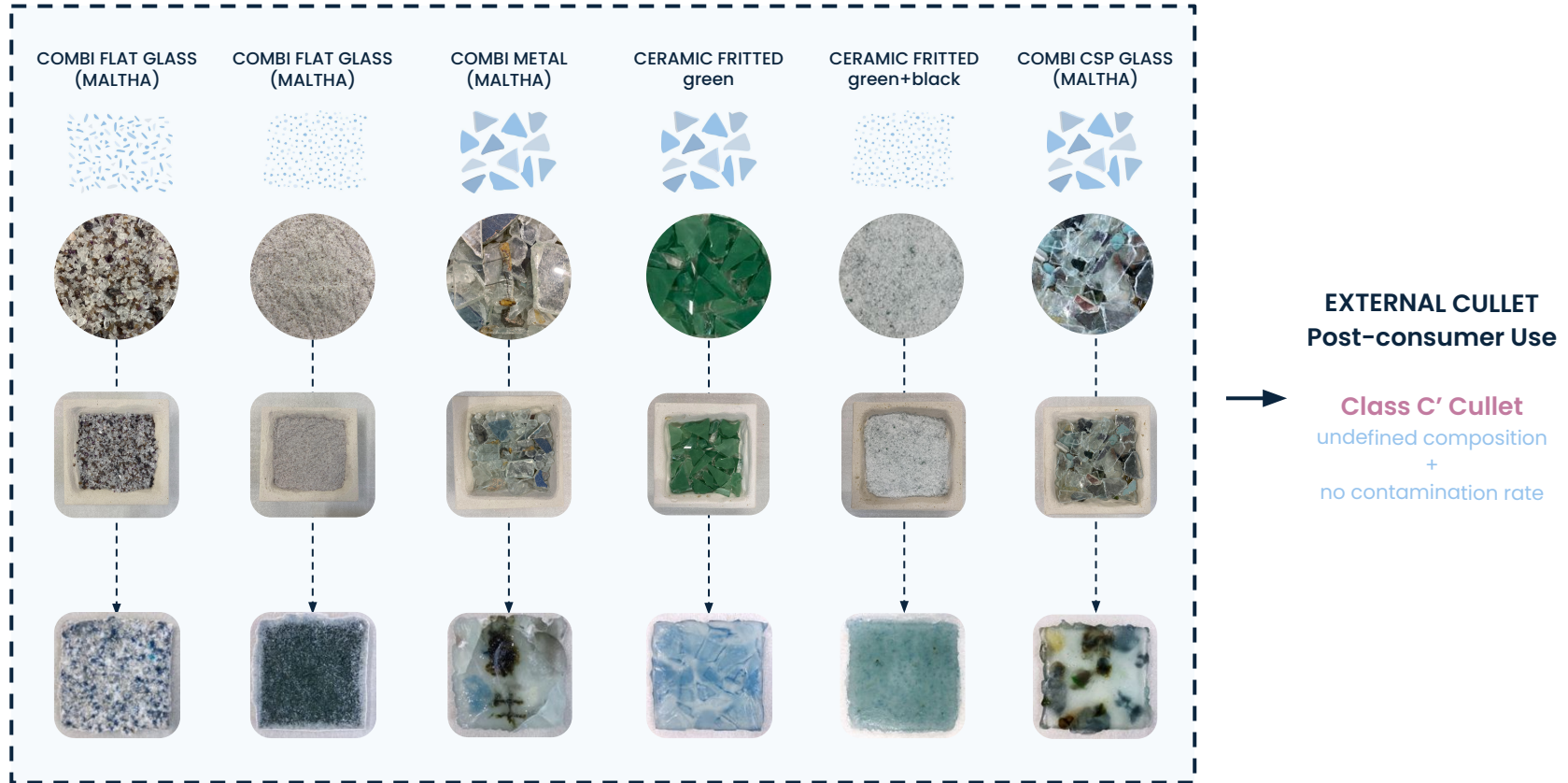
EXPERIMENTAL OVERVIEW



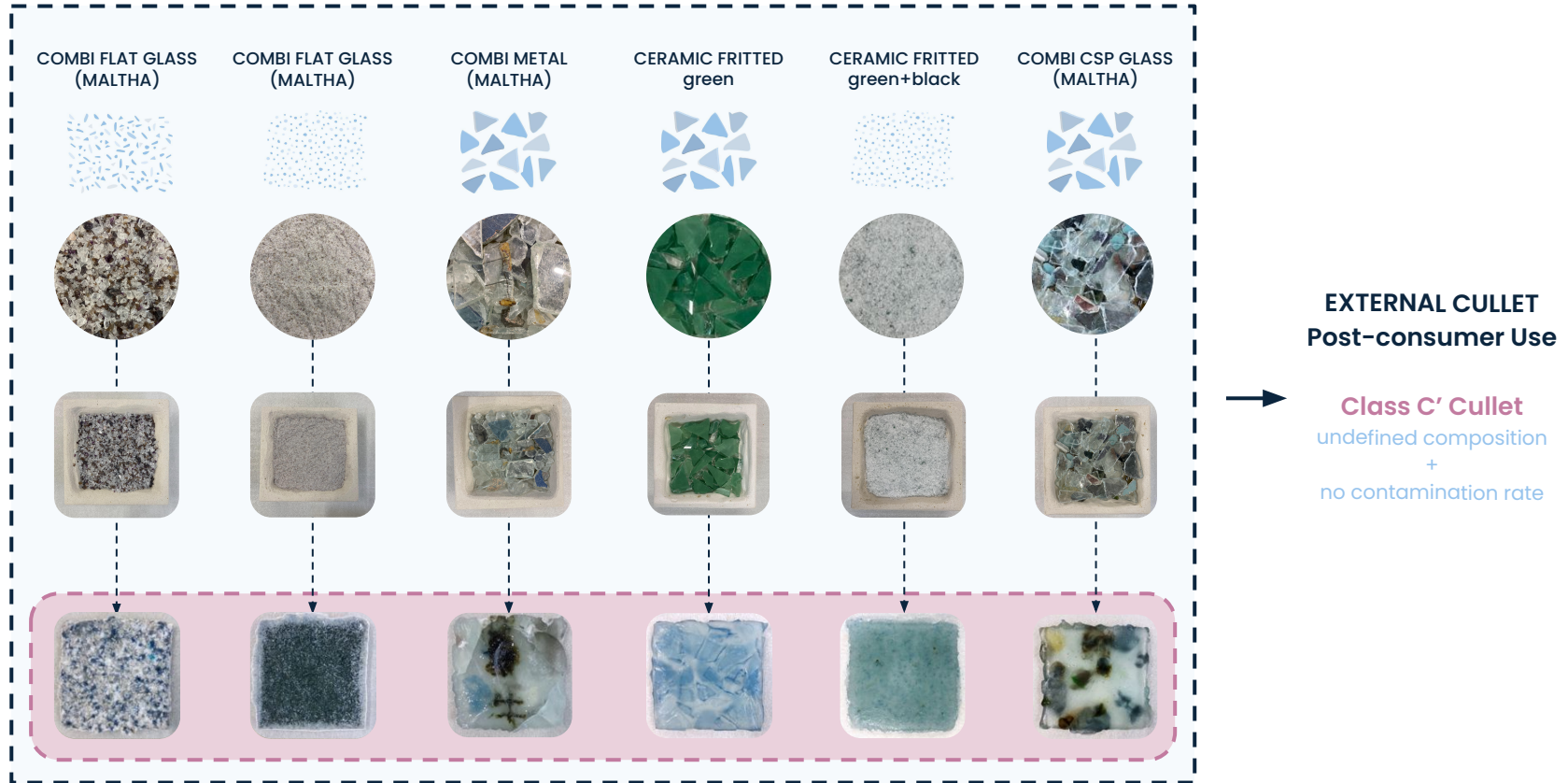
EXPERIMENTAL OVERVIEW



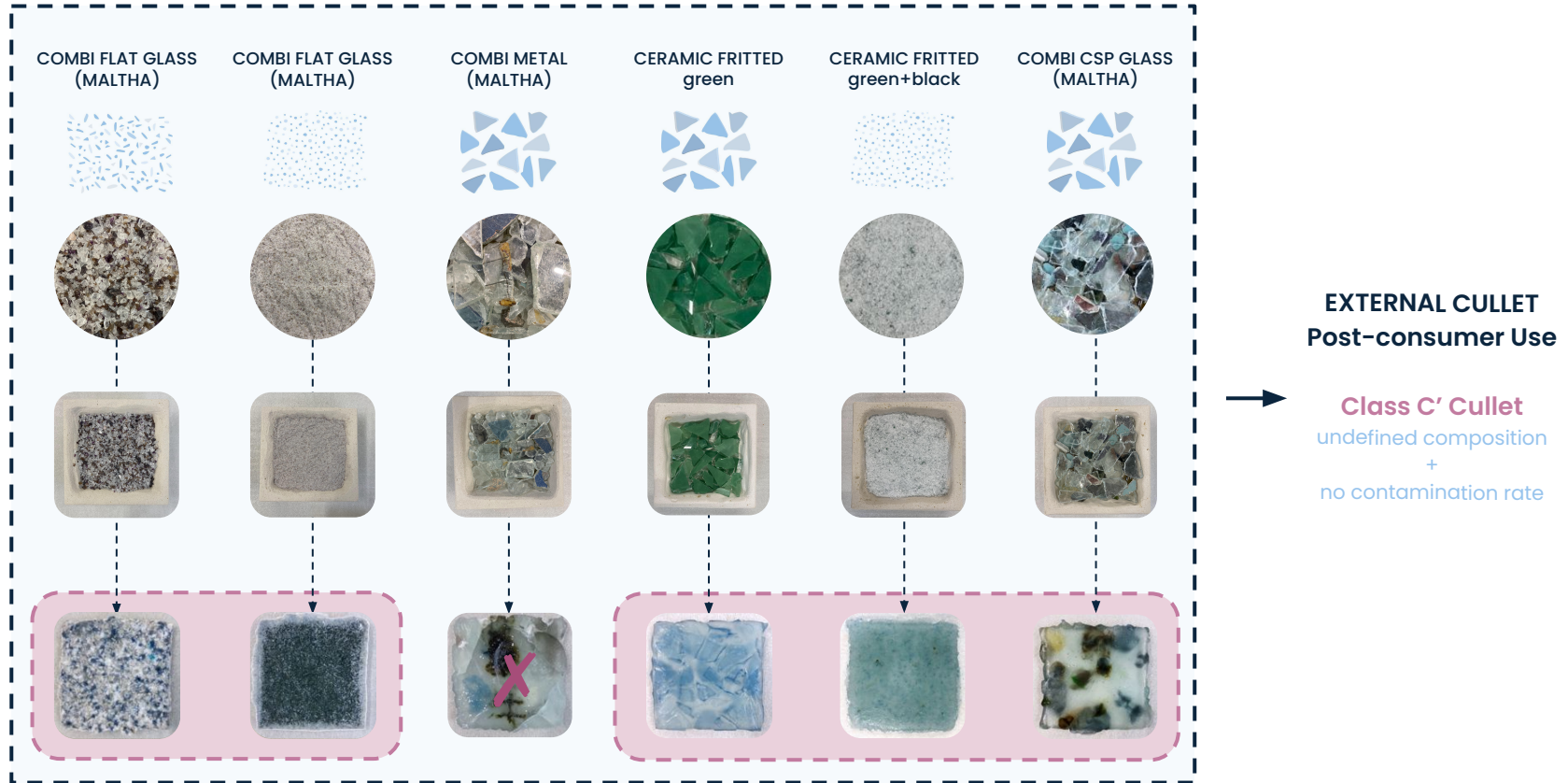
EXPERIMENTAL OVERVIEW



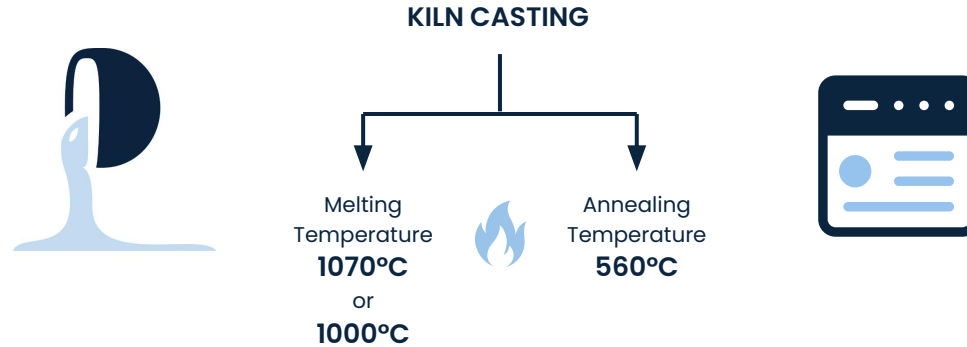
EXPERIMENTAL OVERVIEW



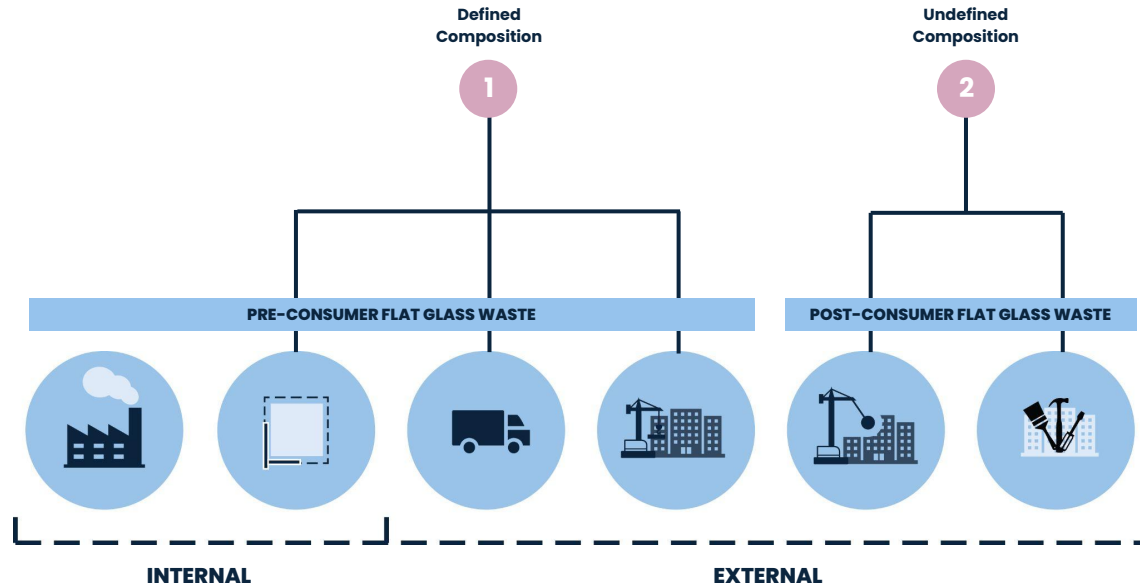
EXPERIMENTAL OVERVIEW



FIRING ROUND II



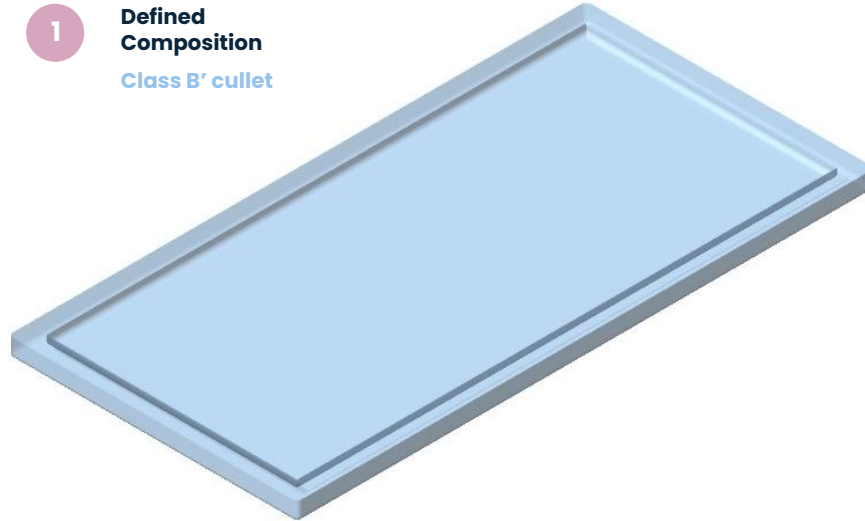
FINAL PRODUCT



1

**Defined
Composition**

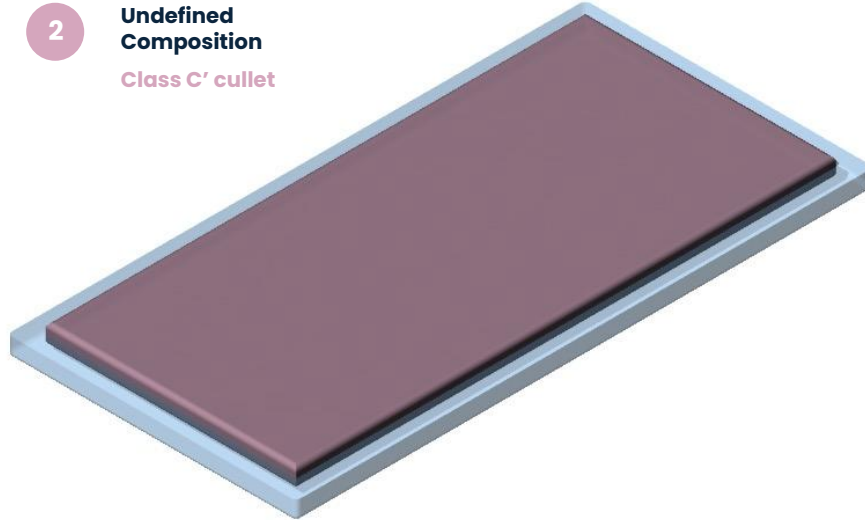
Class B' cullet



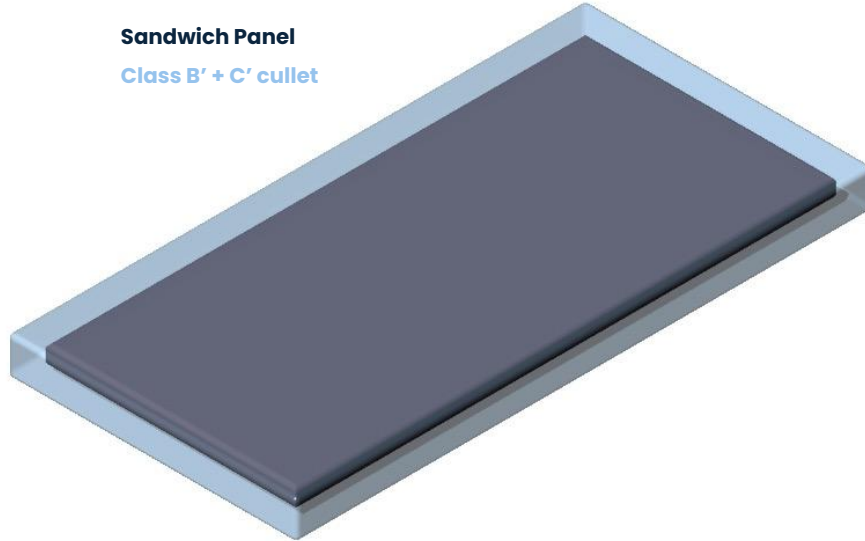
2

**Undefined
Composition**

Class C' cullet



Sandwich Panel
Class B' + C' cullet



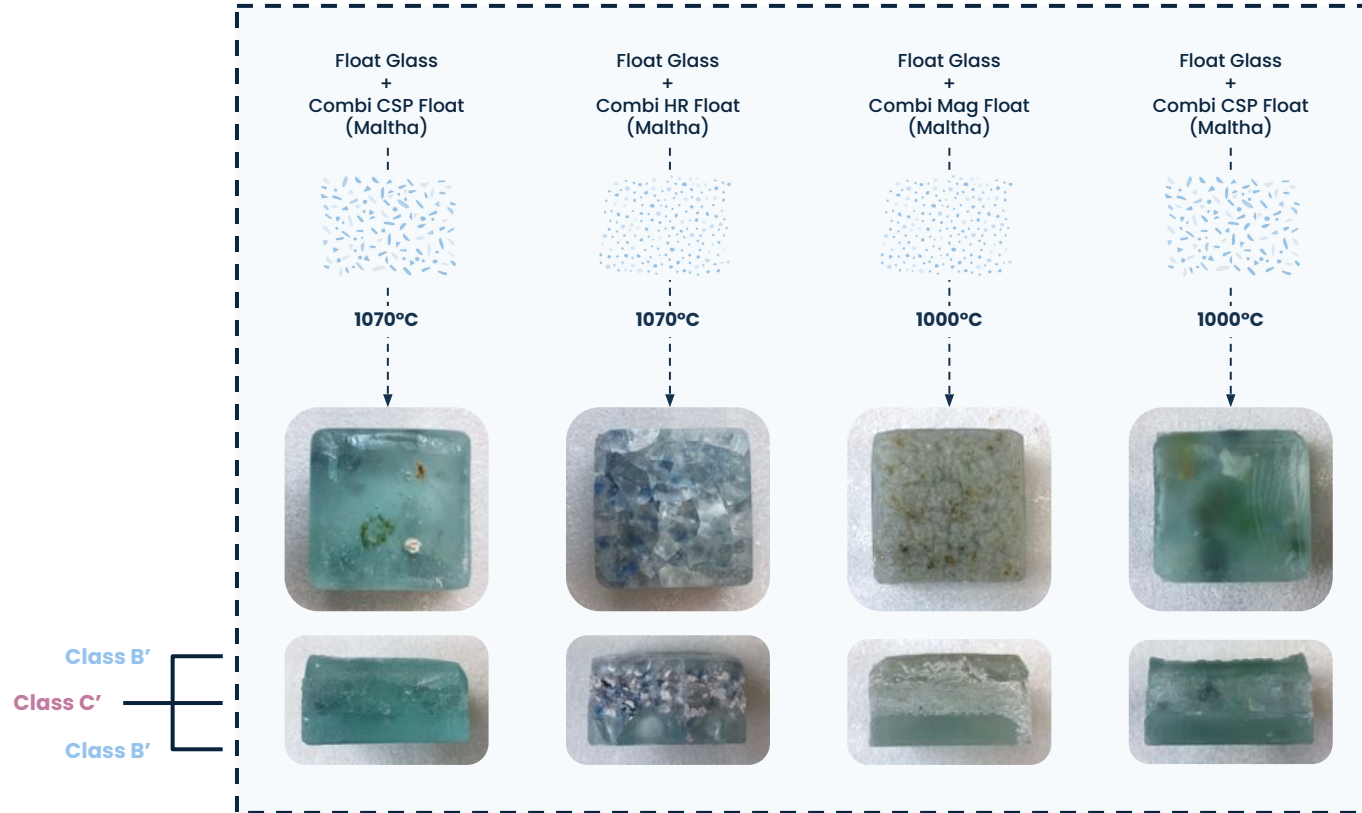
EXPERIMENTAL OVERVIEW

Cullet class B'
Cullet class C'
Cullet class B'

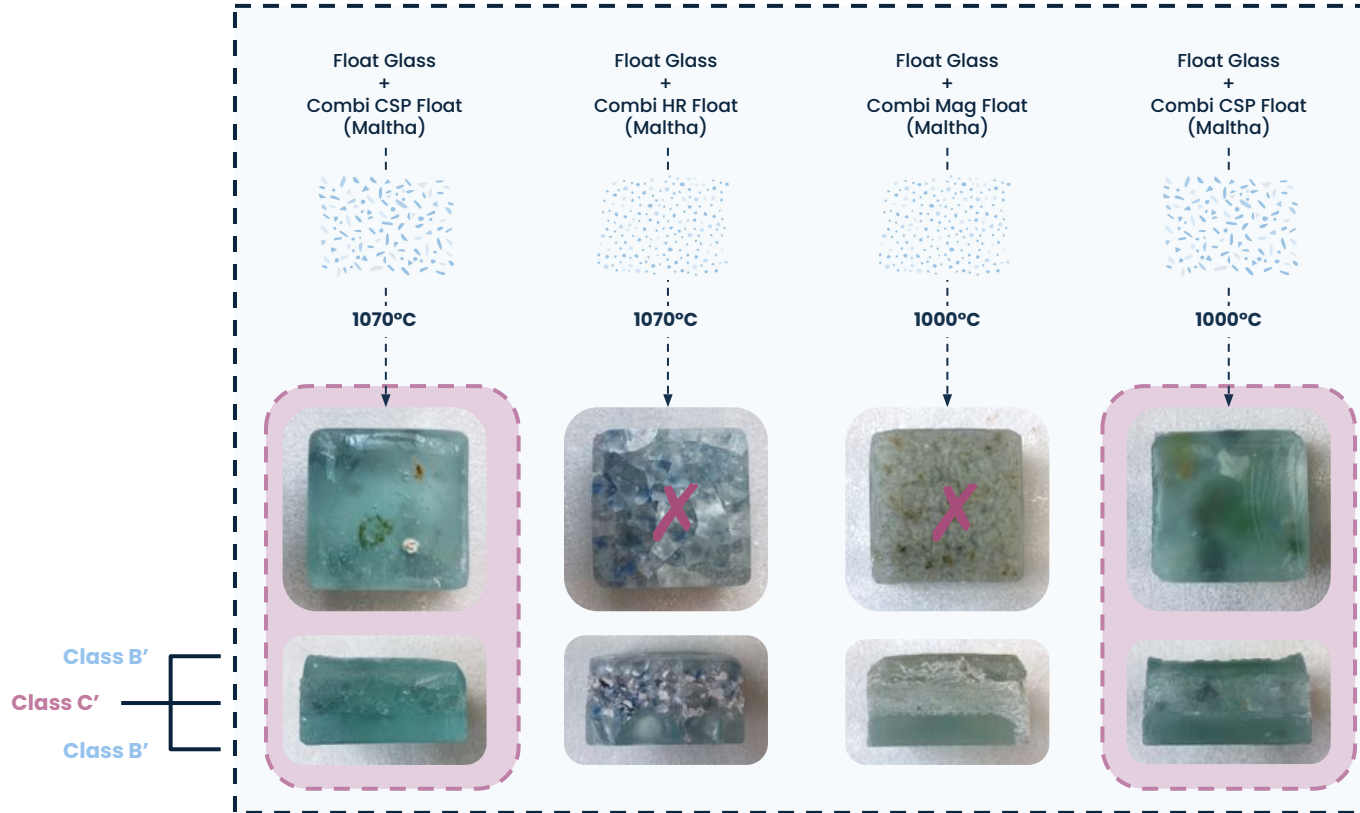


Float glass class B'
Cullet class C'
Float glass class B'

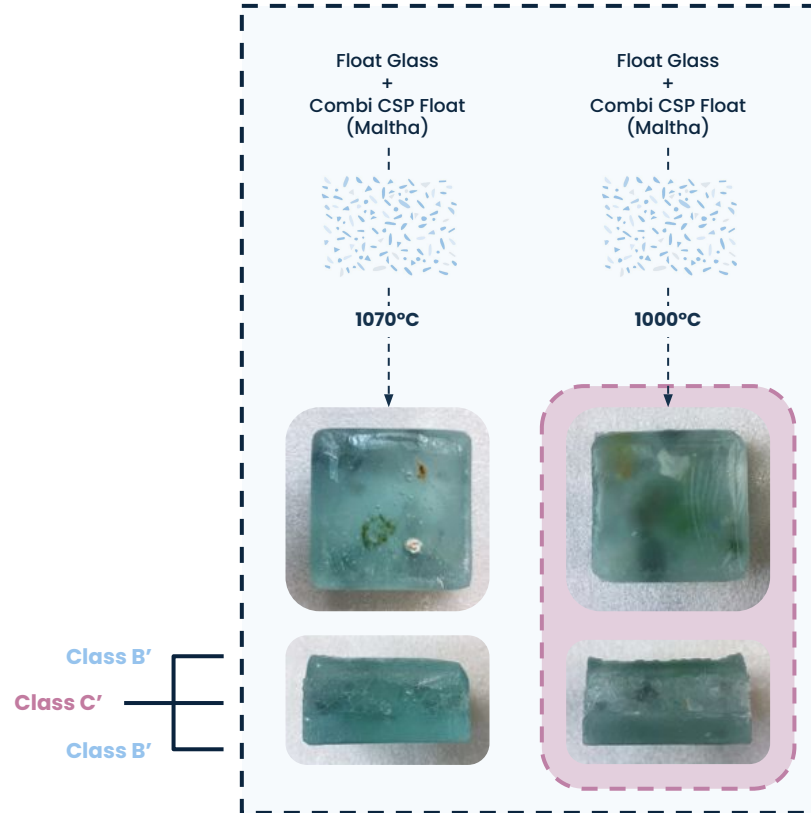
EXPERIMENTAL OVERVIEW



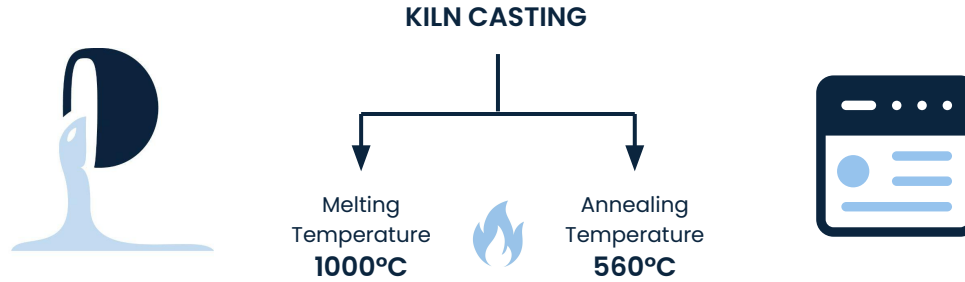
EXPERIMENTAL OVERVIEW



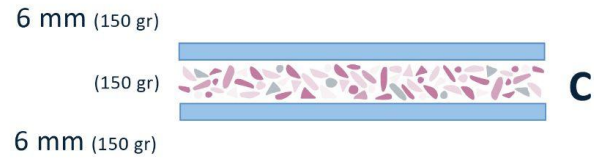
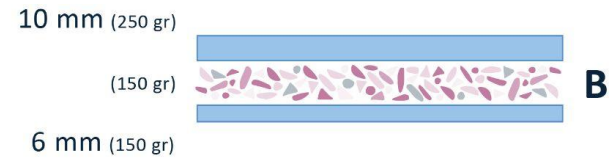
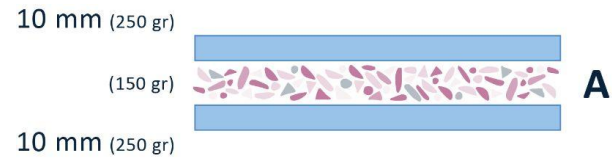
EXPERIMENTAL OVERVIEW



FIRING ROUND III



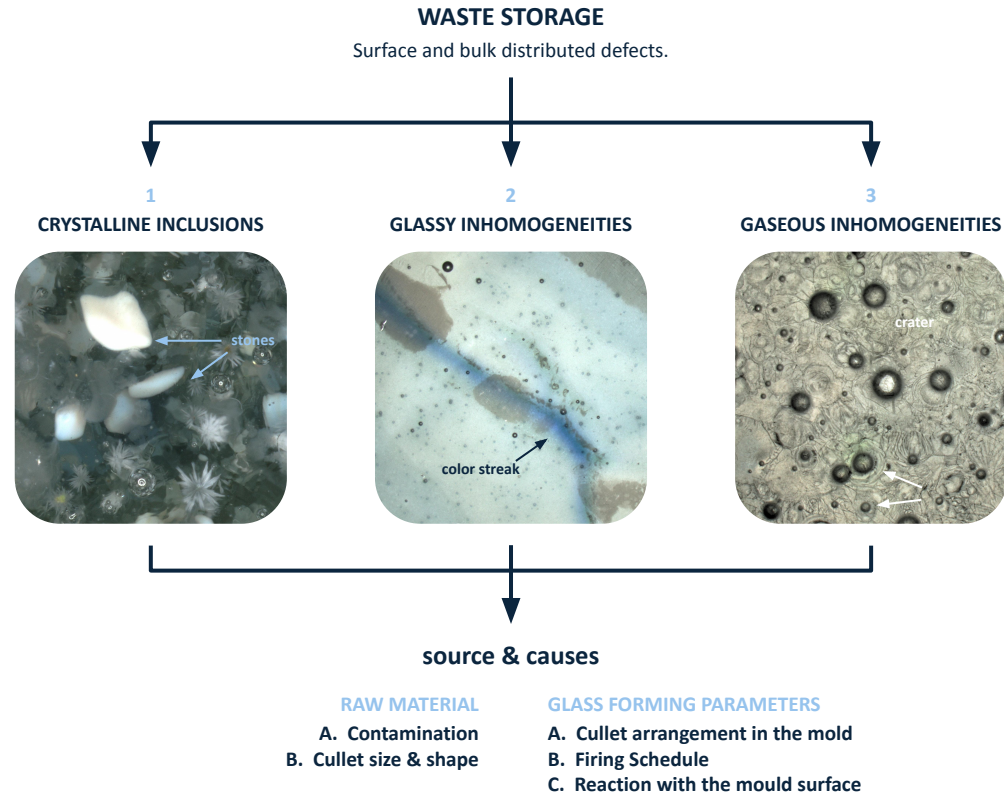
EXPERIMENTAL OVERVIEW





EXPERIMENTAL EVALUATION

DEFECTS EVALUATION

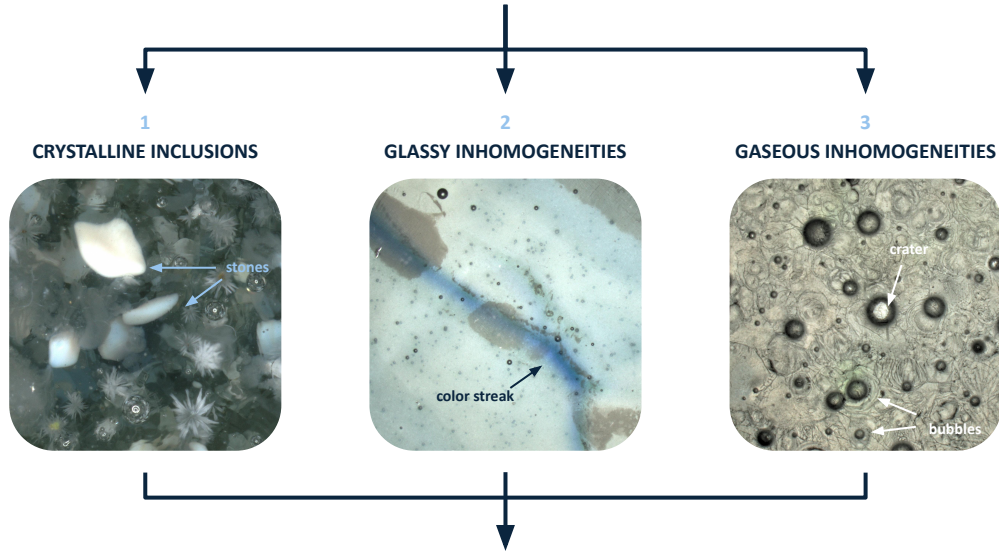


(Telesilla Bristogianni et al. 2020)

DEFECTS EVALUATION

WASTE STORAGE

Surface and bulk distributed defects.



source & causes

RAW MATERIAL

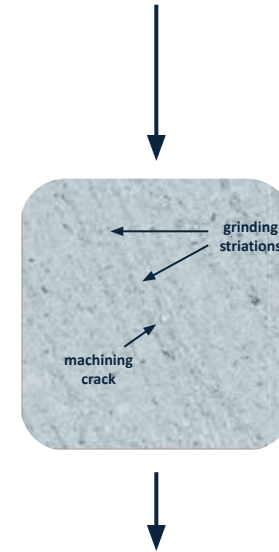
- A. Contamination
- B. Cullet size & shape

GLASS FORMING PARAMETERS

- A. Cullet arrangement in the mold
- B. Firing Schedule
- C. Reaction with the mould surface

POST-PROCESSING & HANDLING

Surface distributed defects.



causes

POST-PROCESSING

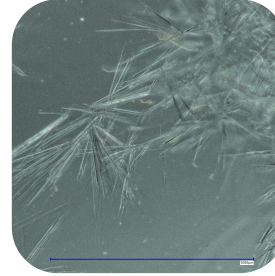
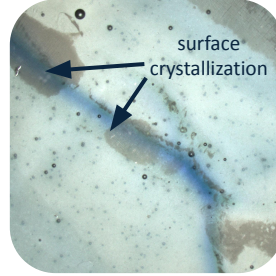
- A. Inadequate removal of existing flaws
- B. New flaws introduction

HANDLING

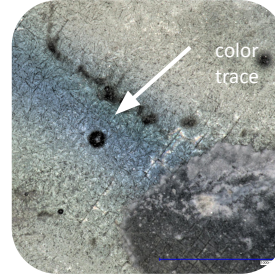
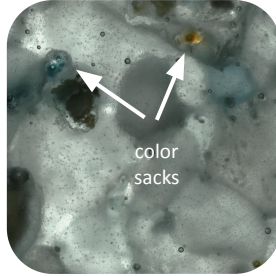
- A. Introduction of random flaws

DEFECTS EVALUATION

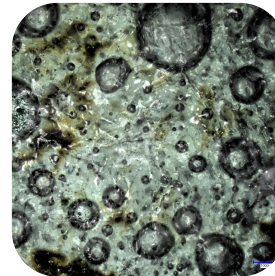
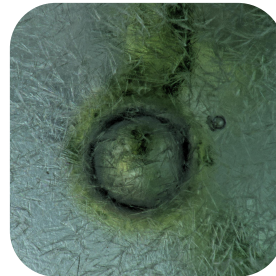
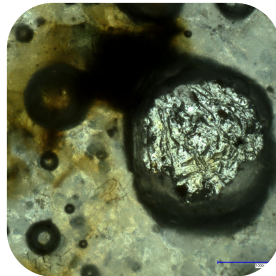
CRYSTALLINE INCLUSIONS



GLASSY INHOMOGENEITIES



GASEOUS INHOMOGENEITIES



STRESS ANALYSIS

A

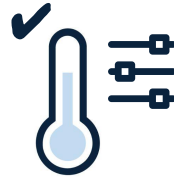


B



C





THERMAL SHOCK



UNPROCESSED

no edge & surface treatment

VS



POST-PROCESSED

edge & surface treatment
(grinding & polishing)
coating application
(UV liquid coating)

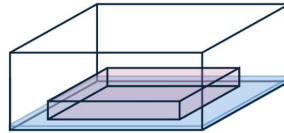
THERMAL SHOCK

$\Delta t: 60^{\circ}\text{C}$

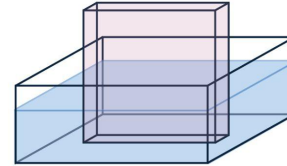
T1



T2



T3



(Oikonomopoulou, 2019)

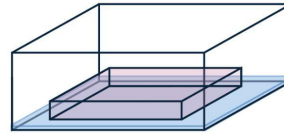
THERMAL SHOCK

$\Delta t: 60^{\circ}\text{C}$

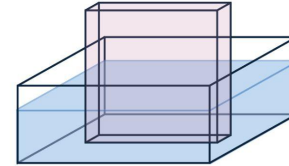
T1



T2



T3



(Oikonomopoulou, 2019)

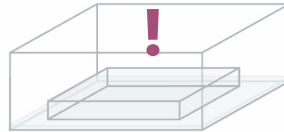
THERMAL SHOCK

$\Delta t: 60^{\circ}\text{C}$

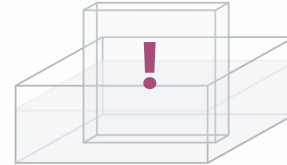
T1



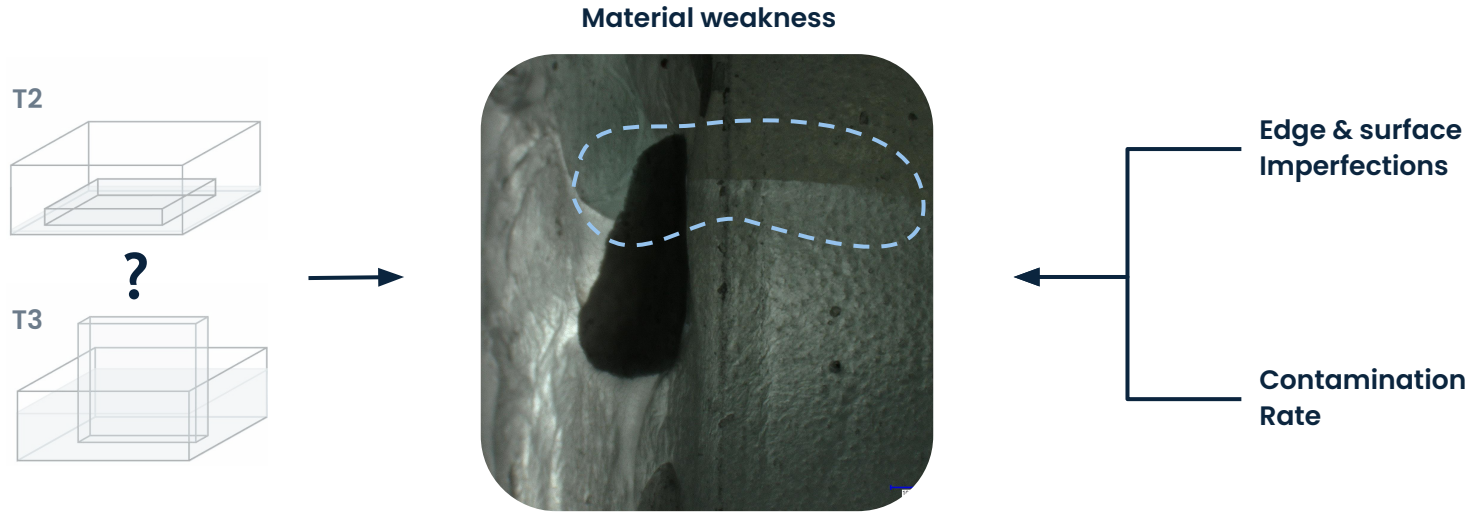
T2

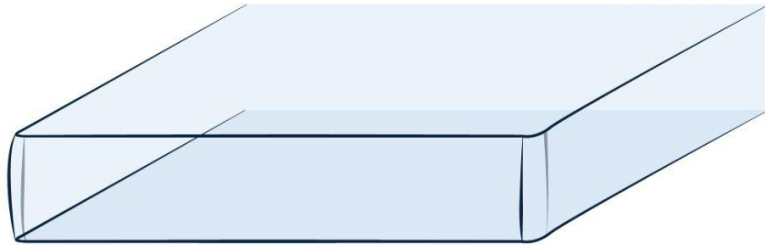


T3

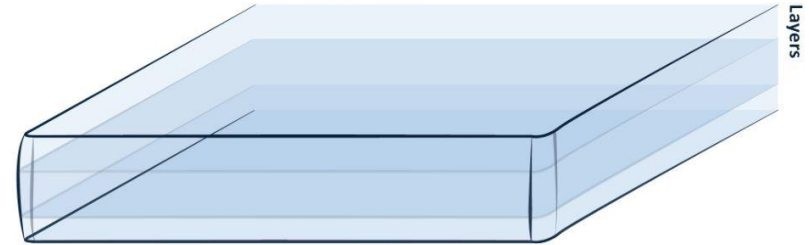


(Oikonomopoulou, 2019)

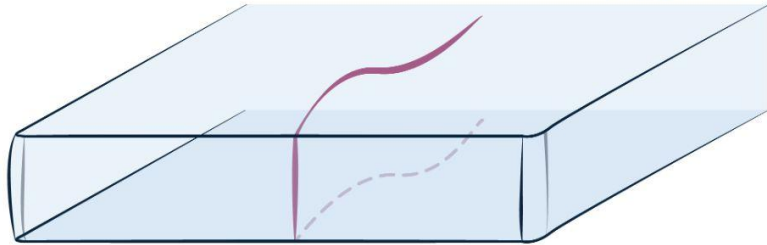




Single Glass Panel



Composite Glass Panel

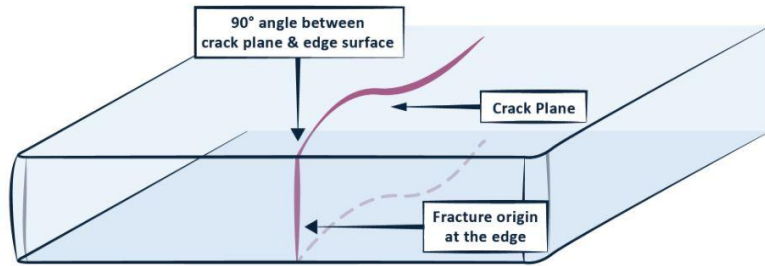


Single Glass Panel

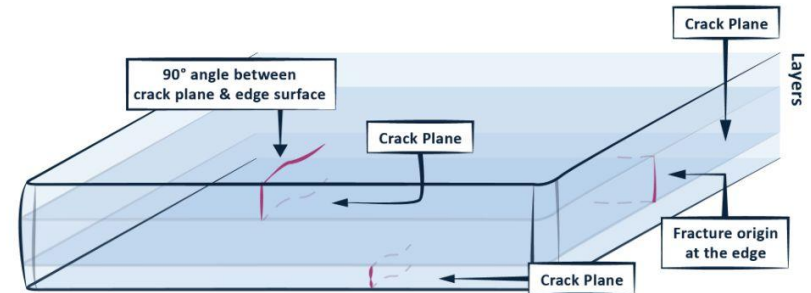


Composite Glass Panel

THERMAL SHOCK FINDINGS



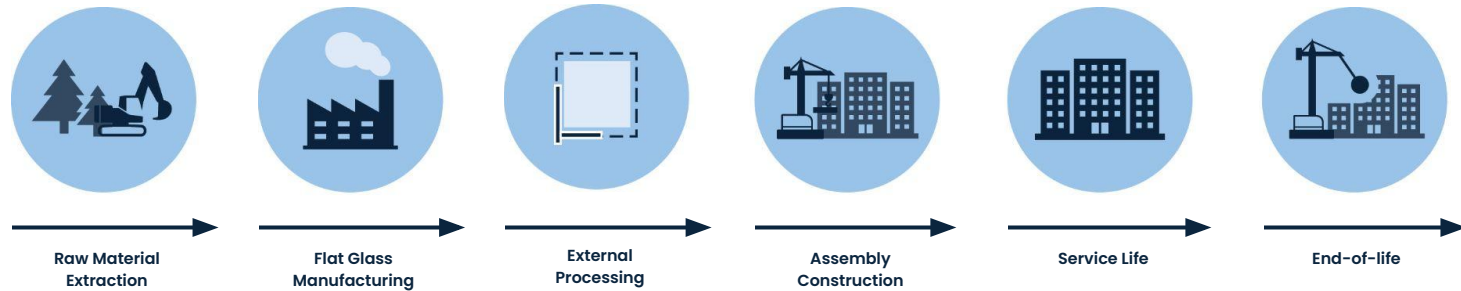
Single Glass Panel



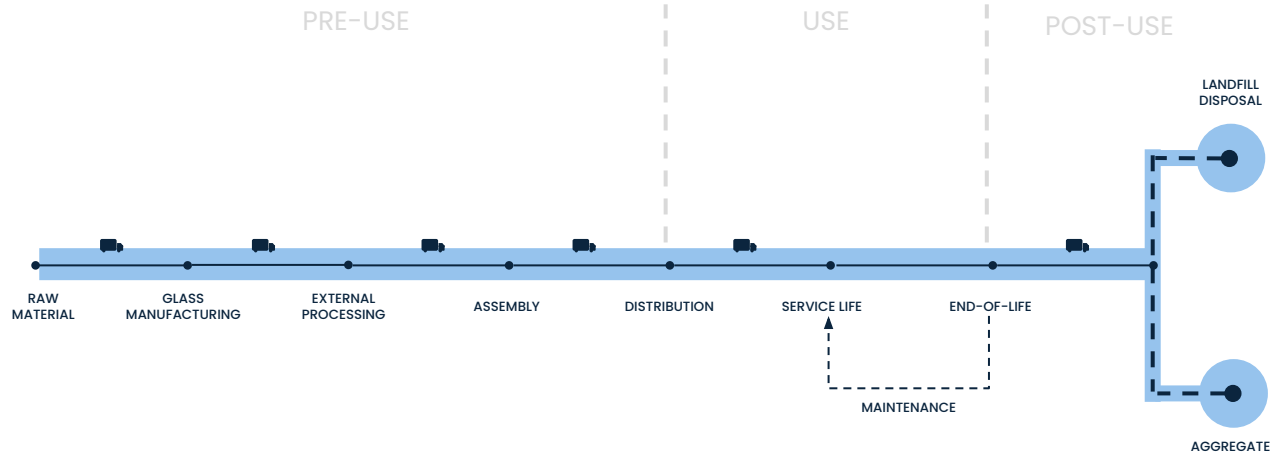
Composite Glass Panel

LIFE-CYCLE SCENARIOS

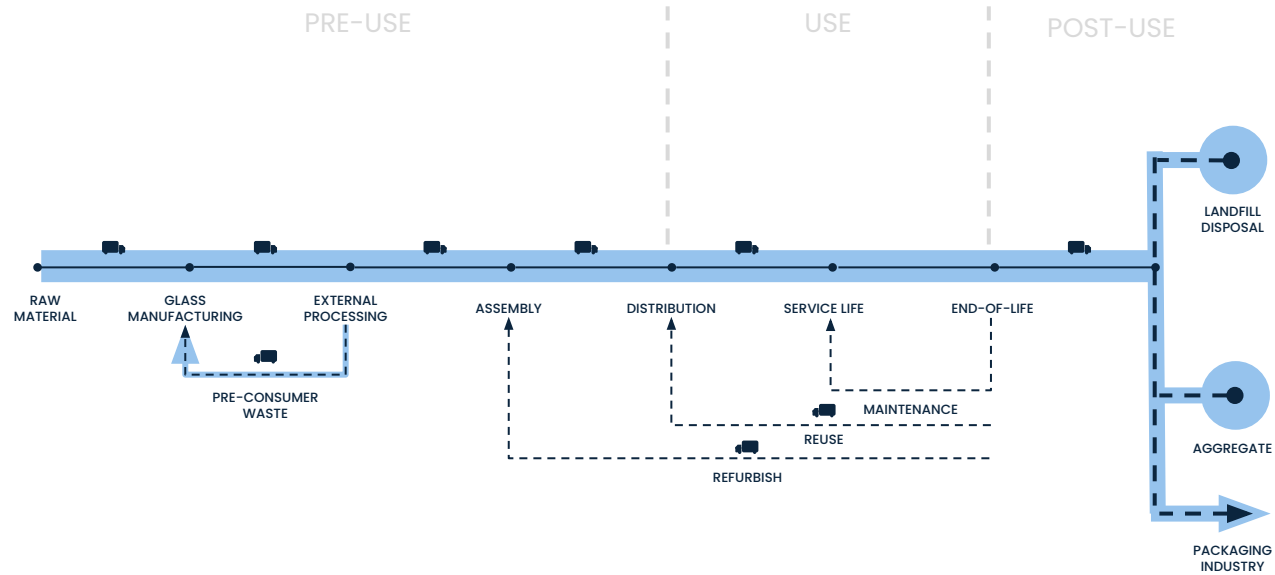
LIFE-CYCLE SCENARIO



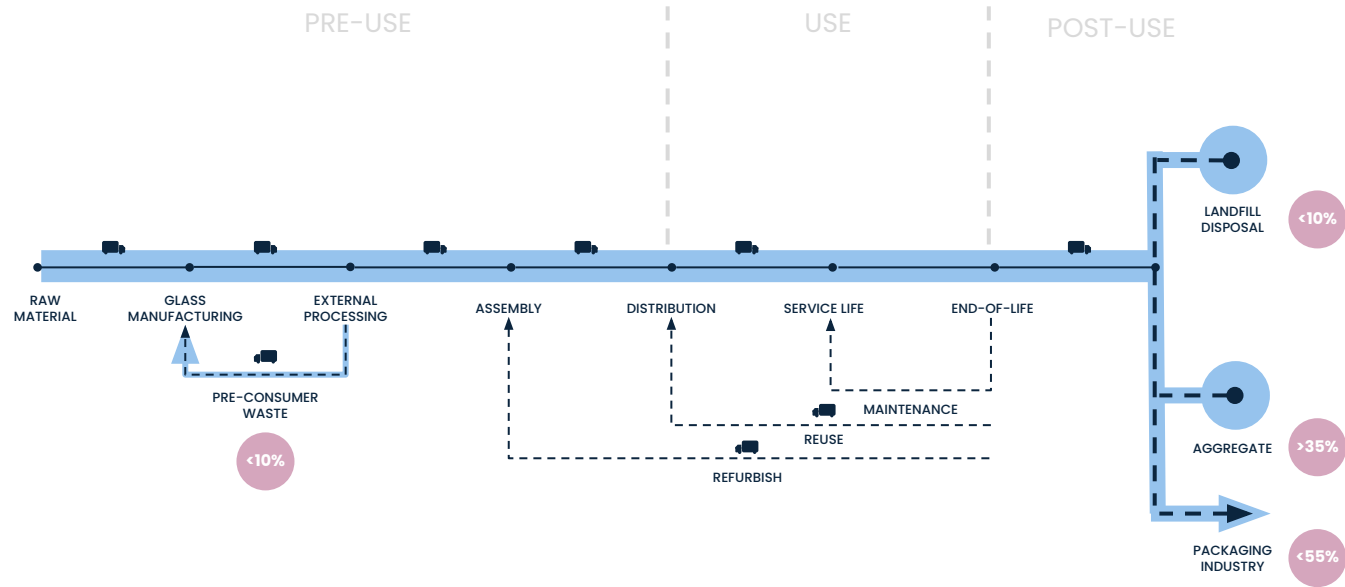
LIFE-CYCLE SCENARIO



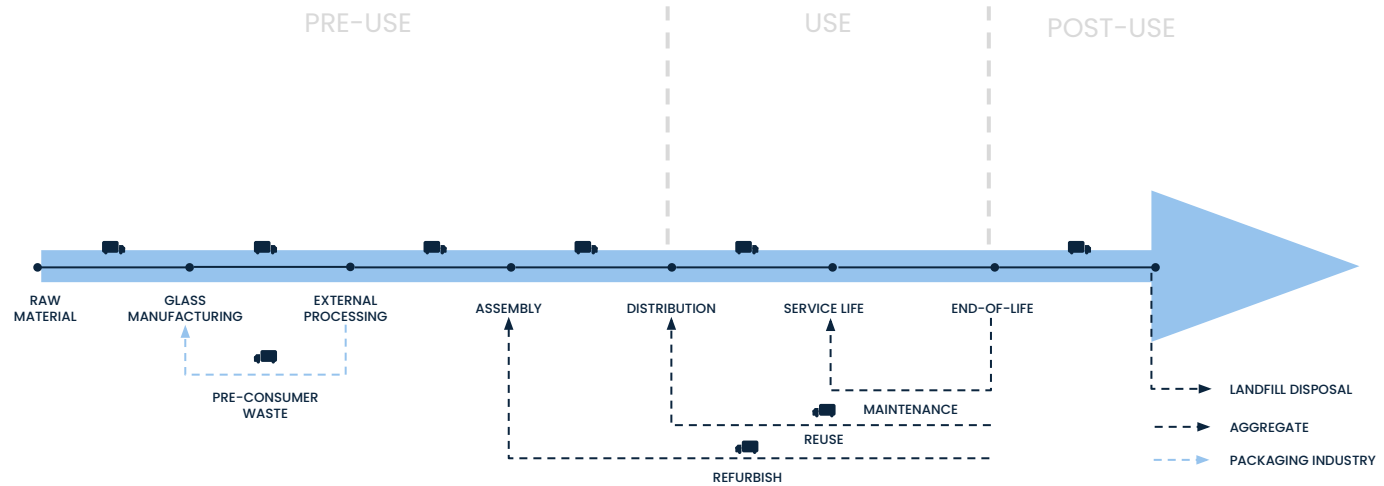
LIFE-CYCLE SCENARIO



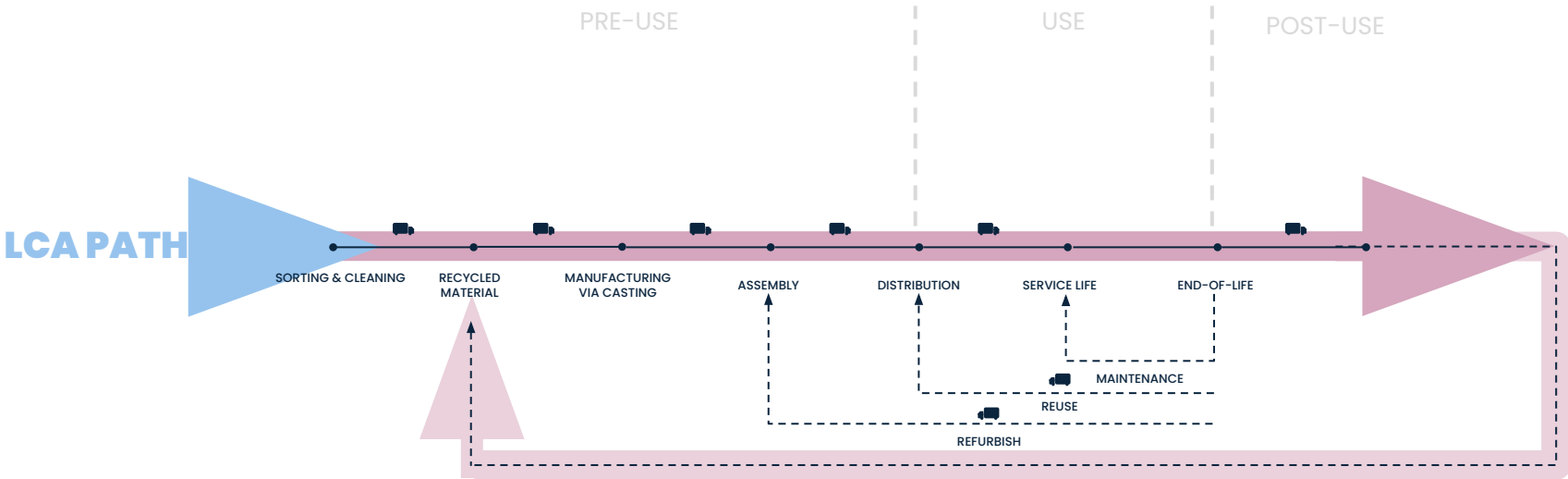
LIFE-CYCLE SCENARIO



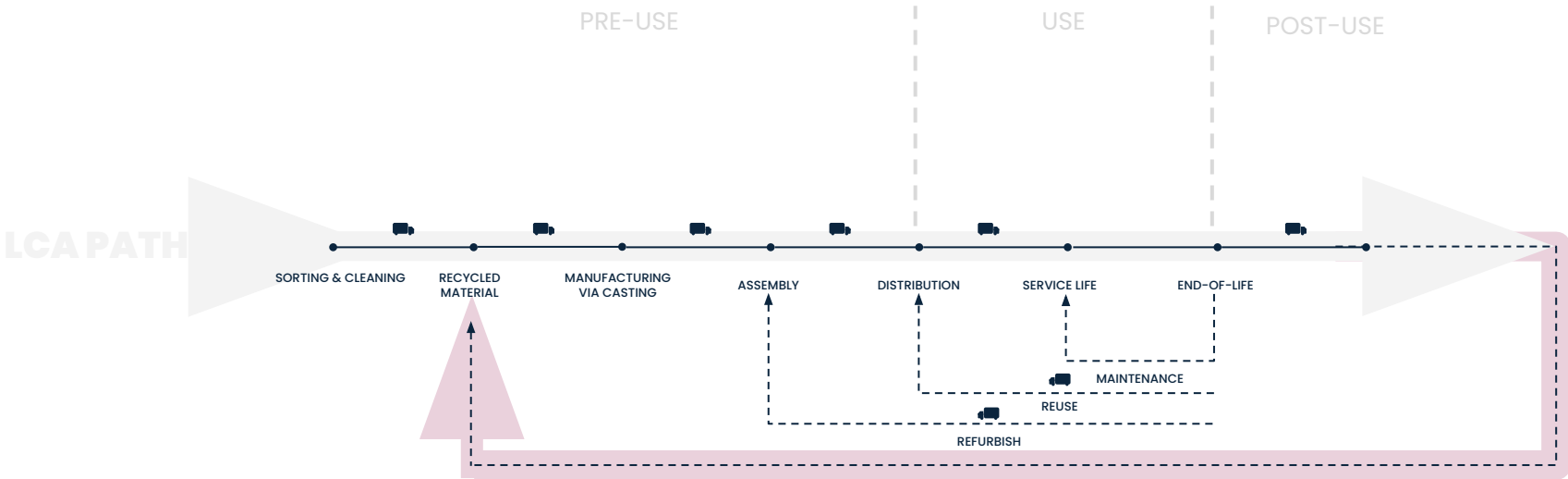
LIFE-CYCLE SCENARIO



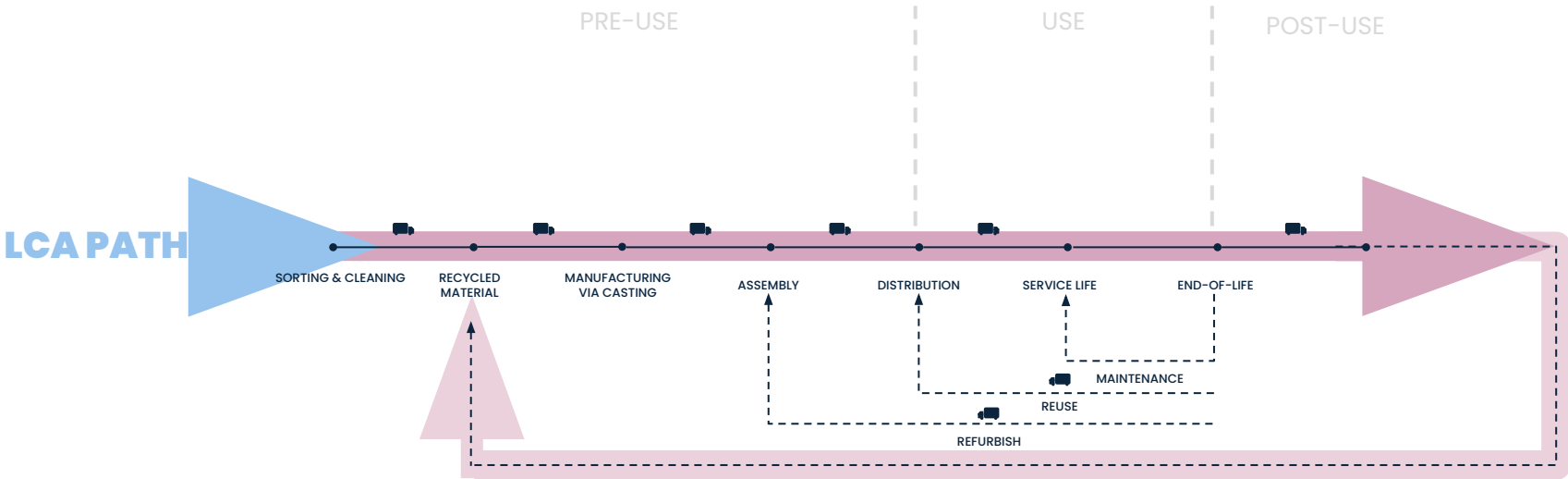
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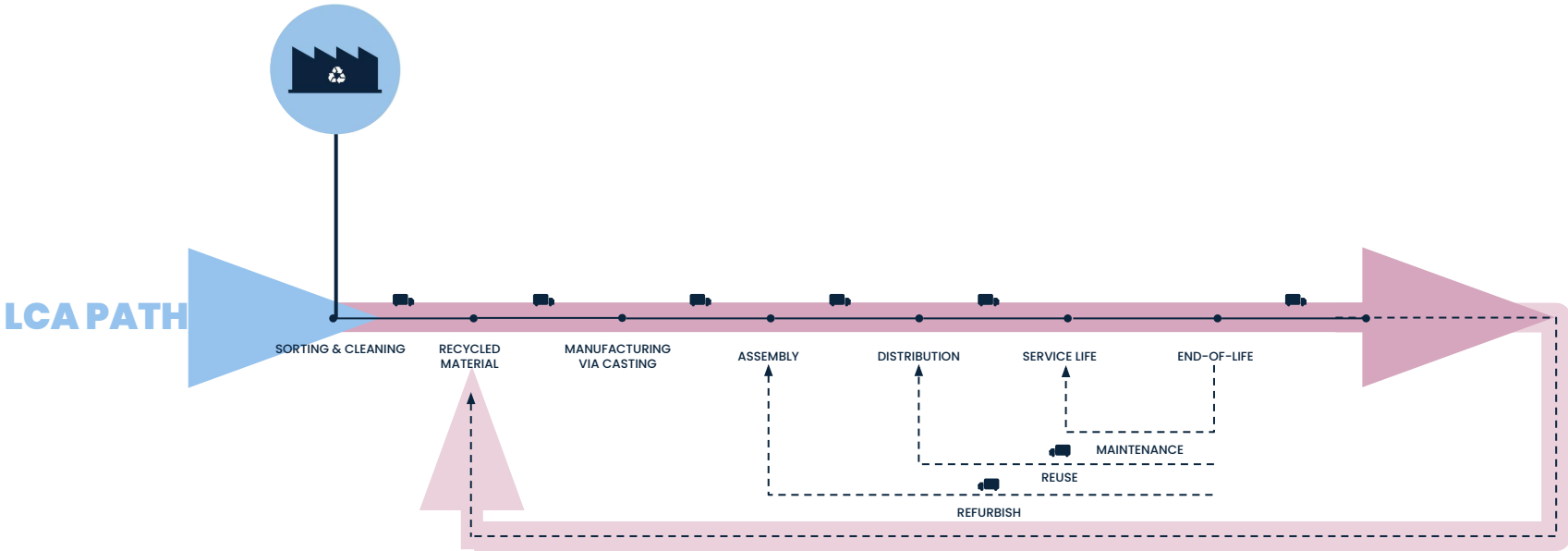
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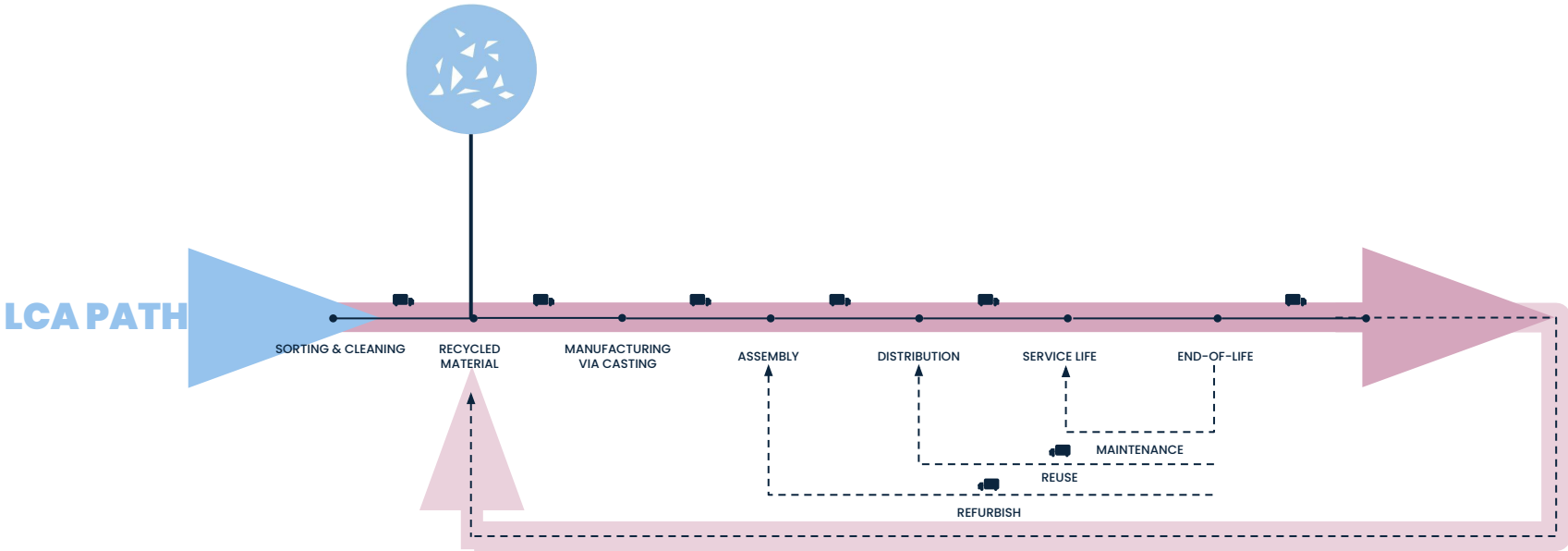
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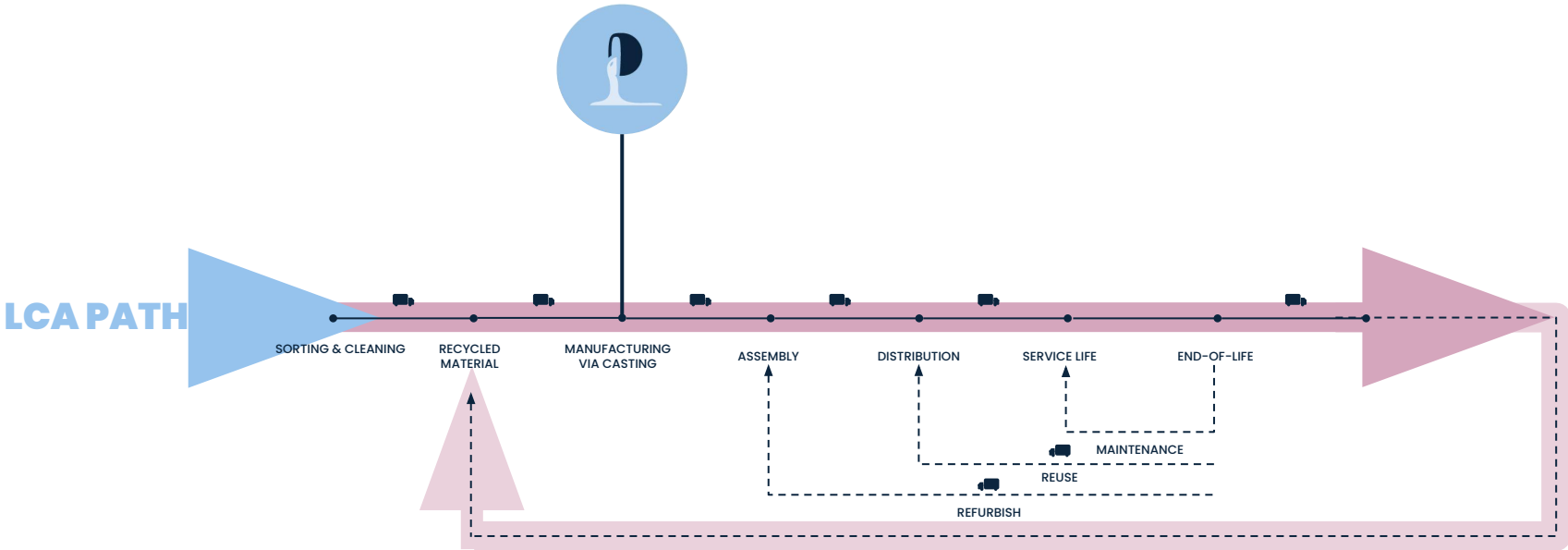
LIFE-CYCLE SCENARIO



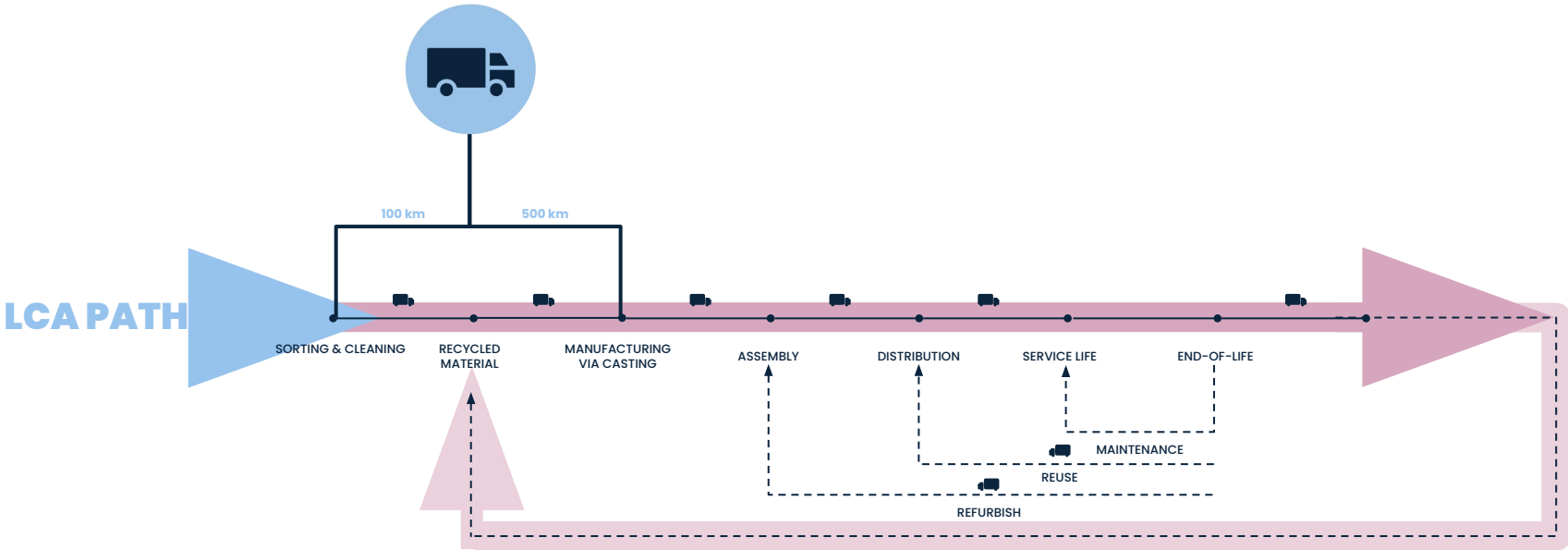
LIFE-CYCLE SCENARIO



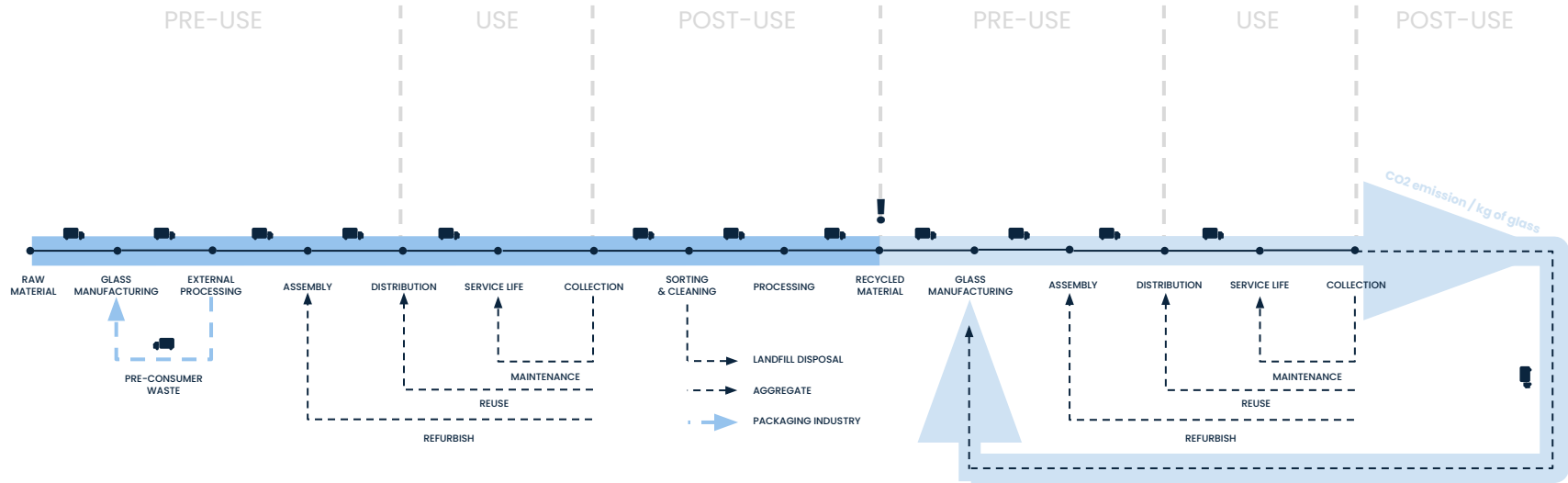
LIFE-CYCLE SCENARIO



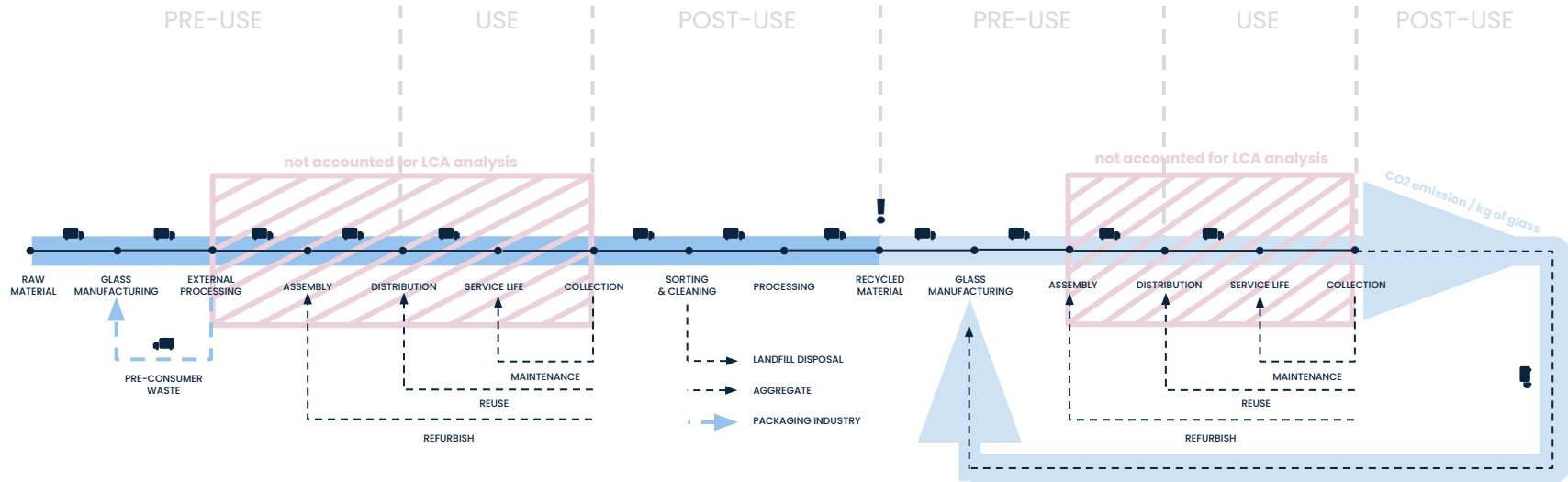
LIFE-CYCLE SCENARIO



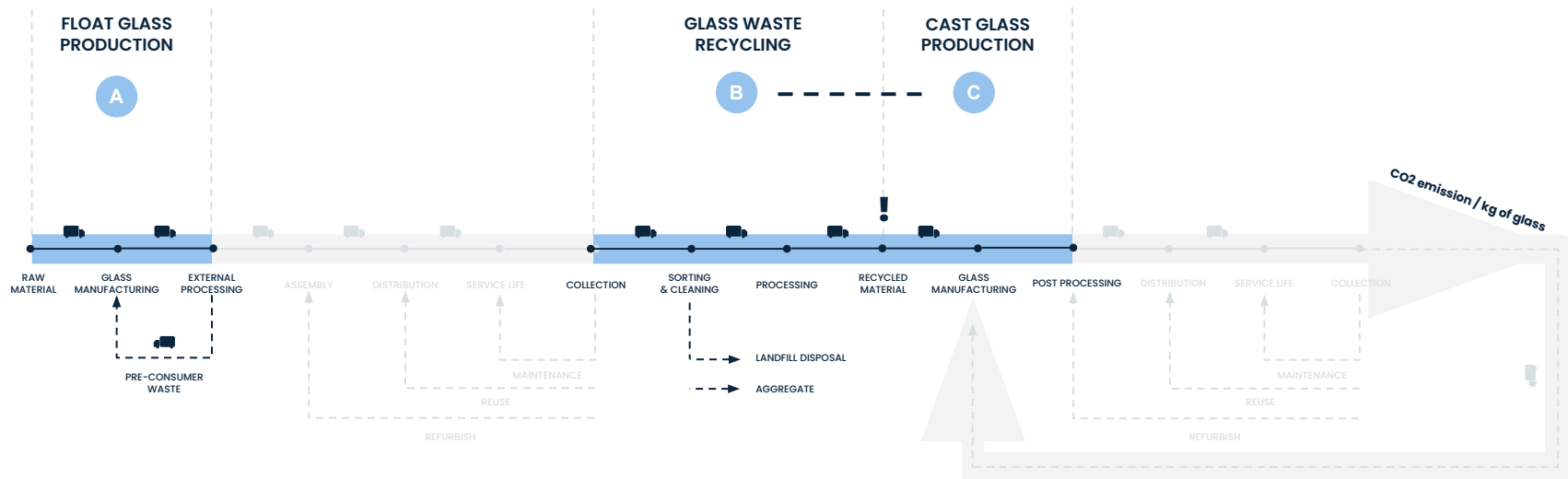
LIFE-CYCLE SCENARIO



LIFE-CYCLE SCENARIO



LIFE-CYCLE SCENARIO

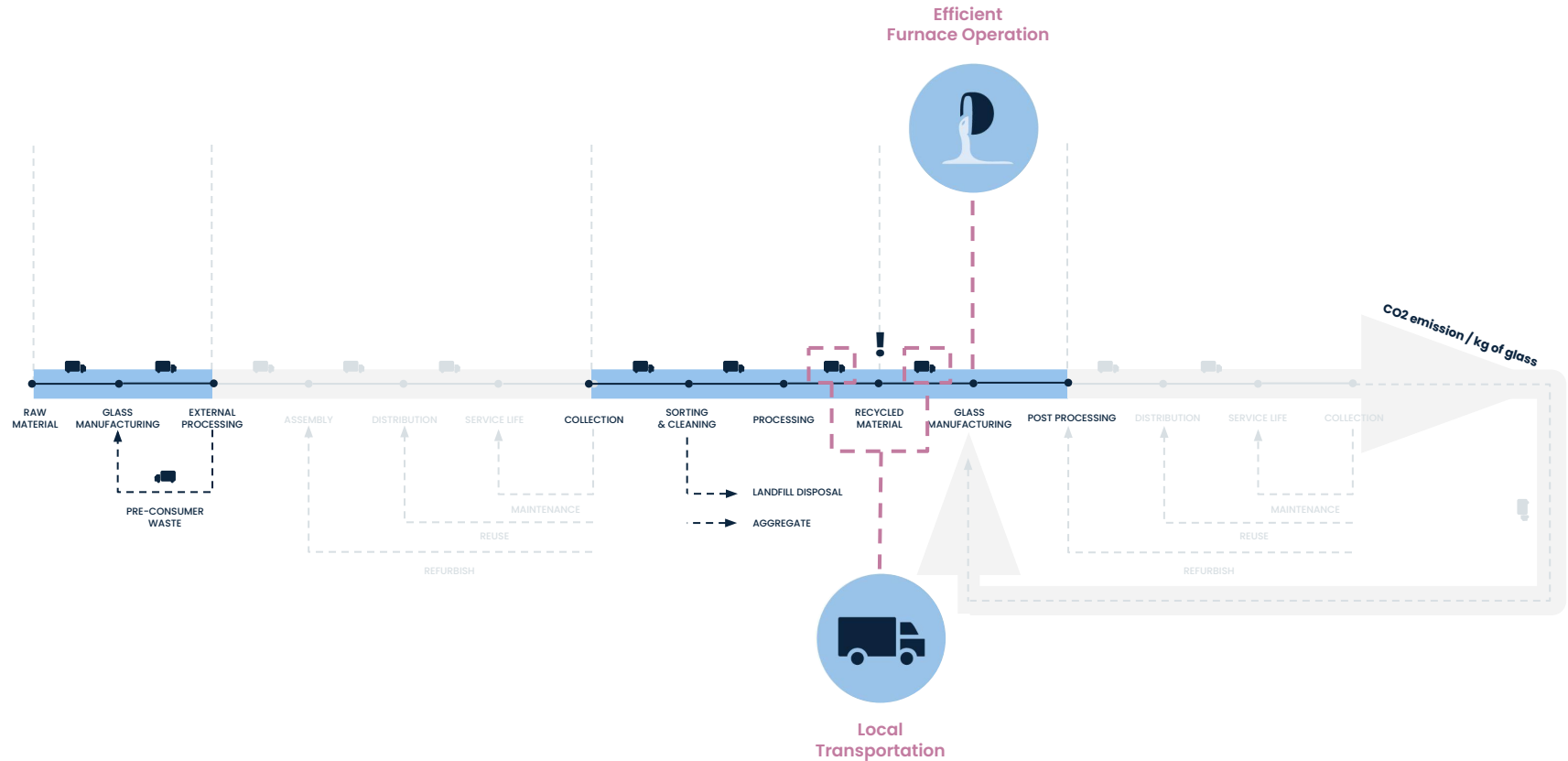


Every 1 kg of **flat glass** results
1.440 kgCO₂ of embodied carbon



Every 1 kg of **100% recycled cast glass**
0.1968 kgCO₂ of embodied carbon

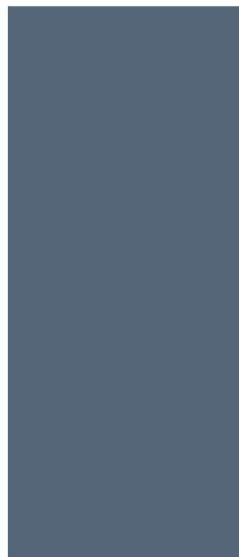
LIFE-CYCLE SCENARIO



IMPLEMENTATION



FINAL PRODUCT



280 x 125 cm



350 x 150 cm



MATT

silky smooth
finish



PATINATED

textured finish
low glare reflectivity
& scratchability



POLISHED

3D effect
color reflection



18 mm



STANDARD PRODUCTION

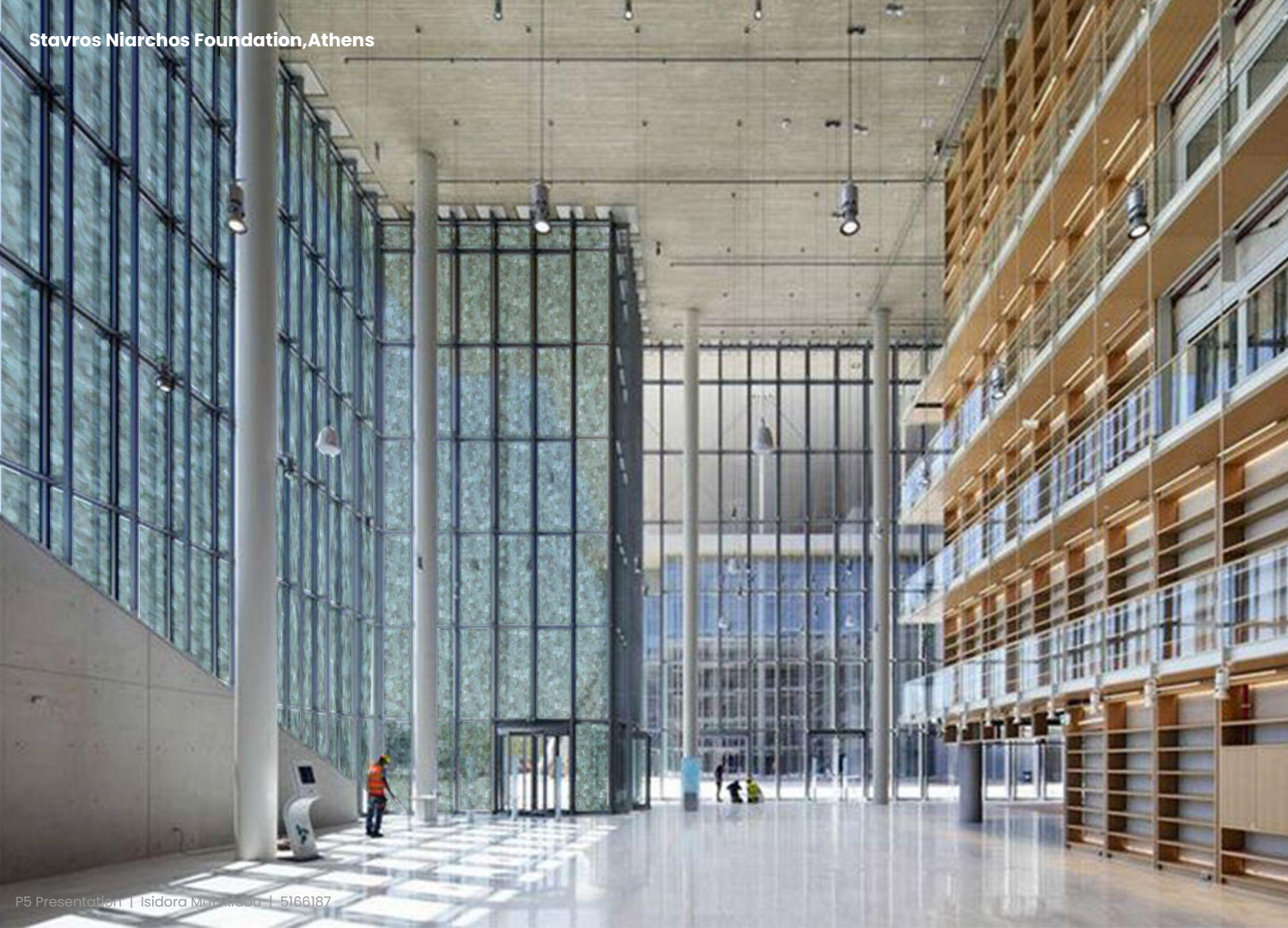
22 mm



26 mm

* 54,12 kg per sq.m, in standard panel thickness







新濠天地



BALUSTRADES



PARTITION WALLS



WALL COVERING



FLOORING

CONCLUSIONS

CONCLUSION

Glass Panel made of C&D Waste



Feasible process through **Casting**

Closed-loop Approach



Obstacles to be overcome
Recycling System Mapping
Sustainable Solution

Recycled Product Fabrication



Experimentation

- waste combination
- firing schedule
- flaws consideration

Product Performance



Stress Analysis with negligible stresses
Thermal Shock further investigation

Sustainability Performance



Rely heavily in Assumptions → **Improvement**

FURTHER RESEARCH

Further experimentation on the material

Structural Evaluation

Safety Mechanisms

Thermal Performance

Cost Estimation

Reversible Connections

LCA comparison with Casting products

Thank you!

... for your attention!