



One Company – Two DOE Funded Technologies that Impact Climate Change on Multiple Fronts: **Plastics, Personal Care Products, and Lubricants**

Utilizing DOE SBIR funding, RiKarbon has developed technologies for cost competitive renewable products that use non-conventional and waste feedstocks to serve the domestic and international specialty and performance chemicals market. RiKarbon products improve U.S. energy security and sustainability.

Funded by the Water Power Technologies Office (WPTO) within the Office of Energy Efficiency Renewable Energy (EERE) in 2018 to address needs by the hydropower community for environmentally-acceptable lubricants (EALs), RiKarbon received Phase I and Phase II awards (DE-SC0018789) to develop 100% bio-based lubricant base oils from sustainably sourced, non-food waste materials (agricultural waste and other bio-based feedstock). Validated at pre-pilot scale with global entities, the lubricant base oil is stable, structurally similar to commercial petroleum-derived poly- α -olefin (PAO) lubricant base-oils and has compatible specifications to meet existing industrial, marine, consumer and niche applications where 2cSt PAO is currently used (hydraulic fluids, compressor oils, engine oils, greases, and functional fluids). This technology mitigates carbon emissions in addition to improving U.S. energy security and sustainability.

Originally targeting hydropower and marine lubricants, customer discovery helped the company better understand the challenges facing the lubricant market and the volumes needed. Hundreds of points of contact were gleaned through conference participation, LinkedIn, and TABA resources so that discussions could be held. For the chemical market as volume goes up, price comes down. For a small company, it would be difficult to hit break-even...or at least it would take a very long time. Small companies can manufacture 1000s of tons of a material but not the millions of tons required to break even. BUT their customer discovery also helped them identify another application for the base oil within the personal care market. What is unique about the personal care market that made it particularly appealing is that it needs only low volumes of a much higher value product enabling RiKarbon to make money while only manufacturing 1000s of tons not millions of tons. PERFECT! Dr. Basudeb (Basu) Saha, founder and CEO of RiKarbon adds “it is interesting that while the commercialization plan submitted with their Phase II application called out the personal care market as a secondary market, it quickly became the primary market for us as a business because of the lower barriers to revenue generation”.

Even with the smaller quantities required, RiKarbon readily learned that they would need to leverage partners for manufacturing. Utilizing a toll manufacturer, they were able to mitigate scale-up risks and even made ~ 3X reduction in cost between Phase I and Phase II. Throughout this time, they were still very engaged with potential partners – one of whom was becoming more and more interested, BASF. In 2021, RiKarbon, BASF and the toll manufacturer they were working with to deliver incremental increases in volume agreed on costing and delivery. BUT when RiKarbon went back to the toller to get started, they were no longer able to meet the delivery schedule – in fact, they were going to have to push the delivery schedule out by an entire year! *The lesson here for other small businesses – never expect things to go as planned...but even so, plans can still work out.* At this point, RiKarbon had no option but to reengage the business opportunity with BASF a bit differently. The silver lining, BASF was so interested in the technology that they suggested a licensing agreement. This was a win for all as BASF was able to meet their volume requirements by doing their own manufacturing, RiKarbon was able to begin generating revenues and the public was finally able to see the anticipated societal benefit mentioned in RiKarbon’s 2018 Phase I application. BASF wanted to license all products but, in the end, RiKarbon only relinquished one product with defined specifications. *Another lesson - don’t put all your eggs in one basket at the outset...keep your options open.*

RiKarbon is continuing working with a number of global lubricant companies to commercialize its 100% bio-based base oils for the lubricant market, a promise it originally made in their 2018 Phase I application. RiKarbon is also expanding its technology scope to produce higher viscosity bio-PAO products by leveraging Phase I and Phase II awards (DE-SC0021559) awarded in 2021 from Basic Energy Sciences (BES) within the Office of Science. Here, RiKarbon is developing technology to turn agricultural waste into 100% bio-based 4cSt PAO lubricant base oil for the larger lubricant market. 4cSt PAO, currently manufactured from petroleum, is used in the formulation of industrial, automotive, food grade, marine and consumer lubricants. Providing environmentally-acceptable lubricants (EALs) improves U.S. energy security and mitigates climate challenges.

In parallel, RiKarbon was also interested in developing a sustainable feedstock from discarded plastic. Approximately 99% of all plastics produced are derived from fossil fuel feedstock making plastic production one of the most greenhouse gas (GHG) intensive industries. Funded by the Bioenergy Technologies Office (BETO) within EERE in 2020 to facilitate a sustainable feedstock supply, RiKarbon proposed the development of upcycled feedstock from discarded plastics collected from the ocean as a replacement for intermediate feedstocks currently produced from petroleum. Utilizing Phase I and Phase II funding (DE-SC0020939), RiKarbon developed the RiPurpose™ technology. Dr. Dana Mitchell from the Bioenergy Technologies Office says, “together with their characterization and processing of ocean-borne discarded plastic, RiKarbon is lending new insight into recycling this material”. Produced from 100% post-consumer plastic, the technology breaks down post-consumer polyethylene terephthalate (PET) plastic into low molecular weight oligomers enabling PET or PET raw materials manufacturers to deliver more environmentally friendly products to satisfy not only end-user demands but also 2025 plastic bottle mandates. RiPurpose™ technology benefits include: low temperature hydrolytic depolymerization, room temperature product separation and the use of mixed color plastics/caps/labels (i.e., there is no separation requirement of the collected post-consumer plastic containers). The process requires no petroleum derived solvent and offers manufacturers up to a 68% CO₂ emissions reduction.

In the case of RiPurpose™ technology, customer discovery helped RiKarbon understand that they didn't have to produce the end-use product but rather could customize the waste PET into PET's building block oligomers for use as a versatile green feedstock to meet multiple polymer manufacturing needs for existing industrial, consumer and niche applications (packaging, containers, fibers, hot glue, pressure sensitive tapes, pads, labels etc.). Understanding this helped with cost, separation efficiency and applications ultimately helping RiKarbon clarify their strategy to market. Because of the specifics of the technology, RiKarbon can do the manufacturing scale up independently. RiPurpose™ enables PET or PET's raw materials manufacturers to use waste plastic to produce end-use polymers or polymers' building block intermediate feedstocks that are currently produced from petroleum. This technology mitigates environmental plastic pollution and climate challenges in addition to improving U.S. energy security and sustainability.

Commercialization is underway at RiKarbon. Following its successful scale-up, the company is now selling its RiPurpose™ Olig product for renewable PET and other high value target applications (adhesives, polyurethanes, epoxies, polyamides, etc.). The company has several partnerships with existing PET and PET raw materials manufacturers and post-consumer plastics sourcing companies for commercial scale deployment of the technology. The RiPurpose™ feedstock is available for purchase from its distributor, [PoliSciTech](#), and directly from RiKarbon.



RiPurpose™ Olig

Advice from Dr. Basu Saha, founder and CEO of RiKarbon. “Coming from academia, you hear how important customers and partners are, but you don't really understand their importance until you get started. Customers and partners are so very important. Voice of the customer is REAL. When you first come from academia, you have a big ego to go along with your big idea. You are going to commercialize your idea, and everyone will want it. But it really is the opposite. You have to go and talk to your customers, find out what they want/need and develop that product. It is a completely opposite way of thinking for most scientists.” It is really important to speak to the leaders in the industry – the established companies – they really know the industry needs and the strategic direction it is headed. “When you have established a relationship with a potential partner, make sure you let them know about all of your products because you may find that they are interested in other technologies you have in development and surprisingly, you might find they have a product interest that you never envisioned.”

Government funding helps the innovator improve an idea and develop it into a product. “Without DOE funding, RiKarbon would not have had the funding to develop these technologies and would not have been able to do the risk mitigation and scale up required to establish relationships with our commercialization partners. The funding has led to job creation and revenue generation. Using the [Phase II diversity supplement](#) enabled us to add two summer interns as well!”

Final words of advice - “there will be challenges – use the DOE funding wisely – talk to customers.”