Deep Innovation Dossier: PurityLoop AI - Advanced Material Reclamation ♻

1. Product Vision & Value Proposition

PurityLoop AI envisions a future where plastic waste is no longer a liability but a high-value, traceable commodity. We are building the critical intelligence layer for the circular economy, replacing archaic sorting methods with next-generation material science precision.

The PurityLoop system utilizes high-speed multi-sensor arrays (including spectral analysis) monitored by proprietary deep learning models. This enables classification and segregation of plastics not just by polymer type, but by specific additives, color, and degradation state—essential for high-quality chemical or mechanical recycling.

Unique Selling Points (USPs):

- Purity Guarantee: Outputs validated feedstock purity exceeding 99.9%, a requirement for meeting premium manufacturing specifications.
- High-Yield Integration: Predictive algorithms optimize material flow into downstream chemical processes (represented by the circular diagram element), maximizing monomer yield and throughput.
- Cost Efficiency: Reduces the operational costs associated with contamination rejection and provides MRFs access to premium pricing tiers for their high-purity output.

1. Consumer & Market Impact

PurityLoop AI addresses critical pain points across high-stakes industrial markets, driving efficiency and sustainability.

Primary User Personas:

1. The MRF Operator (Operational Efficiency Focus): Struggling with low-margin, contaminated bales and increasing regulatory pressure. PurityLoop AI offers a clear path to generating premium, traceable materials, stabilizing revenue streams.

1. The Petrochemical Sustainability Director (Strategic Sourcing Focus): Facing intense pressure to incorporate high percentages of recycled content but limited by the scarcity of reliable, high-purity feedstock. PurityLoop provides a scalable and guaranteed supply solution.

1. The Global Environmental Regulator (Non-obvious/Societal Impact): Concerned that current recycling infrastructure cannot scale to meet global plastics targets. This innovation provides the necessary technological leap to dramatically increase national recycling efficacy and material traceability.

Testimonial-Style Quotes:

“We can finally stop subsidizing trash and start selling raw materials. This fundamentally changes the economics of our facility.” — MRF Executive

“This level of purity means we can meet our 2030 recycled content targets without compromising product quality. It feels like we’ve bridged the gap to the true circular economy.” — Petrochemical Sourcing Lead

“The traceability and yield optimization offered by PurityLoop is exactly the systemic solution we need for scalable environmental compliance.” — Regulator’s Insight

1. Feasibility Assessment

Technological Readiness Level (TRL) Assessment (NASA Scale):

Current State: TRL 5 (System/subsystem breadboard validation in a relevant environment).

Reasoning: Core components (AI, deep learning classifiers, spectral analysis hardware) are individually mature. However, integrating these into a single, high-speed, industrial-grade sorting system that guarantees molecular-level purity, and validating its predictive link to complex downstream chemical processes (the 'microbial' drawing), requires demonstration in a non-lab environment.

Next Stage: TRL 6 (System model or prototype demonstration in a relevant environment). Requires a beta installation in a working MRF for initial performance validation.

Business Readiness Level (BRL) Assessment (KTH Innovation Scale):

Current State: BRL 3 (Validated Problem/Solution Fit).

Reasoning: Extensive market validation confirms that low purity is the single largest economic barrier for advanced recyclers and a major sourcing headache for petrochemicals. The core value proposition (Purity as a Service) is conceptually compelling, but the pricing model, operational costs at scale, and securing formal long-term off-take agreements have not yet been validated.

Next Stage: BRL 4 (Validated Business Model). Requires piloting the solution and locking in initial high-value contracts based on guaranteed purity performance.

1. Prototyping & Testing Roadmap

Phase 1: Minimum Viable Product (MVP) Development (0–6 Months)

- Develop AI vision MVP focusing on classifying only the two most problematic mixed streams (PET vs. PP) at 95%+ purity.
- Build a compact hardware module suitable for integration into existing MRF conveyor belts.
- Establish baseline performance metrics (throughput, purity, latency).

Phase 2: Targeted Field Trials & Data Lock-In (7–15 Months)

- Deploy the MVP in two distinct partner MRF sites (one urban, one regional) for live testing.
- Validate TRL 6: Demonstrate reliable performance under real-world contamination loads.
- Begin parallel business model validation by testing variable fee structures based on purity outputs achieved (BRL 4 validation).

Phase 3: Iterative Refinement & Full System Integration (16–24 Months)

- Expand AI models to recognize 5+ polymer types and complex film contaminants.
- Integrate predictive maintenance and material flow optimization algorithms to manage the input quality for downstream chemical processing partners.
- Refine UI/UX for MRF operators, focusing on low-touch maintenance and high uptime.

1. Strategic Launch & Market Integration

Macrotrends Alignment: PurityLoop AI directly capitalizes on the global shift toward the Circular Economy and stringent ESG (Environmental, Social, Governance) investment mandates, positioning it as an essential utility for sustainable manufacturing.

Strategic Partnerships:

- MRF Integration Partners: Secure contracts with top-tier waste management corporations for standardized, rapid hardware deployment across their networks.
- Petrochemical Off-Takers: Establish binding, multi-year volume agreements with chemical recyclers and resin manufacturers, framing the purity guarantee as supply chain risk reduction.

Distribution Channels:

- B2B Solution as a Service (SaaS): High-margin subscription model covering the AI software license, data analytics, and predictive maintenance features.
- Hardware Deployment: Leasing model for the physical sorting modules, reducing upfront capital expenditure barrier for MRFs.

Pilot Programs & Incentives:

- Pioneer Program: Offer discounted installation and a shared revenue model with the first five MRFs who commit to integrating the PurityLoop system, ensuring high-quality, continuous operational data for further model training.

Framing the Future Normal: As regulators increase minimum recycled content mandates, PurityLoop AI will become the default industry standard required to convert complex post-consumer waste into valuable, circular feedstock, ensuring brand compliance and premium material accessibility.

Next Step

Secure $5M in seed funding to finalize the TRL 6 prototype system build and initiate the targeted field trials (Phase 2) at the first two commercial partner sites.