

The Emerging Green Hydrogen Economy - A MAHB Dialogue with Geoffrey Holland, Author of “The Hydrogen Age”



Photo courtesy of Geoff Holland

‘The transition to a clean, renewable hydrogen economy is already underway’ – Geoffrey Holland.

What does nature teach us about how to power life?

Geoffrey Holland - Nature has had millions of years to evolve the most efficient way to power life. It started with single-celled organisms and expanded as increasingly complex, multicellular plants and animals, including humans, evolved. At the most basic sub-cellular level, all of life survives and thrives on one common energy currency. It is the simplest, most abundant substance in the universe, the first element on the chemical periodic chart... hydrogen. Nearly 90% of all atoms in the universe are hydrogen atoms. All of life’s biochemical processes, at the most basic level, are powered by hydrogen, which is clean, non-toxic, and inexhaustible in supply. What we see now is an emerging era for humanity that will embrace nature’s example, by using sunlight, wind, and other sources of clean, renewable energy to produce electricity.

The problem with electricity is that it must be used when produced; otherwise, it is lost, unless... unless you employ a way to store it for use when and where needed. Nature does it by using hydrogen ions to store energy for use on demand. What we are learning early in the 21st century is that there is no better way to power human civilization than to emulate nature's example, using renewably produced electricity and hydrogen as two sides of the same, clean energy coin.

More and more, we are seeing catastrophic fires, floods, and other weather extremes that are linked directly to climate change. Can we afford to continue our long-standing dependence on dirty fossil forms of energy?

GH - The short answer is, no. Fossil forms of energy are literally made from long-dead plants and animals that have been reduced to basic hydrocarbons like coal, oil, and natural gas. Humans have been extracting and burning fossil fuels since before the beginnings of the industrial age. Our planet's atmosphere is literally flooded with human energy waste. I'm talking about heat-trapping pollutants like CO₂ and methane (CH₄); about 30 billion tons of CO₂ alone annually. The pollution we create traps the sun's energy. That makes the atmosphere hotter, and that translates to melting icecaps, sea-level rise, and extreme weather events that mean more frequent and more powerful wildfires, floods, tornadoes, and super-storms. There are now nearly 8 billion humans on Earth. The pollution we produce from our dependence on dirty fossil forms of energy is putting life on earth increasingly at risk. We humans have to mend our ways. That means ending our dependence on dirty energy. We have clean, renewable energy technologies to do it. We are already embracing nature's clean, efficient example at a cost that is more than competitive with fossil forms of energy. Hydrogen is a big part of what makes a clean energy future possible. Embracing green hydrogen now is not only the right thing to do, it is the only wise course.

The cost of wind and solar energy is already competitive or cheaper than natural gas or any other kind of fossil fuel. Are the big fossil players going away quietly?

GH – Big fossil energy owns Capitol Hill. They control US energy policy. The big players are not going away quietly; not without kicking and screaming and whining about their stranded fossil energy assets and lost profits. But the cost of wind and solar energy has massively dropped in recent years, to the point that electricity generated by wind or solar can be cheaper than energy derived from coal, oil, natural gas, or nuclear power. No matter how much political influence the fossil fuel industry has when the economics go bad for them as is happening now, they quickly lose sway in a world that wants and needs a clean, renewable alternative.

Wind and solar are intermittent in nature. The Sun doesn't always shine; sometimes it's windy, sometimes it's not. How do we get around that?

GH - There is a storage process called pumped hydro that has long been used in conjunction with river dams. The flow of a river passes over a hydropower dam, no matter what. At night, a massive surplus of dam generated electricity is available, no matter what. With 'pumped hydro', surplus dam-generated electricity is used to pump water to another reservoir at a higher elevation. Then you release that water to generate electricity when you need it. Systems like that are expensive to build, but pumped hydro can be a viable option. We also have batteries. They come in all shapes, sizes, and power ratings. In recent decades, batteries have gotten a massive research and development boost. The technology has rapidly matured. For many applications, batteries are a very good way to store and manage renewably generated electricity for use when and where needed. What batteries are not is a panacea. There is another method of storing electricity that complements battery storage very effectively. I'm talking about converting electricity to hydrogen. Hydrogen is not found freely in nature. Hydrogen atoms like to bind with other atoms to make compounds like methane (CH₄) and water (H₂O). Industry produces hydrogen commercially in a process called steam reforming, which costs a lot and pollutes a lot. The Nature-friendly way to produce hydrogen is called water electrolysis. It uses electricity to drive the dissociation of water atoms, separating the hydrogen ions from oxygen protons. What you get from that is called green hydrogen, when the electricity comes from wind, solar, or other clean technologies. For the longest time, green hydrogen has been too expensive for practical application. That is changing rapidly. Electrolysis technology has improved dramatically, to the point that green hydrogen, within the decade, is expected to be cheaper to produce than gasoline, or natural gas. That may sound like an overstatement, but it is not. That is what a review of the literature will tell you. Bottom line: nature has shown us the way. Hydrogen is the optimal clean energy storage medium for renewably generated electricity.

What does a green hydrogen economy look like, and how does it work?

GH - It would be a wonderful, life-affirming testimony to the human potential to adapt to protect the Earth biosphere we all depend on. The green hydrogen economy will run largely on clean, renewable sources of energy, including wind, solar, or an expanding number of other clean energy alternatives. Hydrogen can be burned in a mechanical engine or converted to electricity in a device called a fuel cell. Either way, the only exhaust byproduct is pollution-free steam. Fuel cells were first used in the space program. Since then, they have been adapted to a broad range of applications. In the next decade, look for hydrogen fuel cells to power cars, trucks, and other heavy-duty working vehicles. There are already railroad trains in Europe

powered by hydrogen fuel cells. Airbus and Boeing are looking at the next generation of commercial aircraft to be powered by hydrogen. Fuel cells are already used to power some naval submarines. They are now being scaled up to power the largest, seagoing bulk carriers. A green economy will reflect much of what nature teaches about how to sustain a global society that is good for people, and good for the biosphere. I think and I hope it will also mean that humans will finally understand we are part of nature, not above and superior to it. That's the kind of world we all should wish for.

Is safety an issue with hydrogen, and how does it compare to natural gas and other fossil fuels?

GH - Hydrogen is flammable, but it is no more hazardous than gasoline, or other hydrocarbon chemicals. In addition to being non-toxic, hydrogen is lighter than air. That means, free of containment, hydrogen dissipates rapidly and becomes harmless. The industry has been safely managing hydrogen as a commercial chemical commodity for decades. The US Department of Energy has affirmed that, when managed with reasonable safety protocols, hydrogen is less hazardous than hydrocarbon chemical commodities like gasoline that are used widely in human culture. There is no rational reason to fear a global transition to an economy powered by electricity and hydrogen.

In the US, the fossil fuel industry has long used its influence on public policy to dampen prospects for renewables and hydrogen. How do we change that?

GH - It starts with a well-informed public. We need public policy that puts the political power back in the hands of the people. The corporate media cannot be counted on to be an honest broker. It will participate only up to the point that an informed public becomes a threat to the powerful elites that own our politics. Social media can play a big role in getting the public behind a common, clean energy vision. The good news is the public, particularly young people, appear eager to support political candidates that offer real solutions to their concerns. One solution that is getting a lot of attention is the Green New Deal. In fact, it is a transformative idea, whose time has come. The Green New Deal is a massive jobs program combined with an assertive shift away from dirty fossil fuels to clean renewables and hydrogen. It is also about shifting political power away from self-interested profiteers to a form of democratic governance that puts nature, people, and the planet first.

How do you see government oversight and the role of electric utilities changing with a solar hydrogen economy?

GH - I believe we need a global legal framework that protects the living earth system we all depend on. It needs to obligate all the world's nations and people to a common, unambiguous set of rules and regulations for taking proper care of our planetary home. Fortunately, there is a global initiative called [Common Home for Humanity](#) that does just that. At the state and local level, we must elect government officials, who will enforce that commonly accepted legal standard that puts public stewardship of the planet first. As for the electric utilities, they are already starting to evolve toward being the keepers of the energy internet. They will continue to manage the powerlines, and the energy distribution infrastructure, but they are evolving away from being the primary source of electric power for their communities. In fact, electric power will be something to which every home in a community will contribute through residential solar panels. The production of energy will be democratized and become broadly participatory. That kind of system favors public ownership. I expect that the transition to clean renewables and hydrogen will result in more than a few electric utilities that have been privatized to be returned to public ownership.

Will human tribalism be our undoing, or will we learn to embrace our common humanity, and see ourselves as planetary citizens first and foremost?

GH - Self-interest is the hallmark of tribalism. It's a dead-end for humanity. The atmosphere doesn't recognize national boundaries. The oceans circulate on their own terms. The atmosphere does the same. Weather systems are predictable but not manageable. Moreover, they are being energized dangerously by heat-trapping pollutants that are entirely attributable to humans. We cannot afford to be divided by tribalism and self-interest. We have to get past that. We have to set aside our differences. If we can obey traffic signals and the rules of the road as standards that are in our best interest, we can learn to live under a globally accepted legal framework that will protect our biosphere. That is in our best interest. Our survival may depend on it. We can start by embracing a renewable hydrogen economy using design rules inspired by nature.

Can a transition to clean energy help us find and embrace our place in nature?

GH - There are forces at work in nature right now that are poised to overwhelm humanity. I'm talking about existential threats like climate change and resource overshoot including deforestation, loss of precious topsoil, the squandering of our freshwater aquifers, the strip-mining of our oceans, and the destruction of our planet's biodiversity, which is an essential store of strength and resiliency. We humans are destroying the biosphere. Our Earth's plant diversity is collapsing, and its wild animal populations are in freefall. Humans are entirely responsible. We must repudiate 'business as usual'. We must embrace our common planetary

citizenship. We have the technology. We can remake human society. The transition to a clean, renewable hydrogen economy is already underway. We should all get on board and accelerate the pace as rapidly as possible. COVID-19 is a global scale, wake-up call from nature. The time for a clean, inexhaustible green hydrogen economy has arrived. Let's get it done.

Geoffrey Holland is the lead author of, *The Hydrogen Age*, Gibbs-Smith Publishing, 2007. He is a veteran writer/producer of long and short-form videos focused on clean energy and the environment. He also happens to be the coordinator for the MAHB Dialogue series.

The [MAHB Blog](#) is a venture of the Millennium Alliance for Humanity and the Biosphere. Questions should be directed to joan@mahbonline.org