

Biodegradable and compostable bioplastics: Inflection point now in sight

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According to a recent analysis commissioned by European Bioplastics (an association based in Germany representing about 70 members from the entire value chain of bioplastics in Western Europe), global production capacity of bioplastics will grow from around 2.11 million tonnes in 2018 to about 2.62 million tonnes by 2023 (1).

Global production of plastics, for comparison, in 2017 amounted to 335 million tonnes.



Figure 1. Single-use glass (in PLA), cup and cutlery (from starch) and plate (cellulose and another biopolymer) in biodegradable or compostable plastics used at a Sicily's lido, July 2019. A ban on non-biodegradable plastics enforced since Summer 2019 locally forbids use of conventional plastics.

Starting from single-use products, biodegradable and compostable bioplastics is now ready to rapidly displace non-biodegradable plastics derived from oil on a global scale. The reason, we have lately explained elsewhere (2), lies in the pivotal role that China and India are up to play in this major shift to clean technology.

Accounting for about 37% of the world's population, China (1.4 billion people) and India (current 1.3 billion population) are well suited for large-scale bioplastics manufacturing from biological resources, exactly as it is happening with distributed energy generation thanks to solar and wind power.

To protect its environment, in 2017 China already banned almost all foreign plastic waste imports, causing troubles to most world's plastic waste processing plants. In mid 2019, China's president stressed once again the importance of pollution prevention and control for a truly sustainable economic growth, threatened by polluting technologies such as the use of polyethylene mulch sheets. For example, residual plastic in the top 0.3 m soil layer from such non-biodegradable

sheets (usable for one season only), in 2014 was estimated to vary from 72 to 260 kg/ha, significantly diminishing crop yields (3). Alone, the consumption of polyethylene mulch sheets from Chinese farmers has increased from 6,000 tonnes in 1982 to 1.2 million tonnes in 2011.

It is instructive, then, to learn that in late 2018 a subsidiary of China's state-owned and largest food company began mass production of PLA for packaging its products; or that a Chinese corn processing company along with a sugar company from Europe is building a PLA plant in Anhui Province with a capacity to produce 100,000 tonnes per year by 2020 (4).

In this context, India will not repeat what occurred with its solar cell manufacturers which, likewise those based in Europe, share now a negligible fraction of the >100 GW global yearly production, most of which taking place in China (5).

Indeed, on August 15, 2019, in his Independence Day address, India's premier called for a nationwide ban to eliminate single-use plastics (starting with plastic bags, cups and straws) beginning on October 2, 2019. Several companies already manufacture and innovate in the field of bioplastics in India. One already commercializes entirely biodegradable plastic bags at Rs 3, when previous generation compostable plastic bags in 2012 were selling at Rs 25 (6).

In mathematics the inflection point is the point on a concave (downward) curve where it becomes convex (upward) or vice versa. In management jargon, an inflection point is identified as a moment in time when a driving force leads to disruptive change. In the case of the chemical industry, such driving force, is a combination of global societal megatrends which will shortly reshape the industry (7).

Skeptical managers of today's chemical companies in conventional plastics may wish to learn from what is happening to gas turbine manufacturers for thermoelectric power generation, whose global market has gone from 71.6 GW in 2011 to about 30 GW in 2018 (8). Such dramatic decrease has not been due to lower power and energy demand, which on the other hand has continued to increase, but rather to large-scale adoption of photovoltaic and wind

power occurred in the same years. As the global uptake of solar and wind energy is now touching all countries, well beyond China, Germany, India, Italy, and the USA, the natural gas turbine market will continue to shrink.

Critics of renewable energy for about a decade pointed to its "unsustainable high costs". When the cost of generating electricity using PV modules became the cheapest among all energy sources, they switched their arguments to the "intermittent and intrinsically unreliable nature" of energy generated by weather- and time-dependent sunlight or wind.

Even in a remote Hawaii's island only in the course of the present year (2019) one utility company will save the large amount of money previously needed to import more than 1,000 tonnes of diesel fuel. The latter fuel previously burned in a thermoelectric power plant is now replaced by the energy generated by a 28 MW solar photovoltaic park coupled to storage in a 100 MWh Li-ion battery energy system (9). The electricity supplied by the new renewable energy system, furthermore, is of much *higher* quality (frequency of the alternating current, and stable voltage) than that generated by burning diesel fuel.

Producing bioplastics requires either processing natural polymers or fermenting sugars, and is ideally suited for distributed manufacturing. In a rush to lowering production costs, bioplastics manufacturers across the world will increasingly adopt efficient, continuous production technologies based on heterogeneous biocatalysis, (10) similar to those based on heterogeneous chemocatalysis employed by the petrochemical industry, even though on different scale and under much milder reactions conditions.

By 2023, with India and China leading the global market, we may expect a much larger bioplastics production than forecasted 2.62 million tonnes.

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