

Advancing Entrepreneurship and Start-up Initiatives for Sustainable Chemistry: Learning from Case Studies

Organized by UN Environment and the International Sustainable Chemistry Collaborative Center (ISC₃) / Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), in partnership with the United Nations Industrial Development Organization (UNIDO), the German Chemical Society, the Freie Universität Berlin and the United Nations Institute for Training and Research (UNITAR)

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Compilation of Case Studies

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1. Carlos Ocampo Lopez, Universidad Pontificia Bolivariana: Lessons Learned in Green Chemistry from Applied Research in Biotechnology

Name:	Carlos Ocampo-López, Margarita Ramírez-Carmona, Leidy Rendón-Castrillón and Yesid Vélez-Salazar
Organization/institution/company:	Universidad Pontificia Bolivariana (Colombia) Center of Studies and Research in Biotechnology – CIBIOT
Title of the case study:	LESSONS LEARNED IN GREEN CHEMISTRY FROM APPLIED RESEARCH IN BIOTECHNOLOGY
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>The initiative comprises a strategy for the creation of green chemistry projects in the Faculty of Chemical Engineering at Universidad Pontificia Bolivariana (UPB), all of them in the context of biotechnology as approach to integrate curriculum, applied research and market.</p> <p>This initiative contributes to green chemistry because it builds capacities for applied research and technology transfer as a response to the pressing problems facing communities in rural and urban areas of countries such as Colombia.</p> <p>As a result, they were obtained new projects with technical novelty, market oriented, scalable and including Social Innovation, which represent a source for new business.</p> <p>Trough the Center of Studies and Research in Biotechnology (CIBIOT), three significant courses of chemical engineering where impacted in the form of a pathway in the curriculum, as follows:</p> <p>-Product Design (Semester I): It provides capabilities for Ideation, value proposition creation and market discovery according to reality of communities.</p> <p>-Organic Chemistry (Semester III-IV): a couple of courses in which students learn about chemical or biochemical alternatives and experimentation by focusing in the environmental implication of industrial activity.</p> <p>-Process Design (Semester IX): finally students learn Process Synthesis, Scale Up and Economic Evaluation, according to real constraints coming from the market.</p> <p>Through this strategy, new generations of chemical engineers are being capable of appropriate green chemistry gradually and develop better research and technologies.</p> <p>As an example, we present the four major projects in green chemistry from CIBIOT, demonstrating how biotechnology could be scalable from lab to market:</p> <ol style="list-style-type: none"> 1. Production of organic molecules from agro-residues by biotransformation (Patented, created for Colombian farmers). 2. Wastewater treatment by using alga (Pilot plant was designed, built and then transferred to EPM company in Colombia) 3. Gold extraction by biological processes (Financed by Government of Colombia to avoid the use of mercury by artisanal miners, pilot plant was built and 2 patent applications are in process, it comprises a plan for social innovation)

	<p>4. Simultaneous collection and biotrating of used batteries: Biological research to innovate in bioremediation of hazardous residues (Pending patent).</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>Green chemistry begins working with communities being aware of market pains and human relationship. This is the key to succeed during the technology implementation and transfer with companies.</p> <p>Social innovation is the key factor to assure technology appropriation and business creation; normally projects begin in the lab and then are aligned to the market. Communities are resistant to change if they are not involved in the process from the beginning.</p> <p>Project Based Learning improves capabilities to generate value propositions in green chemistry. By doing so, the integration of students to project formulation creates new generations of researchers with potential for technology transfer.</p> <p>Green chemistry could be incorporated gradually to core curriculum as a learning process, not in the form of a single cathedra. It creates better professionals and enhances applied research.</p> <p>Young researchers being educated in biotechnology and technology commercialization represent a potential investment for future entrepreneurship in green chemistry.</p> <p>The main challenge we face in academia is the investment for technology development in green chemistry, especially in the context of biotechnology, because people believe that these results are not profitable or even scalable to industrial size. However, we propose in this workshop a new way to integrate the academia, and communities in order to strengthen green productivity in the region.</p>

2. Prashanth W. Menezes, Technical University of Berlin: Development of a Cost-effective, Earth-abundant and Non-toxic Photocatalyst

Name:	Dr. Prashanth W. Menezes
Organization/institution/company:	Technical University of Berlin
Title of the case study:	Development of a cost-effective, earth-abundant and non-toxic photocatalyst
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<ul style="list-style-type: none"> • We present for the first time, a photocatalyst that ‘completely’ decomposes soluble water contaminants into non-toxic molecules, either in solution or as liberated gas using visible light or sun light. This in-expensive photocatalyst can easily be synthesized and up-scaled from a facile approach involving earth-abundant metals and applied in the process of treatment with substantially low-energy consumption. Hence, this low-cost solar energy driven catalytic step could directly be introduced in the chemical cycling process of waste water treatment and the quality of the water greatly enhanced to be readily used for various purposes. Currently, we have tested and optimized our product in laboratory conditions, and it decomposes most if not all of the bacteria, pharmaceutical wastes, antibiotics, biomolecules, cyanides, carcinogens, biomolecules, organic solvents, natural and synthetic dyes, N-heterocycles, silicon waste and most remarkably, even degrades plastics under solar light irradiation. In the first stages, we plan to introduce this product within Germany subsequently extending the concept to other countries in Europe and in the world where sun light is plentiful. In this regard, we have already applied for a patent and currently wait for final confirmation. • Chemical and biological wastes, especially from health-care and pharmaceutical industries have a huge negative impact on the health of humans, flora and fauna. Presently, it is very hard for existing water treatment plants to introduce or maintain the most efficient, reliable and economically viable system that significantly lowers the contamination of waste water (even treated water) for reuse. We aim to address the fundamental challenges plaguing water treatment plants, which is to develop a system that could remove ‘all remaining’ dissolved contaminants and to considerably improve quality standards, before the water is being discharged into the rivers comes out of these plants. • This product that we have developed can easily be up-scaled, and devices implementing this technique can be made without much or little effort. This concept would in fact be even more advantageous and successful not only in other regions of Europe, but also in Asia, Africa and South American continents where sun light is abundant. Further, the concept can be extended in the area of energy conversion and storage, especially solar fuels, where water is splitted in to hydrogen and oxygen using sunlight and can be used as energy converter for various purposes.
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? 	<ul style="list-style-type: none"> • We haven’t commercialized the product yet; nevertheless, we can still contemplate what makes this product highly versatile and why it can be successful in the area of waste water treatment. First of all, we have synthesized and developed a cost-effective, earth-abundant and non-toxic photocatalyst comprising of clusters of transition metals that are chemically stable and easy to handle. In our laboratory, we have already tested numerous harmful and hazardous chemicals as well as biological

<ul style="list-style-type: none"> • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>wastes effectively that are rather demanding to decompose and cannot be removed by traditional and existing conventional techniques. In addition to this, we recently used ‘fully treated water’ from a water treatment plant in Berlin and applied our catalytic process to it. Strikingly, we could successfully decompose up to 46% of the organic content in already treated water by making it ‘potentially clean’ which further substantiates the implantation of new promising technologies into the betterment of existing waste water treatment. Furthermore, we have guidance from Prof. Dr. Matthias Driess, one of the pioneers in the field of molecular and materials chemistry as well as Prof. Dr. Reinhard Schomäcker, an expert in chemical reaction engineering here at the Technical University of Berlin.</p> <ul style="list-style-type: none"> • There are several hurdles that we may face during the successful commercialization of this product, but the key challenges that need to be addressed in the initial stages have been discussed below. Firstly, we are keenly looking out for potential investors, who are interested and firmly believe in our product. In addition, we are planning to submit proposals to gather funding from the federal ministry of education and research (BMBF) and the European Commission. We also plan to approach other prestigious chemical and pharmaceutical industries within Germany, such as Covestro, Lanxess, BASF and Bayer. Secondly, we understand that finding the right people for collaboration, such as partners from the waste water treatment plants who could help us in growing is equally vital and therefore, we have presently initiated a fruitful cooperation with Berliner Wasserbetriebe in Berlin. We are also in touch with <i>Charité</i> - the largest university hospital in Berlin, Technical University of Berlin, Freie University, and Humboldt University and so on. Thirdly, the cost-effectiveness of the synthesis to up-scale the photocatalyst from multi-gram to multi-kilogram scale and better optimization of the reaction conditions in the catalytic process. Finally, we are already in the process of developing our novel non-noble approach from lab-scale technique to implementing prototypes by depositing more effective films from the photocatalyst aiming towards a fully-fledged semi treatment plant. In addition, we imperatively require R&D laboratory space in order to make this concept effective and highly successful. • The most important message we would like to share is “Let’s conserve and cherish or pollute and perish”. As we see, there has been a worldwide matter of great concern to treat waste water and reprocess it to an appropriate manner which meets the strictest standards. With our product, we aim to reduce the significant negative influence of waste water on human, animal or plant life and reduce or lessen the damage to the natural environment.
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3. Irene Erdelmeier, Innoverda: Introducing New Reactions and Technologies in Industrial Synthesis: Challenges and Opportunities for Start-up Initiatives for Sustainable Chemistry

Name:	Irene Erdelmeier
Organization/institution/company:	Innoverda
Title of the case study:	Introducing new reactions and technologies in industrial synthesis: Challenges and opportunities for start-up initiatives for sustainable chemistry.
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>The start-up initiative INNOVERDA has been launched in Paris/France in January 2017 and the company will be officially created end of September 2017. INNOVERDA is dedicated to implement Green Chemistry Processes in Industry. Specifically, we design and develop continuous flow electrochemistry and biomimetic processes, with the goal to substitute corrosive and/or toxic agents in chemical and pharmaceutical production. Moreover, this technology, i.e. electrosynthesis, is a powerful and promising technology for the biorefinery concept, to obtain platform molecules from biomass.</p> <p>Since the launch of the project, the concept has been validated at the lab scale for three different applications, and first contacts with potential clients have been established.</p> <p>This start-up thrives to advance green and sustainable chemistry by two means:</p> <ol style="list-style-type: none"> 1. It can change and/or improve significantly industrial production processes by not only replacing corrosive and/or toxic agents, but also by improving selectivity and efficiency, using electrical energy (i.e. renewable energy), thereby offering ecological and economic advantages. 2. The transformation and valorization of biomass (in preference waste) requires the development of new processes to supply in an economic and ecological way starting materials for the chemical industry, replacing petrochemical feed stocks by biomass. <p>Most importantly, this technology can be applied in a flexible way on various scales, replicated in other regions and may conveniently be scaled-up.</p> <p>In our vision, it holds the promise to become a mainstream sustainable production technology for the pharmaceutical and chemical industry.</p> <p>Prior to this venture, I have co-founded with Jean-Claude Yadan and Marc Moutet in 2002 another start-up, Tetrahedron, which is dedicated to bringing to the market safe natural and nature-derived amino acids for nutrition, cosmetics or pharmaceutical applications. One of our key products is ergothioneine, a rare natural amino acid, for which we developed a biomimetic green chemistry process in water, up to an industrial scale. Several tons of ion-exchange resins and more than 20 tons of solvents could be saved thanks to our invention compared to other processes. Ergothioneine has recently acquired the status of “Novel food” under the trade name “Ergoneine” in Europe and can now be commercialized. As this regulatory process took several years, Tetrahedron suspended recently the research and development of further</p>

	products/processes and is concentrating currently on the marketing and commercialization of its key product.
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>From both start-up experiences, some insights can be extracted:</p> <p>Key factors of success have been:</p> <ol style="list-style-type: none"> 1. For Innoverda, the possibility to join an Open Lab Initiative in Paris (“La Paillasse”, www.lapaillasse.org) with a Biology lab infrastructure. Interestingly, the project was accepted in residence due to the fact that it is dedicated to sustainable chemistry and chemistry in water, and fosters the use of renewable energy. Moreover, such an Open Lab structure offers the opportunity to interact with other scientific and technological initiatives in the sustainability field, as also open citizen science projects. <p>Tetrahedron could be launched 2002 in an academic environment (ENSCP, Paris) at not too high costs for infrastructure and access to scientific literature/databases/ congresses.</p> <ol style="list-style-type: none"> 2. Innovation by development of a biomimetic chemical synthesis process in water, and transversal technology transfer to introduce new purification technologies for chemistry in water, offering ecological AND economic advantages. 3. Considering the up-scaling from the beginning on, with a holistic view on the process/product. This requires building strong relationships with equipment suppliers (in the optimal case with an option to rent equipment for validation of new processes before investing in an acquisition). 4. Highlighting and quantification of ecological and economical improvements thanks to the introduction of the respective technology/product (i.e. evaluating continuously the efforts towards more sustainability). <p>There are several phases in the start and development of initiatives dedicated to Sustainable Chemistry, with specific challenges and hurdles (i.e. the start-up itself; a first consolidation phase, prototype production/pre-launch; industrial production with authorization to market). Each phase requires a wide diversity of competences, which are not obvious for the founders/entrepreneurs.</p> <p>Therefore, the Start-up itself but also the transition between these different development phases may constitute critical moments.</p> <p>Critical issues and challenges we faced initially and during development:</p> <ol style="list-style-type: none"> 1. Finding an appropriate infrastructure to start and validate the key idea - Proof of Concept (lab space with at least one chemical fume hood and a minimum of appropriate equipment/material). 2. High upfront investments (time and money) required with late return on investment, in particular when introducing new technologies in the production with Contract Manufacturing Organizations. 3. Regulatory procedures were far longer than announced and expected. 4. Marketing efforts and budget were difficult to estimate for scientists (often by far underestimated). 5. Potential clients are not willing to pay a premium price for a more sustainable process or product, regardless the fact that it is difficult to offer in the early phases a competitive pricing structure. <p>Actions to overcome potential barriers:</p>

	<ul style="list-style-type: none"> • Build dedicated platforms or collaborative centers (for example in academic institutions) for academic and non-academic “outsider” start-up initiatives with labspace/fume hoods and a minimum of appropriate equipment, including access to scientific databases, for a minimum residence time of 3-6 months. A counterpart of the residents could be to participate in green chemistry training for students or professionals, or in open science/citizen science projects (e.g. 1 day/week). • Advocate for public procurement policies introducing a quota for more sustainable products. • Help start-up initiatives in measuring their efforts towards more sustainability in a gradually more complex ways, from simple metrics such as mass and energy balances to more complex indicators (e.g. LCA as proposed in the World Business Council for Sustainable Development, see the EU-Project SPIRE, GC3 roundtable Green Chemistry metrics). • Build a network of experts to accompany start-up initiatives in the transitions from initial start-up to later stages, helping to face the non-chemical challenges (i.e. market study, identification and validation of market needs, regulatory frameworks) and to select the required competences to join the start-up team (if necessary). <p>Single most important message:</p> <p>Facing the competition with low-cost productions due to long-established and depreciated installations and “grandfathered” products, innovations in sustainable chemistry may reach the market, become mainstream and offer safer products and processes, if actions are taken to influence public procurements policies and to accompany start-ups in the critical transitions from early lab phase to industrial production.</p>
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4. Cristina Mottillo, ACSYNAM Inc.: From Innovation to Corporation: Bridging the Gap between Green Chemistry Research and Business

Name:	Cristina Mottillo
Organization/institution/company:	ACSYNAM, Inc.
Title of the case study:	From innovation to corporation: bridging the gap between green chemistry research and business
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>ACSYNAM, Inc. is a start-up company and spin-off of the McGill University Department of Chemistry located in Montreal, QC, Canada. The five-member executive team is composed of co-founders Dr. Cristina Mottillo (post-doctoral researcher), Dr. Tomislav Friščić (Associate Professor), Christopher Nickels (Master's student), Dr. Simon Girard (post-doctoral researcher), and Dr. Chao-Jun Li (Professor), combining over 50 years of experience and expertise in the green chemistry field. The ACSYNAM initiative was started over four years ago as a collaborative research project and has resulted in a full research program and spin-off company focused on the development of the green and sustainable synthesis of advanced porous adsorbents called metal-organic frameworks (MOFs). MOFs are a relatively new class of advanced adsorbents which have just recently (September 2016) penetrated the global market after over twenty years of intense worldwide academic and industrial research. MOFs are the breakthrough solution for today's green technology challenges such as the safe and efficient storage of clean fuels including hydrogen and natural gas, as well as the reversible sequestration of greenhouse gases (GHG's) from the atmosphere. Despite their enormous potential for green applications, the highly energy-intensive, wasteful, and costly methods of manufacturing MOFs have presented a roadblock to their widespread implementation on an industrial scale. The ACSYNAM initiative employs a patent-pending technology which enables the production of high-quality MOFs while reducing the danger, toxicity, and negative environmental impact associated with conventional chemical manufacture. The technology employs supercritical CO₂ and avoids conventional solvents, is easily scalable, and adaptable to different industry sectors. The elimination of traditional organic solvents from the process not only removes carcinogenic, mutagenic organic chemicals from the manufacturing process, but also eliminates the inherent risk of spills which comes with using liquid solvents. Additionally, the avoidance of solvents enables us to access simple and rudimentary metal-based feedstocks, which are less corrosive, less dangerous, and less costly than their more soluble alternatives. Because the technology is safer and more economical than incumbent technologies, it serves as an opportunity to reduce the cost and logistical difficulties associated with MOF manufacture, which will facilitate their adoption in green technologies on an industrial level.</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? 	<p>The complex landscape of green chemistry and its implementation on a global scale is represented in cases such as ACSYNAM, which began as an academic research project. As many green chemistry-related innovations begin at the academic level, the ACSYNAM case study provides an excellent opportunity to assess the challenges associated with commercializing green technologies from university-based research labs. Key factors in ACSYNAM's early success include:</p>

<ul style="list-style-type: none"> • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<ul style="list-style-type: none"> i. Financial support for innovations derived from academic research which lead to the formation of university spin-off companies: Government funding for highly qualified personnel (graduate students, postdoctoral researchers) and assistance in filing the patent application was beneficial in alleviating some of the initial financial strain associated with the start-up. ii. The opportunity to participate in university-based start-up competitions and management training programs: Participation in the McGill start-up competition and management training program were excellent initiations into the local start-up scene, and led to valuable pitching experience and business training. iii. The opportunity to conduct multidisciplinary research that is academically relevant and benefits the start-up innovation: Academic research can further support the green chemistry innovation, thereby fuelling the start-up's success. <p>There were also roadblocks limiting the targeted expansion of ACSYNAM in its first year:</p> <ul style="list-style-type: none"> i. Insufficient funding for infrastructure development: Funding programs targeting the purchase and development of specialized equipment should be a focus of programs aimed at the advancement of sustainable chemistry innovations, many of which often require laboratory or manufacturing facilities. ii. Lack of resources pertaining to gaining business expertise: The availability of business expertise (training, mentoring, partners with business experience, industry players) is essential for complimenting the technical skills of entrepreneurs with scientific backgrounds and the formation of a well-rounded executive team. iii. The absence of university incubator that can assist with growth in early phases of the business: University incubators are invaluable resources for start-ups in the early phases, and should be available at all research-centric academic institutions. <p>The viability of sustainable innovations, such as that on which ACSYNAM is based, are usually confirmed at the research and development stage. The failure or success of green technologies and start-ups is therefore dependent not on the quality of the technology, but on the ability to bring it from prototype to market. There is a fundamental gap between green chemistry innovators and the business world that needs to be filled to ensure the success of ACSYNAM and other sustainable start-ups alike. In that respect, there must be a paradigm shift whereby green chemistry technologies are not regarded by industry players as more costly and complicated, but as simple and cost-effective alternatives that are beneficial to their business model as well as the environment.</p>
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5. Edu Inam, University of Uyo: Building Sustainable Chemistry Laboratories in CEESR

Name	EDU INAM
Organization/Institution/Company	UNIVERSITY OF UYO, UYO, NIGERIA
Title of Case Study	Building SC Laboratories in CEESR, UNIUYO
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (350)</p> <ul style="list-style-type: none"> • What product/service do you offer and in which country(s)/region(s)? what is the current status (laboratory research, patent pending, commercialization) • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/ replication in other regions and / sectors? 	<p>This initiative is to build a modern laboratory infrastructure for research, innovation and enterprise in sustainable chemistry. The laboratories when completed will offer world class research environment to conduct, research, innovate and create opportunities in green chemistry across Sub-Saharan Africa. It would provide training and capacity building in green and sustainable chemistry as well as serve as launch pad for green and sustainable chemistry products and services into Nigerian Market.</p> <p>Specifically, the laboratory will provide support for scaling up ongoing research projects on:</p> <ol style="list-style-type: none"> Valorization of Agriculture Biomass for Waste Water Treatment: The aim of this is to examine the effectiveness of using activated carbon obtained from locally-available agro-biomass for abstraction of colour from dyes. If successful, these products may be commercialized for use in waste water treatment. Utilization and Biochar from Sewage Sludge for Soil Remediation: The Niger Delta region of Nigeria has had over 6700 incidence of oil spills which has resulted in over 2.3 million barrels of oil spilled into the environment. The estimated cost of clean-up of the Niger Delta runs into billions of US dollars. The aim of this research project is to develop environment-friendly products from locally-available materials and commercialize same. <p>This initiative will open new and exciting prospects to tap into the vast and unexplored material resources available in the Sub-Sahara African region. The initiative has potential to be upscaled to include several specialized laboratories in sustainable chemistry and can be replicated in other Universities in other regions.</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words)</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start up a success/why is your start up not (yet) successful • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you like to share at the workshop? 	<p>A. Factors that contributed to the progress so far:</p> <ol style="list-style-type: none"> Ownership: Most research centers in Nigeria are funded by the public sector which makes it dependent on government for funding. This has hampered research and innovation in Nigeria due to bureaucratic inefficiencies associated with the public sector. One of the unique features of CEESR which has contributed significantly to our progress so far is the ownership structure, i.e. public-private partnership. We have designed an ownership structure which allows potential beneficiaries to also share in the ownership of the CEESR. Inclusion of Business Model to the initiative - We have included a business model to ensure there would be return on investment for potential investors, researches and partners. Thus, we are flexible and ready to adapt to changes in markets, economics and financial outlooks. Personnel: We have endeavored to incorporate key experts with multidisciplinary background and competences in research and business development to ensure that we balance research needs with market needs.

	<p>iv. Strategic Partnership – We have identified strategic in-country and out-country partners and have signed and exchanged Memorandum of Understanding with some. The initiative is phased with future scale up potentials.</p> <p>B. Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)?</p> <p>i. Funding - This is the single most important challenge especially in the developing countries. We have opened the initiative to multi-stakeholder participation to attract funding. This is done in a very controlled manner to avoid capture or derailing the project by any stakeholder.</p> <p>ii. Bureaucracy – This challenge brings unnecessary delays, we have involved experts in the government to help deal with this.</p> <p>iii. Innovation capacity and infrastructure – we recognize this even when our initiative is completed, this will always remain a challenge in a very dynamic global community. Our method of dealing with this is to promote and seek collaborations and partnerships. It is on this note that we have collaborations with Gwangju Institute of Science and Technology, South Korea, Lancaster Environment Centre, Lancaster University, Georgia Institute of Technology, Atlanta, USA and the American Chemical Society. We welcome partnerships from Organisations and institutions in Germany.</p> <p>iv. Acceptance – the cultural mindset of institutions and organizations in Nigeria is relatively slow to accept and support to homegrown initiatives in research and innovation. We have carried out several enlightenment and engagement activities to ensure the initiative is accepted.</p> <p>C. What is the single most important message you would like to share at the workshop?</p> <p>Nigeria has the largest market in sub-Sahara Africa, hence there are lots of opportunities for green chemistry entrepreneurs. There are several challenges which result in longer payback period for research-based products. Nevertheless, the opportunities outweigh the challenges and risks. Therefore, I will encourage entrepreneurs to never give up the future is SC.</p>
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6. Janet Angel, EcoBioClean®: Crude to Food

Name:	Janet Angel - CEO
Organization/institution/company:	JACOR LLC
Title of the case study:	“Crude to Food” EcoBioClean®
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>According to the OIL SPILL GOBAL INTELLIGENCE REPORT large oil spills, or those over 34 tons have occurred in over 112 nations in the last several decades. EcoBioClean®, our patented technology has an important role to play in the safe management of toxic chemicals on land and at sea. In line with the Global Chemical Outlook Goals, we are working to “minimize significant adverse impacts on the environment and human health, while meeting today’s needs without compromising the future.” The development of this formula came just days after the Deep-Water Horizon disaster in 2010 when I took a small scientific crew into the gulf waters just one mile off shore Grand Isle, Louisiana to collect samples and conduct insitu tests. The story of our entering the noxious ocean waters for sake of scientific research at a time of high and controversial stakes, was informative and beyond all the devastation witnessed at location, it might have been a solid introduction to the laborious and unexpected 6-year process to secure a US Patent award. EcoBioClean® is a safe and smart technology that <i>remediates toxic hydrocarbon deposits using solely eco-friendly elements</i>. This comprehensive green chemistry application rapidly – in under 10 minutes, reduces a crude oil slick in salt or fresh water to tiny particles the size of ground black pepper. It continues to reverse engineer and transform those elements into beneficial particles suitable for aquatic or ground life with total resolution occurring in some circumstances in as little as seven days. Considering the wisest global management of chemicals, EcoBioClean cost-effectively eliminates the need to deposit toxins into landfills, underground tanks, reservoirs and other ineffective out-of-sight out-of-mind methods. It can be applied to existing repositories for faster degradation of stored contaminants. During a chemical hazard, this application provides a rapid response and level of safety for all those endangered. It has a positive effect on the air, water, land, vegetation, and wildlife and reduces potential toxicity up the food chain to the human level. Beyond crude oil, it is effective at remediating many other forms of hydrocarbon contaminations such as gasoline, jet fuel, pesticides, motor oils, solvents and more. EcoBioClean can effectively support better clean-up methods locally, regionally, and at the international level to serve global matters. Scientifically aligned with nature it could be used as the final phase of clean-up to complement other industrial methods currently in place. We are poised to commercialize and seek appropriate partnerships.</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome 	<p>As a start-up entity in the field of green sustainable chemistry, we encountered more than a few barriers to success. The road forward was often unclear and Venture Capitalists wanted tests. Unattached to a large university or giant chemical company posed research and development funding obstacles. Federal Grants are not easily obtained and require application expertise which start-ups often do not possess. SBA loans are available but require 20% out of pocket to secure. Functioning favorably in the land of the giants in the chemical industry can be intimidating and prohibitive and some behaved aggressively. We also experienced visibility, credibility and funding issues due to the misunderstanding of green</p>

<p>potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)?</p> <ul style="list-style-type: none"> • What is the single most important message you would like to share at the workshop? 	<p>chemistry, its values and what role it could play within the chemical arena. As a small business entrepreneur, the road to patent award entailed heavy patent attorney fees and years to final award as we pressed on despite discouragements. International patent fees can cost millions of US dollars. Pre-patent uncertainties caused delays and potential theft of IP intricacies. We found there to be governing and use inconsistencies for green chemical applications state to state, at the federal level and internationally. Beyond typical labeling laws, distribution channels, manufacturing challenges and unfair market competition as a small sustainable entity, there is a good deal of red-tape and time wasted by the voluminous documentation required and tests to be performed. To improve ease of marketplace entry we believe that the patent process and regulations need to be simplified, small business loans and/or grants need to be available and supported by agencies that will most benefit by the development. Governments and authorities could level the playing field regarding the requirements for testing green-based technology vs chemical applications. It would be beneficial to have advocates that help start-up initiatives in this arena move from inception to marketplace both nationally and internationally. We believe when intellectual property is deemed to be of global value, authorities could establish an infrastructure that helps start-up entities move more easily through the patent protection process, regulations, and on to collaboration possibilities including financial support, further development of intellectual property, ancillary avenues for use of patented product/technology, to create easier entry to commercialization. We rose above many of these barriers because we stuck to our mission and invested heavily into our intellectual property. There is now a high level of contemporary interest in EcoBioClean® from prominent scientists, Venture Capitalists, large corporations, oil and gas companies, the US Government and various countries around the globe. We have aligned ourselves with the International Commerce Department, completed needed tests and are now poised for commercialization. We have not yet chosen partnerships that will take us to that next level. We are certain there is a wealth of technology awaiting your help in the start-up sustainable sector. As we seek these new and better technologies let us raise the bar and leave no footprint behind for generations to come. Our hope is that we can collaborate to sustain our future through these innovations and alliances that deserve an unencumbered path. It is our great honor to join you on this journey!</p>
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7. Luis Guillermo Marroquin, Acumuladores Iberia: Putting into Action a Low-cost, ESM and Cleaner Production and Sustainable Chemical Way of Recycling Used Lead Acid Batteries

Name:	Luis Guillermo Marroquin
Organization/institution/company:	ACUMULADORES IBERIA
Title of the case study:	Putting into action a low-cost, ESM + Cleaner Production + sustainable chemical way of recycling Used Lead Acid Batteries
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>The start-up initiative seeks to provide technical assistance to replicate in different parts of the world the successful formula of a small size, low-cost, ESM + Cleaner Production + sustainable chemical way of recycling Used Lead Acid Batteries, developed by Acumuladores Iberia in Guatemala.</p> <p>The Acumuladores Iberia formula which is offered to the world, significantly reduces the adverse health and environmental impacts of ULAB recycling and is approached in the manner of a circular economy by obtaining close to zero waste ULAB recycling, while also contributing to a reduced carbon footprint and diminished depletion of a non-renewable resource: lead, and also complying with the Basel Convention, because it will minimize transboundary movements of the hazardous waste from a priority waste stream. It will allow countries or sub-regions to set up low cost, sustainable chemistry+ESM+Cleaner Production ULAB recycling facilities, reducing the use of mined lead, diminishing carbon emissions compared with the process of primary lead extraction from mined sources, and carbon emissions originated by ULAB transboundary shipments.</p> <p>Improving furnace operating efficiency, not only reduces unwanted by-products, such as sulfur dioxide and slag, but it reduces the smelting cycle times and thereby the amount of energy used to recover the Lead. Less energy not only improves the financial viability of the enterprise, but reduces Green House gas production and virtually eliminating sulfur dioxide emissions eliminates one of the main causes of acid rain. In addition improving the viability of an SME that recycles ULAB, will enable more SME recycling plants to be commissioned and increase the levels of domestic recycling, which in turn reduces the transboundary movements and the carbon footprint of the LAB to ULAB to LAB life cycle.</p> <p>This ULAB private sector start-up will help to comply with the UNEA 2016 resolutions on sustainable chemistry, on the ESM of chemicals and wastes, and more specifically, on the ESM of ULAB, reducing the significant adverse impacts of childhood lead exposure¹ as unsound management of ULAB is estimated to be responsible for up to 80% of global lead contamination.</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p>	<p>The innovative sustainable chemistry of this ULAB recycling formula, which was supported by the Basel Convention Regional Centre for Central America and Mexico (BCRC-CAM), the Secretariat of the Basel Convention, Brian Wilson from the International Lead Association (ILA) and the Guatemalan National Cleaner Production Centre, has been solidly recognized at the national, sub-regional and international levels and exhibited at the 2015 Science Fair in Geneva, with the occasion of the Triple COP of the Basel,</p>

¹ See "Economic Costs of Childhood Lead Exposure in Low- and Middle-Income Countries" por Teresa M. Attina¹ and Leonardo Trasande ^{1,2,3,4,5}

¹Department of Pediatrics, ²Department of Environmental Medicine, and ³Department of Population Health, New York University School of Medicine, New York, New York, USA; ⁴Wagner School of Public Service, New York University, New York, New York, USA; ⁵Department of Nutrition, Food Studies, and Public Health, Steinhardt School of Culture, Education, and Human Development, New York University, New York, New York, USA..

<ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>Rotterdam and Stockholm Conventions, as well as the 2016 Climate Kick MOOC organized by the European Institute of Innovation and Technology and BRS (https://learning.climate-kic.org/courses/e-waste-mooc).</p> <p>The Acumuladores Iberia initiative aims to facilitate the dissemination of their low cost sustainable chemistry solutions which can be applied to already operating ULAB recycling facilities as well as to facilitate the set up of new low-cost sustainable chemistry ULAB recycling facilities in different parts of the world.</p> <p>As a new start up, Acumuladores Iberia sustainable chemistry technical assistance services will benefit by having an endorsement of a UNEP sustainable chemistry international initiative, and by having financial support for the marketing of their valuable services, for exploratory field visits and for the financing of the implementation of their recommendations. Funding partners may include among others international cooperation agencies from donor countries, development banks, Global Environmental Facility and private companies interested in a high impact highly profitable corporate social responsibility venture.</p> <p>Main message: Waste is a reflection of inefficiency in the recycling/production process</p>
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8. Emmanuel Odjam-Akumatey, Ecological Restorations: Introducing Natural / Organic Pesticides to Vegetable Farmers in Tuba, Ghana

Name	EMMANUEL ODJAM-AKUMATEY
Organization/Institution/Company	ECOLOGICAL RESTORAIONS
Title of Case Study	INTRODUCING NATURAL/ORGANIC PESTICIDES TO VEGETABLE FARMERS IN TUBA, GHANA.
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (350)</p> <ul style="list-style-type: none"> • What product/service do you offer and in which country(s)/region(s)? what is the current status (laboratory research, patent pending, commercialization) • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/ replication in other regions and / sectors? 	<ul style="list-style-type: none"> • Organic pesticide produced from the neem tree (Neem extract) in Ghana. It is not currently available to farmers and on the market • Hazardous chemicals have had and continue to have a greater toll on human health and the environment The benefits of Green/ Sustainable Chemistry to add up to the above cannot be underestimated. A study through the project “awareness raising on the effects of POPs and the introduction of Integrated Pest Management among vegetable farmers in Tuba, Ghana” by Ecological Restorations (2004) showed the high increase of hazardous chemicals. With this project, farmers were introduced to organic farming through the production of compost and the use of Neem extract as an alternative to the use of inorganic pesticides. The results showed a high increase in production and the improvement in the health of farmers with the reduction in symptoms associated with the use of inorganic pesticides. With this, the production of inorganic pesticides would be reduced and human health and the environment would be improved.
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words)</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start up a success/why is your start up not (yet) successful • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you like to share at the workshop? 	<p>Factors that made the start-up a success</p> <ul style="list-style-type: none"> • Availability of the Neem extract and compost • Readiness of farmers to use the product • Preparedness of farmers to accept new products at a cheaper cost • Environmental benefits <p>Challenges</p> <ul style="list-style-type: none"> • non-readiness of farmers to use the product persistently due to non-availability • cumbersome process of producing the Neem extract • lack of equipment and finance in producing the extract and compost for constant supply at a reduced cost. • Farmers are not encouraged because the price of the organic product would be higher than what they produce now and obviously people would go in for the cheaper one. <p>OPPORTUNITIES</p> <ul style="list-style-type: none"> • Farmers would be relatively better off in both economic and health terms if this is used in vegetable production. <p>IMPORTANT MESSAGE</p> <ul style="list-style-type: none"> • Let’s live in harmony with the environment, if we stress it, it will stress us!

9. Douglas Cutter, SAFIC: Ghana Blending Project

Name	Doug Cutter
Organization/Institution/Company	Safic (Pty) Ltd
Title of Case Study	Safic Ghana Blending Project
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (350)</p> <ul style="list-style-type: none"> • What product/service do you offer and in which country(s)/region(s)? what is the current status (laboratory research, patent pending, commercialization) • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/ replication in other regions and / sectors? 	<p>1. Brief description of the initiative</p> <p>Safic (Pty) Ltd established small blending facilities in African markets. Ghana is an identified region and we have established a successful start-up there. Concentrates are sent from South Africa and blending occurs in Accra and the regions.</p> <p>We have established Women’s empowerment groups along with (amongst others) Bright Generation Community Foundation to locally blend sell and support the products.</p> <p>The project is currently self-sustaining. Laboratory research for effective and safe Concentrates and Premixes are ongoing.</p> <p>2. How this contributes to advancing green and sustainable chemistry</p> <ol style="list-style-type: none"> a) Less product and reduced hazards. The customers identified in the market are predominantly using petrochemical hazardous solvents in their applications. We have introduced water based products that are equally (or more) effective and are significantly less hazardous. As the product can be diluted, significantly less is used. b) Reduced waste and increased energy efficiency. Were water based products have been used; they have been sold as ready-to-use products. Our focus is on highly concentrated products that are locally diluted with recycled packaging. We have significantly reduced packaging waste and transport (energy) requirements. c) Systems Approach The concentrates are produced in an ISO 9000 and 14000 certified plant focused on waste and risk reduction. These systems are applied at the sites. d) Sustainability The process has reduced overall product cost at point of use and has created local employment and skills generation. <p>3. Potential for up scaling and replication in other regions or sectors</p> <p>There is definite potential for replication in other regions; the system also allows us to be flexible in different areas in meeting different needs for different areas. Once established, the plants can easily grow and upscale due to the modular nature of the set-up.</p> <p>Sharing information across regions let us strengthen the system.</p> <p>As local demand grows, local raw material feedstock becomes an option.</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words)</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start up a success/why is your start up not (yet) successful 	<p>We have been successful, so far, because:</p> <ol style="list-style-type: none"> 1. The products work and they perform better than current local competitors. 2. Start-up costs are relatively low and income can be generated relatively quickly. 3. We have achieved significant cost reductions by minimizing transport and packaging.

<ul style="list-style-type: none"> • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you like to share at the workshop? 	<p>4. The regional nature of the business creates regional jobs where the product is used and this encourages local support.</p> <p>The key challenges we face are:</p> <ol style="list-style-type: none"> 1. Local bureaucracy, product and plant registrations. Sometimes new innovations are not covered in local legislation, so this can take time. 2. Educating local communities and governments to the benefits of green chemistry. 3. Identifying the correct partners and ensuring standardization across areas. 4. Local availability of suitable packaging and containers. 5. Developing and protecting intellectual property while transferring technology and decentralizing production safely. <p>Most important message:</p> <p>Regional and local blending or production of water based products, if handled well should meaningfully reduce environmental impact while being sustainable. This downstream production will create regional markets for upstream green and renewable raw materials that do not currently exist.</p>
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10. Juergen Jelly, ACTICELL: Environmentally Friendly Chemicals for the Textile Industry

Name:	Juergen Jelly
Organization/institution/company:	ACTICELL GmbH
Title of the case study:	ACTICELL: environmentally friendly chemicals for the textile industry
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p><u>Products/Services</u></p> <p>ACTICELL is the leading R&D company regarding environmentally friendly chemicals for the textile industry. The first objective is to replace harmful and hazardous chemicals – like PP (potassium permanganate) – which are currently heavily used to bleach jeans.</p> <p>We are focusing on two impacts:</p> <p>1. Environment</p> <p>Non-hazardous chemicals, no release of heavy metals like in case of PP, no water pollution</p> <p>2. Workers health and safety</p> <p>Many of the currently used chemicals cause serious illnesses. E.g. PP: suspected reprotoxic substance, which is likely to be classified as "H361d, Repr. 2" and labeled with "GHS08" and the hazard statement "H361d – suspected of damaging the unborn child" (ECHA Community Rolling Action Plan (CoRAP) Update 2017 (EC number 231-760-3)).</p> <p>Currently we have 3 main products in our product portfolio:</p> <p>1. Laser booster</p> <p>Status: Launched</p> <p>A non-hazardous water-based formulation that is sprayed on jeans before they are lasered in order to get a used look effect.</p> <p>2. Ozone product</p> <p>Status: Customer trials</p> <p>A non-hazardous water-based formulation that is sprayed on jeans. A water-free ozone treatment will develop the used look effect already at room temperature.</p> <p>3. Dyestuff enhancer</p> <p>Status: Customer trials</p> <p>A non-hazardous water-based formulation that modifies the molecular structure of the textile in a special way that generates deeper dye shades and thus helps to significantly save dyestuff and auxiliary chemicals.</p> <p><u>How does the initiative advance sustainable chemistry?</u></p> <p>ACTICELL is focusing on sustainable chemistry only. Being a university spin-off in the field of chemistry, we are at the forefront of the development of new technologies and solutions in our industry with the objective to commercialize products that tackle huge problems. Beside the scientific background, it's exactly this knowledge of commercialization in combination with our established world-wide network, which is of importance to help pushing sustainable chemistry out of the labs into the market.</p> <p><u>Does the initiative hold potential for upscaling/replication in other regions and/or sectors?</u></p>

	<p>Absolutely! ACTICELL is already working globally with partners in Europe, Africa, Asia and the Americas</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>Key factors and challenges:</p> <p>1. Sales: Understanding the stakeholders, decision processes and entry barriers of the industry</p> <p>The textile industry is complex with many stakeholders and influencing parameters. A deep understanding for the processes, how decisions are made, and the market itself, is absolutely necessary to survive. It is what we would call an old economy which comes typically with some high entry barriers. Although the market seems to be dominated by some big brands, it has a very low concentration and even the biggest corporates do not own high market shares.</p> <p>Targeting sustainability, environmental safety as well as workers health and safety gives you quick access to the players but realizing sales is something totally different. It took us close to three years to understand all the different forces pulling in different directions and to build a network so that we can realize the first sales with.</p> <p>2. Regulatory affairs vs. market</p> <p>As it is the case with many innovations, the textile industry is reluctant to adopt new technologies if they do not have to.</p> <p>However, public outrage e.g. leading to the ban of sand blasting made most of the companies stop using it.</p> <p>Understanding what triggers the industry to use new technologies is key.</p> <p>However, regulatory bodies that focus on specific problems related to serious issues for the environment and workers, leading to updated regulations (e.g. for the use of hazardous chemicals) would be a strong support to open the doors for new technologies and products.</p> <p>Example:</p> <p>The most prominent chemical currently used for jeans bleaching is potassium permanganate (PP), which is considered to be used on 50–70% of all garments. PP contains the heavy metal manganese and is currently under review by ECHA/REACH and was added to the Community Rolling Action Plan (CoRAP) Update 2017 (EC number 231-760-3) as suspected reprotoxic substance, where it is likely to be classified as "H361d, Repr. 2" and labeled with "GHS08" and the hazard statement "H361d – suspected of damaging the unborn child".</p> <p>3. Money</p> <p>Not only to be successful in R&D, but also to understand the above mentioned key factors and to overcome the barriers, substantial financial resources are needed esp. in an industry as big as the textile industry, and you are facing huge corporations on every stage of the value chain.</p> <p>Message:</p> <p>Don't eat the yellow snow! :-)</p> <p>Seriously, never loose your sense of humor!</p>

11. Leonardo Zambotti Villela, BioativosGroup: Providing the Means to Achieve a Sustainable Bio-refining Process

Name:	Leonardo Zambotti Villela
Organization/institution/company:	BioativosGroup
Title of the case study:	Providing the means to achieve a sustainable bio-refining process.
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>BioativosGroup has been developing a holistic strategy for converting renewable natural resources into high quality and 100% safe natural products. This means extraction of high-value products (pigments, antioxidants and other bioactive compounds) in a bio-refining context and transformation of waste residues in new products.</p> <p>The Startup's goal is to become an international key player at the Bioeconomy field in 2020. In order to achieve it, the founders gathered a highly experienced team with more than three decades of expertise in bio-refining processes using sub- and supercritical technologies (selective extractions with the lowest environmental impact). By proposing an integrated bio-refining process with a holistic approach that includes the production of high-value microalgae biomass, the costs of manufacturing with these scalable technologies reduce significantly, meaning a paradigm shift.</p> <p>The aforementioned knowledge allowed Bioativos to project and build a multipurpose CO₂ supercritical fluid extraction (CO₂-SFE) and pressurized liquid extraction (PLE) system for processes development and small production (funded by the Sao Paulo Research Foundation – FAPESP and the partners).</p> <p>Among the products from Bioativos' portfolio is the clove oil (contain at least 80% of eugenol), which is extracted in less than 1 hour (efficiency of at least 95%). Another example is the production of essential oil, piperine and resinoid from black pepper in a 2 hours process.</p> <p>Since the CO₂ used in the process does not accumulate in/degrades the waste residues (differently from hexane and other solvents), their reuse as raw material in other processes is possible. In order to add value to these feedstock, and other resources (sugarcane bagasse and straw, grape peel and seeds etc.), Bioativos has being investing on R&D. Currently, a continuous flow hybrid sub- and supercritical water equipment for hydrolyzing waste residue from CO₂-SFE is under construction (funded by FAPESP). One of the objectives is to hydrolyze carbohydrate polymers in few minutes and make the monomers available for other processes (e.g. fermentation).</p> <p>In addition, Bioativos has been assisting some big Brazilian companies to add value to their waste residue by designing CO₂-SFE and PLE facilities. Their objectives are to increase profitability and reduce the potential environmental impact of waste residues.</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p>	<p>There are some key factors which made Bioativos to succeed:</p> <ul style="list-style-type: none"> • <u>Highly experienced team</u>: every person in the team has technical and scientific backgrounds that allowed the Startup to take some shortcuts. Our team has more than 30 year of experience in bio-refining processes, which permitted to design, build and operate the aforementioned systems. This fact reduced the initial investment needs, since

<ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>expenditures with training and purchase of equipment were drastically lowered. Also, the knowledge of the team was essential to have access to high-risk investment, usually funded by government foundations such as FAPESP (ca. US\$ 1MM invested).</p> <ul style="list-style-type: none"> • <u>Partners to develop complementary processes</u>: Besides of the own team, Bioativos has important partnerships with Research Institutes and Universities that are developing complementary processes. Two examples are demonstrated below: <ol style="list-style-type: none"> 1. As aforementioned, Bioativos is developing a continuous flow sub- and supercritical water system that can be used for hydrolyzes of waste residues from CO₂-SFE extractions. Also, the separation of cellulose, hemicellulose and lignin from lignocellulosic feedstock and their hydrolyze have been evaluated to provide sustainable chemical building blocks. In order to add value to these C5- and C6-sugars blocks and lignin-derivatives through complementary processes (e.g., fermentation), Bioativos has a pivotal partnership with the Green Chemistry SENAI Innovation Institute. 2. One of the Bioativos' objectives is to mitigate the CO₂ release after the bio-refining processes. In this sense, the Startup had developed two completely new low-cost culture media for <i>Haematococcus pluvialis</i> and <i>Dunaliella salina</i> microalgae cultivation. The laboratory results show a 95% reduction in the nutrient costs for the biomass production. Besides mitigation, Bioativos will produce the biomass to extract the natural astaxanthin, lutein and beta-carotene that are extremely valuable and have high market demand. In order to transfer these results to a commercial scale, Biomass SENAI Innovation Institute is scaling up the cultivation and testing different downstream technologies. <p>Regarding the challenges, most of them are related to investments. They are not accessible for Startups that aim to be a capital-intensive industry. However, this challenge motivated the team to develop alternative business plans while to reach the principal aim, i.e., to be a bio-refinery with global impact, is not possible. One of them is to design, build and operate CO₂-SFE and PLE facilities within the industries. In this business plan, the client invests on the equipment and adapts the infrastructure, being the Bioativos the operator. Nowadays, the Startup is negotiating with two industries, one food and one pharmaceutical industry.</p> <p>One important message: There are lots of opportunities at the Bioeconomy field that are waiting for Startups interest on clean technologies. Continuous innovation in this area will provide the means to reduce the dependency of non-friendly environment technologies.</p>
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12. Jose Angelo Ohno, Ecometano: Use of Landfill Gas as Fuel Interchangeable to Natural Gas

Name:	Jose Angelo Ohno
Organization/institution/company:	Ecometano Empreendimentos Ltda
Title of the case study:	Use of Landfill Gas as Fuel Interchangeable to Natural Gas.
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<ul style="list-style-type: none"> • RNG (Biomethane) – Renewable Natural Gas – Upgraded Landfill Gas to replace Fossil Natural Gas in the grid, petrol stations and industry. • -GNR Dois Arcos, Rio de Janeiro State – It has already started up (since 2015). It was not allowed to inject biomethane into the pipeline grid. Therefore, Ecometano was selling Biomethane on spot (compressed), by trucks to each client. Regulation to inject into the grid was only approved on June, 31st 2017. • -GNR Fortaleza, Ceará State – In construction, is expect to start up on November, 1st 2017. • RNG is supposed to displace fossil fuels, and, at the same time, avoid methane emissions in landfills, promoting renewable energy. • Favorable laws and regulations: Firstly, in Rio de Janeiro state, second São Paulo, and then, Ceará state. Other states in Brazil are expected to do the same.
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<ul style="list-style-type: none"> • These are the key factors for success: • Plan “B” – While waiting for ANP (Brazilian agency for Natural Gas and Biofuels) regulation framework, we supplied industrial and commercial companies on spot. • Partnerships with Universities and Institutes for developing methods for analysis (siloxanes, VOCs, and so on) • Emission Reductions Policy – Favorable laws for renewable natural gas in Rio de Janeiro and São Paulo states. • Challenges and Opportunities • Lack of regulatory framework – ANP (Brazilian Regulatory Agency has not focused on RNG, but Natural Gas, Ethanol and Biodiesel. • Lack of standardized methodology – Siloxanes and VOCs had not standard methods for analysis • Lack of infrastructure – Grid pipelines were designed only for Natural Gas • Pioneer project – New, unknown • Never give up. It is difficult, but there is no other alternative, but Renewable Energy for the future.

13. Charles Dimmler, Checkerspot: Better Materials Designed through Biotechnology and Brought-to-Life through Applications Development

Name:	Charles Dimmler
Organization/institution/company:	Checkerspot, Inc.
Title of the case study:	Better Materials Designed through Biology and Brought-to-Life through Applications Development
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>We design high performance materials. We use biotechnology to design new molecular building blocks, chemistry to use these building blocks to create materials with novel physical properties, and advanced fabrication to build multi-material end-use products. We were founded in 2016 in the San Francisco Bay Area. Our initial materials focus is on making better textile coatings such as safer, non-PFC waterproof-breathable fabrics; foams and elastomers that have improved strength-to-weight ratio and use safer chemistry (non-isocyanate); and high performance industrial lubricants and solvents that are safe and biodegradable. We are now generating revenue. We have commercial partnerships. We are actively prototyping end-use products and expect to grow product revenue starting in 2018. Our strategic plan includes commercializing and licensing our technology into other regions.</p>
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>First, the most important message to share in the workshop is the importance of Applications Development. Based on our past experience developing and commercializing the Algenist™ skincare brand, we have an understanding of the value of bringing-to-life and commercializing novel materials in end-use consumer applications, as opposed to a dependence on business-to-business ingredient commercialization. Too many materials companies make the mistake of relying entirely on partnerships and B2B sales to drive adoption of new technology. This puts far too much risk into the hands of third parties that can be too unpredictable. Further, the value in “showing” what’s possible with new technology is far more compelling than “describing” what might be possible. It is a mistake to underestimate the emotional connection people can have to finished consumer goods. Done correctly, tremendous value can be created through applications development.</p> <p>Second, to commercialize a product it must solve a customer need, whether that is price or performance. Too many safer, or more sustainable, materials technologies have failed at adoption because they were too expensive and did not create real value for the customer. They also targeted applications dominated by commodity feedstocks. This strategy is flawed because commodity markets are so price sensitive. New materials technologies should target delivering high performance first and foremost.</p> <p>The third lesson learned is you have to “earn” your way into large markets. Too many companies try to scale their production too quickly. They built manufacturing capacity ahead of proven demand for their products. It is far more sensible to prove demand and attractive unit economics (gross margins) at smaller scale first, having line-of-sight to growing into much larger markets. This is a crawl, walk, then run model. It’s very difficult for new technology to be born and go straight to a sprint with large scale production.</p>

	<p>Fourth, capital formation is critical to growing any business. Capital is available for strong business plans: e.g., team, technology, addressable market, unit economics, and scalability. However, it is critical for leadership teams to also manage their cash burn and focus on delivering against demonstrable goals, milestones that deliver shareholder value. All new ventures are risky and quite often it takes longer and requires more capital than expected. It is critical to ensure pragmatism in strategic planning and goal-setting, maintaining credibility with investors (in good times and during challenges) and to plan for the inevitable set-backs and delays.</p>
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14. Neelam Vaidya, ViridisChem Inc.: Toxicity Focus is Essential for Green Chemistry Adoption and Sustainable Product Development

Name	Neelam Vaidya
Organization/institution/company:	ViridisChem, Inc.
Title of the case study:	Toxicity focus is essential for Green Chemistry Adoption and Sustainable Product Development
<p>Briefly describe your initiative(s) and how it contributes to sustainable chemistry (approximately 350 words):</p> <ul style="list-style-type: none"> • What product/service do you offer/plan to offer and in which country(s)/region(s)? What is the current status (e.g. laboratory research, patent pending, commercialization)? • How does the initiative advance sustainable chemistry? • Does the initiative hold potential for upscaling/replication in other regions and/or sectors? 	<p>Green Chemistry Adoption prescribes that companies must evaluate toxicity impact throughout the product development lifecycle, minimize the toxic waste generation, and use of toxic raw material. As a result, there is a critical need to understand the toxicity of chemicals in terms of ecological and health impact.</p> <p>But there are critical roadblocks hindering Green Chemistry/Sustainable Chemistry Adoption:</p> <ul style="list-style-type: none"> • Information on the starting material is non-existent (toxicologists only focus on the end-product toxicity) • Chemists/engineers who define manufacturing processes can't understand toxicity data • Suppliers of mixtures and formulations are not able to provide accurate toxicity analysis (complex, dependent on the reactivity of chemicals, and environmental factors), and don't want to disclose the content information (their IP). As a result, Manufacturers and retailers are using formulations without fully understanding its toxicity <p>HOW DOES OUR INITIATIVE CONTRIBUTE TO ADVANCING GREEN CHEMISTRY?</p> <p>ViridisChem has built the most comprehensive toxicity database with over 90 million chemicals. It has also developed analysis modules that use machine-learning algorithms, and take into account the chemical interaction, concentration within mixture, to offer increasingly accurate toxicity analysis of chemical, mixtures/formulations and product development processes.</p> <p>Utilizing these technologies, we are offering software products on yearly subscription to companies worldwide:</p> <ul style="list-style-type: none"> • Chemical Analyzer (launched with paying customers): Provides comprehensive physical and toxicological properties of any known or unknown chemical, offers full GHS classification and identifies most US and international regulatory concerns. Chemical's toxicity impact is measured in terms of health, safety, and environment scores, and shown visually and shows it graphically so that chemists and engineers can understand easily • "Material Dashboard" (under development): A platform, somewhat like blockchain platform, to be used by all players within consumer industry supply chain that allows suppliers to securely input detailed content information of mixture/formulations, and create dynamic detailed reports without disclosing the ingredient details. Suppliers can then share these reports in varying levels of details with manufacturers, retailers, or certifying agencies through role-based access levels. <p>Manufacturers can use this platform to aggregate the toxicity of all the mixtures and formulations involved in their product development, and get</p>

	early insight about any regulatory threshold of toxic chemicals they may encounter.
<p>Explain key insights and lessons learned that may be relevant for other entrepreneurs, policy makers, and the international community (approximately 500 words):</p> <ul style="list-style-type: none"> • What are 3-4 key factors which made your start-up a success/why is your start-up not (yet) successful? • Which challenges and opportunities did you face? What action is needed to overcome potential barriers (e.g. innovation capacity, financing, bureaucracy, infrastructure)? • What is the single most important message you would like to share at the workshop? 	<p>After initial discussion with key customers from different industries, we quickly realized that to build unique solutions that can immediately benefit the industries, there were some common requirements:</p> <ul style="list-style-type: none"> • Comprehensive Information: Since the chemicals and mixtures are used across multiple sectors, we must have the relevant information of every starting material, not just a subset of chemicals, so that we can offer accurate analysis • Transparency: Knowing the source of data, whether it is experimental, or estimated, and disclosure on what properties contribute to the scores, is important to customers • Ease of Use: Whatever solution we offer, it must be easy to use, not require elaborate training, and must concisely provide the most relevant industry specific information to the scientist (nobody has time to sift through plethora of information) • Significant Value Proposition: With many tools available in the market, for our solutions to have quick market adoption, we must offer values that are significant. Consolidation of information shown in easy format, unique relevant features that differentiate our products from others in a significant way, as well as pricing that matches the ROI <p>One of the biggest challenges we faced is how to prioritize the industries we should focus on. Since chemicals are used in 96% of worldwide products, our software solutions can be useful for almost all industries. With access to the most comprehensive toxicity database in the worldwide market covering most organic, inorganic chemicals, polymers, we can create wide range of industry-specific solutions. We decided to initially focus on Pharmaceutical industry and education sector to build a robust tool with rich features that help research departments. We received very valuable feedback that helped us enrich our product, and are receiving experimental data that has enriched our database.</p> <p>Now we are expanding our focus to consumer products manufacturer sector and are gaining rapid traction.</p> <p>Second biggest hurdle we are experiencing is the reach to the investor community in Silicon Valley, California, for whom Green Chemistry is a new and unknown market. We need Seed Funds to help us recruit one of the most respected expert in Green Chemistry, and to support the enterprise customer's high-security requirement, so that they can use our tools to evaluate the toxicity measures of their proprietary chemicals.</p> <p>Understand who your stakeholders are, and get full understanding of the market pain, before you design your solution. Develop solutions that are easy to understand and use.</p>