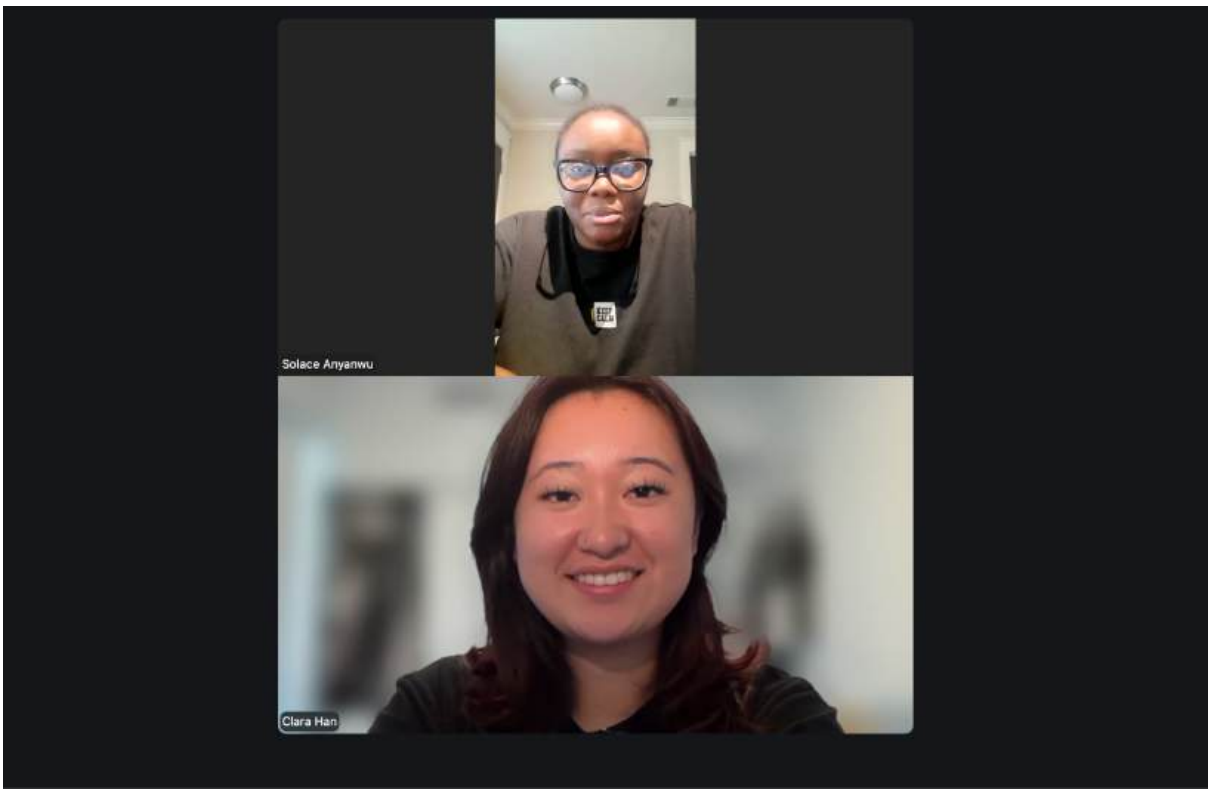
# Industry/Community Interviews

## Solace Anyanwu




**Their role:**
Solace Anyanwu is a PhD candidate in electrochemistry at the University of Alabama with an MSc in biocatalysis through the Erasmus Mundus program. Their previous work involved bioelectrochemistry and immobilized enzymes, while their current research focuses on fuel cells and membrane transport. This background provided relevant expertise in enzyme immobilization, process design, and biocatalytic systems.

**Contents of the interview:**
Our discussion focused on the practical and safety considerations involved in applying PET-degrading enzymes beyond the laboratory. Solace compared purified, immobilized, and living engineered systems, recommending purified or immobilized enzymes as safer and more practical options for wastewater treatment and industrial recycling. They highlighted immobilization as a way to improve enzyme stability, enable reuse, and reduce the containment concerns associated with genetically engineered microorganisms. A major challenge they identified was reaction time, since wastewater treatment operates continuously while PET degradation may require much longer residence times. This led to a discussion of continuous-flow systems, thermostability, enzyme recovery, and the importance of designing around realistic operating conditions. Solace also emphasized life-cycle assessment and green chemistry, including pre- and post-processing requirements, solvent safety, and overall resource use.

**How the interview shaped our project:**
The interview encouraged us to evaluate PETase candidates beyond predicted degradation performance and consider their suitability for real-world processes. Stability, immobilization, reuse, and reaction kinetics became important factors when thinking about future implementation. Solace's emphasis on life-cycle assessment also reinforced the need to consider the full treatment process rather than assessing enzyme activity in isolation. Their suggestion to explore molecular docking provided another potential approach for understanding enzyme-substrate interactions and supporting candidate prioritization.

**Excel O. Amaefule**




**Their role:**
Excel Amaefule is an interdisciplinary researcher and advocate working across energy justice, water justice, climate adaptation, and sustainable development, particularly in Sub-Saharan Africa. His background spans civil engineering, environmental politics, development, and science education. As founder of the Eden Resilience Action Lab, his work focuses on community-centred approaches to climate resilience and environmental justice.

**Contents of the interview:**
Our conversation examined how environmental biotechnology could be implemented responsibly in Nigeria. Excel explained that regulatory challenges often arise from gaps in enforcement, coordination, and technical capacity rather than from a complete absence of policy frameworks. PET-degrading biotechnology may also fall between existing regulatory categories, creating uncertainty around which agencies would be responsible for oversight. We also discussed limitations in wastewater infrastructure, including insufficient treatment capacity, funding, maintenance, and reliable power, which can affect where enzyme-based technologies could realistically be applied. Excel emphasized the risks of ethics dumping and extractive research, stressing that open access does

not automatically guarantee equitable benefit-sharing. He also highlighted the importance of community involvement, data-origin transparency, accessible tools, and policy communication that connects scientific evidence to existing priorities.

**How the interview shaped our project:**
The interview challenged us to consider how local infrastructure and regulatory capacity affect whether a biotechnology solution can be transferred between regions. It also expanded our understanding of accessibility by showing that an open database should consider factors such as bandwidth, compatibility, and transparency about where biological data originates. Excel's emphasis on making decisions with communities rather than for them became an important principle in our approach to responsible deployment and stakeholder engagement. His feedback also reinforced the need to consider equity alongside technical performance when developing PETadex.

## Dr. Temitope Olawunmi Sogbanmu



**Their role:**
Dr. Temitope Olawunmi Sogbanmu is an environmental toxicologist and Senior Lecturer at the University of Lagos with expertise in environmental risk assessment, pollution management, and evidence-informed policymaking. She has served on Environmental Impact Assessment review panels for Nigeria's Federal and Lagos State Ministries of the Environment and conducts research in environmental evidence synthesis and knowledge translation.

**Contents of the interview:**
Our discussion focused on the environmental evidence needed before plastic-degrading enzymes could move toward real-world use. Dr. Sogbanmu emphasized that a solution should not create new environmental risks while addressing plastic pollution, making it important to assess unintended enzyme activity and the toxicity of degradation products. She also stressed that controlled laboratory experiments alone cannot establish environmental safety and that testing should increasingly reflect realistic conditions. Regulators would need broader evidence showing how the technology behaves

outside the laboratory and whether its by-products can be safely managed. Beyond technical validation, she emphasized trust, communication, and engagement across the value chain. Co-creation with communities and collaboration across disciplines were highlighted as important components of responsible research and innovation.

**How the interview shaped our project:**
Dr. Sogbanmu's feedback strengthened our focus on environmental safety beyond enzyme activity alone. We considered the need to evaluate degradation products, unintended interactions, and performance under conditions that better reflect real environments. Her perspective also reinforced the importance of clearly distinguishing computational predictions from experimentally validated evidence within PETadex. Finally, her emphasis on co-design encouraged us to include perspectives beyond enzyme researchers when considering how the technology could eventually be developed and applied.

## Dr. Julie Goddard and Dr. Sonia Su




**Bio for Dr. Julie Goddard:**
Dr. Julie Goddard is an educator & Director of Research in Biomaterials & Biointerfaces in Food and Agriculture at Cornell University. Her research is tailored to applying material chemistry to improve food safety, food quality, and sustainability. She works on development of enzymes, biodegradation of microplastics in food and agriculture, and synthetic biology. She previously worked on a project where they engineered new PETase enzyme variants designed to perform in complex conditions. With a chemical engineering background, she brought research experience as well as engineering expertise from a Wet Lab and sustainability perspective.

**Bio for Dr. Sonia Su:**

Dr. Sonia Su obtained her PhD in the Goddard Research Group at the Cornell University Department of Food Science. Her work focused on enzyme research for bioremediation, specifically the breakdown or consumption of environmental pollutants to ultimately reduce pollution.

**Societal Impacts**

To explore the societal impacts thoroughly, they recommended frequently consulting the wastewater treatment facilities and the general public. This will allow stakeholders to be informed when decisions are being made. Stakeholders can then intervene when they notice concerns, and are able to propose corresponding solutions that would mitigate harmful societal impacts. Furthermore, frequent and honest discussion with stakeholders build trust, and may allow PetaBite to be more easily accepted amongst them.

**Validation Process: From Identifying a Promising Enzyme Candidate to Having Confidence in its Capabilities**

Dr. Goddard and Dr. Su identified that the first step of validation should be to identify the location in which the process is intended to take place (eg. in waste water, identify whether the enzyme should work in sludge or effluent). Based on that condition, they explained that it is important to verify the enzyme is able to perform well in that tailored condition; she pointed out that each wastewater treatment plant uses a different set of chemicals and materials and thus the wastewater substance itself is highly variable. This step would be done in two increments: first by working in a controlled environment using buffers and adjusting it to get repeatable results, and then by using actual wastewater that comes from the target wastewater treatment plant. It is noteworthy that they mentioned wastewater changes depend on region and season, as dietary patterns vary across cultures and geographic areas throughout the year. Additionally, fluctuations in outdoor temperatures could influence wastewater treatment facilities, particularly those located outdoors, potentially exposing enzymes to harsh weather conditions. Finally, they emphasized that it is important to gather sample stakeholder responses to the project to be able to deploy it smoothly and validate it from a community perspective.

**Performance Metrics for Indication of Real-World Success**

Dr. Goddard and Dr. Su explained that while the performance metrics vary depending on the research question, in this project's context, they recommend comparing an enzyme's performance to a baseline enzyme, such as FAST-PETase. This validated the Dry Lab team's work, since the Dry Lab team incorporated a comparison of searched enzymes with FAST-PETase. Some particular metrics they recommended paying attention to included turnover rate, activity per unit enzyme, durability, and enzyme activity in an extreme condition.

**Biosafety Concerns in Deployment**

Dr. Goddard and Dr. Su highlighted the importance of considering specifications and meeting standards before deploying enzymes in any context to ensure health and environmental safety is maintained. They emphasized that it could be difficult to predict byproducts when the enzyme is deployed, as different environments vary heavily in their composition and it is difficult to account for all possible ways in which the enzymes may react. They recommended the use of AI tools to help predict the reactions enzymes may have with various environmental conditions.

**Reflection or Next Steps**

Based on the feedback from Dr. Goddard and Dr. Su, the team was inspired to continue reaching out to various stakeholders to receive as much input as possible regarding societal impacts and validation

of the project itself. In future work, the team planned to consider enzyme byproducts and potentially add information about them into PETadex.

## Susy Kamil

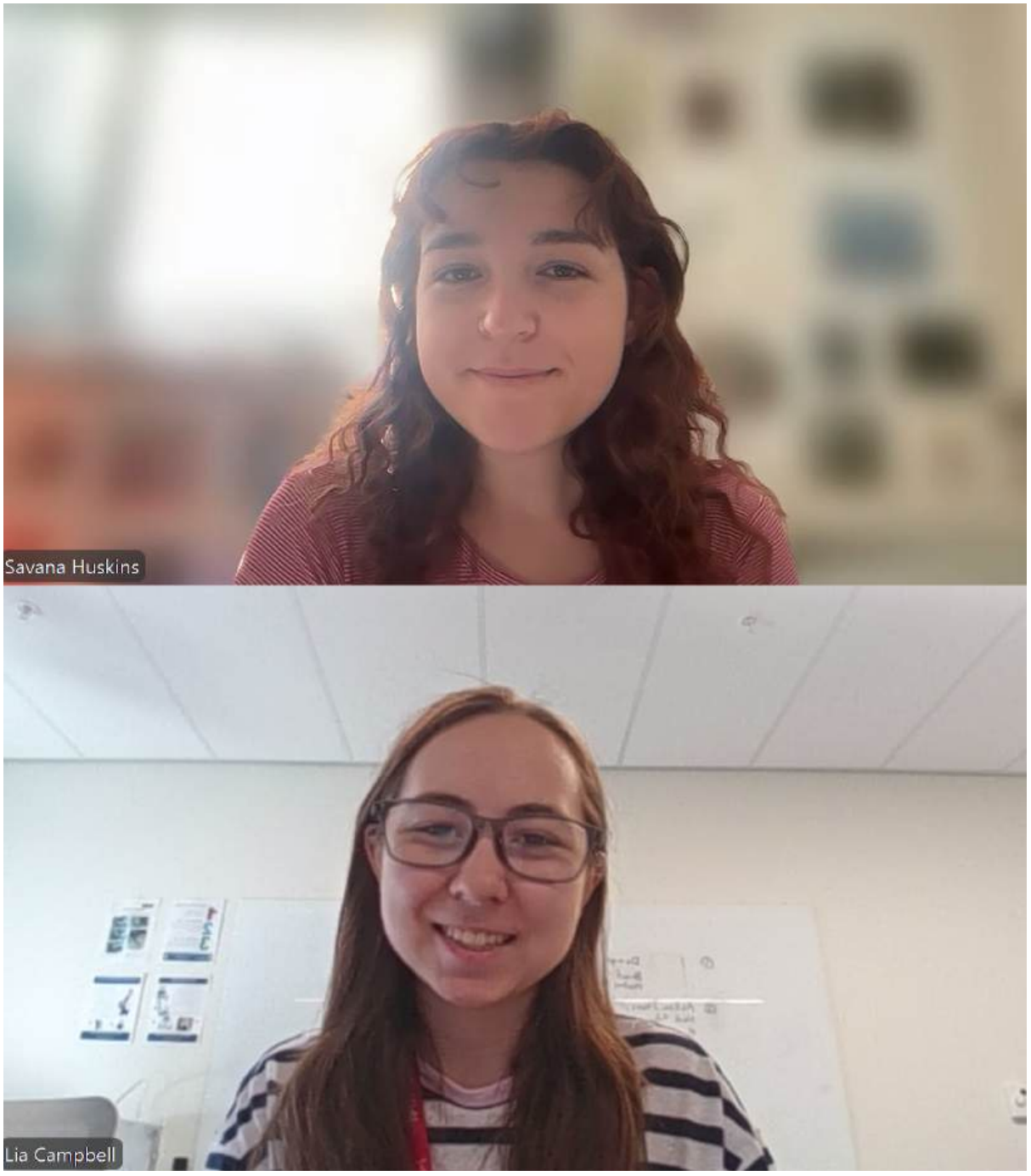



**Bio:**
Ms. Susy Kamil is an expert on Environmental Sustainability & Circular Economy Specialist, with experience in Waste Management. Living in Bali, she brought a global perspective to the discussion and provided insights that helped shape our sustainability report.

**Evaluating the Ecological Impact**
She highlighted the importance of estimating the environmental footprint of the project. This helped inform the sustainability report in which initial calculations of the carbon footprint produced through Wet Lab, Dry Lab, and Hardware were conducted and incorporated into Section Four. Ms. Kamil also recommended that we consider the impacts of this project on water and energy when evaluating the project's sustainability. Based on this feedback, Section Two of the sustainability report was modified to highlight energy considerations and water usage and management.

**Reflection or Next Steps**
Based on Ms. Kamil's feedback, the sustainability report was strengthened by adding empirical assessments of carbon footprint and considerations for energy and water usage. Moving forward, conducting a thorough environmental impact assessment could help formally highlight gaps that were overlooked in our design from a sustainability perspective.

# Savana Huskins




**Bio:**
Savana is a graduate student at Colorado university in the department of Chemical and Biological Engineering with a bachelors of Bioengineering from Stanford University. In 2022, she was part of an iGEM team that developed an optimized reactor for PET Hydrolysis. She conducted literature review, lab experiments, stakeholder outreach, and lectured for their education program. While she gave holistic feedback, her advice focused on our project process and missing considerations.

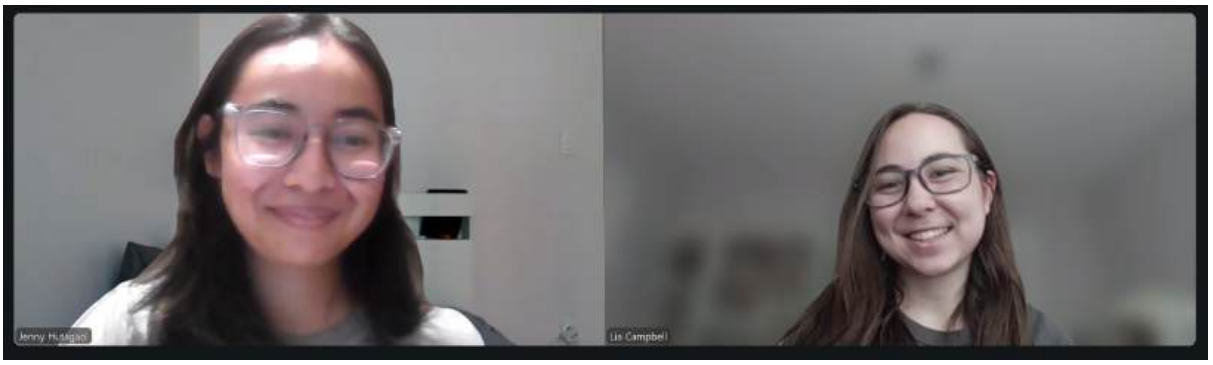
**Importance of Stakeholder Feedback**
Savana recommended that we meet and directly consult individuals who worked at wastewater treatment plants. In the early phases of the project, we had already consulted several such individuals;

however, she emphasized that it was important to continue receiving input from them to ensure that the project remained aligned with stakeholder needs. She also recommended that we reach out not only to professors but also to experts from industry and graduate students to ensure that there was a range of expertise and perspectives throughout every step of the project.

**Anticipating of Barriers to Implementation**
Savana highlighted that PETase byproducts were often toxic and that purified enzymes might not be scalable, making it difficult to directly translate in-lab implementations into real-world applications. She thus recommended that it could be worthwhile to explore how coupled reactions with other enzymes might overcome this issue or to investigate methods of capturing the byproducts and recovering or recycling the captured elements. Furthermore, she raised concerns about potential environmental contamination through the introduction of enzymes into wastewater; she recommended thoroughly experimenting with actual wastewater to ensure that the enzymes were not harmful to the environment before bringing the project to market.

**Reflection or Next Steps**
Through the interview, we were reminded of the importance of continuing to interview and check-in with workers of wastewater treatment plants and relevant experts to ensure our project progress aligns with their needs. Furthermore, we were able to identify potential future next steps, such as exploring the byproducts created through enzymatic degradation and developing corresponding methods to ensure that the enzymes helped rather than harmed the environment.

## Jenny Hutagaol




**Bio:**
Jenny is a Sustainability and Data Analyst at Seven Clean Seas who is an expert about Waste Management and Plastic Reduction. She is an Environmental Engineering Graduate and provided insight into advice for the sustainability report as well as plastic reduction.

**Consideration of Ethical and Societal Impacts**
Jenny highlighted the concern that promoting the use of PETases could encourage consumers to recycle plastic rather than reduce its use or reuse it, due to the perception that plastic is easy to recycle. To address this, she recommended gathering consumer perceptions about plastic usage after learning about PetaBite and determining whether this would lead to more or less sustainable actions among consumers. Furthermore, she emphasized the importance of educating community members when implementing this project; if community members did not understand how PETases degrade plastic, they might perceive enzymes as toxic or dangerous. She emphasized the importance of

educating the community and gathering community perceptions about plastic-degrading enzymes before moving forward with implementation.

**Reflection or Next Steps**
Since there are no one-size-fits-all solutions to plastic waste, Jenny suggested that the team ensure that the impact of varying environmental conditions at each particular wastewater treatment plant or other location of use was explicitly evaluated for each suggested enzyme. Furthermore, she recommended looking into other polymers that were more difficult to degrade; in future iterations, the project could expand to include enzymes that could degrade a range of polymers rather than just PET.

# Dr. Niti Sharma

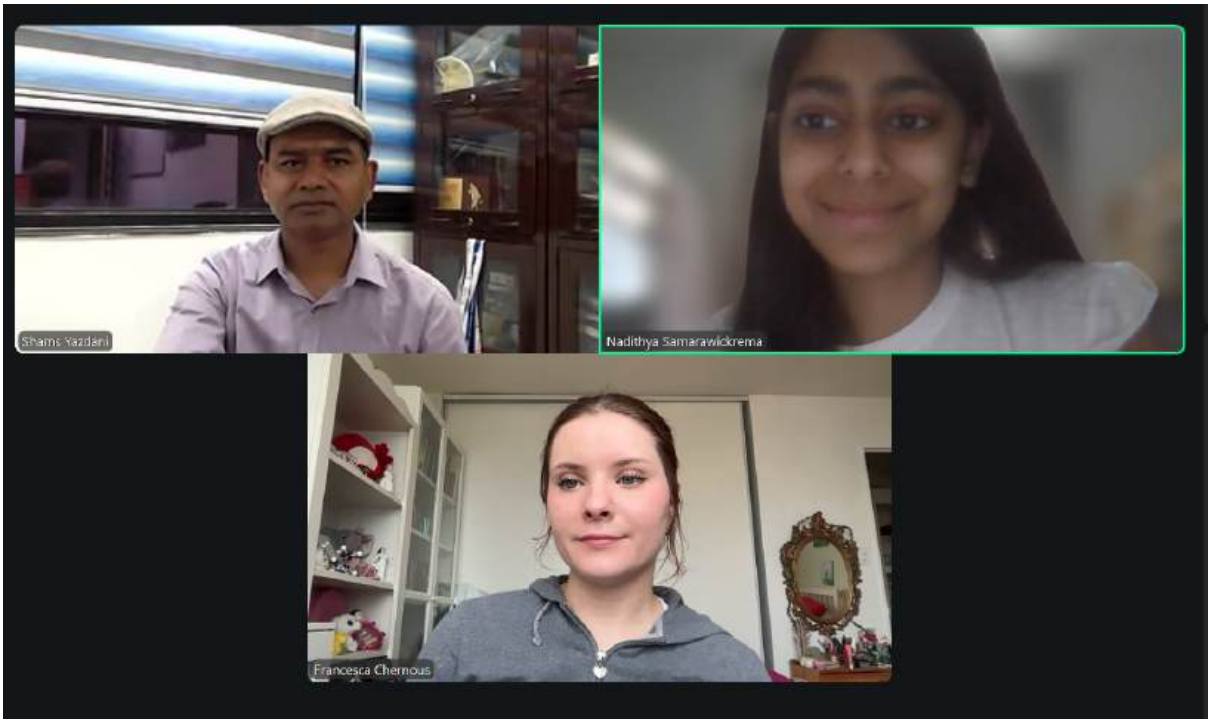
[No picture available - written feedback]
**Bio:**
Dr. Niti Sharma is a researcher specializing in river sediment microbiology and plastic pollution in natural water systems in India. Her field experience spans from environmental characterization of open water bodies to sediment metagenomics and the practical realities of conducting bioremediation research in India. She provided written feedback focused on ecological risk and the regulatory landscape our project would face if deployed in Indian ecosystems.

**Contents of interview:**
Dr. Sharma explained that open water systems are complex environments in which numerous biotic and abiotic factors interact simultaneously and also that baseline knowledge on things like temperature, pH, oxygen levels, sediment and water microbial composition, water level and flow, inlet and outlet sources and the aquatic animals present in the system is essential before any deployment. She raised the concerns about the concentration and dose of biodegrading material as a central question, since an amount effective in the lab may not be effective across a large open water body. She also drove us to consider whether degrading enzymes would themselves affect water quality or shift biotic composition among plankton, benthos and aquatic animals and raised potential biomagnification effects on human health through fish consumption, recommending that a formal ecological risk assessment should be conducted before any deployment. Drawing on her field data, she also told us that PETase activity in river systems was higher in the dry season than the wet season, and that temperature, pH and dissolved oxygen all showed positive relationships with activity, with sites of higher activity corresponding to particular bacterial and fungal species in the river sediment environment.
Furthermore, regarding assay design, she pointed out the difficulty of controlling and accounting for many simultaneously interacting factors at the scale of a real water body. She also talked about regulation and she mentioned that an NOC(No Objection Certificate) from state departments would be required for bioremediation work on a given river or lake and that most lakes and wetlands fall under forest or fisheries and require prior permission. Finally, She mentioned that plastic-degrading enzymes that we deploy would need to interact with sediment parameters and other pollutants such as heavy metals and as a result, filtration systems/mechanisms should be designed to control and contain unintended release of our enzymes with seasonal variation in mind.

**Reflection and Next Steps**
Dr. Sharma's feedback had a strong emphasis on keeping degradation contained. It moved our implementation thinking toward engineered, bounded environments such as wastewater treatment

plants and filtration modules rather than direct release into rivers or sediments, where the number of uncontrolled interacting variables makes safety very hard to establish. Her point that enzymes may alter water quality and propagate through plankton and fish into human diets became part of how we frame biosafety in our project, and we adopted her recommendation into our sustainability report to mention that a formal ecological risk assessment is a prerequisite rather than a later formality. Her regulatory guidance gave us a realistic and first hand account of the permissions a deployment in India would require highlighting that the path to implementation runs through state departments, local communities and prior ecological study as opposed to just technical readiness.

## Dr. Shams Yazdani




**Bio:**
Dr. Shams Yazdani is a senior group leader at the International Centre for Genetic Engineering and Biotechnology (ICGEB) in New Delhi, India, where he leads the Metabolic Engineering and Synthetic Biology Group. His research focuses on high-throughput microbial engineering, metabolic pathway optimization, and bioprocess development for industrial biotechnology.

**Contents of interview:**
Dr. Yazdani first talked about how a team with limited automation could screen an extremely large sequence space. He emphasized that a well-tuned machine learning model accounting for target conditions such as temperature and reactor environment is essential and that the model must be continuously refined rather than trusted to produce a perfect candidate on the first pass. For our assay designs, he advised that the strongest assays link enzyme performance directly to cell growth, which can be read out spectrophotometrically through OD600 measurements. He also mentioned that our GFP-based(Green Fluorescence Protein) assay must quantify fluorescence intensity rather than simply detect presence, which requires an appropriate detector.

He then talked about feasibility, explaining that a wastewater scale process would need to run continuously or semi continuously, with enzymes immobilized on millimetre-scale microporous beads so that only solubilized, enzyme-free material exits the reactor through filtration. He stressed on the importance of the volume of calculation this requires, including residence time of water, enzyme loading per kilogram of plastic per hour, and separate degradation rates across the full range of microplastic sizes, since larger particles need longer residence times. He also raised a few other concerns that we should consider as we develop our project. This included the presence of things like inhibitors, denaturants and detergents that may be present in the deployment environment.
Lastly, he also provided alternative deployment contexts, including ocean beds, spraying over plastic dumps, detergents, drinking water filters and household biodigesters for community level composting. However, he did also mention that expanding into these alternatives while using a live strain rather than an isolated enzyme brings a GMO regulatory framework into play.

**Reflection and Next Steps**
Dr. Yazdani's feedback pushed us to think about implementing a filtration step that would retain plastic until it is degraded and ensure no enzyme leaves in the effluent. His concerns about denaturants and detergents in real wastewater became a criterion in how we prioritize candidate enzymes. His observation that Indian wastewater treatment targets also reframed our implementation thinking in our sustainability report where we talked about how adoption would require making the case for a problem that plants are not currently mandated to address.

## Dr. Aamer Ali Shah



**Bio:**
Dr. Aamer Ali Shah is a Professor in the Department of Microbiology at Quaid-i-Azam University in Islamabad, Pakistan, with over 17 years of research experience. His work focuses on environmental microbiology, the biodegradation of plastics, bioremediation, and the production of industrially significant enzymes. With over 182 publications and more than 13,000 citations, he is one of the most prolific researchers in this field and has collaborated with institutions in Japan, China, Sweden, and the USA. He brings a grounded, field-based perspective to enzyme discovery, isolating plastic-degrading microbes directly from real environments rather than through computational means alone.

**Contents of the interview:**
Dr. Shah explained how his lab confirms plastic degradation using a combination of growth assays on plastic as the sole carbon source, microscopy to confirm biofilm formation, weight loss measurement, and chemical analysis using HPLC, GC-MS, or LC-MS to identify specific breakdown products. On scale-up, he outlined technical challenges including enzyme instability under fluctuating temperature, pH, and salinity, product inhibition from accumulating intermediates, and accessibility issues posed by crystalline versus amorphous plastic. He also raised the economic barrier that downstream purification of PET monomers currently costs more than obtaining virgin polymers from fossil fuels. On ecological impact, he emphasized that life cycle assessment must be conducted before deployment, not after. On regulatory frameworks, he walked us through the Nagoya Protocol, the Cartagena Protocol on Biosafety, NIH guidelines for recombinant DNA in the environment, and the role of Institutional Biosafety Committees and dual use research concern frameworks.

**Reflection and Next Steps:**
The regulatory frameworks Dr. Shah outlined, particularly the Nagoya Protocol and the Cartagena Protocol, provided a concrete starting point for our regulatory report on what governance structures apply to PETadex and any future environmental deployment. His principle that ecological impact assessments must precede deployment was incorporated into how we frame biosafety in our project documentation.

## Dr. Natasha Anwar

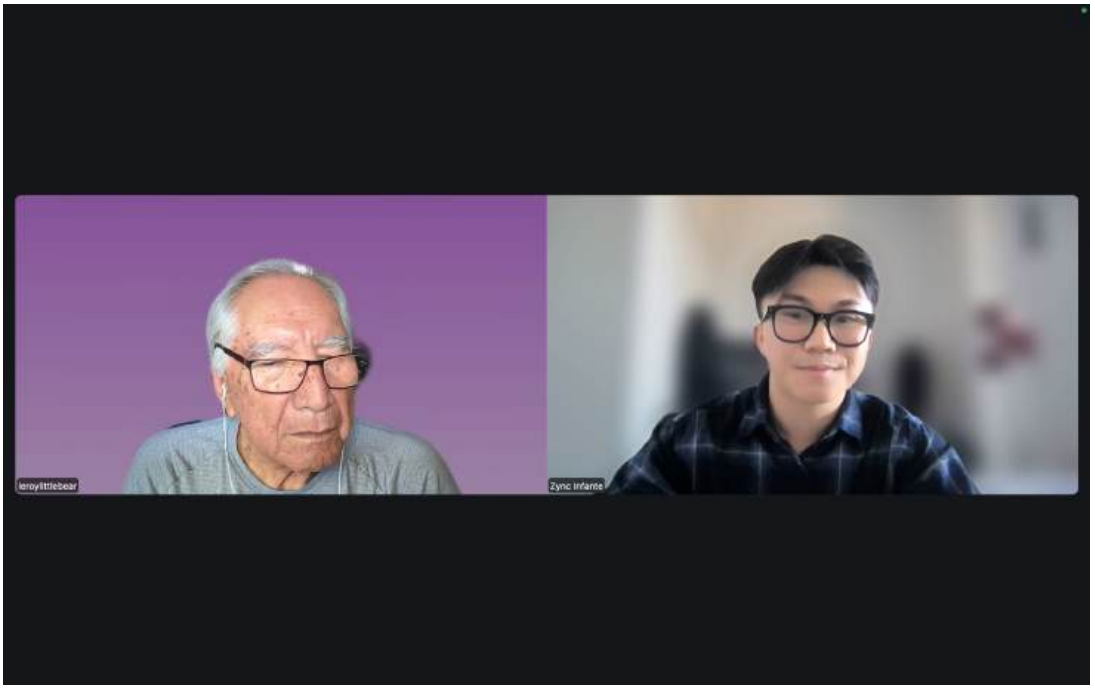


**Bio:**
Dr. Natasha Anwar is a Consultant Molecular Pathologist at Aga Khan University Hospital in Pakistan and Associate Faculty at the Centre of Biomedical Ethics and Culture at SIUT. She has been involved in genetic testing and research in Pakistan for many years and has developed an interest in how ethical standards relate to genomics, with a focus on ensuring they are contextualized based on social, cultural, religious, and economic differences. She was recently elected to Pakistan's National Bioethics Committee for Research and brings a dual perspective as both a working molecular biologist and a bioethicist.

**Contents of the interview:**
Dr. Anwar provided an overview of Pakistan's research ethics landscape, noting that much of the country's biological research falls outside existing regulatory guidelines, with governance focused primarily on clinical trials rather than environmental or synthetic biology applications. She explained that university-level research typically requires only IRB approval, while internationally funded projects fall under the National Bioethics Committee. She challenged us to think beyond whether our technology works to whether it could realistically be implemented, raising questions of affordability and mobility in lower-income settings. On meaningful stakeholder engagement, she emphasized that ethics is most credible when teams document the specific changes they made as a result of stakeholder conversations rather than treating it as a checkbox. On AI-guided predictions, she recommended independently validating a cohort of AI outputs against human-validated results before trusting the broader dataset.

**Reflection and Next Steps:**
Dr. Anwar's challenge to document specific changes made as a result of stakeholder conversations directly influenced how we structure our human practices documentation. Her regulatory overview of Pakistan's IRB and National Bioethics Committee structure provided our team with a realistic account of the approval pathway any deployment in Pakistan would require. She also offered to remain in contact and assist with our ethics report, establishing an ongoing resource for the team.

# Dr. Leroy Little Bear



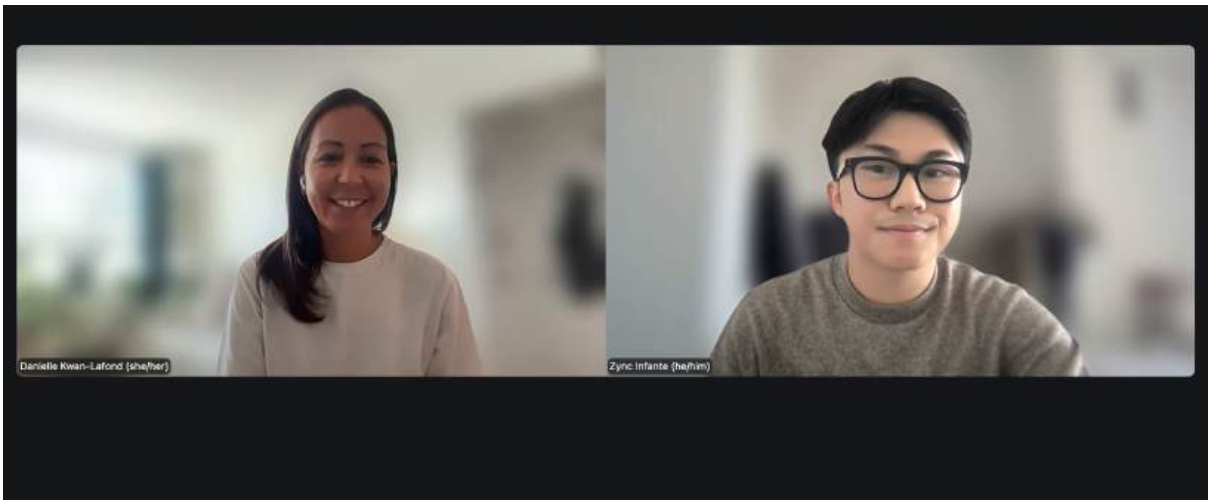

**Their role:**
Dr. Leroy Little Bear is one of Canada's most influential Indigenous scholars and legal thinkers. He helped secure the inclusion of Indigenous rights in Section 35 of the Canadian Constitution, contributed to the early development of the United Nations Declaration on the Rights of Indigenous Peoples, and founded Canada's first Native American Studies Department at the University of Lethbridge.

**Contents of the interview:**
Dr. Little Bear discussed plastic pollution through an Indigenous worldview centered on balance, relationships, and responsibility. He explained that many environmental challenges arise when human activities disrupt the natural relationships that sustain ecosystems. The conversation explored differences and commonalities between Indigenous and Western scientific perspectives, particularly in how they approach environmental stewardship and problem solving. Dr. Little Bear emphasized that successful environmental solutions should not only address immediate problems but also contribute to restoring long-term ecological balance. He also highlighted the importance of considering future generations when evaluating the impact and sustainability of technological innovations.

**How the interview shaped our project:**
The interview helped us frame plastic degradation as part of a broader effort to restore balance within ecosystems rather than simply removing waste from the environment. Dr. Little Bear's emphasis on interconnectedness encouraged us to think more critically about how our technology could affect communities, ecosystems, and future generations. His insights reinforced the importance of evaluating

our project's ethical and societal implications alongside its technical performance. The discussion also encouraged us to continue integrating Indigenous perspectives into our human practices work and decision-making processes. Overall, the interview strengthened our commitment to developing a solution that is both scientifically effective and socially responsible.

## Dr. Danielle Kwan-Lafond




**Their role:**
Dr. Danielle Kwan-Lafond is an Assistant Professor at the University of Toronto Scarborough and founder of the UTSC Indigenous Garden. Her work focuses on Indigenous knowledge systems, environmental stewardship, community engagement, and decolonized education. [thecanadia...lopedia.ca]

**Contents of the interview:**
Dr. Kwan-Lafond discussed Indigenous perspectives on environmental stewardship and the interconnected relationships between people, land, water, and all living systems. She emphasized that Indigenous knowledge should be recognized as a form of science developed through generations of observation, experimentation, and interaction with the environment. We also discussed the importance of transparency and meaningful engagement with communities affected by environmental research. Dr. Kwan-Lafond highlighted the value of understanding the history, cultural significance, and governance of the lands where scientific work takes place. She explained that local and Indigenous knowledge can complement scientific approaches and provide context that may not be captured through conventional data alone.

**How the interview shaped our project:**
This interview encouraged us to think about plastic pollution not only as a technical challenge but also as an issue that affects relationships between people and the environment. Her perspective reinforced

the importance of transparency and stakeholder engagement when considering future applications of our PET-degrading technology. We were also encouraged to view Indigenous knowledge as a valuable source of environmental expertise that can complement scientific research. As a result, we placed greater emphasis on understanding the broader social and environmental impacts of our work. The interview ultimately helped us develop a more holistic approach to environmental responsibility and project implementation.

## Prof. D. Grant Allen



**Their role:**

Prof. D. Grant Allen is a Professor in the Department of Chemical Engineering and Applied Chemistry at the University of Toronto, the Frank Dottori Chair in Pulp and Paper Engineering, and a core Principal Investigator at BioZone, the Centre for Applied Bioscience and Bioengineering. His research centres on bioprocess engineering, with decades of hands-on experience in biological wastewater treatment, biofiltration, and anaerobic digestion of industrial and municipal waste. Much of that work developed in close partnership with the pulp and paper industry, which carries an environmental compliance burden comparable to what PetaScale will face deploying a novel enzyme into WWTPs. He has also advised government on research tax credit claims and has experience translating bioprocess research into implemented, regulator-approved systems. We approached him because he has taken biological treatment technologies through implementation at industrial and municipal scale in Canada, so he can speak firsthand to how the CEPA and New Substances Notification process, provincial permitting under the Ontario Water Resources Act, Environmental Compliance Approvals, and biosolids land-application rules play out for a facility operator rather than how they read on paper.

**Contents of the interview:**

We asked Prof. Allen where in a treatment train an enzyme-based microplastic reduction technology would realistically be deployed, and whether any solids or sidestream processes offered a stronger fit.

He began with the central difficulty. Municipal wastewater is highly diluted and carries competing organics, colloids and solids that bind to PET and hinder enzyme activity, which makes cost-effectiveness our primary challenge. He expected that any workable deployment would require immobilizing the enzyme on a support to prevent washout.

He then identified several integration points. The secondary clarifier stood out, since PET accumulates in sludge there and residence times are longer. He also raised dosing into the bioreactor or the return activated sludge line, where higher solids concentrations may help retain the enzyme. Each option needs experimental validation on three questions: whether the enzyme binds to sludge, whether its hydrophobicity increases retention, and what its half-life is under wastewater conditions.

Prof. Allen was candid that WWTP deployment will be difficult while remaining achievable. He advised that demonstrating the WWTP use case successfully would give us a commercial foundation, and that we should secure IP before publishing, since these findings would break new ground in the enzyme field.

He also noted that industrial applications would require continuous dosing. Given the dilution constraints in municipal systems, he recommended prioritizing PET-rich industrial wastewater streams and landfill leachate, where microplastic concentrations are far higher and flow volumes lower, which makes enzyme treatment more feasible and cost-effective.

**How the interview shaped our project:**

Prof. Allen's recommendations converged with Rasha Maal-Bared's independently, which gave us confidence in sidestream and solids-phase deployment rather than treating the main water stream. We now design around immobilized enzyme on a support, which also addresses the containment question regulators raise. His three validation questions became explicit test criteria for our bioreactor array: sludge binding, hydrophobicity-driven retention, and enzyme half-life under realistic wastewater conditions. His point about dilution also strengthened our case for the textile effluent and landfill leachate verticals, where concentration works in our favour. Finally, his advice on sequencing IP before publication reinforced the PetaBite and PetaScale separation in our timeline, with the provisional patent filed around manuscript submission.

# Dr. Azizur Rahman



**Their role:**

Dr. Azizur Rahman works with the Canadian Centre for Climate Change Research (CCCR), where his group develops ocean-derived biomaterials, including chitin, chitosan and collagen, as feedstocks for biodegradable plastics that can substitute for conventional polymers. His work sits on the production side of the plastics problem, developing materials designed to break down rather than persist, which places him at the opposite end of the plastics life cycle from PetaScale.

**Contents of the interview:**

We met on June 7, 2026 to understand how our degradation work might connect to materials development. Dr. Rahman described CCCR's approach to replacing conventional polymers with marine-derived biomaterials, and the constraints that come with sourcing and processing those inputs at scale.

The most consequential part of the conversation concerned what happens to PET after our enzymes act on it. Enzymatic degradation of PET yields terephthalic acid and ethylene glycol, and Dr. Rahman suggested that these recovered monomers could serve as feedstock for upcycling work rather than being treated as waste products. That reframing connects remediation to materials production directly: the output of our process becomes an input to someone else's.

**How the interview shaped our project:**

This conversation gave concrete shape to Phase 3 of our long-term roadmap, which moves PetaScale from remediation toward circular materials. Before this meeting, upcycling was a direction rather than a pathway. Dr. Rahman identified the specific handoff point, namely recovered TPA and EG, and a category of partner who would want them. It also changed how we think about the economics of our

verticals, since monomer recovery adds a potential revenue stream alongside treatment fees in streams concentrated enough to make recovery worthwhile. We now view textile effluent and landfill leachate as candidates for recovery as well as degradation, and we treat relationships with biomaterials researchers as part of our longer-term partnership strategy.

## Chad Clendenning

**Their role:**

Chad Clendenning operates the Grand Falls-Windsor wastewater treatment plant in Newfoundland and Labrador. The facility is a lagoon-based system upgraded in 2020, and it discharges into a salmon river, which places it in one of the tightest regulatory environments in Canada. Wastewater enters a headworks building, passes through 6 mm step screens, a compressor and bagging system, and a vortex unit for grit removal. Three large blowers provide aeration, and UV treatment disinfects the final effluent before discharge. As a plant operator rather than a consulting engineer, Chad represents exactly the decision-maker our Selling and Customer Relationships section identifies: the person responsible day-to-day for keeping effluent within permit limits.

**Contents of the interview:**

Chad asked first how the technology works. We explained our machine learning-guided enzyme discovery pipeline and the PET-specific degradation mechanism, and he confirmed the key distinction, that our enzymes break PET into monomers rather than fragmenting it into smaller microplastics.

He then raised practical deployment questions. He asked where enzymes would be introduced, comparing the lagoon itself against a pre-lagoon tank, and he flagged the environmental conditions his plant actually runs under. Lagoon temperatures swing seasonally from roughly 5 °C to 40 °C, while pH remains relatively stable. He was direct that operators would need case studies and evidence demonstrating both effectiveness and safe coexistence with the existing microbial communities their treatment depends on.

On market fit, Chad saw a role for the technology in both wastewater and drinking water treatment. He noted rising concern about microplastics and nanoplastics in source waters, and pointed out that many cities draw drinking water from rivers receiving upstream wastewater discharge, so treatment at both ends would offer what he called double protection.

On regulation, he observed that the United States already has microplastic tolerance regulations for source waters, while Canada currently issues guidance numbers rather than enforceable limits. He expects Canadian regulation to follow.

**How the interview shaped our project:**

Chad's temperature range gave us a concrete design specification rather than an assumption. A 5 °C to 40 °C seasonal swing is wider than the ambient conditions we had been targeting, and it now defines the operating envelope our enzyme candidates must handle for lagoon-based plants. His requirement for evidence of safe coexistence with existing microbial communities added a test to our validation plan that no advisor had raised, since our earlier work focused on PET degradation rather than effects on the biology a plant already depends on. His observation about drinking water drawn downstream of wastewater discharge also widened how we frame the value of our technology, connecting effluent treatment to source water protection. Finally, his read on Canadian regulation, that guidance will become enforceable, supports the timing argument in our Problem Statement, and it comes from an operator who would be subject to those rules rather than from a policy analyst.

## Dr. Ryan Prosser



**Their role:**

Dr. Ryan Prosser, Associate Professor, School of Environmental Sciences, University of Guelph. His research group studies microplastics in biosolid-amended agricultural soils and their impact on soil organisms. He directly studies the biosolids-and-land-application side of our thesis: whether microplastics in biosolids are a problem, and whether reducing them would matter. He has also worked closely with WWTP operators.

**Contents of the interview:**

Overall, Prosser was strongly positive about our approach and felt that it validates the biosolids side of our thesis. He identified wastewater treatment plants (WWTPs) as a strong starting point and considered the overall concept technically sound. Importantly, he suggested that targeting microplastics in the water (influent), rather than directly in the biosolids, is the more practical approach. Attempting to break down microplastics within biosolids is complicated by the high concentration of organic matter, whereas treating them while they are still present in the water would avoid many of these challenges.

He also viewed the value proposition as legitimate, although he emphasized that the current motivation for microplastic removal is driven more by public perception and precaution than by demonstrated environmental harm. At environmentally relevant concentrations, microplastics in biosolids-amended soils do not currently appear to reach levels that cause measurable harm to soil organisms. However, he considered the public and reputational pressure surrounding microplastics to be a meaningful driver for municipalities rather than a weakness in the value proposition. In his view, adoption is therefore plausible if the treatment can be implemented at a reasonable cost, particularly because wastewater treatment operators are already highly aware of and concerned about microplastic contamination. He also noted that regulation could become an additional driver, as regulatory attention has historically progressed from nutrients and metals to emerging contaminants such as PFAS, with microplastics potentially being the next area of focus.

From a technical perspective, Prosser did not consider the expected breakdown products to be a major concern. Terephthalic acid (TPA), for example, would likely be present at extremely low concentrations and would ultimately mineralize in soil. The more important risk is incomplete degradation, particularly the possibility of fragmenting larger microplastics into nanoplastics rather than fully degrading the material. Finally, the primary adoption gatekeeper will be demonstrating that the treatment does not interfere with the existing wastewater treatment process. In particular, operators will need confidence that the approach will not negatively affect the microbial communities responsible for secondary treatment, as maintaining the performance and stability of these biological processes is critical to WWTP operations.

**How the interview shaped our project:**

The interview with Dr. Ryan Prosser helped refine both our value proposition and our commercialization strategy. His feedback reinforced our belief that wastewater treatment plants are a strong initial market for PetaScale, as municipalities already have a growing awareness of microplastic contamination and may be motivated to reduce it through public and environmental pressure. At the same time, the discussion helped us refine how we communicate the problem: rather than claiming that microplastics in biosolids-amended soils are definitively causing ecological harm at current environmental concentrations, we should frame their presence as an emerging environmental

concern that warrants precautionary removal. This allows us to communicate the importance of addressing microplastics without overstating the existing evidence.

Additionally, Dr. Prosser identified compatibility with existing wastewater treatment processes as a critical adoption barrier, particularly the need to demonstrate that PetaScale does not negatively affect the microbial communities responsible for secondary treatment. This helped us identify an important area for future validation and shifted our feasibility assessment beyond simply demonstrating PET degradation toward demonstrating that degradation can occur safely within the broader WWTP environment. Finally, his comments on the potential for future microplastic regulation strengthened our view that, while public perception is currently a major adoption driver, regulatory pressure could provide an additional long-term incentive for municipalities to adopt microplastic removal technologies.

## Dr. Aaron Yip



**Their role:**

Aaron Yip, PhD (Chemical Engineering, University of Waterloo; now Postdoctoral Associate, Duke University). Lead author on *"Degradation of PET plastics by wastewater bacteria engineered via conjugation"* (Microbial Biotechnology, 2024). His PhD work is the closest existing analogue to our wastewater application — engineering wastewater bacteria to express a PET-degrading enzyme (FAST-PETase), with the long-term goal of degrading microplastics in wastewater treatment plants (WWTPs).

**Contents of the interview:**

Dr. Yip highlighted that wastewater is a plausible but technically challenging environment for PetaScale deployment. While demonstrating enzyme activity in a controlled laboratory setting is relatively straightforward, translating this activity into a real wastewater treatment environment presents substantially greater challenges. The complex composition of wastewater can inhibit enzyme

activity through factors such as unidentified compounds produced by microorganisms, pH effects, and potential self-inhibition at high enzyme concentrations. In addition, wastewater treatment occurs at a large scale and typically at ambient temperatures, with water passing through a treatment plant in approximately one day. Since temperatures around 20–30°C can limit enzymatic kinetics and heating or cooling such large volumes of water is not economically realistic, the enzyme would need to maintain sufficiently high activity under naturally occurring conditions. Delivering enough enzyme throughout such a large volume of water therefore represents a significant unresolved feasibility challenge.

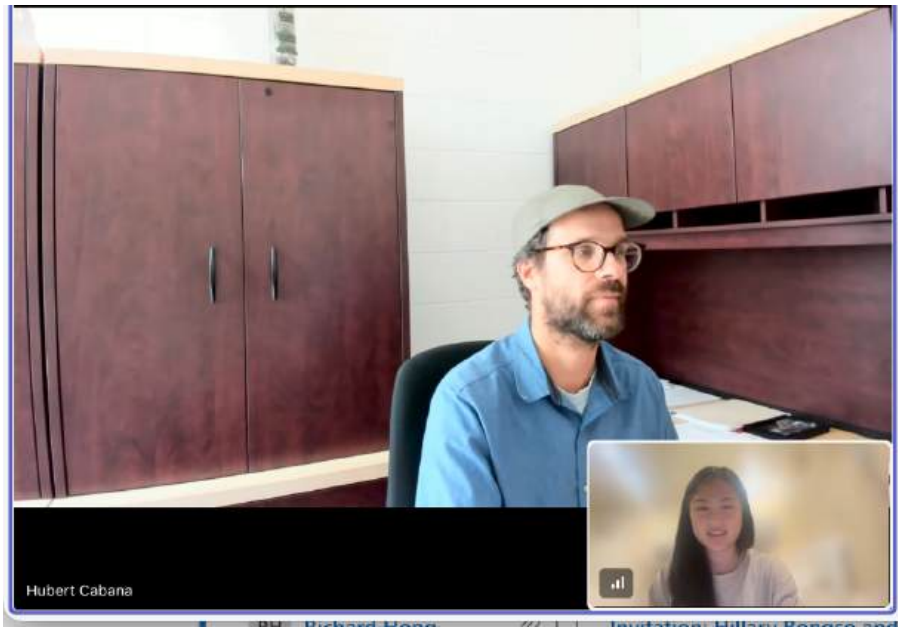
Dr. Yip also identified several considerations for experimental validation. Initial testing could use purified enzymes in sterilized greywater to isolate the effects of the wastewater environment on enzyme activity before introducing the additional complexity of microbial communities. Although major disruption of the wastewater microbiome is not necessarily expected, Dr. Yip noted that there is limited research examining how introducing an exogenous enzyme could affect microbial communities. Finally, Dr. Yip suggested recycling-facility wash water as a potential alternative application because these streams can contain higher and more consistent concentrations of plastic while requiring treatment of a smaller volume of water. This could represent a promising future application of PetaScale beyond municipal wastewater treatment.

**How the interview shaped our project:**

The interview with Dr. Yip reinforced the importance of treating municipal wastewater as a challenging but realistic deployment environment rather than assuming that successful laboratory degradation will directly translate to a full-scale treatment plant. This prompted us to place greater emphasis on validating enzyme performance under increasingly realistic wastewater conditions, particularly with respect to temperature, potential inhibitors, enzyme concentration, and interactions with the existing microbial community. The recommendation to begin with purified enzyme in sterilized greywater also helped inform a more controlled experimental progression, allowing us to isolate the effects of the wastewater environment before introducing additional biological complexity.

Importantly, the interview did not change our decision to pursue wastewater treatment plants as our initial beachhead. Instead, it helped us better understand the technical barriers that must be addressed for this application to be feasible. Dr. Yip's suggestion to explore recycling-facility wash water also expanded our view of PetaScale's longer-term commercialization potential. While this is not our current target market, the higher concentration of plastic and more consistent composition of recycling-facility wash water could make it an attractive future vertical once the technology has been validated in wastewater treatment. Overall, the interview helped us distinguish between our immediate beachhead and potential future applications, while highlighting the environmental and operational conditions that our enzyme platform will ultimately need to withstand.

# Prof. Hubert Cabana




**Their role:**

Prof. Hubert Cabana is a Professor of Environmental Engineering at the Université de Sherbrooke, with a PhD in Biological and Environmental Engineering from the Université catholique de Louvain. His research focuses on environmental biotechnology, particularly fungal and enzymatic processes for removing contaminants such as pharmaceuticals from wastewater. Over the past decade, he has developed reusable immobilized enzyme biocatalysts and bioreactors, and published a techno-economic analysis of laccase production for hospital wastewater treatment. We approached him because his work offers one of the closest Canadian precedents for applying enzymes to real wastewater, giving him valuable insight into deployment, cost, and regulation.

**Contents of the interview:**

Prof. Cabana began by highlighting a critical concern: degrading PET does not necessarily make it safer. As PET breaks down, its products become more soluble and bioavailable, allowing microbes to use them as an energy source but potentially making partially degraded fragments more toxic than the original plastic. He stressed the importance of assessing toxicity across the entire system.

He identified lack of demand, rather than technology, as the biggest barrier to adoption. Since microplastics are not currently regulated, WWTPs have little incentive to pay for additional treatment, especially when costs are measured per cubic metre. Biosolids regulations remain limited, largely addressing odour and toxicity, while Quebec's rules focus on larger plastic debris. He explained that Canadian environmental standards are largely adopted at the provincial level, with provinces deciding whether to implement standards

proposed by the Canadian Council of Ministers of the Environment. He considered Canada's framework more relaxed than those of the EU or US. His own enzymatic research never entered the CEPA process because it remained at research scale, and he noted that enzymatic treatment is generally more expensive than conventional methods.

On technical feasibility, he pointed out that his enzymes targeted soluble contaminants in flowing water, whereas PET in sludge is insoluble and surrounded by organic matter and bacteria that restrict enzyme contact. He expected findings from one wastewater source to be broadly transferable across plants, with enzyme stability under different pH, temperatures, and competing enzymes being the more important challenge. He also suggested exploring drinking water treatment and concentrated floating plastic accumulations as alternative applications.

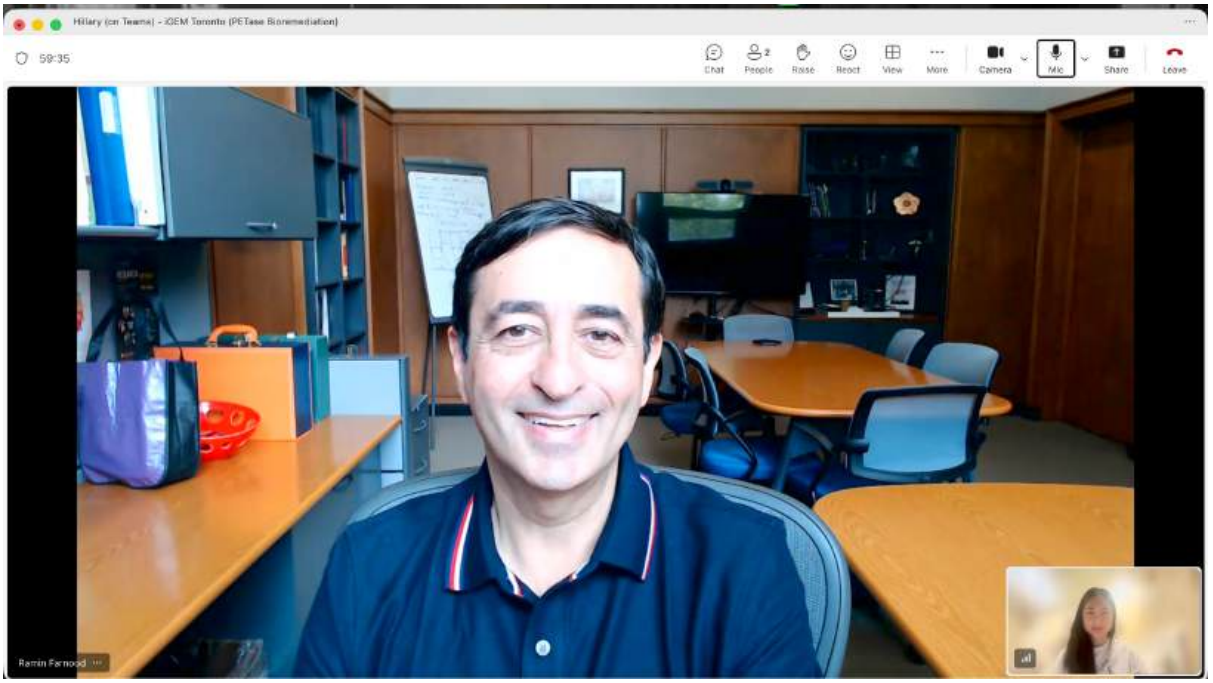
**How the interview shaped our project:**

Prof. Cabana's insights pushed us to look beyond whether our enzymes can degrade PET and consider whether the resulting products are actually safe. We began clarifying whether our target should be full depolymerization into TPA and EG or a defined intermediate threshold, along with how to establish its safety.

His emphasis on the demand gap also reshaped our commercialization approach. We recognized that technical performance alone would not convince WWTPs to adopt the technology, making cost per cubic metre a key consideration and future regulation a potential driver rather than an existing incentive.

Technically, his feedback identified enzyme-substrate contact in sludge as a major risk and reinforced the importance of testing enzyme stability across varying pH, temperatures, and competing enzymes. Finally, his suggestion of drinking water treatment, later independently echoed by Chad Clendenning, strengthened our interest in source water protection as a secondary market.

# Prof. Ramin Farnood




**Their role:**

Prof. Ramin Farnood is Professor and Chair of the Department of Chemical Engineering and Applied Chemistry at the University of Toronto. His research focuses on advanced water treatment technologies, including membrane separation, UV disinfection, and advanced oxidation, to remove chemical and microbial pollutants for water reuse. His recent work explores emerging contaminants in industrial wastewater and sludge, including from steel mills and petrochemical refineries. He has also collaborated with Ontario's Ministry of the Environment on projects such as nutrient discharge into Hamilton Harbour. We approached him for his process engineering expertise and insight into how enzymatic treatment could realistically fit into existing WWTP infrastructure and budgets.

**Contents of the interview:**

Prof. Farnood emphasized that deploying enzymes requires careful reactor engineering, not just effective biology. Since enzymes generally act more slowly than chemical reactions, he recommended calculating the residence time and reactor volume needed to achieve meaningful PET degradation at a given flow rate. While secondary clarifiers are common across municipal WWTPs, their existing residence times may not be sufficient. He also stressed testing enzymes across typical seasonal wastewater temperatures (10–25 °C) and challenging operating conditions, including heavy rainfall, high flow rates, and pH fluctuations.

He highlighted another limitation: during heavy rainfall, some wastewater bypasses treatment entirely. In his Hamilton research, these bypass events accounted for roughly half of total nutrient loading, meaning an in-plant solution would primarily address wastewater processed under normal operating conditions.

He also questioned whether targeting PET alone would deliver enough value, given that PET represents only a fraction of the microplastics present in wastewater. From an economic perspective, he explained that municipal WWTPs operate as cost centres and generally prioritize regulated contaminants. Treatment may be easier to justify when the resulting water has economic value, such as for irrigation. He also noted Ontario's emerging interest in microplastics, particularly in drinking water.

As an alternative, he suggested converting PET into monomers or oligomers for upcycling, potentially creating a revenue stream. However, this would require a concentrated PET waste stream rather than mixed municipal wastewater. His central message was that financial sustainability is essential for adoption, whether through regulatory requirements or economic incentives.

**How the interview shaped our project:**

Prof. Farnood's feedback helped us translate enzyme performance into practical engineering requirements. We began treating residence time and reactor volume as critical design considerations, evaluating enzyme kinetics against available contact time at potential deployment points, including secondary clarifiers previously suggested by Prof. Allen.

His recommendations also expanded our validation priorities to include seasonal temperatures, pH fluctuations, and high-flow conditions. His discussion of bypass events helped us define our treatment scope more realistically, focusing on wastewater processed during normal operations rather than untreated extreme-weather discharges.

His concern regarding PET's proportion of total microplastics pushed us to strengthen the justification for a PET-specific solution. Finally, his emphasis on financial viability encouraged us to explore PET upcycling and monomer recovery as potential revenue opportunities alongside wastewater treatment, an approach later reinforced by Dr. Azizur Rahman.

# Dr. Purnananda Guptasarma



**Their Role:**

Dr. Purnananda Guptasarma is a structural biologist and protein engineer at IISER Mohali, specializing in protein folding, stability, and function. His research includes engineering thermostable PET-degrading enzymes to improve plastic degradation efficiency and support closed-loop recycling.

**Contents of the Interview:**

Our interview with Dr. Guptasarma focused on the challenges of developing PET-degrading enzymes for real-world applications. He explained that conventional PETases have limited catalytic efficiency and recommended exploring alternative enzymes, such as cutinases, and synergistic enzyme systems. He highlighted the difficulties of degrading microplastics directly in wastewater, particularly due to large treatment volumes, limited enzyme–substrate interactions, and challenges with enzyme production at scale. Regarding our Wet Lab screening methods, he emphasized that detecting enzyme activity does not necessarily indicate degradation efficiency, as differences in enzyme expression can influence results. He also raised concerns about relying heavily on AI for enzyme discovery, given the limited experimental data available to reliably predict enzyme performance.

**How the Interview Shaped Our Project:**

Dr. Guptasarma's feedback encouraged us to reconsider the feasibility of large-scale wastewater applications and focus on establishing realistic goals for our Wet Lab experiments. His insights reinforced the importance of evaluating enzyme stability, catalytic efficiency, and scalability alongside degradation activity. For PETadex, his concerns about AI predictions highlighted the need to clearly communicate the limitations of computational screening and emphasize experimental validation rather than presenting predicted candidates as definitively superior. Overall, his feedback helped us adopt a more critical approach to evaluating our project's feasibility and communicating its limitations.

# Karen Wirsig



**Their Role:**

Karen Wirsig is an environmental advocate with Environmental Defence Canada, an organization focused on protecting human health and the environment through policy advocacy and public

engagement. Her work addresses plastic pollution, emphasizing pollution prevention, corporate accountability, and stronger environmental regulations.

**Contents of the Interview:**

Our interview with Karen focused on the environmental, ethical, and regulatory considerations surrounding plastic-degrading technologies. She emphasized that preventing plastic pollution should remain the priority, as removing microplastics once they enter the environment is extremely difficult. She raised concerns about unintended environmental consequences, particularly whether enzyme-based degradation could release harmful byproducts or interact unpredictably with plastic additives. She also highlighted the economic challenges of implementing these technologies at scale and the lack of clear regulatory standards for microplastics in water. She suggested exploring more targeted applications, such as wastewater and drinking water treatment facilities, where interventions may be more practical. Additionally, she encouraged engagement with municipalities and communities affected by plastic pollution to better understand their needs.

**How the Interview Shaped Our Project:**

Karen's feedback encouraged us to consider the broader environmental impacts of enzymatic plastic degradation, particularly the importance of evaluating breakdown products and potential unintended consequences. Her recommendations reinforced the need to identify realistic applications rather than presenting enzyme-based cleanup as a complete solution to plastic pollution. She also encouraged us to explore wastewater and drinking water treatment as potential intervention points and engage with municipalities and affected communities to understand practical challenges. Overall, her insights helped us approach PETadex with a stronger emphasis on environmental safety, feasibility, and responsible implementation.