# Building the BLUE ECONOMY

Nature itself shows us how to innovate, generate wealth and create jobs. By Gunter Pauli

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**HUMANITY'S LEAP TOWARD** sustainability requires more than buildings with a green feature or a recycling program for a single waste stream. We will achieve sustainability when we design our systems the way ecosystems function and evolve. Ecosystems connect, creating networks of networks, where each contributes to the best of its ability, operates with clearly defined boundaries and endlessly cascades nutrients and energy using the enduring laws of physics. The same management principles apply in deserts, alpine mountain ranges, wetlands or tropical rainforests.

Traditional business thinks that only shedding jobs can increase productivity. Nature knows better. At a time of crisis, with millions out of work and hundreds of millions facing bleak futures, we need to put the blue job machine to work. Natural systems unleash local entrepreneurship. They show us the ways of right livelihood, what is right for the planet, right for the commons and right for a generation of youth seeking useful, rewarding work.

Today's business models have failed. The path to success through mergers and acquisitions, leveraged assets, permanent debt and exotic financial tools was really a path to collapse. This generation and future ones are threatened with trillions in debt, with no promise or hope of increased well-being.

Today's green business model has also failed to achieve its vision and goals. The idea that business would provide more capital and consumers would pay more to reduce our carbon footprint languished even when everyone believed the economy would grow forever. When governments are sinking into debt and millions are unsure they will have a job tomorrow, how can paying more motivate anyone? This model, rooted in romanticism, can only succeed for those who are wealthy enough to equate a cleaner conscience with a cleaner planet.

Replacing a toxic process with a less toxic alternative is "doing less bad." This is exactly the approach that sees billions of dollars invested in less toxic and longer lasting batteries. Yet, even less toxic batteries rely on mining, smelting and toxic chemistry. Even less toxic batteries will be dumped into the environment and landfills, poisoning our ecosystem and posing long term health hazards. Is it enough to do less bad? A thief is a thief even if today's theft is less than the last. Companies receive environmental awards for polluting less even as they continue polluting!

The Blue Economy replaces bad with good. For example, fire- and flame-retardants produced from food-grade ingredients protect without endangering our food supply or poisoning our homes. Blue transcends green because it does not depend on wealth or capital to afford economic or ecological savings. Instead, it orders and joins processes through the wisdom of nature. It works in the First World; it works in the Third World. It produces revenue rather than promises of something good downstream. It produces jobs.

Biomimicry has shown us the wonders nature can teach us. Yet, these ideas have had no appreciable effect on even First World economies with capital, much less Third Word economies without. Blue transcends green because it does not simply marvel at nature but follows nature's systems and considers the whole. In a blue economy, sustainable efficiency is achieved by substituting what is not needed with what is functional and by combining several innovative technologies into an integrated whole, just as habitats and ecosystems do.

Every people, every nation needs pragmatic means to achieve sustainability and resource efficiency. The principles of the Blue Economy will work because they can be, and have already been, adopted in commerce, large and small. Cheerleading people to do the right thing or incremental improvements in energy efficiency will never accomplish what can be achieved by producing income, cutting costs or improving marketability. The Blue Economy seeks sustainability by creating economic value. Business can use these principles to become more efficient, to provide jobs and to earn income while reducing the risks and social costs of pollution. Young entrepreneurs, and entrepreneurs young at heart,

can develop sustainable enterprises that offer meaningful work, valuable products and social equity.

The Blue Economy articulates a set of principles. One central principle is to cascade nutrients and energy the way ecosystems do. A cascade is a waterfall. It requires no power; it flows with the force of gravity. It transports nutrients between biological kingdoms—absorbed minerals feed microorganisms, microorganisms feed plants, plants feed other species, with the waste of one becoming nourishment for another. Cascading energy and nutrients leads to sustainability by reducing or eliminating inputs such as energy and eliminating waste and its costs, not just as pollution but also as inefficient use of materials. In ecosystems there is no waste because the byproducts of one process are inputs to another process.

These principles closely align with the ways ecosystems thrive: All aspects are sustainable; toxins are contained; use what is locally available, such as naturally recurring energy resources that depend on the laws of physics; respond to all environmental and human needs; always evolve to higher levels of efficiency, from efficiency to sufficiency to abundance; always cascade energy and nutrients, leverage multiple revenue streams to create a geometric return on investment; leave nothing to waste, everything generates value; everyone plays a unique role—full employment; use a bundle of innovations to solve a systemic problem.

**Innovators around the world are finding ways to use natural physics and biochemistry to cascade matter and energy in fully harmonious and renewable flow**

One example to light our way forward and exemplify the principles is the case of the silk worm: its nontoxic, natural biopolymer and its ecosystem. Millennia ago, when the Chinese faced a growing demand for food and limited land, they embarked on a quest for additional arable farmland. They learned that the wild moth's caterpillar, known as the "silkworm"—even though it is not a worm—converts leaves to nutrients, which easily blend with soil bacteria, quickly attracting micro-organisms. They hypothesized that this natural symbiosis of caterpillars and trees could regenerate and maintain soil fertility, thus guaranteeing food security for an expanding population.

When, according to Chinese legend, the Chinese Empress Si-Ling-Chi ("lady of the silkworm") discovered the manufacture of silk, the experiment that had begun to regenerate topsoil led to the production of silk cloth. Thus, when synthetic polymers made from petrochemicals replaced a renewable (silk) with a non-renewable (petroleum), farmlands were deprived of millions of tons of fertilizer. The millennial experience of regenerating topsoil fell into oblivion since its byproduct could not compete in the modern market. Worse, while plastics and polymers made their inroads into every segment of society, the land now required fertilizers for continued production. This increased the energy input for fertilizers, furthering our dependency on fossil fuels and increasing greenhouse gas emissions.

The Silk Group in Oxford University's Department of Zoology, directed by Professor Fritz Vollrath, is a creative resource for biocompatible polymers. While working in Panama, Vollrath encountered the "golden silk orb weaver" spider. By studying how this spider composed and recycled its silk, and its three-dimensional spinning techniques, the Silk Group is able to produce equipment and processes to manufacture silk tubes and filaments as conduits for nerve regeneration, medical sutures and medical devices to regenerate damaged cartilage and bone tissues, as well as replacing titanium in products as varied as airplane parts and razors. If we compare a the life cycle of titanium with the simplicity of converting mulberry leaves to silk, or to manufacturing processes that control pressure and moisture at more-or-less ambient temperatures, we quickly understand how we can move toward sustainability with the outcome of greenhouse gas reduction.

Likewise, if you only sequester the $CO_2$ produced by carbon-based electrical generation, you only reduce the load. If you use a generation station's existing water retention basins and produce algae with the exhaust $CO_2$, you eliminate the $CO_2$ and produce biofuel. Ninety percent of the infrastructure is already in place and financed. Therefore, fixing carbon requires only a small additional investment and the new revenue stream from biofuel more than compensates for the cost. Compare this with pumping $CO_2$ into oil wells or the deep under the ocean. In Brazil, applying this approach produces four cash flows: carbon credits, spirulina for nutrition, fuels made from the algae lipids and esters from the algae remains, which are ideal for cosmetics.

The conversion of this massive waste, especially agro-waste, finds profound inspiration in ecosystems. Take the case of sugar mainly sourced from cane. The sugar content of cane is limited to 10 to 15 percent. Thus, each ton of sugar produced accounts for only 10 to 15 percent of the biomass. The rest is waste known as "bagasse." Bagasse is typically incinerated and provides a cheap source of energy. Where natural systems seldom use fire as a source of energy, we humans use fire all the time. To us, it so often seems the best way forward that we ignore better options. The only component of bagasse that really provides energy is lignin. The rest, hemicellulose and cellulose, creates massive carbon emissions because these substances burn without contributing useful heat.

PHOTOGRAPH: GUNTER PAULI

It makes ecological sense to use bagasse to produce paper and cardboard. Of course, paper industry officials will argue that it is not the right type of fiber. Given current production systems and the one-and-only myopia derived from decades of research and development, they are right. This tropical fiber does not fit their supply chain management, which is based on pines and eucalyptus, which are planted massively around the world. However, a quick calculation produces some astonishing figures. At a rate of 15 to 30 tons per acre annually, bagasse provides 100 to 200 tons of fiber during the seven years required to grow the fastest-growing pine trees to maturity. In terms of fiber, sugar cane beats the best genetically modified trees from temperate climates. Paper or pollution?

Solar power concentration is already an emerging and proven industry in Spain. Concentrating solar energy using optical principles inspired by the dragonfly can power a generator, a technology that is well developed and easily implemented. By 2050, annual investments in concentrated solar power could exceed $100 billion, creating almost two million jobs and saving 2.1 billion tons of $CO_2$.

A vortex can remove air, salt and other impurities using only the force of gravity. Vortex technology allows the water that flushes toilets on the 10th floor to be reused just one or two floors below, thus reducing by a factor of 10 the water wasted flushingtoilets. By employing gravity-powered vortex devices to replace the toxic chemistry used to purify water, or the energy required to make potable water from the sea, we move a bit closer to a sustainable world.

If you produce ice, you freeze both water and air. Air is an insulator and the energy needed to freeze and maintain the ice in hockey rinks and ice arenas is dependent on the amount of air the water contains. Many cities around the world find that the energy costs of ice rinks are one of their highest expenditures. When a vortex eliminates the air, the energy savings are a positive contribution, reducing costs and decreasing the effect on climate change by eliminating the greenhouse gases from 100,000 kW hours per year of electrical generation.

An initiative by Carmenza Jaramillo in cooperation with the Colombian Coffee Growers Association demonstrates the possibility of converting biomass wasted on coffee farms to food, providing proof that a cash crop's waste can provide food security. The research started in 1994 and built on the pioneering work of Professor Shuting Chang of the Chinese University of Hong Kong, who generated as many shiitake mushrooms on coffee waste substrate as on oak trees that were logged and shredded to dust. Ivanka Milenkovic of the University of Belgrade contributed scientific research establishing that, after harvesting the mushrooms, the spent substrate is a quality animal feed. The supply of mushroom and animal protein increases disposable income while providing cash from exports. This system positively impacts the provision of food and creates local employment. As a result, today an estimated 10,000 people have direct and indirect jobs, including distribution and packaging.

An extension of the program in Zimbabwe headed by Chido Govero lifts orphans out of poverty. The employment potential exceeds 50 million jobs if all the coffee farms around the world were to apply this cascading of nutrients. If this program were extended to tea farms and apple orchards, the employment potential doubles to 100 million. The potential food generating capacity will exceed the present tonnage of all fish farming.

Such projects will usher in the Blue Economy. Innovators and entrepreneurs around the world are finding ways to use natural physics and biochemistry to cascade matter and energy in fully harmonious and renewable flows. They are accumulating wealth, generating value and providing jobs using what is readily available. In a Blue Economy, the current unsustainable models of production and consumption will be outdated and eliminated. A vicious cycle of over-exploitation of labor and the Earth, with an ever-increasing burden of carbon emissions, will cease. It will become a virtuous cycle of using what is available, increasing social capital incrementally and bringing innovations to the marketplace that help meet the basic needs of all. The Blue Economy can enhance our lifestyles, benefit our planet and use and conserve materials and energy in remarkable ways.

Let us cease to demand more of the Earth and those who toil. Let us do more with what we have, and with what nature generates unceasingly.