

Exploring AI For Packaging Circularity

The Consumer Goods Forum's Plastic Waste Coalition in collaboration with Bain & Company

January 2026



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Summary & Introduction



The Consumer Goods
FORUM

Introduction

Packaging circularity is one of the most complex and urgent challenges facing the consumer goods industry today. Decisions made early in the packaging lifecycle can lock in environmental, operational, and cost impacts for years. At the same time, regulatory expectations are rising globally, and businesses must navigate material innovation, recyclability trade-offs, and data and reporting requirements.

The Consumer Goods Forum's (CGF) [Plastic Waste Coalition of Action](#), in collaboration with Bain & Company, has developed this paper to provide a practical, industry-informed perspective on how artificial intelligence (AI) can help unlock value and support the transition to circular packaging at scale.

Drawing on expert interviews with CGF members, case studies, and market analysis, the research shows that 30% of companies are already leveraging AI across the packaging lifecycle—from optimising product design and reducing material use to improving sorting and traceability. While AI can support every stage of the lifecycle, 70% of companies see the greatest potential in packaging design, and 40% note that AI can help map where and why material loss occurs.

This paper identifies the five main challenges that currently limit progress in circular packaging and highlights 15 AI solutions, with four key use cases demonstrating tangible results:

- Packaging design optimisation
- Generative new design
- Advanced sorting
- Material traceability

By sharing these insights, the report aims to support collaboration across brands, retailers, solution providers, and technology experts, enabling companies to prioritise action, adopt practical AI solutions, and scale circular packaging solutions more effectively.

We hope this paper serves as a valuable guide for CGF members and the wider industry, helping turn potential into impact and accelerating the journey toward a truly circular economy for packaging.



AI for packaging circularity | Summary



5 Key circularity pain points

Shared by stakeholders across the packaging value chain, from design to recycling

Material innovation challenges

Reuse system complexity

Recyclability gaps

Recycled content access

Regulatory & data pressure



15 AI use cases

Solving for both technical & system packaging challenges

Enhanced Data



Operational Efficiency



Innovation



Material traceability

Design optimization

Consumer education

Supplier scoring & selection

Advanced sorting

Generative new design

Automated reporting

Smart Bins

Enhanced chemical recycling

...

..

..



8 prioritized use cases

Based on their ability to unlock multiple pain points with high relevance and impact

Advanced sorting

Material traceability

Supplier scoring & selection

Generative new design

Design optimization

Material discovery

Automated compliance & reporting

Forecast & tracking of reuse

4 of these already gained real traction

Offering early proof points of feasibility and impact



For different players, different fits

Stakeholders will leverage different use cases based on roles, priorities and capabilities

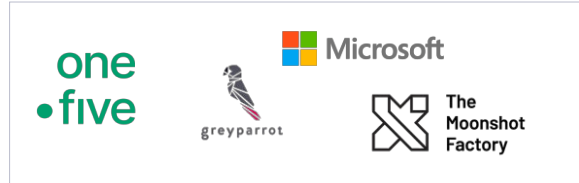
Internal and external tools and experts were used to identify AI use cases for packaging circularity

Industry expert interviews

7 CGF Member Companies: CPGs & Retailers, and Converters



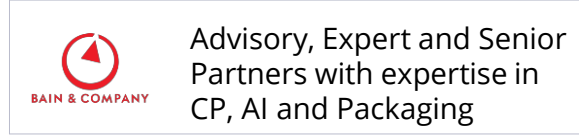
Solution providers



NGOs



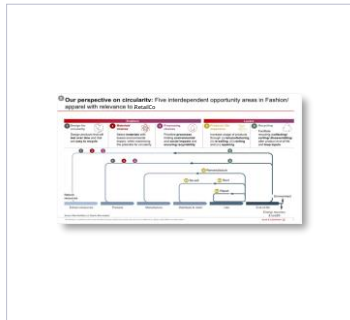
Bain expert network



Warm thank you to all participants!

Bain expertise and previous work

Circularity model & strategy



Technologies for sustainable packaging

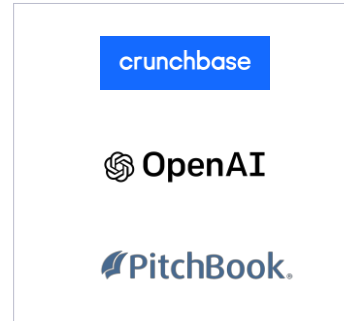


AI in supply chains operations



Research tools & references

Start-up identification and mapping



Market trends and data and analysis



Policy standard and innovation references



Company reports and press releases

Packaging manufacturers and converters



CPGs and Retailers



Other organizations and expert hubs



Packaging circularity requires a step change, with AI as one of the key tools to unlock solutions

With increasing expectations and pressure to deliver on packaging circularity...

Regulations and expectations toward packaging circularity are getting higher and stricter

EPR¹

Committed fee from companies for packaging accountability

PPWR²

Enforces EU-wide standards for circularity³

Others

e.g., AGEC law in France, Green Deal targets in EU

Due to technical challenges, companies have softened their sustainable packaging targets



Modifying targets,
for more flexibility



Adjusting thresholds
to adapt to the current environment

Targets are often reshaped because taken assumptions have been changing in the current context



More **complex** materials



Data **blind spots**

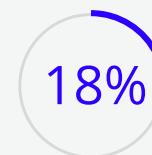


Resource **requirements**

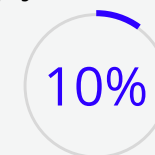
... AI should be looked at as a key enabler, considering its proven track record of impact across various other industries

Supply chain optimization with Plastic&Co

Leveraged AI through predictive analytics and bottleneck reduction to gain real-time supply chain insights



Cut in logistic cost



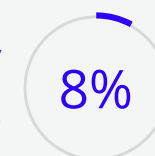
Drop in emissions

Better sourcing with Chem&Co

Applied AI to assess suppliers and streamline procurement



Cut in cost of procurement



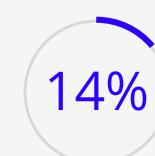
Drop in emissions

Predictive maintenance with Material&Co

Implemented AI to detect faults in polymer lines



Drop in downtime



Drop in emissions

Material discovery with Chem&Co

Harnessed AI to enable the creation of sustainable product



Cut in R&D cost



Drop in emissions

What we heard from you:

AI has high potential but implementation is held back by key bottlenecks

Interview
Panel

45%

Global CPGs or
retailers

35%

AI & technology
solution providers

20%

Packaging prod
& converters

There is conviction that AI will unlock
packaging circularity...

100%

of interviewees have considered
AI for circular packaging

30%

of interviewees have started to
pilot or implement AI solutions

Interviewees think AI will help the most across the packaging value chain:

70%

For design
& optimization

"Design is where AI can have the biggest impact;
but it's hard to scale because we lose control once
it's in the consumer's hands"

From TechCo

65%

For packaging
traceability

"AI could help map where and why loss happens;
today we just don't know"

From PackCo

40%

For reporting
and compliance

"We use AI to validate green claims; flag what's
misleading and track against compliance"

From RetailCo

... though critical bottleneck to scale up
solutions have been identified



Data fragmentation (in >70% interviews)
"AI is only as good as the data.
And we're feeding it garbage"

From TechCo



Change management (in >60% interviews)
"We just started exploring AI. It's insightful;
but honestly, we're not technical experts"

From CPGCo



Investment / ROI (in >55% interviews)
"We already spent millions on watermarks.
Now AI feels like another bet."

From RetailCo



Stakeholders misalignment (in >45% interviews)
"Design doesn't match sorting. And sorting
isn't ready for today's designs"

From CPGCo



Confidence gaps (in >30% interviews)
"Teams don't know what AI can or should deliver.
That creates hesitation"

From PackCo

The report will explore ways around those bottlenecks to start incorporating AI (and partnering with AI-driven start-ups) where it can make the biggest difference for packaging circularity

To support your packaging circularity journey, we identified the most impactful AI solutions

A 15 use cases identified along the packaging value chain ...

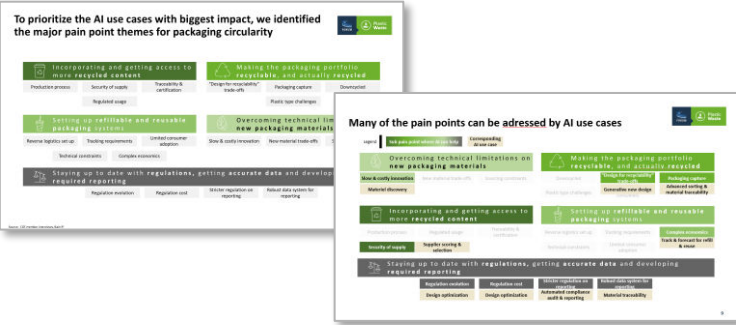
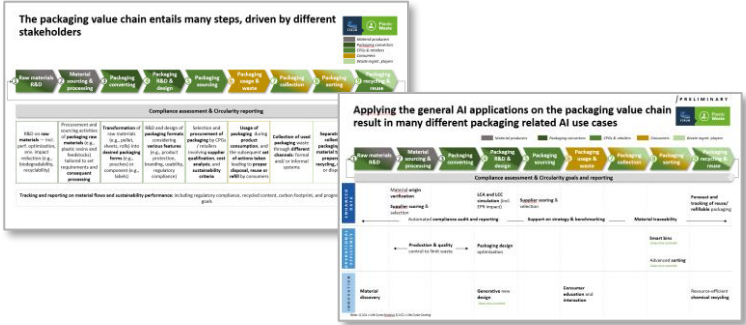
B Of those, 8 address the major packaging pain points ...

C ...with 4 standing out for highest maturity, others still growing

15 AI use cases were identified across the packaging value chain

8 of those AI use cases are solving for the highest-priority packaging pain points

All 8 use cases offer collaboration potential, but 4 have already shown clear feasibility and benefits

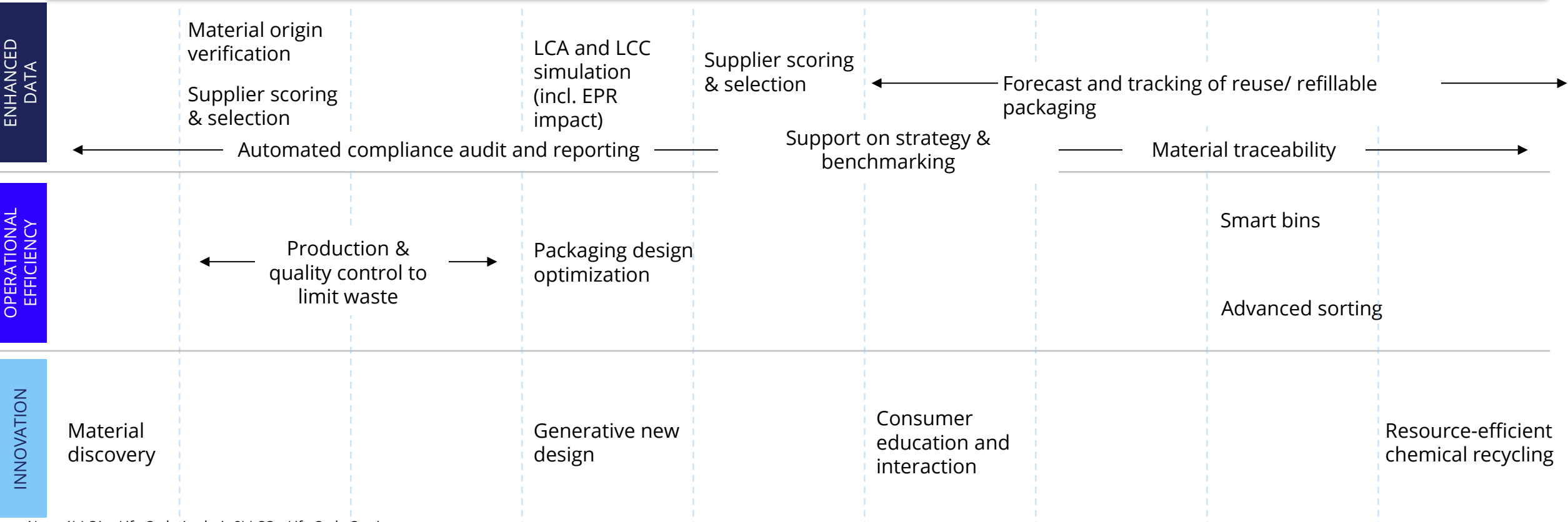


A 15 AI use cases accelerate packaging circularity across the value chain

Material producers Packaging converters CPGs & retailers Consumers Waste mgmt. players



Compliance assessment & Circularity goals and reporting



Note: 1) LCA = Life Cycle Analysis 2) LCC = Life Cycle Costing

B To prioritize the AI use cases with biggest impact, we identified the major circularity pain points...

Overcoming technical limitations on new packaging materials

- Slow & costly innovation
- New material trade-offs
- Sourcing constraints

Making the packaging portfolio recyclable, and actually recycled

- Packaging capture
- “Design for recyclability” trade-offs
- Plastic type challenges
- Downcycled
- Proper waste disposal at consumers

Incorporating and getting access to more recycled content

- Production process
- Regulated usage
- Traceability & certification
- Security of supply

Setting up refillable and reusable packaging systems

- Reverse logistics set up
- Tracking requirements
- Complex economics
- Technical constraints
- Limited consumer adoption

Staying up to date with regulations, getting accurate data and developing required reporting

- Regulation evolution
- Regulation cost
- Stricter regulation on reporting
- Robust data system for reporting

B ...Of which many can be addressed more efficiently through AI given their complexity & data needs

Legend | Sub pain point where AI can help Corresponding AI use case

Overcoming technical limitations on new packaging materials

Slow & costly innovation New material trade-offs Sourcing constraints

Material discovery

Incorporating and getting access to more recycled content

Production process Regulated usage Traceability & certification

Security of supply Supplier scoring & selection

Making the packaging portfolio recyclable, and actually recycled

Downcycled "Design for recyclability" trade-offs Packaging capture

Plastic type challenges Generative new design Advanced sorting & material traceability

Setting up refillable and reusable packaging systems

Reverse logistics set up Tracking requirements Complex economics

Technical constraints Limited consumer adoption Track & forecast for refill & reuse

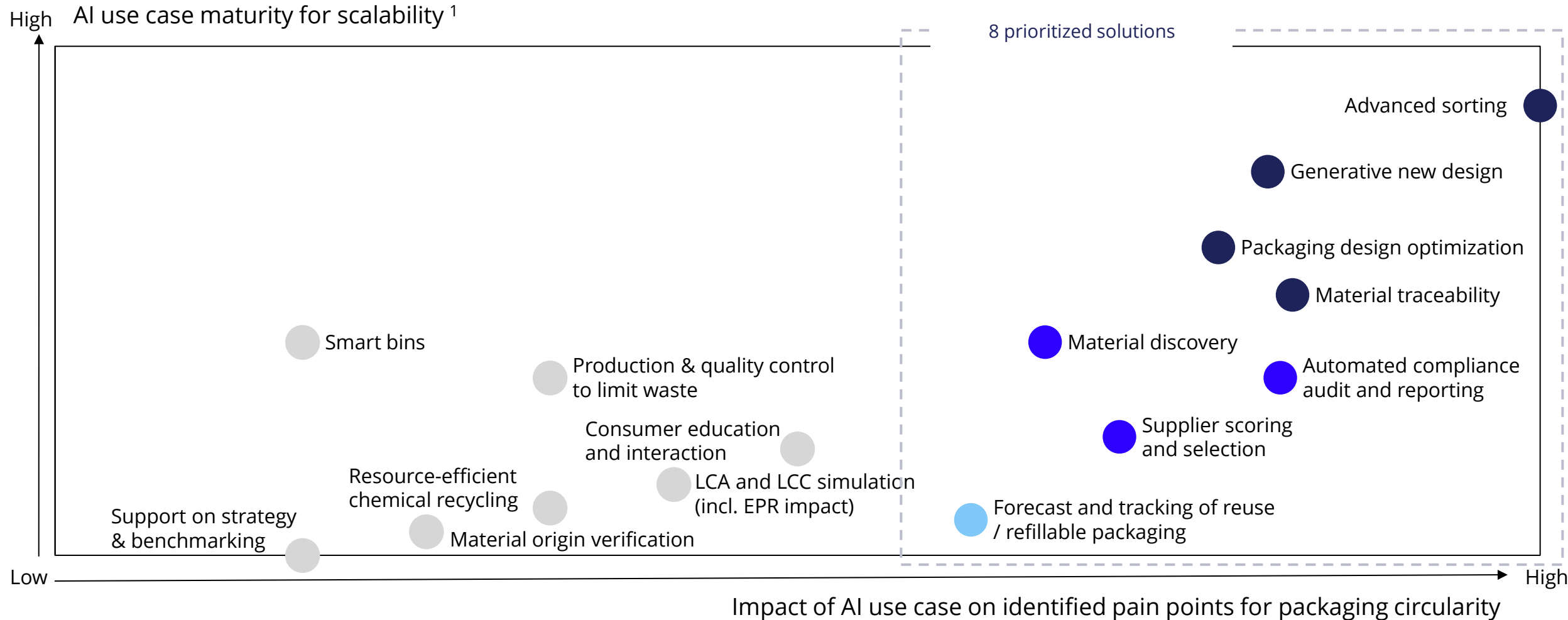
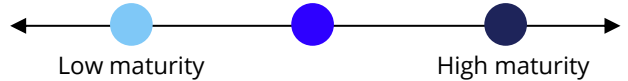
Staying up to date with regulations, getting accurate data and developing required reporting

Regulation evolution Regulation cost Stricter regulation on reporting Robust data system for reporting

Design optimization Automated compliance audit & reporting Material traceability

B

A subset of 8 use cases offer stronger maturity and the highest potential for impact

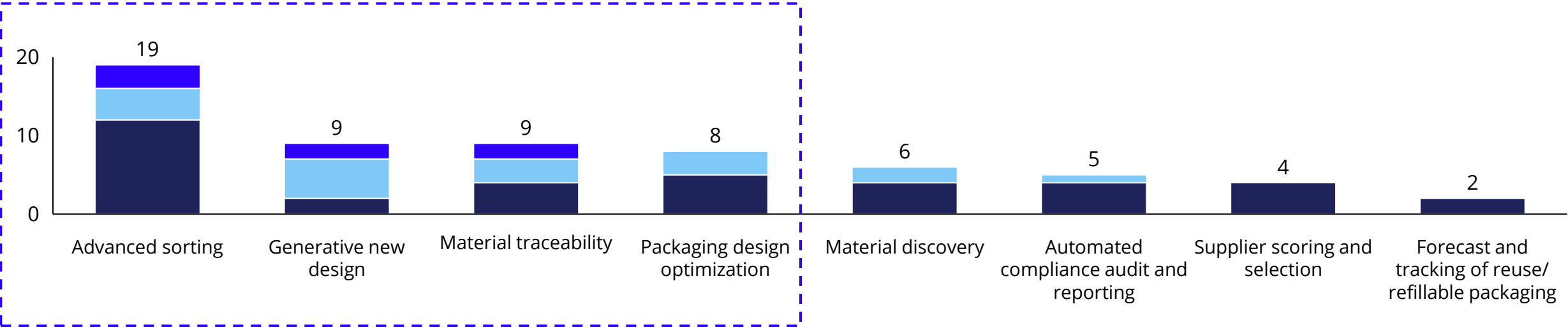


Note: 1) Taking into account # and type of players identified; data, CAPEX and infrastructure requirements 2) LCA = Life Cycle Analysis and LCC = Life Cycle Costing

4 out of 8 prioritized use cases stand out with higher maturity, offering proof points for scale

Start-ups and Tech. Providers Corporate Non-profit Organization & Universities

Number of actors, by type, involved on the 8 prioritized AI use cases (non exhaustive, total = 62)



Methodology employed for player counts

1 player using or providing a solution = 1 count, when corporate are partnering with a start-up for a solution, then the use case (solution) is counted twice: 1 for the start-up and 1 for the corporate (vs. when corporates develop solution in-house)

Sources used for player identification



Start-up research and mapping



CPGs articles and market reports

Several start-ups & tech providers offer solutions, with some corporates already implementing

Pain points: Recycled content, Recyclability, Refill & reuse, New material & design, Law, data & report

- 1 Supplier scoring & selection
- 2 Generative new design
- 3 Advanced sorting
- 4 Material traceability

Start-ups/ tech providers

Corporates

- 5 Material discovery
- 6 Packaging design optimization
- 7 Automated compliance audit and reporting
- 8 Tracking/ forecasting for refill/ reuse

Start-ups/ tech providers

Limited players identified
Part of the solution with players such as:

Corporates

Source: Company websites; CGF member interviews

Prioritized AI use cases differ depending on their role in value chain

Based on pain points that can be solved though AI enabled solutions

AI use case	New material & design	Recyclability	Recycled content	Refill & reuse	Law, data & report
Material producers	<p>Major pain point: Slow and costly innovations to uncover raw material that enhance packaging circularity</p> <p>Material discovery</p>				
Packaging convertors	<p>Major pain point: Slow and costly innovations to uncover new material mix to enhance packaging circularity</p> <p>Material discovery</p> <p>Generative new design</p>	<p>Major pain point: Trade-offs on recyclability vs other properties</p> <p>Generative new design</p> <p>Material traceability (for brands to understand waste flows & convertors to stay ahead of innovation opportunities)</p> <p>Generative new design</p> <p>Material traceability</p>	<p>Major pain point: Fragmented supply, with poor transparency on available volumes of recycled content</p> <p>Supplier scoring & selection</p>		
CPGs & retailers with private labels				<p>Major pain point: Containers tracking required across cycles to monitor damage, end-of-life and to optimize the flow and efficiency of the reuse system</p> <p>Tracking/forecasting of refill & reuse</p>	<p>PP: EPR schemes differences and smart pack design guidelines by country</p> <p>Pack design opt.</p> <p>PP: Cumbersome reporting on pack circularity and lack of standardization</p> <p>Automated reporting</p>
Waste management companies		<p>Major pain point: Limited sorting performance with some packaging, though recyclable, not sorted adequately and ending on incineration/ landfill</p> <p>Advanced sorting</p>			<p>Major pain point: Need to map waste flows to further collaborate with CPGs/ retailers and be able to share insights</p> <p>Material traceability</p>

Bottlenecks to scale AI include data quality, implementation cost, change management, limited resources & collaboration



Limited access to high-quality data

- Supplier data is often hard to access, resulting in limited visibility into item-level packaging specifications
- Waste flows data are often inconsistent, outdated, or unavailable, especially in low-infrastructure markets

“Supplier data is fragmented and often inaccessible, limiting our visibility into item-level packaging specifications. For AI solutions to work effectively, accessibility to data is crucial”
RetailerCo



High implementation costs

- High upfront costs and unclear ROI make it challenging to justify investment in AI systems
- Legacy systems make integration expensive and technically complex

“The cost of AI based solutions is a challenge, to overcome it, we need to clearly demonstrate a compelling vision and showcase the tangible benefits to justify the investment”
RetailerCo



Change management hurdles

- Design and operations teams may be skeptical of AI recommendations, especially when outputs are seen as a “black box”
- AI tools often require a new way of working which can conflict with current decision processes

“The biggest challenge with AI isn't just the technology itself, but shifting the mindset. Teams often raise skepticism about AI recommendations”
TechProvider



Resource constraints

- Internal bandwidth to test, iterate, and scale AI pilots is limited
- Few organizations have dedicated AI experts that can support teams to deploy AI powered solutions

“It takes a lot of time for the associates to look at solutions, understand them and really adopt them”
CPGCo



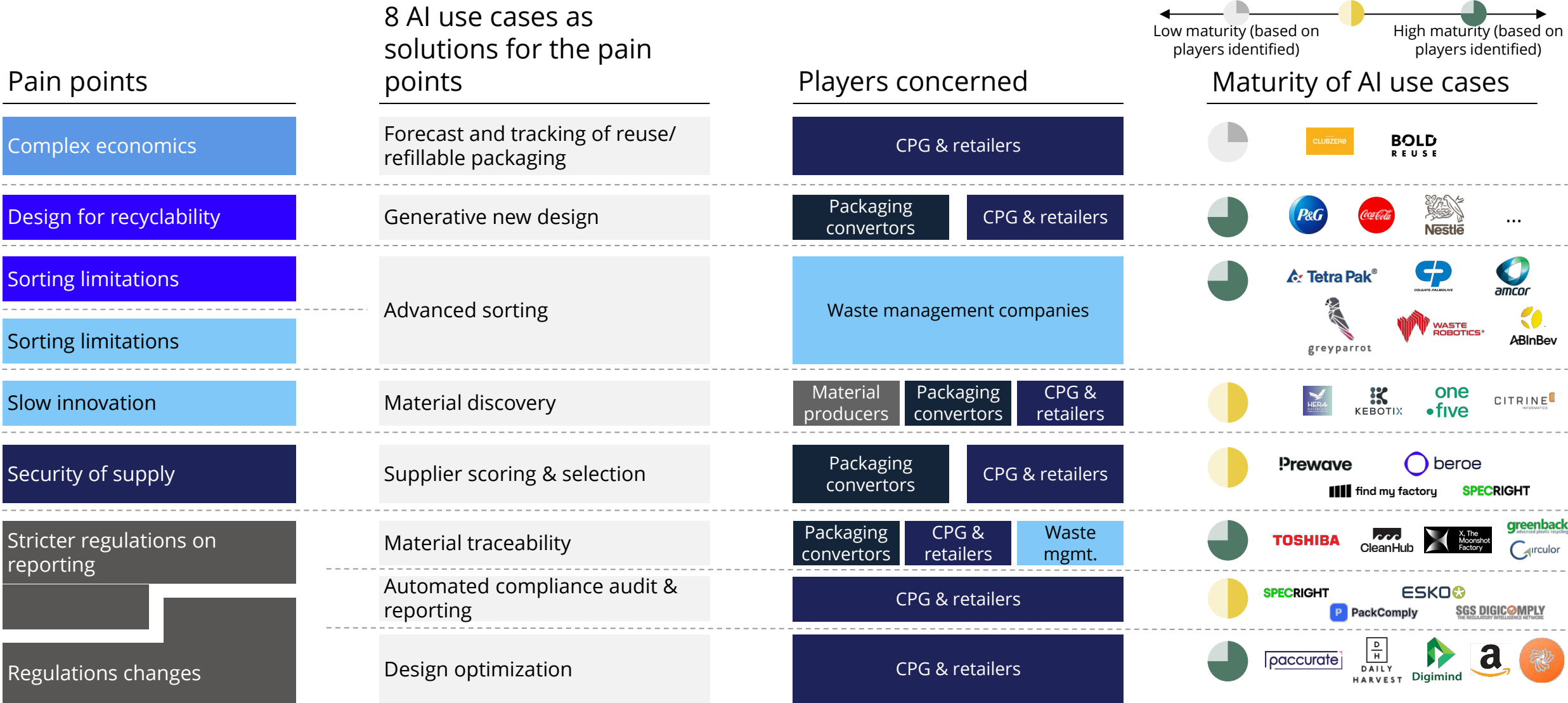
Limited collaboration across value chain

- Lack of collaboration among stakeholders leads to unclarity on the the types of recycled materials brands need and what recyclers can actually offer
- Confusion on who should pay and who will benefit (e.g., CPGs, waste managers, governments)

“It's not just a technical issue, the real barrier is market collaboration, alignment on what is the exact demand and needs from brands”
TechProvider

Challenges can be overcome through effective implementation, primarily via partnerships and ecosystem collaboration, and, when necessary, through in-house solutions

8 AI use cases have high potential to accelerate circularity challenge

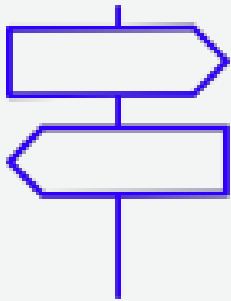


Source: Company websites; CGF member interviews

Key actions to take as next steps

1

Prioritize relevant AI use cases for your company by identifying what would bring the most value



2

Investigate selected use cases and **leverage the long list of partners** to identify the most relevant one for you and initiate discussion



3

Maintain momentum by driving progress and fostering **alignment across key stakeholders**



Full Detailed Report



The Consumer Goods
FORUM

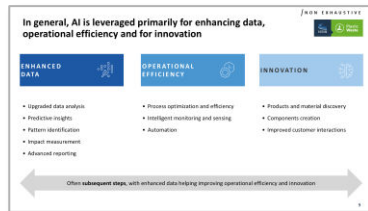
To support your packaging circularity journey, we used a 3-step approach to identify the most impactful AI solutions and partners

Determine the AI use cases applicable to packaging

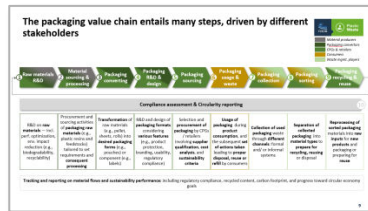
Prioritize AI use cases based on pain points and maturity levels

Identify the right partners and business cases to navigate AI challenges

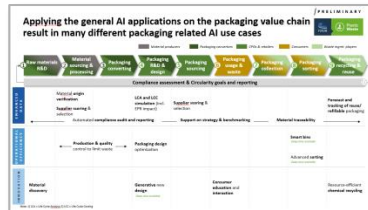
1 Define the general AI applications



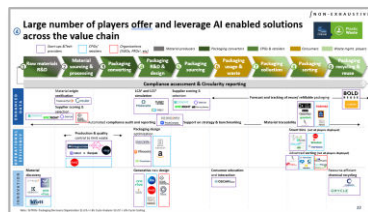
2 Determine packaging value chain



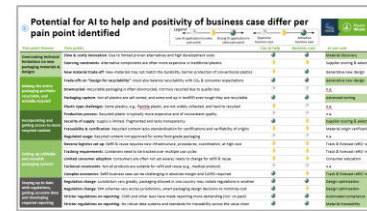
3 Overlay the value chain and AI applications to identify AI packaging use cases



4 Validate the AI packaging use cases by exploring existing solutions



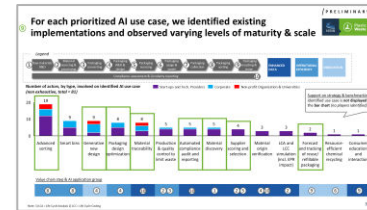
4 Uncover packaging circularity pain points and assess potential role of AI



5 Prioritize 8 AI use cases based on their link to the packaging pain points



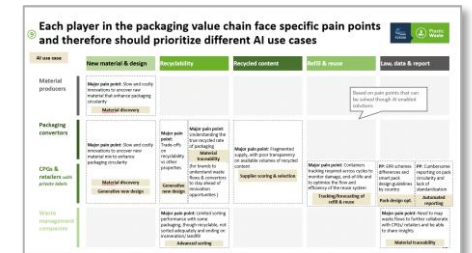
6 Assess level of maturity of solutions



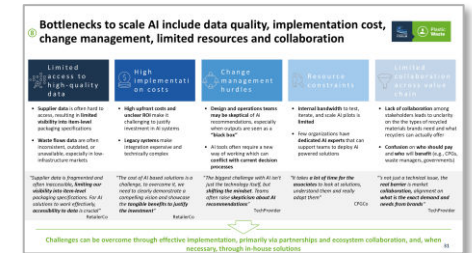
7 Display the 4 most relevant AI use case to start based on relevance and maturity



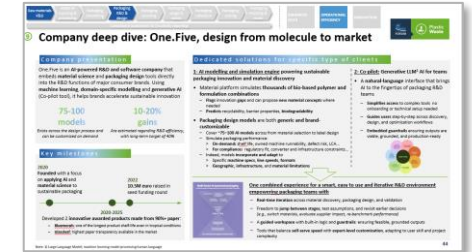
9 Point out the most relevant use cases for the different stakeholders



10 Recognize bottlenecks to scale AI use cases



11 Build overview of partners to implement solutions



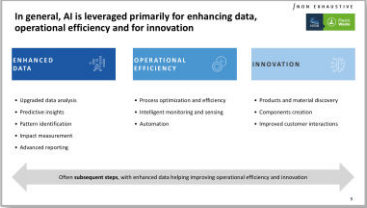
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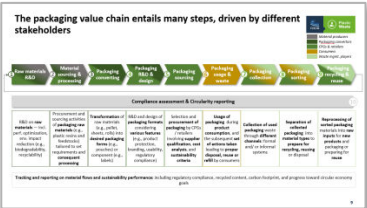
Prioritize AI use cases based on pain points and maturity levels

Identify the right partners and business cases to navigate AI challenges

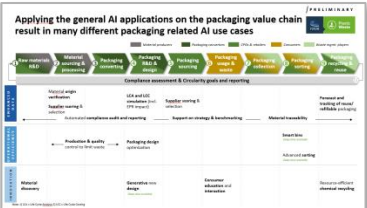
1 Define the general AI applications



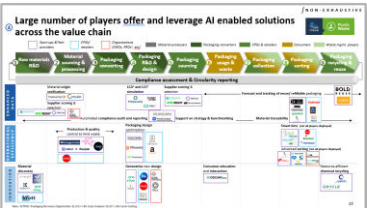
2 Determine packaging value chain



3 Overlay the value chain and AI applications to identify AI packaging use cases



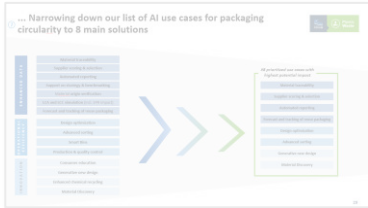
4 Validate the AI packaging use cases by exploring existing solutions



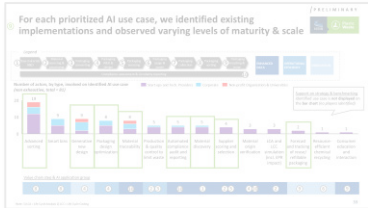
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5 Prioritize 8 AI use cases based on their link to the packaging pain points



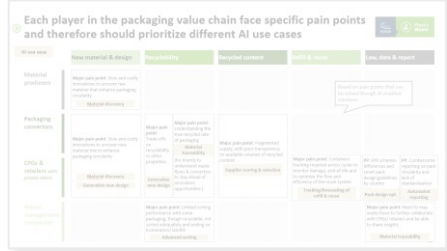
6 Assess level of maturity of solutions



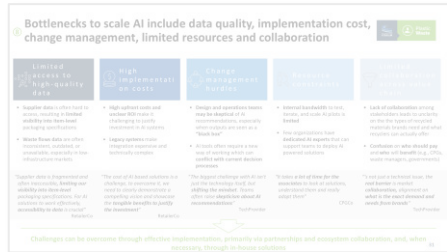
7 Display the 4 most relevant AI use case to start based on relevance and maturity



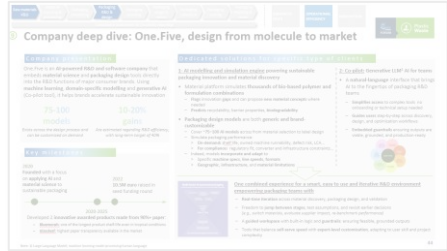
9 Point out the most relevant use cases for the different stakeholders



10 Recognize bottlenecks to scale AI use cases



11 Build overview of partners to implement solutions



① In general, AI is leveraged primarily for enhancing data, operational efficiency and for innovation



- Upgraded data analysis
- Predictive insights
- Pattern identification
- Impact measurement
- Advanced reporting



- Process optimization and efficiency
- Intelligent monitoring and sensing
- Automation



- Products and material discovery
- Components creation
- Improved customer interactions

Often subsequent steps, with enhanced data helping improve operational efficiency and innovation

② The packaging value chain entails many steps, driven by different stakeholders

- Material producers
- Packaging converters
- CPGs & retailers
- Consumers
- Waste mgmt. players



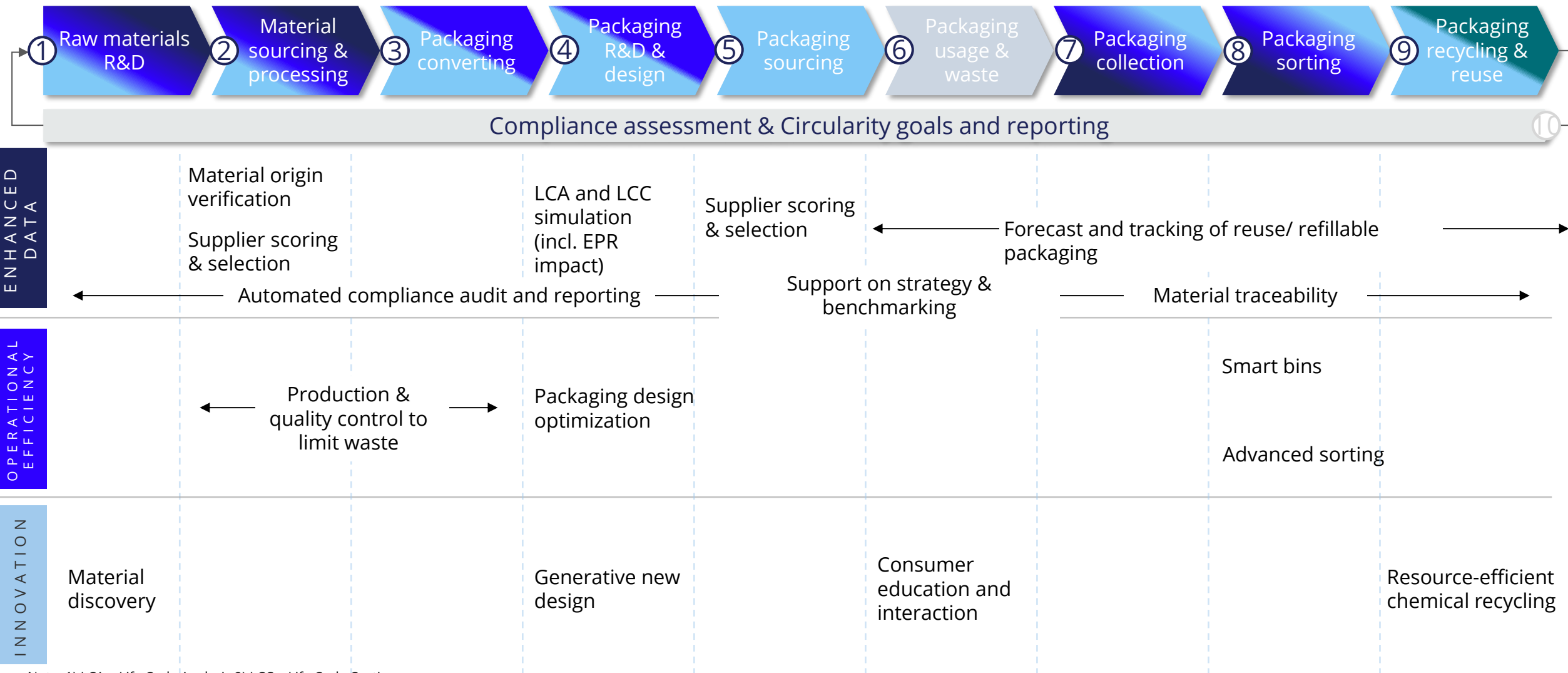
<p>R&D on raw materials — incl. perf. optimization, environmental impact reduction (e.g., biodegradability, recyclability)</p>	<p>Procurement and sourcing activities of packaging raw materials (e.g., plastic resins and feedstocks) and consequent processing</p>	<p>Transformation of raw materials (e.g., pellet, sheets, rolls) into desired packaging forms (e.g., pouches) or component (e.g., caps)</p>	<p>R&D and design of packaging formats considering various features (e.g., product protection, branding, usability, regulatory compliance)</p>	<p>Selection and procurement of packaging by CPGs / retailers based on cost, quality and sustainability criteria</p>	<p>Packaging usage during consumption, and disposal, reuse or refill of packaging by consumers</p>	<p>Collection of used packaging waste through different channels: formal and/ or informal systems</p>	<p>Separation of collected packaging into material types to prepare for recycling, reusing or disposal</p>	<p>Reprocessing of sorted packaging into raw inputs for new same or diff. applications and/or preparing for reuse</p>
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Tracking and reporting on material flows and sustainability performance: including regulatory compliance, recycled content, carbon footprint, and progress toward circular economy goals

3

Applying the AI applications on the packaging value chain results in many different packaging related AI use cases for circularity

Material producers Packaging converters CPGs & retailers Consumers Waste mgmt. players



③ Back up: Deep-dive on AI use cases for packaging circularity

ENHANCED DATA

Material origin verification: AI enables the digital tracking of raw and recycled materials across the supply chain, verifying their origin, and certification which helps support sustainability claims, and maintain chain-of-custody

Supplier scoring and selection: AI enhances supplier mgmt. by analyzing complex and unstructured datasets (e.g., via NLP³) to support sourcing decision-making, from identification to performance monitoring

LCA¹ and LCC² simulation (incl. EPR impact): AI simulates both LCA to understand CO2 impact of packaging and LCC to understand economic cost of EPR schemes

Forecast and tracking of reuse/ refillable packaging: AI leverages predictive analytics to forecast demand, usage, pilot programs, based on real time tracking data (e.g., RFID)

Automated compliance audit and reporting: AI aggregates packaging data across the value chain, automates regulatory checks, checks that packaging is compliant across countries and generates compliance reports

ENHANCED DATA

Support on strategy & benchmarking: AI supports yearly target & strategy refresh and competitors' benchmarking (e.g., compare peers performance, adapt to regulations)

Material traceability: AI support post-use packaging traceability through tools, such as computer vision and AI-enhanced analytics supporting the creation of waste flows and insightful feedback loops (e.g., sorting rate) for brands

OPERATIONAL EFFICIENCY

Advanced sorting: AI enhances packaging waste sorting by combining computer vision, robotics, and real-time analytics to accurately identify materials and generate waste intelligence

Production & quality control to limit waste: AI utilizes machine vision and sensor data to monitor packaging lines in real time, detect anomalies (e.g., mislabeling) to limit waste

Packaging design optimization: AI design optimization enhances existing packaging by reducing material usage, optimizing dimensions for shipping to support regulatory requirements (e.g., recycled content rate)

OPERATIONAL EFF.

Smart bins: AI supports sorting in real-time of disposed packaging items via computer vision, giving direct instructions on proper sorting

INNOVATION

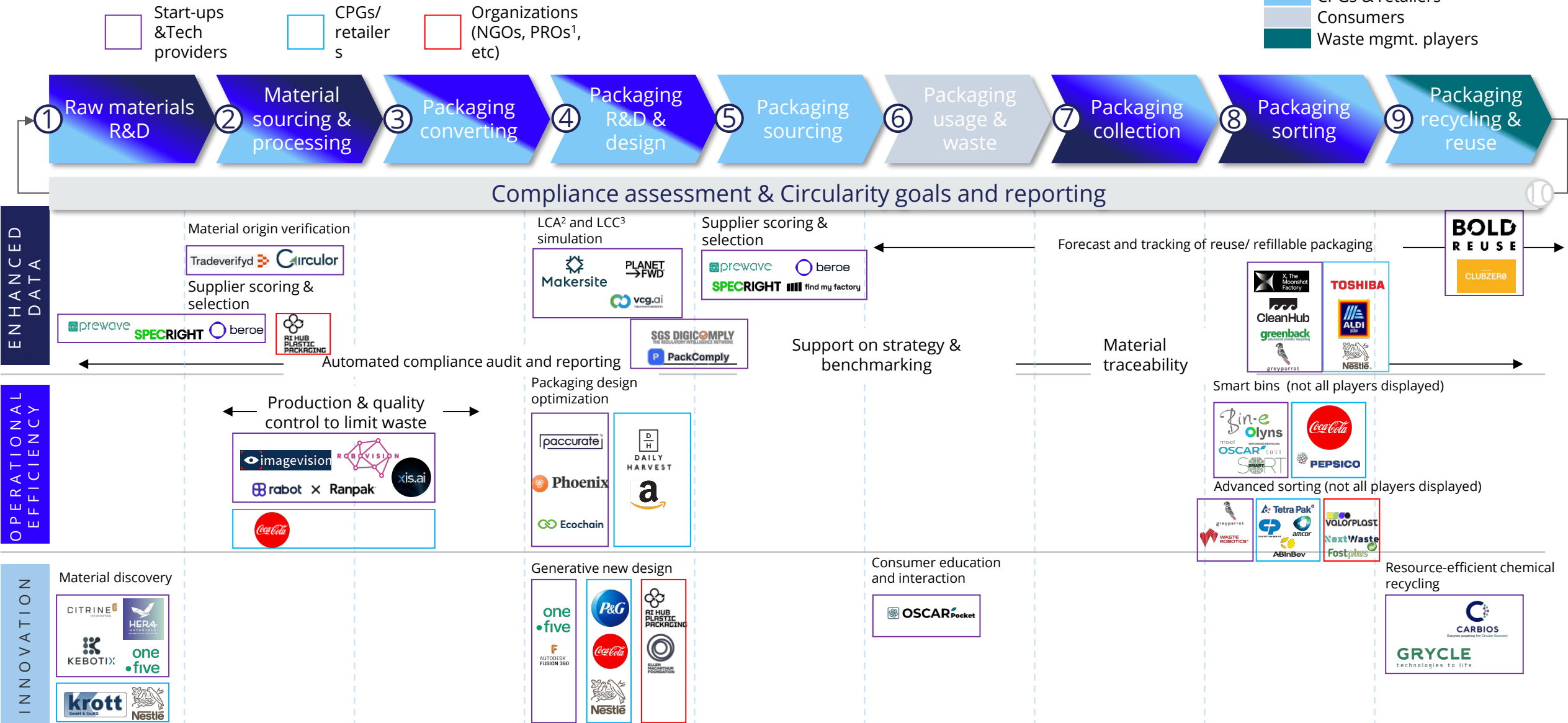
Material discovery: AI accelerates sustainable material discovery by generating novel molecular structure, simulating properties to predict performance

Generative new design: AI-powered generative design that creates entirely new packaging formats by using deep learning, generative algorithms, and simulation models

Consumer education and interaction: AI engages consumers through chatbots and enhanced marketing campaigns (e.g., to promote better sorting and refill behaviors)

Resource-efficient chemical recycling: AI helps develop enzymes or processes that can break plastics into monomers efficiently, allowing further recycling

4 A large number of players offer and leverage AI enabled solutions across the value chain



Note: 1) PROs: Packaging Recovery Organization 2) LCA = Life Cycle Analysis 3) LCC = Life Cycle Costing | Source: Company websites; CGF member interviews

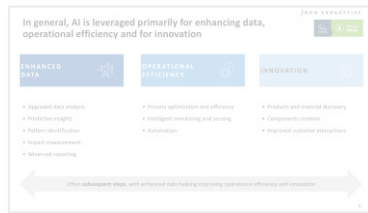
To support your packaging circularity journey, we used a 3-step approach to identify the most impactful AI solutions and partners

Determine the AI use cases applicable to packaging

Prioritize AI use cases based on pain points and maturity levels

Identify the right partners and business cases to navigate AI challenges

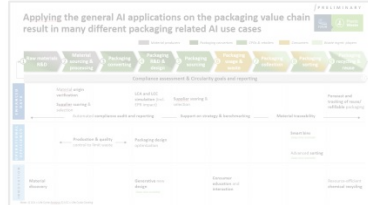
① Define the general AI applications



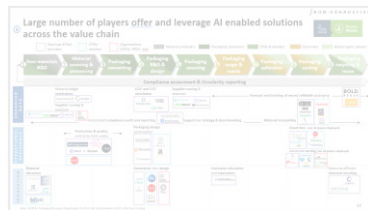
② Determine packaging value chain



③ Overlay the value chain and AI applications to identify AI packaging use cases



④ Validate the AI packaging use cases by exploring existing solutions



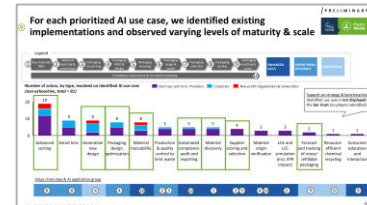
⑤ Uncover packaging circularity pain points and assess potential role of AI



⑥ Prioritize 8 AI use cases based on their link to the packaging pain points



⑦ Assess level of maturity of solutions



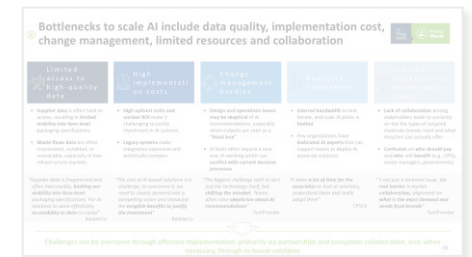
⑧ Display the 4 most relevant AI use case to start based on relevance and maturity



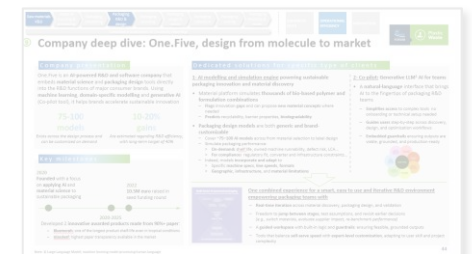
⑨ Point out the most relevant use cases for the different stakeholders



⑩ Recognize bottlenecks to scale AI use cases



⑪ Build overview of partners to implement solutions



5 To prioritize the AI use cases that will have the biggest impact, we identified the major pain point themes



Overcoming technical limitations on new packaging materials



Making the entire packaging portfolio recyclable, and actually recycled



Incorporating and getting access to more recycled content



Setting up refillable and reusable packaging systems



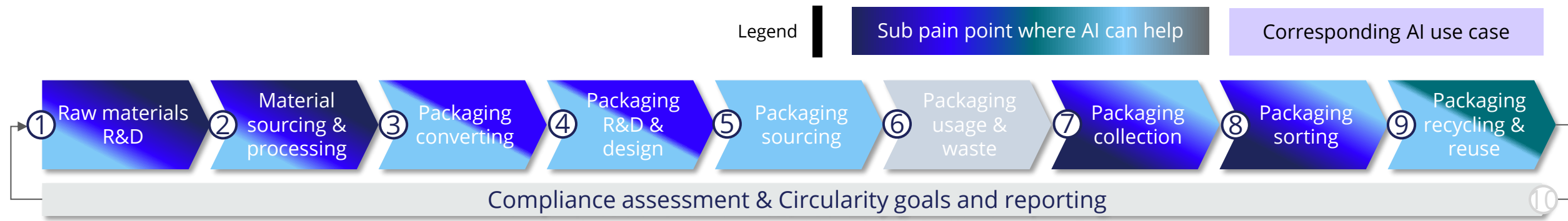
Staying up to date with regulations, getting accurate data and developing required reporting

5 The potential for AI and the strength of the business case vary by pain point



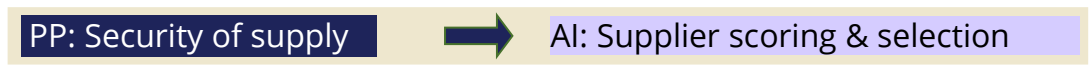
Pain point themes	Pain points	Can AI help	Business case	AI use case
Overcoming technical limitations on new packaging materials & designs	Slow & costly innovation: Due to limited proven alternatives and high development costs			Material discovery
	Sourcing constraints: Alternative components are often more expensive vs traditional plastics			Supplier scoring & selection
	New material trade-off: New materials may not match the durability, barrier protection of conventional plastics			Generative new design
Making the entire packaging portfolio recyclable, and actually recycled	Trade-offs on "Design for recyclability": Must also balance recyclability with CO ₂ & consumer expectations			Generative new design
	Downcycled: Recyclable packaging is often downcycled, not truly recycled due to quality loss			n.a.
	Packaging capture: Not all plastics are sell sorted, and some end up in landfill even though they are recyclable			Advanced sorting
	Plastic type challenges: Some plastics, e.g., flexible plastic, are not widely collected, and hard to recycled			n.a.
Incorporating and getting access to more recycled content	Production process: Recycled plastic is typically more expensive and of inconsistent quality			n.a.
	Security of supply: Supply is limited, fragmented and lacks transparency			Supplier scoring & selection
	Traceability & certification: Recycled content lacks standardization for certifications and verifiability of origins			Material origin verification
	Regulated usage: Recycled content not approved for some food-grade packaging			n.a.
Setting up refillable and reusable packaging systems	Reverse logistics set up: Refill & reuse requires new infrastructure, procedures, coordination, at high cost			Track & forecast refill/ reuse
	Tracking requirements: Containers need to be tracked over multiple use cycles			Track & forecast refill/ reuse
	Limited consumer adoption: Consumers are often not yet aware/ ready to change for refill & reuse			Consumer education
	Technical constraints: Not all products are suitable for refill and reuse (e.g., medical product)			n.a.
	Complex economics: Refill business case can be challenging in absolute margin and CAPEX required			Track & forecast refill/ reuse
Staying up to date with regulations, getting accurate data and developing reporting required	Regulation change: Jurisdiction vary greatly, packaging allowed in one country may violate regulations in another			Design optimization
	Regulation change: EPR schemes vary across jurisdictions, smart packaging design decisions to minimize cost			Design optimization
	Stricter regulations on reporting: CSRD and other laws have made reporting more demanding (incl. on pack)			Automated compliance
	Stricter regulations on reporting: No robust data systems and standards for traceability across the value chain			Material traceability

5 High-potential AI solutions are emerging to address key pain points...

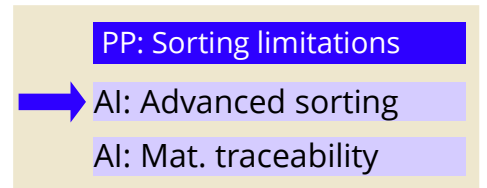


Material producers Packaging convertors CPGs & retailers Consumers Waste mgmt. players

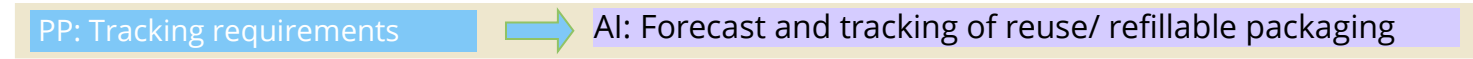
Recycled content



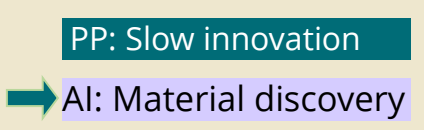
Recyclability



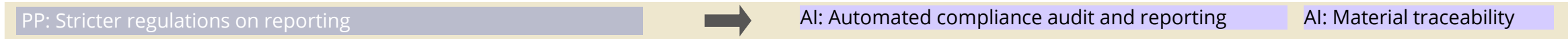
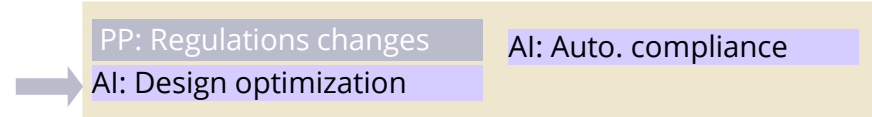
Refill & reuse



New material & design

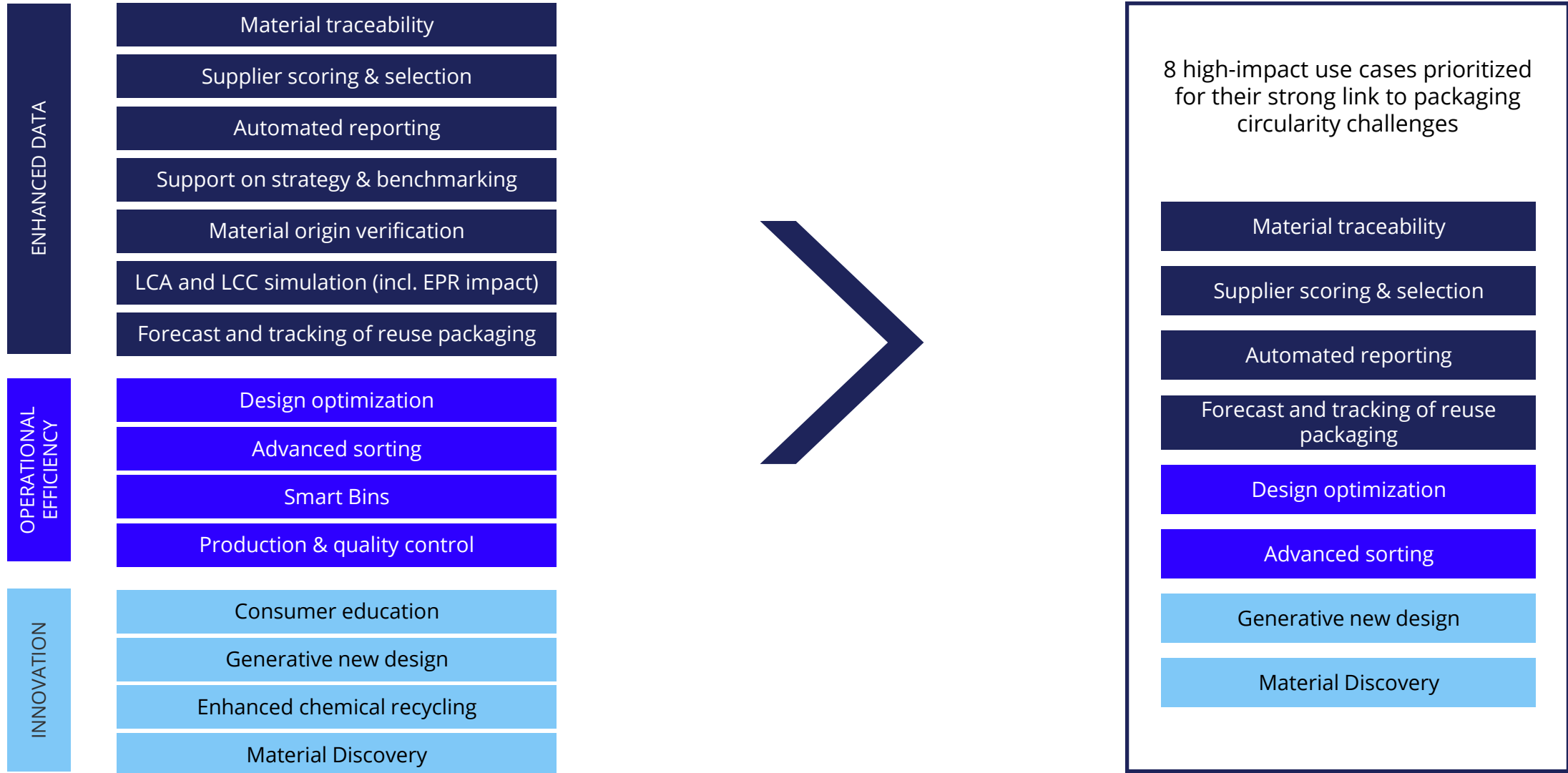


Law, data & report



6

... narrowing down our list of AI use cases for packaging circularity to 8 main solutions



7 AI use cases span different maturity levels, among prioritized, several are already backed and show scalability signals...

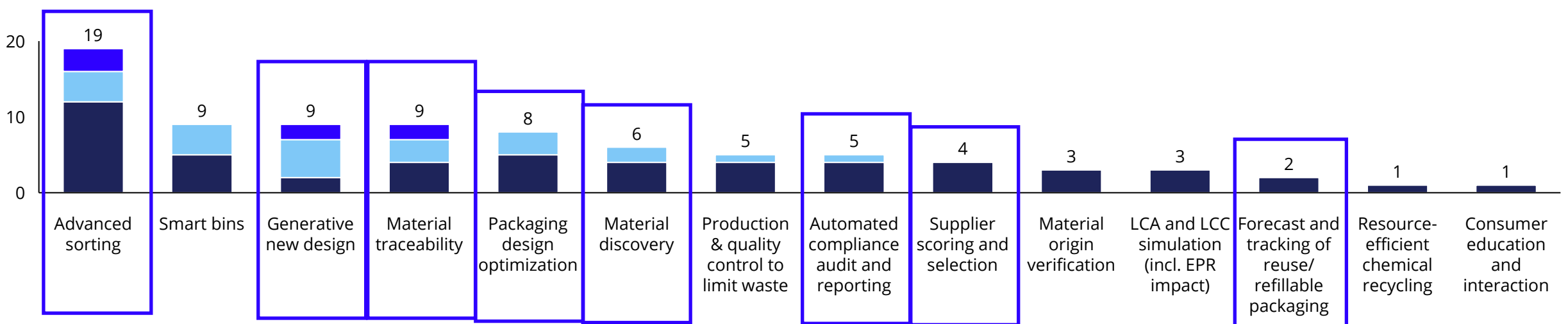
Legend



Start-ups and Tech. Providers Corporate Non-profit Organization & Universities

Support on strategy & benchmarking
identified use case is not displayed on the bar chart (no players identified)

Number of actors, by type, involved on identified AI use case (based on 84 initiatives/ actions)

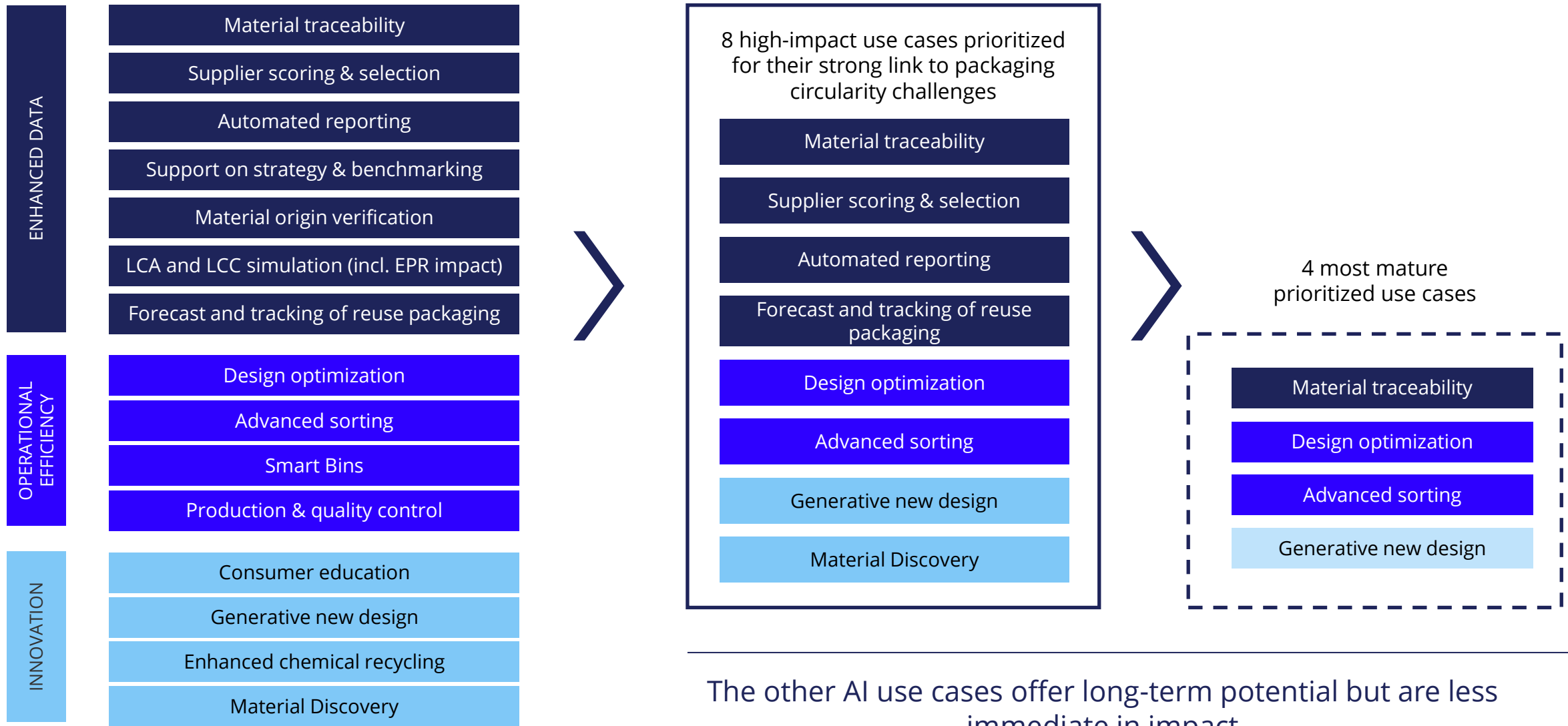


Value chain step & AI application group



Note: 1) LCA = Life Cycle Analysis 2) LCC = Life Cycle Costing | Source: Crunchbase

... refining the shortlist to highlight the 4 most actionable use cases with the fastest path to value and most partners available



The other AI use cases offer long-term potential but are less immediate in impact

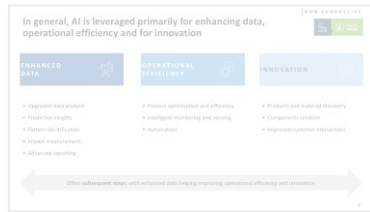
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1 Define the general AI applications



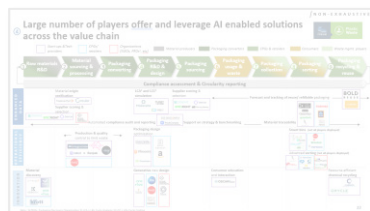
2 Determine packaging value chain



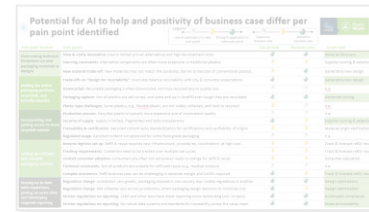
3 Overlay the value chain and AI applications to identify AI packaging use cases



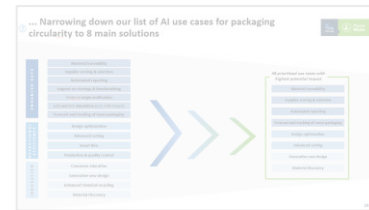
4 Validate the AI packaging use cases by exploring existing solutions



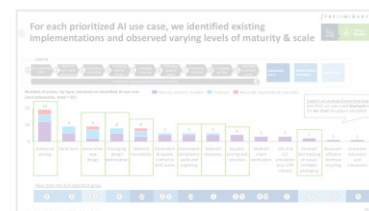
5 Uncover packaging circularity pain points and assess potential role of AI



6 Prioritize 8 AI use cases based on their link to the packaging pain points



7 Assess level of maturity of solutions



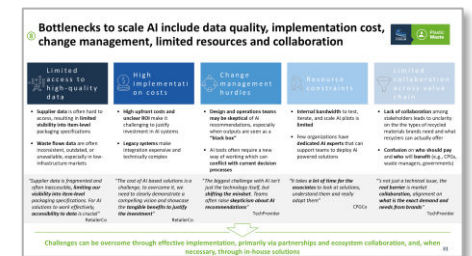
8 Display the 4 most relevant AI use case to start based on relevance and maturity



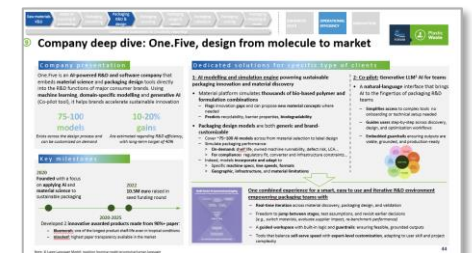
9 Point out the most relevant use cases for the different stakeholders



10 Recognize bottlenecks to scale AI use cases



11 Build overview of partners to implement solutions



8 Each player in the packaging value chain face specific pain points and therefore should prioritize different AI use cases

AI use case	New material & design	Recyclability	Recycled content	Refill & reuse	Law, data & report
Material producers	<p>Major pain point: Slow and costly innovations to uncover raw material that enhance packaging circularity</p> <p>Material discovery</p>				
Packaging convertors	<p>Major pain point: Slow and costly innovations to uncover new material mix to enhance packaging circularity</p> <p>Material discovery</p> <p>Generative new design</p>	<p>Major pain point: Trade-offs on recyclability vs other properties</p> <p>Generative new design</p>	<p>Major pain point: Understanding the true recycled rate of packaging</p> <p>Material traceability (for brands to understand waste flows & convertors to stay ahead of innovation opportunities)</p> <p>Material traceability</p>	<p>Major pain point: Fragmented supply, with poor transparency on available volumes of recycled content</p> <p>Supplier scoring & selection</p>	
CPGs & retailers with private labels				<p>Major pain point: Containers tracking required across cycles to monitor damage, end-of-life and to optimize the flow and efficiency of the reuse system</p> <p>Tracking/forecasting of refill & reuse</p>	<p>PP: EPR schemes differences and smart pack design guidelines by country</p> <p>Pack design opt.</p> <p>PP: Cumbersome reporting on pack circularity and lack of standardization reporting</p> <p>Automated reporting</p>
Waste management companies		<p>Major pain point: Limited sorting performance with some packaging, though recyclable, not sorted adequately and ending on incineration/ landfill</p> <p>Advanced sorting</p>			<p>Major pain point: Need to map waste flows to further collaborate with CPGs/ retailers and be able to share insights</p> <p>Material traceability</p>

Based on pain points that can be solved though AI enabled solutions

10 Bottlenecks to scale AI include data quality, implementation cost, change in management, limited resources and collaboration



Limited access to high-quality data

- Supplier data is often hard to access, resulting in limited visibility into item-level packaging specifications
- Waste flows data are often inconsistent, outdated, or unavailable, especially in low-infrastructure markets

“Supplier data is fragmented and often inaccessible, limiting our visibility into item-level packaging specifications. For AI solutions to work effectively, accessibility to data is crucial”
RetailerCo



High implementation costs

- High upfront costs and unclear ROI make it challenging to justify investment in AI systems
- Legacy systems make integration expensive and technically complex

“The cost of AI based solutions is a challenge, to overcome it, we need to clearly demonstrate a compelling vision and showcase the tangible benefits to justify the investment”
RetailerCo



Change management hurdles

- Design and operations teams may be skeptical of AI recommendations, especially when outputs are seen as a “black box”
- AI tools often require a new way of working which can conflict with current decision processes

“The biggest challenge with AI isn't just the technology itself, but shifting the mindset. Teams often raise skepticism about AI recommendations”
TechProvider



Resource constraints

- Internal bandwidth to test, iterate, and scale AI pilots is limited
- Few organizations have dedicated AI experts that can support teams to deploy AI powered solutions

“It takes a lot of time for the associates to look at solutions, understand them and really adopt them”
CPGCo



Limited collaboration across value chain

- Lack of collaboration among stakeholders leads to unclarity on the the types of recycled materials brands need and what recyclers can actually offer
- Confusion on who should pay and who will benefit (e.g., CPGs, waste managers, governments)

“It's not just a technical issue, the real barrier is market collaboration, alignment on what is the exact demand and needs from brands”
TechProvider



Challenges can be overcome through effective implementation, primarily via partnerships and ecosystem collaboration, and, when necessary, through in-house solutions

Source: Company websites, CGF member interviews, Bain IP

11

For each prioritized use case, you can find in deep-dive section a library of resources on AI solutions, key companies and partners



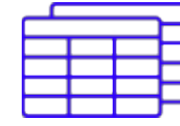
AI use cases deep-dive

- Brings AI use cases to life by providing examples of AI solutions from:
 - Start ups/ tech providers
 - Large corporates/ CPGs
 - Organization (e.g., PROs, NGOs)



Key companies deep-dive

- Presents in-depth profiles of promising startups and tech providers offering targeted AI solutions for each use case, supporting potential partnership opportunities



Overview of potential partners

- Offers a comprehensive list of startups and tech providers mapped to each AI use case

The image displays a collection of informational cards for various AI use cases in packaging. Each card follows a similar layout:

- Use case deep dive:** A brief description of the AI solution and its benefits.
- Start ups and Tech providers:** A list of companies offering solutions for this use case.
- Corporate and CPGs:** A list of large companies using these solutions.
- Organizations:** A list of NGOs or other organizations involved.
- Key milestones:** A timeline of significant events for the use case.
- Company presentation:** A detailed profile of a specific company, including its mission, solutions, and impact.

Visible cards include:

- Use case deep dive: Advanced sorting:** AI-powered systems enhance packaging waste sorting by combining computer vision with robotic automation and analytics.
- Use case deep dive: Generative new design:** AI-powered generative design creates entirely new packaging formats by using deep learning, generative algorithms (e.g., GANs, VAEs), and simulation models.
- Use case deep dive: Packaging design optimization:** AI-powered design optimization enhances existing packaging by identifying opportunities to reduce material usage, optimize dimensions for shipping, and improve recyclability.
- Company deep dive: Greyparrot, turning waste into insights:** A company providing waste intelligence solutions powered by AI.
- Company deep dive: One.Five, design from molecule to market:** A company providing end-to-end packaging solutions from R&D to production.
- Company deep dive: Fusion: Generative and circular design for packaging:** A company providing generative design and circular design solutions for packaging.
- Use case deep dive: Generative new design:** AI-powered generative design systems that combine simulation engines and multi-objective optimization with sustainability insights.
- Use case deep dive: Advanced sorting:** AI-powered systems enhance packaging waste sorting by combining computer vision with robotic automation and analytics.
- Use case deep dive: Advanced sorting:** AI-powered systems enhance packaging waste sorting by combining computer vision with robotic automation and analytics.

Deep Dives



Advanced sorting: Use case deep dive



AI-powered systems enhance packaging waste sorting by combining computer vision with robotic automation and analytics: computer vision enables robotic arms to **identify and separate materials** with high precision, while AI-powered analytics **generate real-time waste intelligence** (e.g., for reporting) based on collected data

Start ups and Tech providers



- Provides AI-powered vision systems for conveyor belts in sorting facilities
- Is capable to identify >100 packaging types, delivering granular data on material type, brand, and recyclability



- Deploys compact robotic sorting arms guided by AI enhanced computer vision to identify and recover materials like flexible plastics, cartons while generating data on what packaging formats are recovered, helping to validate circularity claims or inform EPR compliance



- Deploys robotic arms guided by AI and 3D vision to identify and extract targeted packaging materials from mixed waste
- Optimizes for speed and precision in sorting complex streams (e.g., post-consumer flexible packaging) hence helping to reduce labor while increasing the purity and recovery rate of recyclables

- Uses an AI enhanced-robot that can identify, and sort used Tetra Pak beverage cartons collected from residential areas (in partnership with waste management plant in Australia)
- Aims that robots can recognize and sort various types of beverage cartons, such as dairy milk, plant-based 'milk', juice to further understand its own waste flows

Corporate and CPGs

- Trial among the first GreyParrot's latest feature, Deepnest,, to gain product-level recyclable waste data and address knowledge gaps

- Partners with "Glacier" to understand the impact of newly designed fully recyclable toothpaste tube by using Glacier's vision-based AI for real-time sorting (e.g., to test impact of marketing campaigns on recycling rate)

Organizations (e.g., NGOs, PROs)



- Partners with "Indaver" (a waste mgmt. and recycling company), which is piloting an AI-powered quality control system in PMD (plastic, metal, and drink cartons) sorting centers
- Focuses on improving accuracy and consistency of sorted packaging waste, which directly impacts the quality of recycled materials via a camera and an AI software that are installed on the sorting line to automatically detect sorting errors, such as opaque PET in clear PET streams



- Manages a research project with "Recycleye" (an AI-powered sorting equipment manufacturer) and with TotalEnergies to utilize AI and machine learning to identify and separate food-grade polypropylene from household waste



Advanced sorting: Company deep dive, Greyparrot turns waste into insights



Company presentation

Greyparrot is a waste intelligence solution powered by AI which identifies and tracks products post-consumption, improving sorting processes and generating insights, supporting recyclers and brands to understand where their items end up, quantify their recyclability and provide recommendations to improve their packaging circularity (e.g., on design)

20+
countries

Are already employing the tool (incl. UK, France, Australia, South Korea)

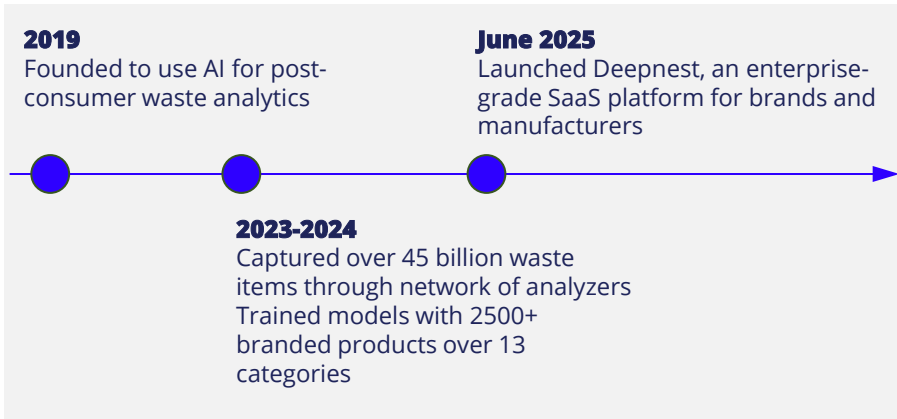
111+
classes

can be identified using computer vision

~99.7%
accuracy

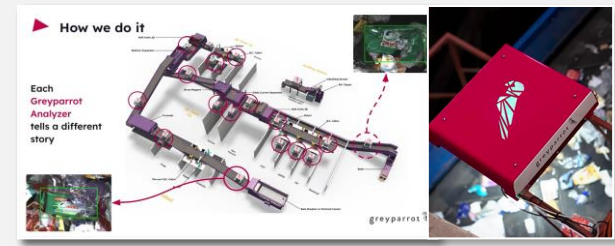
can be reached in the sorting of classes in supercharged facilities

Key milestones



Dedicated solutions for specific type of clients

- Solution 1- Analyzer Units – primary for MRFs¹
- “Eyes & brains” of facilities using computer vision relying on a dual model with material recognition (edge based) and brands recognition (cloud based)
 - Capture video on all passing waste objects generating operational metrics on:
 - Yield quantity and quality** (e.g., contamination rates, material purity)
 - Facility performance** (e.g., lines under or overloaded)
 - Deployed above conveyor belts to monitor all materials, collect metrics and support sortation (see image below)
 - Can also integrate with sorting equipment via open API (e.g., in MRF in South K.) where it actively informs and instructs third-party robotic sorters
 - Enable supercharged² sorting (e.g., refine PET bales from 92% to 98–99% purity)



- Solution 2- Deepnest – primary for CPG brands and packaging manufacturers
- AI-powered SaaS solution leveraging Analyzer Unit data and “on the top” features to close the loop between post-consumer waste and packaging design decisions
 - Tracks and scores packaging performance in real-world recycling systems (e.g., with the Deepnest Score (see below))
 - Validate assumptions and test packaging design at scale. Monitor trend behaviour over time and know what and how brands compare

Collected information shared to users
Metric computed from detectability (how often packaging is detected) and sortability (how often it reaches the right targeted recycling stream)

Deepnest Score

- Potential application (non-exhaustive)**
 - Helps to flag underperforming product even if technically recyclable and well marketed
 - Supports design tweaks and optimization (e.g., sleeve size, label contrast)
 - Useful for prioritization, benchmarking, and reporting

Additional features helps brands pinpoint what’s causing a problem: design vs. infrastructure vs. sorting logic

Insight lenses (e.g., policy)

Visual dataset access

Analyst Expert writeups

Note: 1) Material Recovery Facility 2) Adjective used for certain enhanced material recovery facilities in France | Source: Greyparrot company website & interviews
















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INNOVATION

Advanced sorting: Selected ecosystem of solution providers (1/3)

AI-powered systems enhance packaging waste sorting by combining computer vision with robotic automation and analytics: computer vision enables robotic arms to **identify and separate materials** with high precision, while AI-powered analytics **generate real-time waste intelligence** (e.g., for reporting) based on collected data

AI-powered waste solutions combining **robotic sorting with AI-driven computer vision** for real-time material identification and separation, **and real-time data analytics where AI transforms visual data into actionable insights** (e.g., waste management performance, SKU-level sortability scores)

Company names	Geography	Product description (differentiators)	Scale
 AMP ROBOTICS®		Stationary and mobile robotic systems combined with real-time data analytics dashboards	 Founded in 2015, raised \$91M in funding (2024), 400+ systems globally, identifies 50+ categories of waste
 WASTE ROBOTICS®		Robotic arms with AI vision, possibility for multiple arm collaborative picking, additionally cloud-based waste analytics	 Founded in 2016, raised \$10M in funding (2023), partnered with Greyparrot , expanding into Europe
 RECYCLEYE		Off the shelf robotic arms enhanced with dashboard insights on waste stream composition	 Founded in 2019, raised \$17M in funding (2023), installed in locations across Europe and India, partnered with FANUC and Microsoft
 GLACIER		Compact sorting system, designed for seamless integration into existing material recovery facilities	 Founded in 2019, partnership with Colgate-Palmolive, financially supported by Amazon
 olyns RETHINKING RECYCLING		Reversed vending machine, monetization through advertising and data insights, focused on consumer interface	 Founded in 2019, raised \$4M in funding (2023), agreements in place with large retail brands in USA

ENHANCED
DATAOPERATIONAL
EFFICIENCY







INNOVATION

Advanced sorting: Selected ecosystem of solution providers (2/3)

AI-powered systems enhance packaging waste sorting by combining computer vision with robotic automation and analytics: computer vision enables robotic arms to **identify and separate materials** with high precision, while AI-powered analytics **generate real-time waste intelligence** (e.g., for reporting) based on collected data

Type 2/3: Robotics solutions

AI-powered waste solutions leveraging **robotic sorting with AI-driven computer vision** for real-time material identification and separation

Company names	Geography	Product description (differentiators)	Scale
		Deep learning integrated sensors for both municipal and industrial recycling	Operating revenue of \$1.3M (2024), 105,000+ installations in 100+ countries, leading position in the industry
		Modular sorting systems focused on heavy and construction & demolition waste	Founded in 2007, acquired by Terex Corporation (2022), identifies 500+ categories of waste, commercially deployed in 15+ countries
		Deep learning focused on delivering easily adaptable solutions for existing material recovery facilities, minimizing the need for retrofitting	Founded in 2012, financial support of the European Union, deployed in Europe and USA



ENHANCED DATA

OPERATIONAL EFFICIENCY













INNOVATION

Advanced sorting: Selected ecosystem of solution providers (3/3)

AI-powered systems enhance packaging waste sorting by combining computer vision with robotic automation and analytics: computer vision enables robotic arms to **identify and separate materials** with high precision, while AI-powered analytics **generate real-time waste intelligence** (e.g., for reporting) based on collected data

Type 3/3: Data analytics solutions

AI-powered waste solutions leveraging **real-time data analytics where AI transforms visual data into actionable insights** (e.g., waste management performance, SKU-level sortability scores)

Company names	Geography	Product description (differentiators)	Scale
		Camera only system which needs to be plugged into existing system	 Founded in 2019, raised \$11M in funding (2022), deployed in 20+ countries, recognizes 111 material categories
meet 		Computer vision to detect waste types, bin fullness, and contamination , enabling proactive waste management ,	 Founded in 2017 by Intuitive AI, deployed in PepsiCo, AT&T, airports, public spaces , primary dedicated to offices or shared waste collection areas and small-to-mid-sized MRFs ¹
		Insights regarding post-sorting transparency	 Founded in 2021, partnership with TOMRA (company providing AI-powered sorting systems), team of six people
		Unique concept combining shredding of undifferentiated waste into flakes, followed by AI-driven automated recognition and separation (with self-learning system capable of identifying new materials), resulting in sorted, reusable flakes ready for reintegration into production.	 Founded in 2017, backed by crowdfunding , few known installs, team of four people, mostly prototype stage



ENHANCED DATA

OPERATIONAL EFFICIENCY

INNOVATION

Generative new design: Use case deep dive



AI-powered generative design **creates entirely new packaging** formats by **using deep learning, generative algorithms** (e.g., GANs, VAEs)¹, and **simulation models** to explore thousands of design and material combinations to serve defined high-level goals – like sustainability, durability, or shelf impact

Start ups and Tech providers

one
• five

- Uses a proprietary AI platform to model and discover next-gen sustainable packaging design and materials (e.g. barrier paper, compostable films, fiber-based laminates)
- Prototypes rapidly structural packaging solutions (e.g., pouches, wraps, and trays) optimized for recyclability and/or biodegradability
- Manufactures these innovations at pilot scale, and partners with CPGs and converters to bring them to market

F
AUTODESK
FUSION 360

- Utilizes generative design algorithms to explore a vast array of design alternatives based on specified constraints and goals
- Enables packaging engineers to reduce material usage while maintaining structural integrity and brand fit
- Facilitates rapid prototyping and testing, shortening development cycles and promoting sustainable design choices

Corporate and CPGs



- Uses AI algorithms to analyse its packaging portfolio and evaluates which package designs use the most material and then employs AI to test combinations to redesign packaging



- Leverage AI to analyze unstructured and large set of consumer data (e.g., social media, survey) to identify which packaging attributes, (e.g., recycled content, recyclability, label-free, resonate most, ensuring packaging aligns with consumer values and enabling the firm to prioritize packaging specifications



- Leverages AI to simulate and assess various packaging material combinations, helping balance sustainability goals with other key criteria (e.g., durability, product protection)
- Uses AI-powered digital twins to virtually test packaging performance, minimizing the need for physical prototypes and reducing material waste

Organizations (e.g., NGOs, PROs)



- Develops AI tools through its lab KIOptiPack, that support the optimization of circular design and production of plastic packaging using recycled materials
- Ensures safe, high-quality use of recycled content, it helps standardization and process optimization, connected through a central digital platform
- Gives access to all its members (e.g., Amcor, Unilever) to the central digital platform, AI models and best practices with goal to co-develop solutions



- Educates on how companies can leverage AI to go from linear to a circular economy by sharing best-practices examples:
 - Using AI-enabled generative design tools to create products and materials optimized for disassembly, durability, repair, and recycled-content use
 - Using rapid prototyping driven by machine learning that helps surface highly circular solutions early in the design process



Compliance assessment & Circularity reporting

Generative new design: Company deep dive, One.Five designs from molecule to market



Company presentation

One.Five is an AI-powered R&D and software company that embeds material science and packaging design tools directly into the R&D functions of major consumer brands. Using machine learning, domain-specific modelling and generative AI (Co-pilot tool), it helps brands accelerate sustainable innovation

75-100 models

Exists across the design process and can be customized on demand

10-20% gains

Are estimated regarding R&D efficiency, with long-term target of 40%

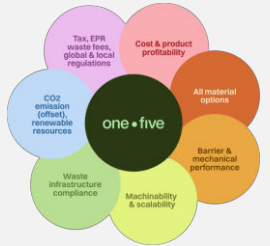
Dedicated solutions for specific type of clients

1- AI modelling and simulation engine powering sustainable packaging innovation and material discovery

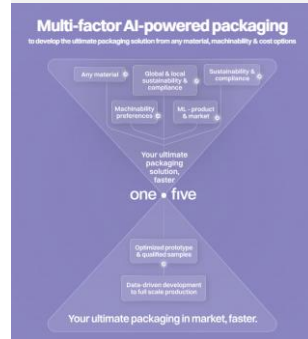
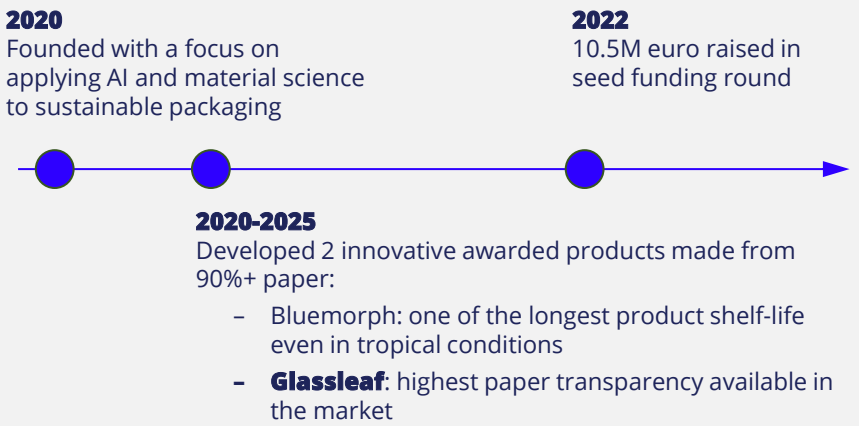
- Material platform simulates thousands of bio-based polymer and formulation combinations
 - Flags innovation gaps and can propose new material concepts where needed
 - Predicts recyclability, barrier properties, biodegradability
- Packaging design models are both generic and brand-customizable
 - Cover ~75-100 AI models across from material selection to label design
 - Simulate packaging performance:
 - > On-demand: shelf life, owned machine runnability, defect risk, LCA...
 - > For compliance: regulatory fit, converter and infra. constraints...
 - Indeed, models incorporate and adapt to
 - > Specific machine specs, line speeds, formats
 - > Geographic, infrastructure, and material limitations

2- Co-pilot: Generative LLM¹ AI for teams

- A natural-language interface that brings AI to the fingertips of packaging R&D teams
 - Simplifies access to complex tools no onboarding or technical setup needed
 - Guides users step-by-step across discovery, design, and optimization workflows
 - Embedded guardrails ensuring outputs are viable, grounded, and production-ready



Key milestones



One combined experience for a smart, easy to use and iterative R&D environment empowering packaging teams with

- Real-time iteration across material discovery, packaging design, and validation
- Freedom to jump between stages, test assumptions, and revisit earlier decisions (e.g., switch materials, evaluate supplier impact, re-benchmark performance)
- A guided workspace with built-in logic and guardrails: ensuring feasible, grounded outputs
- Tools that balance self-serve speed with expert-level customization, adapting to user skill and project complexity

Note: 1) Large Language Model; machine learning model processing human language | Source: One.Five company website & interviews

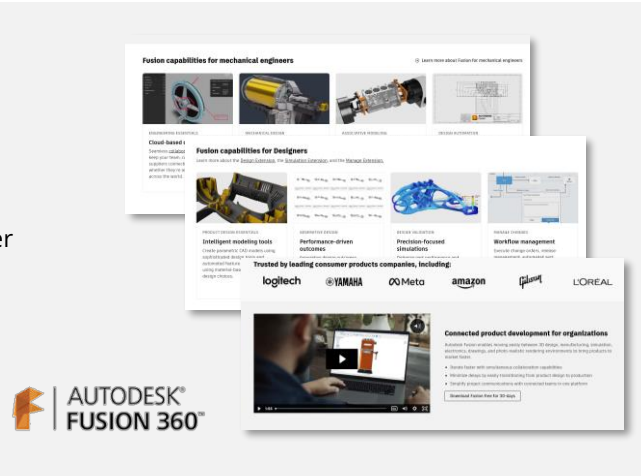
Generative new design: Company deep dive, Fusion leverages AI to generate circular designs



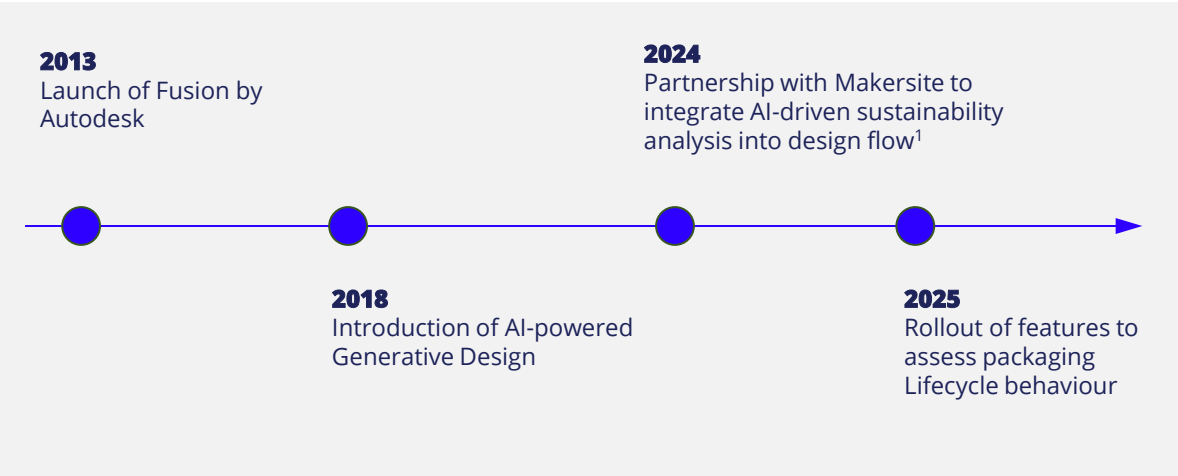
Company presentation

Fusion is a design and engineering platform that integrates AI-driven tools along add-ons, 3D modelling and simulation to facilitate packaging design

Core mission in packaging circularity: Empower product designers and engineers to create innovative sustainable designs while ensuring efficiency and minimum waste in packaging design and prototyping phase



Key milestones



Main solutions and features

- Generative design: AI-powered engine that can generate material-efficient packaging structures
- Simulation tools: Enables virtual testing of packaging reducing the need for physical prototypes
- Flat pattern & nesting tools: Optimizes the layout of dielines² to minimize waste during manufacturing
- Manufacturing Sustainability Insights: Provides metrics like carbon footprint and energy usage to monitor designs phase impact

Impact and engagement

- Reported impact metrics (non exhaustive)
- Achieves material reduction without compromising strength or function
 - Minimizes physical prototyping waste by simulating stress, drop, and fit testing virtually
 - Provides real-time visibility on environmental impact (e.g., recyclability) via specific add-ons like Makersite

Clients and partners







- Client example (non exhaustive)
- Pulpak (Argentina): Used Fusion to design biodegradable molded pulp packaging, cutting stowed product volume by up to 50%
 - Batch.Works (UK): Applied Fusion to create customizable headphone packaging with recyclable materials
 - Vivid Nine (UK): Leveraged Fusion's MSI to measure and lower the carbon footprint of packaging designs

Note: 1) 5.5B\$ Revenue in 2024 2) A dieline is a blueprint or template used in printing and packaging | Source: Autodesk company website



Generative new design: Selected ecosystem of solution providers

AI-powered generative design **creates entirely new packaging** formats by **using deep learning, generative algorithms** (e.g., GANs, VAEs)¹, and **simulation models** to explore thousands of design and material combinations to serve defined high-level goals – like sustainability, durability, or shelf impact

Company names	Geography	Product description	Scale
		AI-powered generative design system that combines simulation engines and multi-objective optimization with sustainability plugins (e.g., Makersite, a startup providing real-time environmental and supply chain data) to assist packaging teams in designing new, lighter, more recyclable, and lower-impact formats	 <p>Founded in 2013, revenue of \$5.5 billion (2024), deployed in packaging, automotive, aerospace, and consumer products industries</p>
		AI-powered R&D and software company that combines machine learning with lab data to rapidly develop innovative recyclable mono-material packaging while also taking into account other specific customers needs (e.g., desired shelf-life, brand formats)	 <p>Founded in 2020, raised €10.5M+ in funding (2022), launched first commercial AI-generated sustainable packaging solution in 2025 while working with food CPG & Co on its own design through their software</p>

Source: Company websites, CGF member interviews

ENHANCED
DATAOPERATIONAL
EFFICIENCY

INNOVATION

Design optimization: Use case deep dive



AI-powered design optimization **enhances existing packaging by identifying** opportunities to reduce material usage, optimize dimensions for shipping, and improve recyclability **through the analysis** of performance data, SKU requirements, and supply chain constraints to **support compliance to regulatory requirements**

Start ups and Tech providers



- Provides AI-powered cartonization algorithms to determine the most space- and material-efficient way to pack products into boxes
- Optimizes for multiple variables simultaneously: box size, void fill, DIM¹ weight, carbon footprint, and packaging cost



- Uses Paccurate to optimize frozen meal shipments; minimizing the amount of dry ice and corrugate required while ensuring temperature compliance and reducing excess material



- Provides a subscription model for an end-to-end AI-powered platform for packaging design, testing, and verification
- Uses initial AI-processed data to create optimized designs which are then tested with virtual workflows using digital twin simulations to ensure their manufacturability and integrity



No client
name shared

- Has collaborated (leading edible oil brand) with Digimind to optimize its packaging and achieved a 13.7% reduction in PET bottle weight for a product with nearly 1 billion units produced annually



- Automates the planning and imposition (Arrangements of the printed product pages on the printer's sheets) processes for packaging and labels supporting lower material waste
- Utilizes intelligent algorithms to evaluate millions of layout possibilities, determining the most efficient arrangement for print jobs



- Utilizes an AI model "Package Decision Engine" combining computer vision, natural language processing, and machine learning to determine most efficient packaging formats
- Managed to avoid over 2 million tons of packaging material waste worldwide since 2015



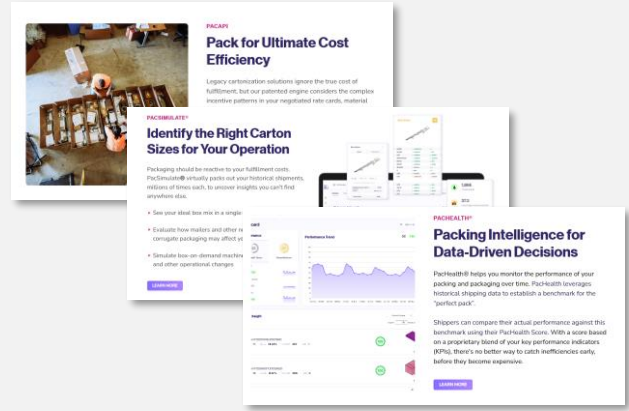
Compliance assessment & Circularity reporting

Design optimization: Company deep dive, Paccurate optimizes secondary packaging



Company presentation

Paccurate is an AI-driven SaaS platform with a specific focus on cartonization optimization (mainly for secondary packaging)



Core mission in packaging circularity: Support the reduction of Scope 3 emissions by optimizing item packaging to minimize shipping packaging material and waste

Key milestones



Main solutions and features

- PacAPI: An API that calculates the most efficient way to pack items (e.g., considering items sizes)
- PacSimulate: Simulates packing scenarios using historical data to identify optimal packaging
- PacHealth: Provides analytics on packing performance, highlighting areas for improvement in efficiency and sustainability (e.g., energy usage)

Impact and engagement

- Reported impact metrics (non exhaustive)
- Up to 18% fewer boxes used on average
 - ~7-14% reduction in corrugate material across clients
 - Lowered DIM weight fees and overall emissions
 - Reduced shipping cost up to 6-15% per order

Clients and partners
















- Example (non exhaustive)
- Clients:
 - E-commerce and Retail: Daily Harvest; Maisonette
 - Logistics and Fulfillment: Barrett Distribution Center
 - Partners:
 - Technology: Integrations with platforms like Hopstack for enhanced warehouse operations

Source: Paccurate company website



Design optimization: Selected ecosystem of solution providers

AI-powered design optimization **enhances existing packaging by identifying** opportunities to reduce material usage, optimize dimensions for shipping, and improve recyclability **through the analysis** of performance data, SKU requirements, and supply chain constraints to **support compliance to regulatory requirements**

Company names	Geography	Product description	Scale
		AI-powered cartonization engine for fulfillment centers, optimizing box selection and product arrangement to minimize shipping volume, reduce packaging waste, and lower transportation emissions, helping companies ship sustainably while reducing costs	 Founded in 2018, raised \$8M+ in funding (2024), partnership with Hunter Douglas, actively utilized by retailers and third-party logistics providers
		AI-powered cloud-based packaging design platform for circular economy, enabling real-time optimization of material use, recyclability, and structural performance to reduce waste, emissions, and costs across the packaging lifecycle	 Founded in 2020, €75,000 grant from the European Union (2022), in early phases of product commercialization
		AI-powered packaging platform combining generative design, material optimization, and carbon footprint tracking to deliver custom low-impact packaging solutions	 Founded in 2020, raised \$32M+ in funding , market presence in Europe, Asia and USA
		AI-powered scalable LCA technology for product, site, and portfolio-level assessments, capable of quantifying and optimizing environmental impact across materials, processes, and supply chains	 Founded in 2011, raised €3M+ in funding (2023), active in 25+ countries, partnership with Skullcandy
		AI-driven preproduction platform capable of automating layout planning and imposition by analyzing production data to optimize sheet layouts, minimize substrate waste, and maximize efficiency	 Founded in 2012, acquired by Esko in 2022 it is now integrated within Esko's solution for packaging suite (e.g., case study on implementation by packaging converters)

Source: Company websites

Material traceability: Use case deep dive



AI enables material traceability by integrating data from sensors, **computer vision** and production systems to track packaging. Using **machine learning** and **pattern recognition**, it verifies claims, and **delivers insights** (e.g., waste flows, sorting defects, miscommunicating labelling) supporting circularity and brand transparency

Start ups and Tech providers

- Offers eco2Veritas™, an AI and blockchain-powered traceability system that certifies the recycling journey of flexible plastic waste, providing auditable chain-of-custody data for EPR compliance and circularity reporting, supporting brands in meeting recyclate¹ and transparency targets



- Pilots with eco2Veritas™ to validate the recovery and recycling of flexible plastic waste collected in-store by Aldi²
- Enables traceability of recycled packaging waste (e.g., plastic waste chemically recycled into verified food-grade containers)

- Applies AI to detect patterns in collection activity (via mobile apps and photos), ensuring traceability of plastic waste removed from coastal regions
- Offers plastic credits to support measurable circularity commitments



TOSHIBA

- Partners with CleanHub to support threatened coastal environment in Asia as part of their sustainability engagement (i.e., prevent 10M tones of waste by '30)
- Uses AI-powered traceability for plastic waste collection, ensuring ISO-verified impact and supporting circularity in coastal regions

- Enables real-world packaging traceability by capturing item-level data at the point of waste using computer vision, connecting end-of-life behavior to upstream design
- Turns waste insights into brand-facing intelligence, helping visualize waste flows, and highlight systemic issues (e.g., low sortability)

- Combines spectral imaging, vision systems, and offline chemical analysis to generate a chemistry-informed dataset on plastic packaging as it enters recycling facilities, enabling precise classification of complex materials at both the point of purchase and the moment they reach recycling facilities
- Applies AI to this data to assess recyclability, support recyclers in optimizing feedstock quality, and predict and improve recycling yields

Organizations (e.g., PROs)



- Focuses, through their lab K3I-Cycling, on improving plastic recycling and creating traceability data to incorporate back into upstream process using AI
 - Develops a Digital Product Passport via an AI interface ("Artificial Neural Twin") to enable full traceability of plastic packaging
 - Uses AI and hyperspectral imaging³ to better identify and sort plastic types, improving recycling output
 - Integrates sensor data to monitor material flows in real time, detect contaminants, and adapt processes

Material traceability: Company deep dive, Greenback leverages AI-powered traceability to reveal insights on flexible plastic recycling



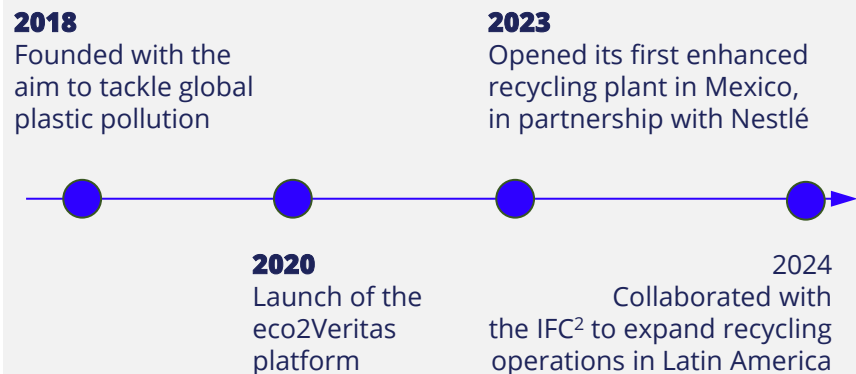
Company presentation

Greenback Recycling Technologies, a recent UK-based tech firm, leverages its platform eco2Veritas (an AI- & blockchain-powered traceability platform) & advanced chemical recycling to close the loop on flexible plastic waste; giving stakeholders, through traceability, actionable insights on their packaging circularity performance

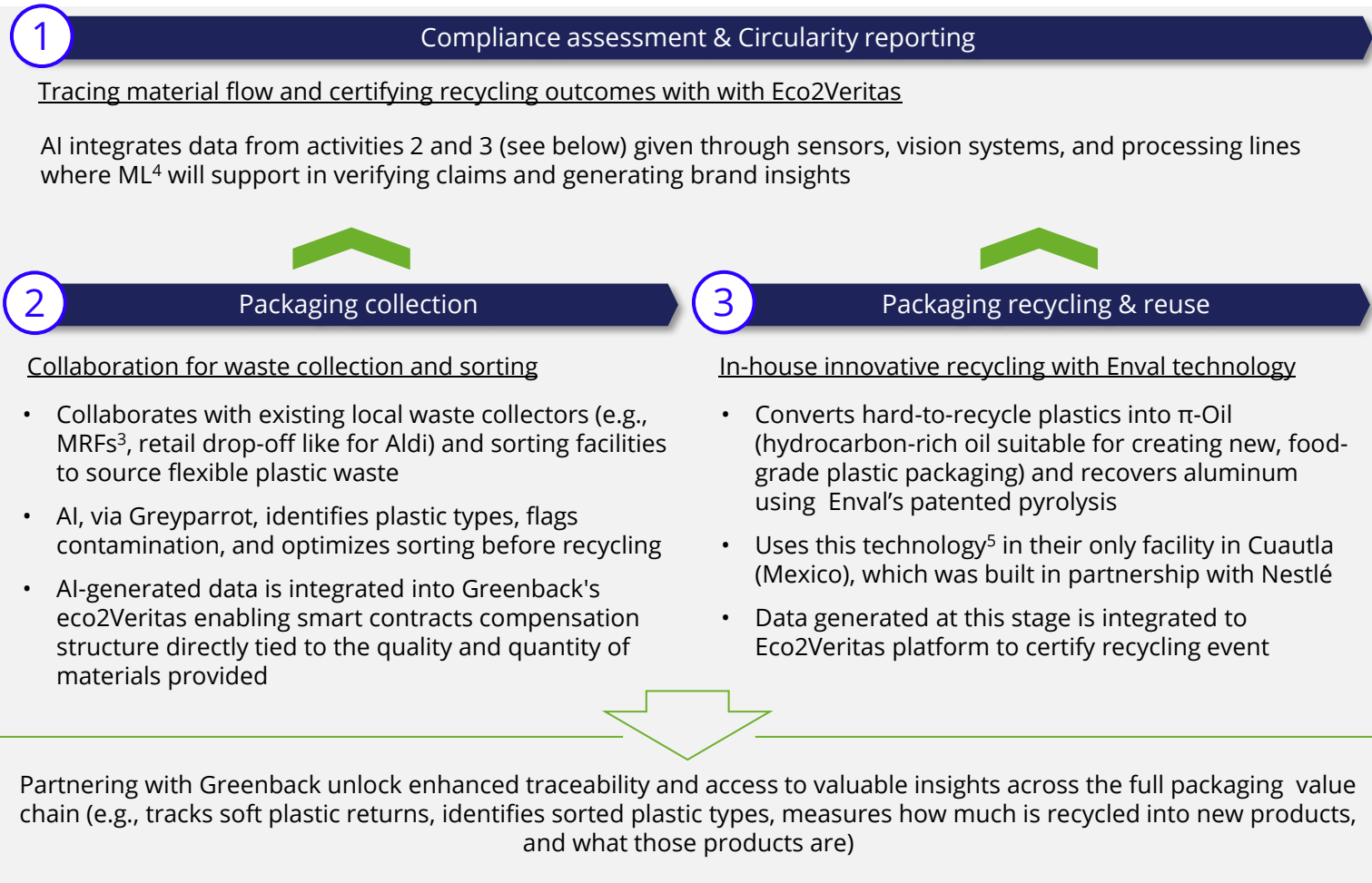
62 & 25 tonnes

Of respectively PE and PP¹ certified recycled by eco2Veritas platform as part of Aldi's 2023 in-store program (out of 300t of flexible plastic collected)

Key milestones



Integrated set of solution enhanced by AI















Note: 1) Polyethylene (PE) and polypropylene (PP) 2) International Finance Corporation (IFC) 3) Material Recovery Facility 4) Machine Learning 5) Currently able to process 3000 tonnes of flexible plastic annually | Source: Greenback company website



/ NON-EXHAUSTIVE

Material traceability: Selected ecosystem of solution providers

AI enables material traceability by integrating data from sensors, computer vision and production systems to track packaging. Using machine learning and pattern recognition, it verifies claims, and delivers insights (e.g., waste flows, sorting defects, miscommunicating labelling) supporting circularity and brand transparency

Company names	Geography	Product description	Scale
		AI- and blockchain-powered traceability system for flexible plastics, capable of certifying recycling processes by integrating sensor and production data to verify material origin, track waste flows, and provide auditable chain-of-custody for EPR compliance and circularity reporting	 Founded in 2018, first recycling plant opened in 2023 in partnership with Nestlé and the Alliance to End Plastic Waste
		AI-enabled traceability platform for coastal plastic recovery, capable of verifying waste collection activities through image data and mobile reporting to detect patterns, ensure claim validity, and generate auditable insights	 Founded in 2020, financially supported by the European Union, 500+ brand partnerships using their traceability and plastic credit system
		AI-powered waste analytics platform for packaging traceability , capable of capturing item-level data at sorting facilities using computer vision to map material flows, identify design inefficiencies, and deliver actionable insights (e.g., packaging redesign, investment priorities)	 Founded in 2019, raised \$11M in funding (2022), deployed in 20+ countries, recognizes 111 material categories
		AI-driven platform that combines advanced imaging, sensor fusion, chemical analytics, and machine learning to analyze the composition of incoming plastic waste and use that data to optimize sorting, recyclability, and overall recycling yield across the value chain	 Part of Alphabet company , founded in 2010, operating globally with partnerships across industry and academia

Source: Company websites, CGF member interviews




/ NON-EXHAUSTIVE

Material discovery: Use case deep dive




AI **accelerates** sustainable material discovery by **generating novel** molecular **structure**, **simulating properties** to predict performance, and **mining scientific data** to identify viable, lower-impact alternatives faster and at lower cost than traditional R&D


Start ups and Tech providers




- Uses a proprietary AI platform that accelerates the process of developing new sustainable packaging materials
- Simulates thousands of bio-based polymer and formulation combinations, rapidly identifying top candidates. Machine learning then predicts material behavior, such as recyclability, barrier properties, and biodegradability, to streamline R&D



- Uses AI to predict material properties based on structure and sustainability constraints
- Enables faster discovery of packaging material polymers that meet performance and circularity goals





- Offers a closed-loop platform combining AI and automated lab robotics for accelerated material discovery, helping surfacing eco-friendly chemical compounds for coatings, films, and packaging applications




- Uses AI to guide the development of alternatives to fossil-based polymers for flexible packaging to replace multi-material film structures in food and other packaging
- Applies material simulation and machine learning to optimize functionality and processability while ensuring compostability or recyclability

Corporate and CPGs






No client name shared

- Has launched with One.Five its first commercial AI-generated sustainable packaging solution tailored for snacks, ready-to-eat foods, and travel accessories
- Partners with One.Five to co-develop a fully bio-based, recyclable paper-based packaging solution



- Teams up with Citrine to accelerate the development of advanced plastic-free packaging solutions

- Has Co-developed an AI-powered platform combining deep search and generative AI to accelerate the discovery of recyclable and compostable packaging materials
- Reduces R&D trial-and-error by mining scientific data and predicting high-performance, sustainability-aligned material alternatives for circular packaging design

Material discovery: Company deep-dive, Citrine Informatics leverages AI to support sustainable materials discovery for packaging



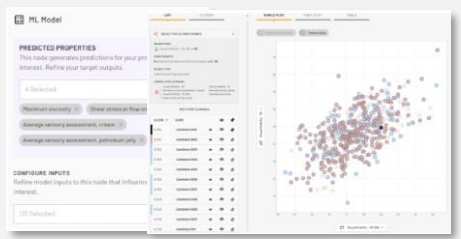
Company presentation

Citrine Informatics is a US-based company, founded in 2013, which publicly launched in 2020 its enterprise and AI platform supporting accelerated discovery and development of sustainable materials. The platform predicts material properties, recommends optimized formulations, and mines scientific data to identify lower-impact material alternatives, enabling faster R&D and supporting packaging circularity initiatives

AI-enhanced set of solution addressing material challenges in packaging

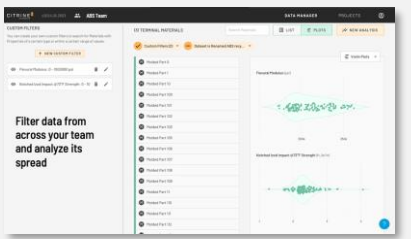
Replacing PFAS in food packaging

AI Solution: Trains ML¹ models on past formulation and property data to rapidly predict bio-based alternatives matching PFAS performance (e.g., barrier properties)



Screening polymers for packaging applications

AI solution: AI models simulate the properties of >2,5k polymers (e.g., via digital twins) identifying the top-performing candidates for lab validation in a fraction of the time



Changing from multi-layer to performant mono-materials

AI solution: Uses ML¹ models trained on structure and performance data to recommend mono-material or compostable layer configurations



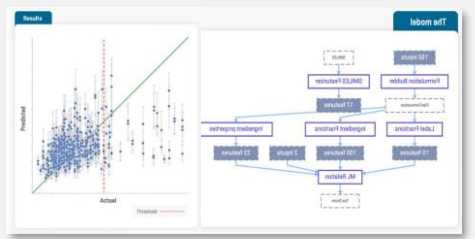
Improving sustainability of polymer formulations

AI solution: Applies inverse design to find viable polymer formulations that meet sustainability constraints (e.g., higher recycled content)



Avoiding toxic failures in complex composition

AI solution: ML¹ models trained on chemical structure and toxicology data predict regulatory risks early, allowing teams to identify and exclude high-risk substance



Note: 1) Machine Learning | Source: Citrine Informatics company website



Material discovery: Selected ecosystem of solution providers

AI **accelerates** sustainable material discovery by **generating novel** molecular **structure**, **simulating properties** to predict performance, and **mining scientific data** to identify viable, lower-impact alternatives faster and at lower cost than traditional R&D

Company names	Geography	Product description	Scale
		AI platform that accelerates the development of sustainable packaging materials through an intuitive chatbot interface designed for R&D teams . Based on R&D team's briefing, the AI platform simulates thousands of bio-based polymer and formulation combinations, and machine learning predicts critical properties	Founded in 2020, raised €10.5M+ in funding (2022), launched first commercial AI-generated sustainable packaging solution in 2025
		AI platform that accelerates sustainable material discovery by analyzing and learning from vast datasets (incl. client proprietary data), enabling the input of specific client requirements , and using generative AI to run virtual experiments , ultimately identifying the most promising material candidates	Founded in 2013, raised €50M+ in funding, large panel of investors (e.g., AME cloud, Alumni Ventures), recognized as Tech Pioneer by World Economic Forum in 2017, and as top 5000 America's fastest growing private companies in 2024
		Closed-loop AI platform that combines enhanced modelling capabilities with advanced deep learning and machine learning, optimized chemical synthesis and process chemistry with active learning powered algorithms and predictive model of reaction pathways based on AI for forward and retro synthesis, enabling continuous prediction, synthesis, and validation of novel materials	Founded in 2017, raise \$ 16M+ in funding , large panel of investors (e.g., Embark Ventures, One Way Ventures), acquired by SandboxAQ in 2024
		AI-driven system that continuously refines bio-based polymer formulations in real time , ensuring consistent quality, lower production costs. Results include new polymer with a carbon footprint just 11% that of traditional plastics	Founded in 2020, raised \$2.5M in 2025, ~10 employees

Source: Company websites, CGF member interviews



/ NON-EXHAUSTIVE

Automated compliance: Use case deep dive



AI is supporting how companies **ensure packaging compliance across various jurisdictions and new laws** (e.g., PPWR) with automated data collection, **designs** against **circularity rules** validation, while also providing **additional insights** through **evolving reports** on various topics (e.g., plastic bans, EPR)

Start ups and Tech providers

SGS DIGICOMPLY
THE REGULATORY INTELLIGENCE NETWORK

- Uses natural language processing (NLP) and machine learning to track and manage regulatory requirements across industries (e.g., plastics bans)
- Produces AI-assisted compliance checklists and documentation to inform decision making while also providing automated tools that generates comprehensive compliance reports, dashboards, and KPIs with minimal manual input

SPECRIGHT

- Centralizes and streamlines access to packaging data (incl. raw material specs) from the different parts of the value chain reducing complexity and manual work
- Uses AI to clean and normalize data from different sources, flagging compliance and information gaps through automated dashboards

PackComply

- Works as a SaaS tool dedicated to packaging compliance auditing automation across global regulations
- Uses machine learning and rules-based engines to assess packaging (e.g., layers, adhesives) and cross-references formats with global legislation (e.g., PPWR, EPR)

ESKO+

- Belongs to Esko's packaging software suite, Esko Comply uses AI to automate the verification of packaging design and labels against regulatory standards
- Leverages image recognition and OCR¹ to scan designs for compliance with packaging claims, icons, font sizes, and layout rules; automatically flagging violations (e.g., missing recycling symbols)

Corporate and CPGs

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Clients – non exhaustive

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- Collaborated to create a centralized platform system for SDM to streamline its fragmented packaging and raw material specifications across 10 luxury beauty brands

Note: 1) Optical Character Recognition | Source: Company websites, CGF member interviews



Automated compliance: Company deep dive, Specright leverages specification data to automate packaging compliance

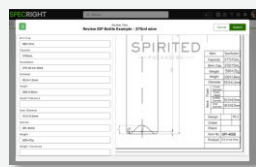


Company presentation

Specright is a US-based SaaS company founded in 2014 that pioneered AI-enhanced Specification Management: the digitization and centralization of all product and packaging specs, facilitating and enabling reporting & audit automation; helping brands manage specifications (e.g. material composition, certifications) at scale, across thousands SKUs and suppliers

2 complementary AI-powered solutions simplifying supply chain management ...

Automated data digitization with SpecIDP



- Application: Automates the extraction and digitization of data from documents such as PDFs and spreadsheets
- Technology: Utilizes Intelligent Document Processing powered by generative AI to accurately extract relevant data fields, facilitating the ingestion of packaging, product, ingredient, and formula specifications into the platform

Conversational data access with SpecGPT



- Application: Enables users to query specification data in natural language (e.g., "Which packaging specs use unrecyclable multilayer film?")
- Technology: Built on large language models (LLMs), this AI-powered chatbot provides instant, context-aware, answers from structured and unstructured data

1M+ product specs managed in the platform, from players like



... by directly feeding data to the platform, accelerating compliance activities



Automated packaging compliance reporting

Structured spec data enables automated weight calculations, material flagging (e.g., plastics), and EPR-ready outputs (e.g., fee modelling) via integrations like Lorax EPI¹



Design scoring and change impact tracking

AI integrated data highlights specs with regulatory risks and shows how material changes impact recyclability, labelling, or compliance exposure



Portfolio optimization and rationalization

Data reveals redundant or risky packaging across portfolios helping to consolidate SKUs, eliminate non-circular variants, and align with compliance frameworks (e.g., EMF²)

Integrates and works with many packaging relevant regulatory framework














Note: 1) Lorax EPI ENVI software provides an EPR, product stewardship, plastic tax and corporate commitment metrics reporting solution 2) Ellen MacArthur Foundation | Source: Specright company website



Automated compliance: Selected ecosystem of solution providers

AI is supporting how companies **ensure packaging compliance across various jurisdictions and new laws** (e.g., PPWR) with automated data collection, **designs** against **circularity rules** validation, while also providing **additional insights** through **evolving reports** on various topics (e.g., plastic bans, EPR)

Company names	Geography	Product description	Scale
		AI-enabled Specification Management platform for packaging and product specs, it enables packaging compliance tracking and material validation via tools like SpecGPT and SpecIDP while also partnering with packaging specialist like Lorax EPI for EPR reporting and fee modelling	 Founded in 2014, pioneer in Specification Management software managing 1M+ specs, reporting features emerging since 2020
		AI-enabled regulatory intelligence platform for packaging compliance , uses NLP ¹ and machine learning to monitor global laws (e.g., plastic bans, PPWR), generate AI-assisted checklists, and automate compliance reporting, dashboards, and KPIs across jurisdictions	 Founded by C-Labs in 2016, acquired by SGS in 2022, active in 150+ countries, primary focus on food safety , partnerships with Bacardi, Coca-Cola, Danone, Nestlé
	n.a.	AI-powered SaaS platform focused on packaging compliance, combines rules engines and ML to analyze materials, layers, adhesives, and formats against laws like PPWR, flagging non-compliance	 Early stage start-up, first to be 100% dedicated to packaging , focus on EU regulatory framework , limited visibility on maturity (no client identified)
		AI-enabled tool using rule-based automation to check packaging design for compliance issues (e.g., formatting violations). Integrated into WebCenter ² , it enables auto-validation, image measurement, and audit-trail generation for label and content approvals	 Founded in 2002 as a packaging management platform , Esko launched Esko Comply in June 2025 (full release planned for November 2025)

Note: 1) Natural Language Processing; 2) Webcenter is Esko's software suite dedicated to solution for packaging (e.g., design) | Source: Company websites



/ NON-EXHAUSTIVE

Supplier Selection: Use case deep dive



AI enhances supplier management by analyzing complex and unstructured datasets (e.g., via natural language processing) to support material and packaging sourcing decision-making across various stages, from suppliers identification to performance monitoring

Start ups and Tech providers

Corporate and CPGs

	<ul style="list-style-type: none"> • Uses AI, especially natural language processing, to identify risk signals impacting suppliers, from vast and unstructured data sets (e.g., news and social media content across 400+ languages, company certifications, annual reports) • Assigns supplier (incl. packaging and raw material) risk and sustainability scores that can be integrated into procurement workflows 	Identified use case in automotive industry (not directly related to packaging)
	<ul style="list-style-type: none"> • Supports supplier (incl. packaging and raw material) performance management through specific “Supplier Management & Collaboration” add-on • Enables evaluation and compliance check (e.g., material content, certificates) of suppliers translating into “scored and sorted” dashboards 	Identified use case in food industry (not directly related to packaging)
	<ul style="list-style-type: none"> • Leverages AI to provide procurement intelligence across over 2,300 categories offering features like supplier (incl. packaging and raw material) discovery and risks monitoring to suggest alternatives based on real-time insights • Features Abi, an AI assistant that delivers contextual responses by combining internal supplier contracts, sourcing data, and risk assessments 	
	<ul style="list-style-type: none"> • Acts as an AI-powered sourcing platform designed to help businesses efficiently discover and evaluate suppliers (incl. packaging and raw material) • Applies clustering algorithms, such as k-means¹, to analyze supplier attributes, enhancing matching and selection processes 	

Note: 1) Popular unsupervised machine learning algorithm used for clustering data points into a specified number of groups (k) | Source: Company websites

Supplier Selection: Company deep dive, Beroe leverages AI to streamline supplier selection and monitoring



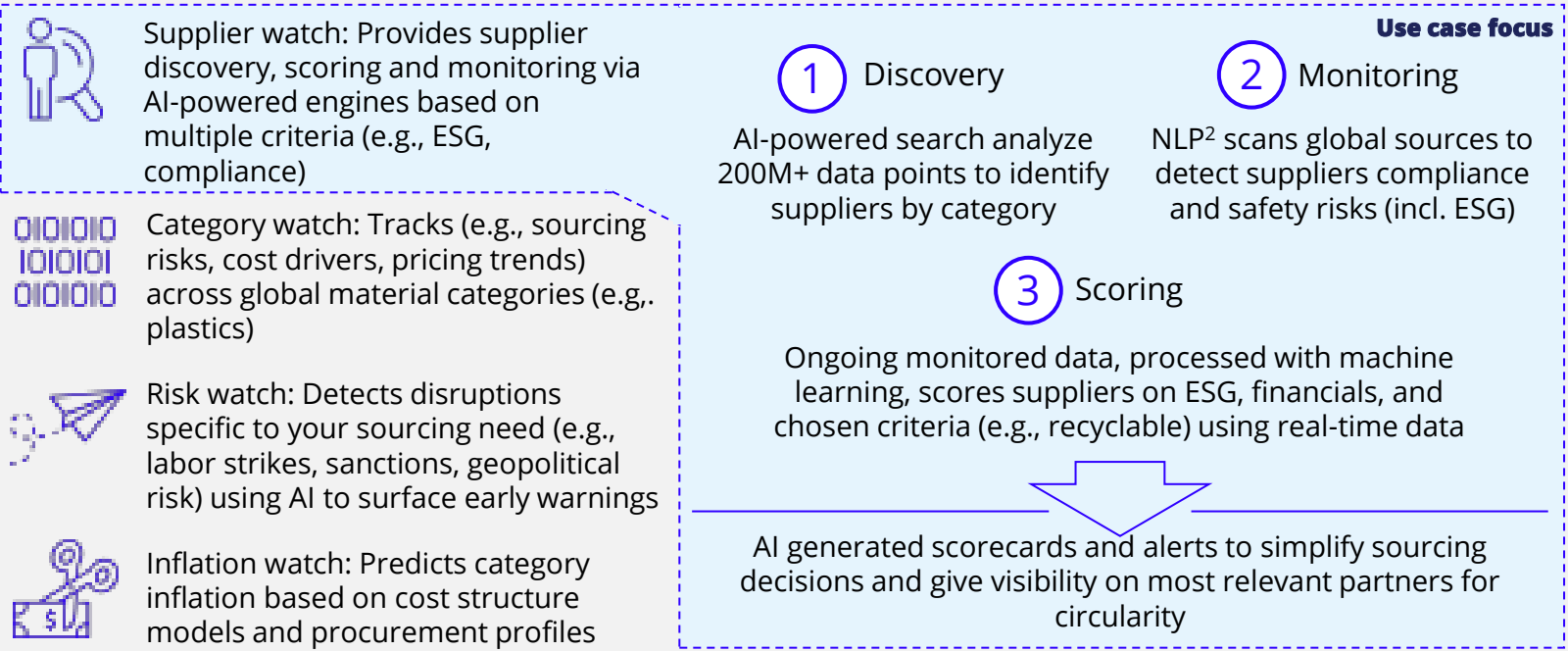
Company presentation

Beroe is a US-based procurement intelligence company founded in 2006. It specializes in providing AI-driven insights and data analytics to procurement professionals, enabling smarter and more circular sourcing decisions across over 2,500 direct and indirect categories (incl. rigid packaging, flexible packaging, resins, plastics)

2 main AI-powered solutions supporting material and packaging sourcing

Beroe LiVE.AI platform

A comprehensive, intelligence platform used by procurement teams to manage sourcing across suppliers, categories, and markets through the following tools:



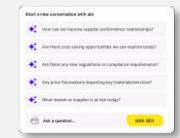
Abi, AI powered procurement advisor



A chatbot trained on conversational¹ AI from Beroe's data lake which can provide:



Detailed insights for sourcing decisions, including ESG performance and pricing forecasts



On-demand answers to sourcing-related questions, leveraging Beroe's extensive market intelligence



Proactive alerts on market shifts and disruptions

12000+
conversations engaged with users in the last year










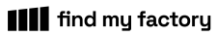


170+
Daily queries answered

Note: 1) Combination of LLM (Large Language Model) and rules-based AI 2) Natural Language Processing | Source: Beroe company website



Supplier Selection: Selected ecosystem of solution providers

AI enhances supplier management by analyzing complex and unstructured datasets (e.g., via natural language processing) to support material and packaging sourcing decision-making across various stages, from suppliers identification to performance monitoring

Company names	Geography	Product description	Scale
		AI-powered supplier and risk intelligence platform using natural language processing and event correlation to detect ESG, legal, and operational risks and score suppliers, verifying risk exposure in real time	 Founded in 2017, trusted by global brands (e.g., Audi, Siemens), supports cross industries regulatory framework of which some related to packaging (e.g., EUDR for EU Deforestation Regulation)
		AI-enabled Specification Data Management platform including a “Supplier Management & Collaboration” module which enables supplier compliance checks (e.g., material composition, recycled certifications) and generates “scored and sorted” supplier dashboards	 Founded in 2014, suppliers related modules were introduced in 2020 and have been further enhanced with performance dashboards in 2023
		AI-driven procurement intelligence platform that facilitates the advancement of packaging circularity by equipping businesses with the necessary insights (e.g., supplier ESG performance) via its LiVE.Ai suite (powered with NPL, AI-enhanced search) and Abi (chatbot) assistant	 Founded in 2006, serves top global enterprises in various industries (e.g., pharma, FMCG), mature category (+2 500) and supplier scoring engine , with coverage of packaging and broader regulatory risks
		AI-driven supplier discovery platform to locate manufacturers by product, region, and certification; helps buyers find packaging producers offering circular or bio-based solutions	 Founded in 2022, benefits from a strong supplier matching interface with growing brand adoption in Europe , suitable for early-stage packaging supplier discovery

Source: Company websites



Compliance assessment & Circularity reporting

ENHANCED
DATAOPERATIONAL
EFFICIENCY

INNOVATION

Forecast for tracking and reuse: Use case deep dive



AI can support complex **reverse logistics** by adding intelligence to real-time tracking technologies like RFID, while **AI-powered forecasting tool** can identify high-potential refill SKUs, optimal store formats, target customer segments, and pilot regions, maximizing sales per unit of investment

Start ups and Tech providers

CLUBZERO

- Offers comprehensive returnable packaging aimed at eliminating single-use waste in the food and beverage industry
- Uses RFID technology for real-time tracking of reusable packaging and then AI to optimize reverse logistics for drop-offs, collection, washing, and redistribution systems with computer vision and optimization model



Corporate and CPGs

- Solutions leveraged mainly in restaurants, not yet for CPGs and retailers
 - The Salad Kitchen: integrates reusable pots and bowls in delivery/takeaways menus to meet sustainability targets
 - University College London: implements ClubZero's in campus cafes and dining areas as part of their zero-waste initiative
 - Notes Coffee: uses ClubZero's cups to offer returnable takeaway coffee solutions at their cafes

BOLD REUSE

- Offers scalable, full-service reusable packaging systems, including container distribution, collection, washing, and return logistics, aimed at eliminating single-use waste across food service, grocery, and events
- Uses RFID technology and AI powered data analytics to track packaging, optimize return rates, and improve operational efficiency



Focus on offering solution at high traffic venues such as sport events and universities, not yet deployed for CPGs and retailers packaging

Limited players offering solutions for AI-powered forecasting tool

Appendix



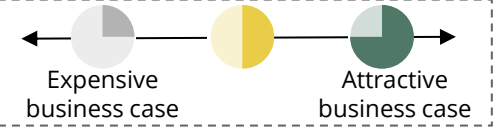
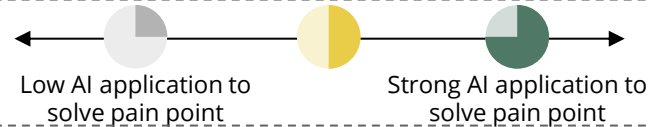


Back up: Some AI applications can help overcome technical limitations on new packaging materials

NEW PACKAGING MATERIALS

Legend

AI use cases



Pain points

How AI can play a role

Business case

Innovation hurdles

- Slow & costly innovation
 - Discovering new materials (e.g., coating for paper based packaging) is slow and costly due to limited proven alternatives and high development costs
- New material trade-off
 - New materials may not match the durability, barrier protection, or shelf life of conventional plastics, esp. for food, personal care, and may affect the look, feel, or functionality

Material discovery
 AI can accelerate material discovery by simulating properties, predicting the behavior of new materials, and uncovering innovative combinations, reducing costly trial-and-error testing

Doing this in-house is costly, but partners already offer reliable, data-ready solutions



Sourcing challenges

- Sourcing constraints
 - Alternative components are often more expensive vs traditional plastics

Generative new design
 AI-powered predictive modelling can help balance the trade-offs between new and conventional materials by simulating their performance, but trade-offs will remain

Building these solutions in-house is complex and slow, but startups already offer ready-to-use tools



Supplier scoring & selection
 AI can assist in supply chain optimization by analyzing global sourcing data and identifying less costly suppliers of alternative materials

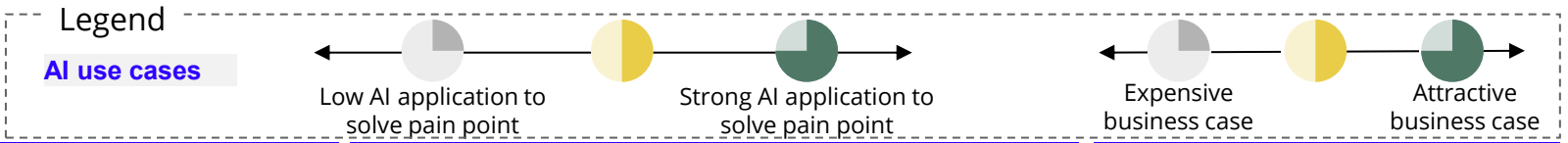
Given limited data, implementation might be time-consuming and costly; some partners identified to speed up the process





Back up: Ensuring packaging is both recyclable and actually recycled is a key circularity challenge, where AI can help

RECYCLABLE & RECYCLED



	Pain points	How AI can play a role	Business case
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Design complexity

- Trade-offs on "Design for recyclability"
 - Designing sustainable packaging often involves trade-offs, between e.g., performance, consumer expectation, fit with current production lines, CO2 impact and recyclability

Generative new design

AI can help optimize design for recyclability in complex packaging materials by balancing multiple factors to find the most effective material mix

Building these solutions in-house is complex and slow, but startups already offer ready-to-use tools that some CPGs have started to adopt



Limitation at sorting and recycling facilities

- Packaging sorting
 - Current sorting systems are optimized for certain plastics, causing technically recyclable materials to be misidentified. CPGs often lack insight into actual recycling rates of packaging

Advanced sorting **Material Traceability**

AI and computer vision enhance sorting of packaging, especially for hard-to-sort plastics. They also offer insights into which packaging is more successfully sorted and recycled, helping brands understand packaging end-of-life

Computer vision requires upfront investment, but the insights it provides can lead to positive ROI, esp. if helps reduce EPR fees; already partners offering solutions



- Downcycled
 - Recyclable packaging is often downcycled, not truly recycled, due to quality loss, contamination, and limited infrastructure

AI can match downcycled plastics with the best-fit secondary markets by analyzing material traits and demand trends

n.a.

- Plastic type challenges
 - Certain plastic types, esp. flexible packaging, face low collection rates and high contamination. Their lightweight and multi-material nature makes them harder to capture and recycle economically

AI can help on optimizing collection and waste dispatch logistics

Advanced sorting

AI-optimized robotic sorters can be trained on filtering out contaminated packaging more effectively than traditional system to redirect them towards to adequate treatment (e.g., washing)

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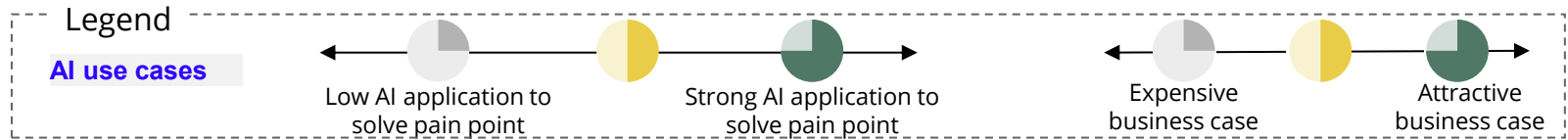
Robotic sorting arms requires upfront investment; but partners already exist





Back up: Incorporating and getting access to more recycled content is a major pain point, where AI can play a role

RECYCLED CONTENT



	Pain points	How AI can play a role	Business case
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Supply chain challenge

- Supply cost & quality
 - Recycled content is typically more expensive and of inconsistent quality compared to virgin material

AI can help on screening recycled content specifications from supplier documentation to assess quality and price, however price challenge and quality will remain

n.a.

- Security of supply
 - Supply is limited, partially driven by growing demand from other industries (e.g., textile)
 - Supply is fragmented, with poor transparency on available volumes across regions and suppliers

Supplier scoring & selection
AI can identify cost-effective suppliers, streamline procurement by forecasting demand and by mapping regional availability. AI accelerates the procurement process, especially when managing many suppliers

Given limited data, implementation might be time-consuming and costly; also, some partners identified to speed up the process
Prewave SPECRIGHT beros find my factory

- Traceability and certification
 - Recycled content lack standardization for certifications and verifiability of origins

Material origin verification
AI can help by automating data collection, verifying supplier claims, standardizing traceability checks across complex supply chains. This improves transparency but doesn't replace physical need for physical verification

While developing such solutions in-house can be complex and time-consuming, several startups already offer ready-made tools
Tradeverifyd Circular

Regulatory limitation

- Limited usage
 - Different types of recycled content are not approved for use in food-grade packaging, limiting the possibility to use recycled content for different CPGs

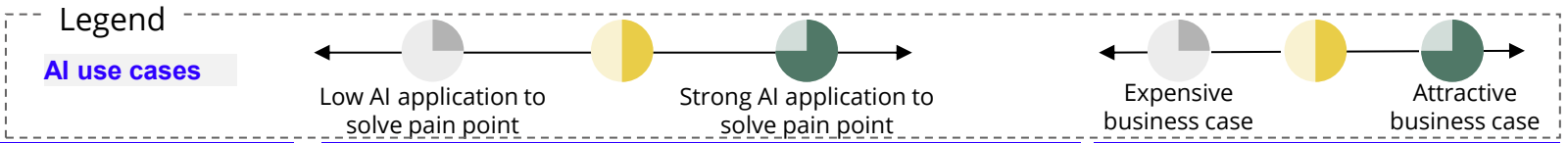
Regulatory approval for food-grade recycled plastics is largely driven by strict safety and quality standards that AI cannot address but it can help monitor evolving regulations in countries where new packaging applications are being authorized, enabling faster compliance and strategic adaptation

n.a.



Back up: AI can help address some pain points in reuse & refill systems, but it is not a silver bullet

REFILL & REUSE



Pain points	How AI can play a role	Business case
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Logistics & operational challenges

- Reverse logistics set up
 - Collecting empty containers from consumers requires new infrastructure, procedures, coordination, at high cost
- Tracking requirements
 - Containers need to be tracked with real time data over use cycles to monitor damage, contamination, or end-of-life

- Tracking & forecasting of reuse/ refillable** (Yellow circle)
 - AI can help optimize e.g., forecast return flows, trucks loads, but main challenge remains the reverse logistic physical infrastructure
- Tracking & forecasting of reuse/ refillable** (Yellow circle)
 - AI complements RFID¹ with RFID providing real-time tracking, and AI delivering insights like end-of-life forecasting

- Attractive business case** (Green circle)
 - AI logistics optimization is a quick and cost-effective solution, if the necessary data is already available
- Expensive business case** (Yellow circle)
 - High upfront investment for RFID + AI model, could be positive for high value packaging and high scale

Change of consumer behavior

- Limited consumer adoption
 - Consumers are often not yet aware/ ready to change due to limited options, low visibility on shelf, lack of training of sales teams

- Consumer education** (Yellow circle)
 - AI can analyze consumer data to identify trends, segment customers, and tailor messaging, but the impact may be similar to that of traditional marketing
- Consumer education** (Yellow circle)
 - AI can guide eco-conscious consumers toward refill and reuse by optimizing shopping choices

- Expensive business case** (Yellow circle)
 - AI-driven marketing campaign and consumer analysis is a cost-effective use case, though obtaining data can be challenging, limited partners identified

Packaging constraints

- Technical constraints
 - Not all products are suitable for refill and reuse, e.g., those requiring sterile, tamper-proof, or protective packaging

- Low AI application to solve pain point** (Grey circle)
 - AI can suggest reuse-friendly packaging designs but can't replace strict regulatory checks for sensitive categories like baby formula

n.a.

Uncertain business case

- Complex economics
 - The refill business case can be challenging in absolute margin (higher margin %, lower absolute value)
 - CAPEX required for new molds or production lines

- Strong AI application to solve pain point** (Green circle)
 - Tracking & forecasting of reuse/ refillable**
 - AI-powered demand forecasting can help identify high-potential refill SKUs to prioritize, store formats, customer segmentation, or regions to pilot

- Expensive business case** (Yellow circle)
 - Demand forecast is a typical use of AI, "easy" to implement, but limited partners identified so far

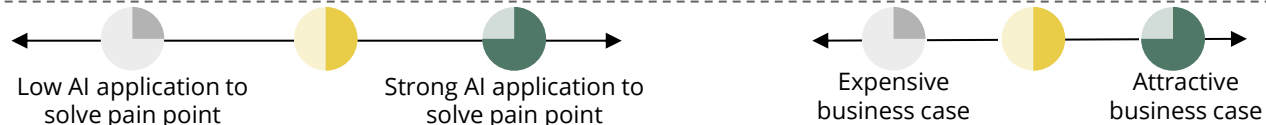
Note: (1) RFID = Radio frequency identification | Source: Company website



Back up: Staying up to date with regulations, getting accurate data and developing required reporting

REGULATIONS, DATA & REPORTING

AI use cases



Pain points



How AI can play a role

Business case

Navigating between jurisdictions

- Regulations changes
 - Multi-jurisdiction sales create sourcing and R&D headaches, as packaging allowed in one country may violate regulations elsewhere, requiring precise item-level
 - EPR schemes and fees vary across jurisdictions. Staying compliant and minimizing cost requires legal oversight, and also smart packaging design decisions aligned with market-specific incentives

- Design optimization**
 - By processing item-level packaging data, AI can help adapt packaging designs to meet diverse regulatory requirements
- Design optimization Automated compliance audit**
 - AI can analyze multi-jurisdictional EPR regulations, helping identify packaging designs that not only comply with local rules but also minimize fees

- Building these solutions in-house is complex, but startups offer ready-made tools, which integrate compliance constraints 
- Some partners that focus on EPR compliance have been identified but not design optimization 

Demanding reporting requirements

- Stricter regulations on reporting
 - CSRD and reporting laws have made reporting more demanding, as companies must ensure that packaging data is audit-ready and transparently disclosed
 - Lack of robust data systems and standards for traceability, tracking packaging across the value chain makes data gathering on packaging circularity performance labor-intensive, error-prone, and inefficient

- Automated compliance audit and reporting**
 - AI can help ensure packaging data is audit-ready by automating the documentation and verification process. It can also streamline and automate the transparent disclosure writing
- Material traceability**
 - AI can strengthen traceability by mapping waste flows, integrating and standardizing data across the value chain, reducing manual effort and errors in tracking and reporting packaging circularity performance

- Some partners have been identified or potential to build solution in house if data/document available   
- Building these solutions in-house is complex and slow, but start-ups already offer ready-made tools for waste flows mapping   