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A Conversation with Dr. Pramod Chaudhari

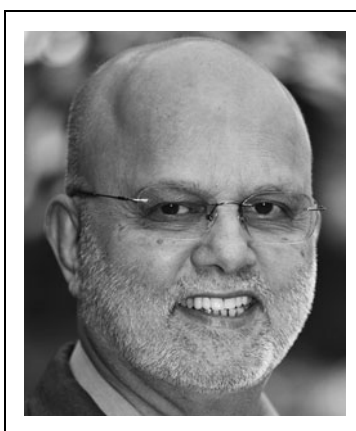
Pramod Chaudhari, chairman and founder, Praj Industries, Pune, Maharashtra, India

Pramod Chaudhari founded Praj Industries nearly 40 years ago because of his affinity for agriculture and a belief that a thriving bioeconomy would benefit both India and the world and with an objective of becoming a significant contributor to mitigating the catastrophic effects of climate change.

Today, Praj boasts a diverse portfolio, thriving ethanol business, global licensing agreements, renewable natural gas and biomaterials. The company has developed proprietary technology-enfinity™, to produce advanced biofuels from cellulosic biomass and has set up a demonstration-scale facility. Praj has developed technology to produce advanced biofuels from cellulosic biomass and operates a demonstration-scale facility. It has signed three contracts for commercial-scale advanced biofuels refineries based on its enfinity™ 2G technology. The first—a 100-kiloliters per day facility at Panipat, Haryana built and operated by Indian Oil—came online in August using rice straw as feedstock. Licenses have also been signed for 2G ethanol plants at Bhatinda, Punjab and Bargarh, Orissa, with Hindustan Petroleum and Bharat Petroleum, respectively.

The company is also working on commercializing sustainable aviation fuel, for which it has a partnership with Colorado's Gevo Inc. Research efforts are underway for biobased marine fuels and biohydrogen as well. *Industrial Biotechnology* recently had the opportunity to interview Dr. Chaudhari about Praj's journey, his perspectives on bioeconomy development in India and globally, and his hopes for a cleaner future.

INDUSTRIAL BIOTECHNOLOGY: Dr. Chaudhari, congratulations for being chosen as winner of William C Holmberg Award for lifetime achievement in the bioeconomy. You are the first non-US citizen to win this coveted award, must be very fulfilling achievement. Please tell us more about it.



Pramod Chaudhari, PhD

DR. PRAMOD CHAUDHARI: I received the award for my work in ethanol and promoting bioeconomy. William Holmberg was with the US DOE and helped establish ethanol blending in gasoline in the late 80s and early 90s. I thought this was a very befitting recognition of the work done by my team. I was very proud to receive it and bring this honor to India for the very first time. I dedicate the award to my Praj colleagues, who shared my vision and worked tirelessly.

The first round of ethanol testing happened in India in 2001–2002. On a pilot basis, the policy was introduced for 5% blending in a few states. The real push for ethanol blending began in 2014. National Biofuels policy became fully effective in 2018. It took around 15 years to get the policy firmly in place across the entire country. It

was a massive effort on the part of all stakeholders. But once in place, it has taken off quickly, with accelerated implementation. India's commitment to ethanol blending was recognized as sustainable climate action at the recent COP27 summit in Egypt.

The Holmberg Award was further recognition that India is on the right track. At the recent ABLC Next 2022 Conference on Bioeconomy in San Francisco, India was recognized as the hottest destination in global bioeconomy. This is due to India's commitment to increasing blending percentages, rapid development of second-generation ethanol, and robust industry ecosystem across the value chain. India has declared that it wants to be energy self sufficient by 2047, when we will mark 100 years of Indian independence. India is also working toward net zero by 2070 for which a five-point roadmap is in place.

So, it was wonderful for our country to receive recognition as a hotspot and it motivates myself and my colleagues to strive harder.

IB: During that same conference at San Francisco, you unveiled your concept of Advanced Biorefineries. This is a term that has been used a lot and people tend to envision in different ways. Can you discuss your vision of what an advanced biorefinery looks like?

DR. CHAUDHARI: This is a pet project of mine. Praj initially had conceived and realized a conventional sugar refinery. Over

the years this evolved into a biorefinery with ethanol production and other co-products. An advanced biorefinery is the next step, making use of lignocellulosic feedstocks and making a variety of value added products—low carbon ethanol, biobitumen, and bioplastics like polylactic acid. We believe we can achieve this with minimum additions of equipment and investment. In this way, assets can be put to maximum use.

This is not necessarily new for Praj—we envisioned multifuel and multiproduct capabilities from a variety of feedstocks, including cellulosic biomass, bamboo, grass, and biomass waste at the beginning of the millennium. We see the value stream evolving to extracting sugars and using those sugars to make biofuels and chemicals. In short, the idea is to use whatever feedstock that is available locally to the maximize the value—improving the cost-benefit analysis. This is achievable, thanks to our second-generation technology.

We have done significant work toward value maximization. Praj's BioMobility platform of technologies includes conventional biofuels such as 1G ethanol, advanced biofuels namely 2G ethanol, renewable natural gas (RNG), next gen biofuels—sustainable aviation fuels (SAF) and future fuels such as biohydrogen, marine biofuels etc. If you are looking at a rice-based biorefinery, that is “starchy” feedstock, you can also make proteins as a coproduct. If the feedstock is lignocellulosic, then Biobitumen is the coproduct. Having a broad range of products and co products improves commercial viability.

The development in cellulosic ethanol space will help farming communities in Punjab and Haryana. The stubble that would otherwise be burned and pollute air is being used to make ethanol. One plant is online and the second will be commissioned early next year.

We are also in advanced discussions with potential customers to implement it in international markets.

We are also working on concept of plant modularization that will help us expand quickly. Construction takes a tremendous amount of time, cost and associated risks. But with modularization, we are able to bring down the investment in all parameters.

Very soon, we will be shipping modularized units for hydrogen plants for a customer in the USA. Our customers like modularization for its convenience and efficiency. The plug and play nature make our solution more attractive, especially where local costs are high and weather conditions are extreme.

Ethanol producers in the US are looking to modernize plants, especially to reduce energy and carbon footprints. Low carbon is especially important for sustainable aviation fuels. We are developing the modularized units for ethanol plants as well.

IB: Praj has been ramping up development of biopolymers. Can you provide our readers with an update on where you are in terms of development and commercialization?

DR. CHAUDHARI: Given the plastics waste crisis, we have identified biopolymers as a major focus area to provide environment friendly alternatives. We have developed several grades of PLA bioplastic as well as polyhydroxybutyrate (PHB)—both are biodegradable. Lab-scale experiments are successful and now we

are in the process of building a demonstration-scale plant that will allow us to showcase technical viability.

We are also looking for early-stage customers and partners. We are seeing good interest from the US. We have funded a biopolymer lab in partnership with renowned institution ICT, Mumbai, that will be very useful for testing purposes. Biopolymers will be used in different applications having various shapes and sizes. Hence properties of the material will be very important. The application lab will be critical to make sure performance is appropriate for specified usage. We can introduce tangible products in the market faster with the help of Potential partners who can provide insight on the performance. We've been working on biopolymers for 2 years and hope to launch a commercial product in 12 to 15 months.

IB: What are your thoughts on advanced recycling versus biodegradable polymers, and what roles they will play in a circular economy?

DR. CHAUDHARI: Biodegradable polymers and advanced recycling, both will be part of the circular economy. However, biopolymers will ultimately become more and more attractive. Biopolymers can also be recycled, either through composting or bio-reprocessing. I feel there will be a reasonable coexistence of the conventional polymers and biopolymers. Both will contribute in keeping the balance of carbon under control and minimize plastics in the environment.

Today, there is huge amount of plastic in the ocean. It affects marine life and hence is a big challenge that needs to be addressed on priority. Recycled polymers can also be used with bitumen in road construction. Initial experiments have shown very promising results. So, there are numerous solutions possible in circular economy by harnessing developments in bioeconomy.

IB: What policy mechanisms do you believe are most effective for cultivating a bioeconomy?

DR. CHAUDHARI: One policy the Indian government has instituted is called Viability Gap Funding, or VGF[, which provides up to 20% of the total project cost, normally in the form of a capital grant at project construction stage]. This really helps new technologies see the light of day.

There are also incentives and subsidies mechanism. Ethanol, for example, uses molasses from the sugar industry as feedstock. There's B molasses, where some sugars are left and you get a higher price for that. And there's C molasses and sugarcane juice. Similar incentives are available for grain feedstocks. Policy intervention of differential pricing for different layers of feedstock have improved commercial attractiveness and has helped ethanol producers develop a product portfolio.

These policies are helpful for everyone involved. For the government, it is saving foreign exchange. It is helping the farming and rural communities by way of additional income from Agri waste and job opportunities. Then there is environmental and health benefit as ethanol burns cleaner leaving less particulate matter in the air. The community benefits on multiple fronts. The work we do uplifts bioeconomy and whole economic cycle as such.

IB: What do you believe are the most significant benefits and challenges to bioeconomy development?

DR. CHAUDHARI: I would say the most significant benefit is what a thriving bioeconomy can do for climate and society. It also holds promise for economic development in rural areas; especially in developing countries, rural economies are important for inclusive growth.

There are still several challenges to overcome. One is how to effectively manage locally available raw materials supply chains. To be sustainable, economically and environmentally, you can't ship feedstocks all over the world. With bioproducts, you can't think in terms of huge scale and capacity that oil industries have. This shift towards decentralized small scale biorefineries is difficult to comprehend from supply chain management perspective. As a solution we suggest processing biomass at the point of generation, reducing shipping and producing semi-processed biomass to reduce carbon footprint and increase convenience.

I think lack of awareness about huge opportunities bioeconomy presents, is also an issue. Consider the importance government has given to electric vehicles, for example—similar emphasis has not been paid to bioeconomy. Solar and wind have

also received a lot of attention. By comparison, bioeconomy has received far less publicity, and very few countries have a stated vision. India has taken great strides in this direction, but attention is lagging in other countries.

IB: As Praj nears its 40th anniversary, what are you most proud of?

DR. CHAUDHARI: I am most proud of the contribution Praj has made to India's social and environmental development. As a company, we contribute to nation-building. India is working to be energy self-sufficient. Currently we import 80% of our crude oil. Biofuels are playing an important role in reducing that dependence. India is already enroute to achieve 20% blending 2025, and flex fuel vehicles are expected to be introduced. India is taking bioenergy and climate action very seriously. And following this, we are working on sustainable aviation fuel that will eventually become mandatory, and we are at the forefront of this.

Our work in bioeconomy helping India to move towards fulfilling nationally determined contributions and sustainable development goals (SDGs) something I find great sense of fulfillment.