

MARKETS & INSIGHTS #6

Biomimicry for the energy transition



As the COP26 in Glasgow just ended and the IPCC is preparing to publish a report on climate change, the first extracts of which are alarmist, the subject of energy transition is more than ever at the forefront. Scientists and public authorities alike are looking for solutions that would allow the use of cleaner energy sources and less expensive consumption patterns, particularly in environmental terms. Faced with these new challenges, biomimicry is making inroads and could become one of the key tools of the energy transition given how multifaceted this approach is.

The concepts of biomimicry & bio-inspiration

These two concepts are still relatively unknown, but behind these somewhat obscure terms lie realities that are well known to all. Biomimicry is about innovating and developing engineering processes by applying and extrapolating what plants and animals can do. Humans have always been inspired by nature and the most cited example of biomimicry is Velcro. This technology was invented thanks to the observation of a plant called burdock. This plant has hooks that can be made, unmade and reshaped, allowing it to spread its seeds. There are many other 'inventions' that can be described as bio-mimetic, and the field of possibilities is seemingly endless. This is particularly true when applied to the energy transition.

The notion of biomimicry is of ancient inspiration, but it was only recently theorised by Janine Benyus in a series of works including her book "Biomimicry: when nature inspires sustainable innovations" published in 1998. The Larousse dictionary defines biomimicry as "a sustainable innovation approach that consists in transferring and adapting to the human species solutions already developed by nature (fauna, flora, etc.)".

To illustrate the interest and challenges of biomimicry, we can cite the example of spider thread. This animal is known for weaving a thread that has incomparable physical properties: it is extremely light and has a high elasticity, while also being incredibly resistant - three times as much as Kevlar and five times as much as steel - and capable of absorbing great shocks. Spider yarn is also biodegradable and biocompatible, i.e. tolerated by the human body. Successfully reproducing this material artificially would open the way to a wide range of applications: parachute cloth, protective helmets, light but resistant suspension cables, bullet-proof waistcoats, and even surgical wire. Even more interesting from an environmental point of view, the teams of researchers who have already succeeded in designing a material similar to spider silk have done so by respecting the natural process: the spider weaves its web at room temperature and using mainly water. By taking inspiration from this arachnid, humans could create a material with extraordinary properties and a much lower environmental impact than the production of nylon, which uses polluting chemical solvents and requires very high temperatures. This could prove to be a revolution for the textile industry, which is known to be very

harmful to the environment. For the time being, many research teams have developed manufacturing processes, but no team has succeeded in bringing its project to an industrially viable scale.

This example highlights one of the main interests of biomimicry: living organisms have been perfecting themselves for billions of years through natural selection and have therefore arrived at highly studied modes of operation. Moreover, nature always aims to optimise its functioning rather than maximise it, i.e. it always seeks to consume as little energy and resources as possible to achieve maximum power and efficiency.

The path to sustainable innovation

As regards the energy transition more specifically, biomimicry is leading to the development of solutions that allow for more efficient production of "clean" energy. In terms of solar energy, for example, research is being carried out to produce artificial photosynthesis directly inspired by the plant world. Indeed, plants - and some animals - have the capacity to capture solar energy and transform it into a reserve of energy that can be used in the future: thanks to the energy intercepted, plants produce a reaction between carbon dioxide (CO₂) and water, which in turn leads to the production of carbonaceous molecules. Research teams have therefore been trying for several years to copy this *modus operandi*, which would have the advantage of generating electricity or hydrogen in an optimal and green way while capturing CO₂ present in the atmosphere. Hydrogen is a widely used source of energy, but its production is for the moment quite polluting, and the development of an ecosystem around "green" hydrogen is currently the subject of ambitious public plans which could be based on this approach.

Another example is wind energy and a Tunisian company that has set out to revolutionise electricity production with turbines inspired by the flapping of hummingbird wings. These new types of wind turbines suffer less loss, can be active in strong winds and require less surface area on the ground, making it possible to install more of them in each target area and to increase the amount of energy captured. Lastly, the design of buildings that consume less energy, as in the case of a shopping centre in Zimbabwe that was inspired by the shape of a termite mound to optimise its air-conditioning system, is one of the avenues to be explored.

These various initiatives clearly illustrate the interest of biomimicry in accelerating the necessary energy transition. In addition to the fact that this methodology can be applied at various scales, both nano and macro, it can concern all areas of our lives: biology, medicine, architecture, physics, etc. It is an intrinsically sustainable model that aims to reconcile human activity with the preservation of biodiversity and resources.

There has been renewed interest in the subject in recent years. As early as 2007, a report by the French Senate on biomimicry as one of the tools of the new industrial revolution and the CNRS ("Centre National de la Recherche Scientifique", the French public institute for scientific research) has made it one of its strategic priorities for the period 2020-2023. Several initiatives are also aimed at making this approach better known and more widespread. Beyond declarations of intent though, public investment still seems to be very low in view of the potential of biomimicry. The movement is therefore probably only at the beginning of a strong growth.

A vast and as yet relatively untapped potential

An economic report by the Fermanian Business & Economic Institute published in 2010 estimated that by 2025 this market could be worth \$1,000 billion and employ 1.6 million people in the United States. This report is not without biases and relies on assumptions that can be described as optimistic, but it does have the merit of imagining the growth that this market could experience. It is reasonable to assume that significant capital flows can be expected in the coming years and it is likely that over time a real market will develop in standard phases. Start-ups are already emerging, as is currently the case for instance with Bioxegy in France, which supports the R&D teams of major industrial groups in designing bio-inspired solutions. These large groups are also working on these subjects internally and greater market integration could take place at a later stage.

From an investor's point of view, there are currently relatively few easy-to-access vehicles for gaining exposure to this theme, but there is no doubt that it should be closely monitored in the coming years in view of the colossal potential it represents.

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