IMPLEMENTATION PLAN AND TECHNICAL SPECIFICATION RePlastic Upcycling Hub — Expanded Version Wrocław University of Science and Technology

1 PROJECT OVERVIEW

The RePlastic Upcycling Hub (hereafter "Hub") will convert post-consumer plastics starting with plastic bottles collected on campus into high-quality 1.75 mm 3-D-printer filament that is made freely available to students. The Hub operates as a living laboratory for circular-economy innovation, integrating Engineering practice, Environmental stewardship, and Entrepreneurship. Most importantly the hub/lab positions WUST as a forward thinking innovative university that supports student-led initiatives towards an environmentally conscious future.

A new partnership with the **Rapid Troopers Lab** (Faculty of Mechanical Engineering) secures dedicated floor space and grants access to two pre-existing extruders. Consequently, capital expenditure is reduced and technology readiness is accelerated. Rapid Troopers will also provide basic preventive maintenance and secure, controlled access to a room maintained by the Mechanical Engineering Faculty.

2 PURPOSE AND OBJECTIVES

• Waste reduction – Divert \ge 3 t yr⁻¹ of PET and HDPE from campus waste streams within the first 24 months.

• **Resource generation** – Produce $\geq 100 \text{ kg yr}^{-1}$ of recycled filament that meets $\pm 0.05 \text{ mm}$ diameter tolerance at a rate of 2 kg of filament per week (estimated).

• Education & research – give opportunity to at least 100 students yr^{-1} in polymer processing, LCA, and manufacturing; enable five interdisciplinary research projects annually.

• **Community impact** – Host twice-yearly design sprints and hackathons promoting sustainable product development, and providing non monetary incentives to reduce capital expenditure.

3 IMPLEMENTATION PHASES & MILESTONE TIMELINE (2025–26)

Phase	Date Range	Principal Outputs	Lead Unit
0 —	May–Jul	MoU with Rapid Troopers;	Project Board
Partnership &	2025		
Planning			

1 — Site	Aug-Oct	power trunking; installation of shredder,	Tech Services +	
Fit-Out	2025	washer, winder; integration of existing	Rapid Troopers	
		extruders		
2 — Process	Nov	Trial runs; QC protocol approved; OHS	Hub Team	
Validation	2025–Feb	evaluation, operator certification		
	2026			
3—	Mar 2026	Ribbon-cutting event; first filament batches	Hub + Marketing	
Operational		released;		
Launch				
4 — Outreach	Apr–Jul	"RePlastic Design Challenge"; external	Hub	
& Scale-Up	2026	workshop for regional schools; KPI report to		
		Rectorate		

4 LOCATION AND INFRASTRUCTURE

The location is placed at the Mechanical Engineering Building, ground floor,

<30 m²(Temporary-access to Equipment). The room is part of Rapid Troopers' secure suite with secured access; custodial cleaning and machine-room maintenance are included in the existing service contract. Unfortunately during our survey, a problem arose. due to lack of space in the mechanical engineering Department, a room which can house the 3d Printers and supporting equipment that is freely accessed by university students remains unclear, but once this project is cleared and student support is shown during the voting round, we are in close contact with the department heads, and a permanent room will be found.</p>

5 PROCESS & TECHNOLOGY DETAILS

1. Manual Bottle Separation - A team will take the collected bottles, separate bottle caps and lables from plastic bottles and arrange them in sorting bins.

2. Washing – 300 L baffled tank, stainless-steel impeller;

3. Drying – 1.5 kW centrifugal dryer;

4.Shredding – Precious Plastic V4 shredder, 7.5 kW, throughput 40 kg h⁻¹ (6–10 mm flakes).

5. Extrusion & Winding – Two Filabot EX2 extruders (Ø16 mm screw, dual-zone band heaters to

250 °C) provided by Rapid Troopers. Laser gauge (0.01 mm resolution) governs closed-loop speed control. Custom Arduino-driven winder (NEMA17 + optical end-stop) spools 1kg per reel.

Inline process data (temperature, torque, diameter) are streamed to an open-source dashboard (Node-RED) for teaching and continuous improvement.

6 EQUIPMENT & COST SUMMARY - revised

Cost Category	Amount (PLN)	Description
Capital Expenditure (CAPEX)	72 380	Equipment, setup, and 10% contingency
Operating Costs (2 years)	343 000	Includes electricity, materials, student crew, chemical QA
TOTAL PROJECT COST	415 380	Full implementation over 24 months

Note: A detailed itemized budget is available upon request.

7 SAFETY, SECURITY & MAINTENANCE REGULATIONS

The Hub will comply with:

- Polish Regulation §321/2023 on Small-Scale Plastic Processing.
- University OHS Ordinance C-12-B/2022 (machine guarding, noise < 85 dB).
- Mechanical Engineering Faculty Lab Code 4 (after-hours shutdown checks).

SOPs (Annex B) cover start-up, emergency stop, cleaning, and quarterly preventive maintenance. Rapid Troopers provide first-line maintenance; complex repairs follow a service contract with certified technicians (24 h response).

8 RISK ANALYSIS AND MITIGATION

Risk	Likelihood	Impact	Mitigation
Contaminated feedstock (PVC, PLA)	М	Н	Density test; reject non-PET/HDPE; student training
Machine downtime	М	М	Redundant extruder; spare-part kit; service contract
Ventilation failure	L	Н	Temperature + VOC sensors trigger auto-shutdown
Data security (dashboard)	L	М	University firewall; role-based access
Low student engagement	L	М	Embed filament use in core coursework; marketing plan

9 MARKETING & COMMUNITY OUTREACH

• **RePlastic Design Challenge** (Nov 2025) – 48-hour hackathon producing functional items from campus waste; judging panel from industry.

• Open Lab Days – Monthly tours in collaboration with Rapid Troopers.

• Digital Campaign - RePlasticPWR on social media; live dashboard with production stats.

• Schools Programme - One-day workshops for upper-secondary pupils (four per year).

10 FINANCIAL STRUCTURE

Total funding requested from Politechnika Nova: 415,380 PLN, covering all capital expenditures and setup costs, including a 10% contingency buffer and operational expenditure.

This structure is designed to support a 24-month pilot phase.

Following this period, operational continuity and expansion will be evaluated based on actual performance, usage demand, and institutional interest, with future funding arrangements to be developed accordingly.

11 CONCLUSION

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Leveraging existing Rapid Troopers infrastructure dramatically lowers both risk and cost while accelerating deployment and technical readiness.

The expanded RePlastic Upcycling Hub is more than a recycling station — it is a living, evolving platform for circular innovation. By transforming tonnes of campus plastic waste into high-performance 3D printing filament, the Hub will not only enrich academic curricula and foster hands-on, interdisciplinary collaboration across faculties — it will actively position Wrocław University of Science and Technology as a national pioneer in circular-economy engineering. This initiative stands to redefine how universities integrate sustainability, fabrication, and research — establishing WUST as a model for scalable, impact-driven transformation in the 21st century, a project we are excited to see envisioned for the university.