The Last Hours of Ancient Sunlight: We're Made Out of Ancient Sunlight

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Excerpt from the book.

We’re Made Out Of Sunlight

"The Sun, the hearth of affection and life, pours burning love on the delighted earth."

—Arthur Rimbaud (1854–1891)

In a very real sense, we’re all made out of sunlight. Sunlight radiating heat, visible light, and ultraviolet light is the source of virtually all life on Earth.

Everything you see alive around you is there because a plant somewhere was able to capture sunlight and store it.

All animals live from these plants, whether directly (as with herbivores) or indirectly (as with carnivores, which eat the herbivores). This is true of mammals, insects, birds, amphibians, reptiles, bacteria...everything living. Every life form on the surface of this planet is here because a plant was able to gather sunlight and store it, and something else was able to eat that plant and take that sunlight-energy in to power its body.[1]

In this way, the abundance or lack of abundance of our human food supply was, until the past few hundred years, largely determined by how much sunlight hit the ground. And for all non-human life forms on the planet, this is still the case—you can see that many of the areas around the equator that are bathed in sunlight are filled with plant and animal life, whereas in the relatively sun-starved polar regions there are far fewer living creatures and less diversity among them.

The plant kingdom’s method of sunlight storage is quite straightforward. Our atmosphere has billions of tons of carbon in it, most in the form of the gas carbon dioxide, or CO2. Plants “inhale” this CO2, and use the energy of sunlight to drive a chemical reaction in their leaves called photosynthesis, which breaks the two atoms of oxygen free from the carbon, producing free carbon (C) and oxygen (O2). The carbon is then used by the plant to manufacture carbohydrates like cellulose and virtually all other plant matter—roots, stems, leaves, fruits, and nuts—and the oxygen is “exhaled” as a waste gas by the plant.Many people I’ve met believe that plants are made up of soil—that the tree outside your house, for example, is mostly made from the soil in which it grew.

That’s a common mistake, however—that tree is mostly made up of one of the gasses in our air (carbon dioxide) and water (hydrogen and oxygen).Plant leaves capture sunlight and use that energy to extract carbon as carbon dioxide from the air, combine it with oxygen and hydrogen from water, to form sugars and other complex carbohydrates (carbohydrates are also made of carbon, hydrogen, and oxygen) such as the cellulose which makes up most of the roots, leaves, and trunk.

When you burn wood, the “sunlight energy” is released in the form of light and heat (from the fire). Most of the carbon in the wood reverses the photosynthesis.The small pile of ash you’re left with is all the minerals the huge tree had taken from the soil.

Everything else was gas from the air: carbon, hydrogen and oxygen.Animals, including humans, cannot create tissues directly from sunlight and air, as plants can. Thus the human population of the planet from the beginning of our history was limited by the amount of readily-available plant food (and animals-that-eat-plants food). Because of this, from the dawn of humanity (estimated at 200,000 years ago) until about 40,000 years ago, the entire world probably never held more than about five million human inhabitants. That’s fewer people worldwide than Detroit has today.I suspect the reason for this low global census is that people in that time ate only wild-growing food.

If sunlight fell on 100 acres of wildlands producing enough food to feed ten people—through edible fruits, vegetables, seeds and wild animals which ate the plants—then the population density of that forest would stabilize at that level. Studies of all kinds of animal populations show that mammals—including humans—become less fertile, and death rates increase, when there is not enough food to sustain a local population. This is nature’s population control system for every animal species: population is limited to what the local plant/food supply can feed.Similarly, people’s clothing and shelter back then were made out of plants and animal skins which themselves came to life because of “current sunlight,” the sunlight which fell on the ground over the few years of their lives. We used the skins of animals and trees (things that had consumed sunlight in recent years) to construct clothing and housing. All these are made from relatively current sunlight.

Extracting more sunlight—from other animals

Something important happened, sometime around 40,000 years ago: humans figured out a way to change the patterns of nature so we could get more sunlight/food than other species did. Our food supply had been limited to those plants and animals that were growing naturally around us. The human food supply was determined by how many deer or rabbits the local forest could support, or the number of edible plants that could be found or grown in good soil.

But in areas where the soil was too poor for farming or forest, supporting only scrub brush and grasses, humans discovered that ruminant (grazing) animals like goats, sheep, and cows could eat those plants that we couldn’t, and could therefore convert the daily sunlight captured by the scrub and wild plants on that “useless” land into animal flesh, which we could eat. So if we could increase the number of the ruminant animals through herding and domestication, then we could eat more of the recent sunlight they were consuming as grasses and plants which were previously useless to humans.This provided to our ancestors more usable energy, both as work animals and as food animals.

And so domestication and herding were born, for which we can find archeological evidence going back over 40,000 years. These practices flourished and spread because they let us eat more of the recent years’ sunlight from a given area of land by using animals as intermediaries.

Extracting more sunlight—from the land

About this same time in history, we also figured out that we could replace inedible forests with edible crops.

Instead of having a plot of land produce only enough food to feed ten people, that same land could now be worked to feed a hundred. The beginning of agriculture is referred to as the Agricultural Revolution, and it began to gather momentum about 10,000 years ago.

Because we had discovered and begun to use these two methods (herding and agriculture) to more efficiently convert the sun’s energy into human food, our food supply grew. Following the basic laws of nature, because there was more food, there could be more humans, and the human population started growing faster.Within a few thousand years of that time, we also discovered how to extract mineral ores from the Earth, to smelt pure metals from them, and to build tools from these metals. These tools, such as plows and scythes, made us much more productive farmers, so the period from 8,000 bc until around the time of Christ saw the human population of the world increase from five million people to 250 million people, a number just a bit smaller than the current population of the United States.

But we were still only using about one year’s worth of sunlight-energy per year, and so even though we were eliminating some competing or food-species, our impact on the planet remained minimal at worst. We weren’t “dipping into our savings” to supply our needs, yet.Then, as it happened, in the Middle Ages we discovered a new source of sunlight (which had been captured by plants nearly 400 million years ago) that fit in nicely with our new theory that it was acceptable for humans to destroy our competitors for food, to convert all resources of the planet to the production of food for humans: coal, by replacing forests as a source of heat and thus freeing land for agriculture, could be used to increase our production of food.

When ancient sunlight got stored in the Earth

Around 400 million years ago, there was an era which scientists named the Carboniferous period. Its name derives from the fact that at the beginning of this period there were huge amounts of carbon in the atmosphere in the form of carbon dioxide.

Carbon dioxide is a “greenhouse gas,” which holds the heat of the Sun against the Earth like the glass of a greenhouse, rather than letting it escape back out into space. During the Carboniferous Period, which lasted 70 million years and extended from 330 to 410 million years ago, there was so much carbon dioxide in the Earth’s atmosphere that the temperature of the planet registered much higher than it does today.The Earth is about 25% land and about 75% oceans, and at that time the entire planet’s land mass consisted of one huge continent which geologists refer to as Pangaea.Pangaea existed long before the arrival of birds and mammals, before the dinosaurs even, and the only life-forms on the planet were plants, fish, insects, and small reptiles. The high levels of carbon dioxide in the air both trapped sunlight energy as heat and provided copious carbon for the plants to use as raw material, so they grew abundantly. Virtually all of Pangaea was covered with a dense mat of vegetation, rising hundreds of feet into the air, creating a thick ground cover of rotting and dead plant matter that became, in some places, hundreds or even thousands of feet deep. The mats of living and dead vegetation became thicker and thicker as this phase continued over 70 million years.

As the plants grew ever more lush, they trapped more and more of the carbon from the atmosphere (converting it into cellulose as leaves, stems and roots), reducing levels of atmospheric carbon dioxide while retaining that carbon as plant material in the thick mat that covered the one continent of Pangaea.

At the same time, the oceans, which cover three-quarters of the Earth’s surface, were also home to huge quantities of plant matter, although much of this was of a simpler type such as single-celled algae and other microscopic plants. These, too, captured the energy of the sun near the surface of the oceans. They used that energy to convert atmospheric carbon dioxide into plant-matter carbon, and then died and settled to the ocean floors.Approximately 300 million years ago, a massive disaster occurred and created one of the five historical extinctions which have struck our planet. Nobody knows exactly why (a collision with a comet or asteroid is suspected), but a huge explosion of tectonic activity disassembled the continent of Pangaea and irrevocably changed the planetary environment.

The Earth’s crust was broken open in many places, volcanoes erupted, and continents crumbled and migrated. In those places where the land masses that were once parts of Pangaea collided with other parts of the former single continent, millions of acres of earth were covered by mountains or other land. The thick mat of vegetation sank underground, taking with it 70 million years’ worth of stored sunlight energy, locked up with carbon.Fifty million years later, the dinosaurs appeared, and another period of relative stability reigned on the Earth and what had become its two major continents, which geologists call Laurasia and Gonwanaland. The Triassic and Jurassic Periods came to an end 205 million years ago when, according to the most widely accepted scientific view, another meteor or asteroid struck the planet, triggering another great extinction which also extinguished the dinosaurs.

The planet moved into another period of geologic upheaval, and the continents of Laurasia and Gonwanaland broke into smaller parts, creating what we now call Asia, North America, South America, Europe, Australia, Africa, and Antarctica. Mountains were created as continents drifted into each other, and some of the plant matter, now millions of years old and hundreds of feet below the surface of the ground, traveled even deeper into the earth, where it was subjected to great pressures.

Using ancient sunlight

About 900 years ago, humans in Europe and Asia discovered coal below the surface of the earth and began to burn it.

This coal was the surfacemost of these ancient mats of vegetation—this 300-million-year-old stored sunlight—and by burning it humans were, for the first time, able to use sunlight energy which had been stored in the distant past.Prior to the widespread use of coal, our ancestors had to maintain a certain acreage of forest land because they needed the wood for heat to survive the cold winters in the northern climates.

Forests captured the “current sunlight” energy, and they could liberate that captured sunlight in a fireplace or stove to warm a home, cave, or tipi during the long dark days of winter.The exploitation of coal, however, reduced their reliance on current sunlight, allowing them to cut more forestland and convert it into cropland, since they no longer were absolutely dependent on the trees for heat. By making more croplands available, they were able to produce more food for more humans, and the population of the world went from five hundred million people around the year 1000 to the first billion living humans in 1800.

This represents a critical moment in human history, for this is when our ancestors started living off our planet’s sunlight-savings.Because our ancestors could consume sunlight that had been stored by plants millions of years ago, they began for the first time to consume more resources—in food, heat, and other materials—than the daily amount of sunlight falling locally on our planet had historically been able to provide.

The planet’s human population grew beyond the level that the Earth could sustain if humans were only using local “current sunlight” as an energy and food source.This meant that if our ancestors’ supply of coal had run out, they’d have eventually faced the terrible choice of giving up croplands (risking famine) so they could re-grow forests for heat, or having enough to eat but freezing to death in the winters. (Or, of course, they could have abandoned the colder climates, and packed their population closer together nearer the equator. But the historic movement of people had been away from the equator, a trend encouraged by the availability of fuel.)We see this same trend today: the availability of a fuel leads to a population that depends on it and will suffer if it’s taken away.Had our ancestors run out of coal, Nature would have taken over and limited their population.

Instead, our ancestors discovered another “bank account” they could tap, another reserve of ancient sunlight: the plant matter which hundreds of millions of years ago had sunk to the floor of the oceans, and had then been trapped below ground and compressed into what we refer to as oil.Another source of trapped sunlight, oil was first widely used around 1850 in Romania. The real boom began, however, in 1859, when oil was discovered in Titusville, Pennsylvania, in the United States. At that time, the world’s population numbered just over one billion people, and the human race was fed both by the current sunlight falling on croplands and their animals’ feed crops, and by a substantial amount of ancient sunlight that they dug up by burning coal taken from the Earth in Europe, Asia, and North America.The discovery of abundant supplies of oil, however, kicked open the door to a truly massive store of ancient sunlight.

By using this ancient sunlight locked up with carbon as a heating source and energy source, and by using it to replace farm animals with tractors, our ancestors increased dramatically their ability to produce food. (Draft animals such as horses and oxen run on “current sunlight”: the grass they eat each day, which was grown using recent sunlight. Thus they are limited in the amount of work they can do—whatever they can eat and convert to energy in one day—compared with an oil-fueled tractor which can burn in one day as much sunlight as would be consumed by hundreds of horses).[2]

More ways to spend our savings

It turned out that people could use oil for far more than just fuel, so as we moved into this century, we began “spending” more of our saved-up sunlight.Oil can be converted to synthetic fabrics (nylon, rayon, polyester), resins for construction of shelter, and plastics (for construction of almost anything, including the keyboard on which this is being typed). Because we could make clothes from oil, we needed less sheep-grazing land and cotton-growing land, thus allowing us to convert even more non-food croplands to food production.

The massive leap in our food supply that began just after the Civil War caused our planet’s population (figure 1) to go from just over one billion humans around the time of the discovery of oil to two billion in 1930.By 1930, we were beginning to use farm machinery extensively, and the use of oil as a means to increase agricultural production—from running tractors to converting oil into fertilizers to manufacturing pesticides—caused our food production to explode. While it had taken us 200,000 years to produce our first billion people, and 130 years to produce our second billion, the third billion took just 30 years.In 1960, world human population hit 3 billion.

But it didn’t stop there. We became more efficient at extracting this stored sunlight from oil, distilling it and making more efficient engines to consume it, and so our food production soared again. As did our population.It took just fourteen years, from 1960 to 1974, for us to grow to 4 billion humans worldwide.

We added another billion in just 13 years, hitting 5 billion in 1987, and our next billion will take only 12 years, as the world’s human population is set to hit 6 billion in 1999.By the fifth billion, in 1987, humans became the most numerous species on Earth in terms of total biomass. Around 1990, we became the most numerous mammalian species on the planet, outnumbering even rats. There is now more human flesh on the planet than there is of any other single species. We now consume more than 40% of the world’s total “net primary productivity” (NPP), which is the measure of the sum total of food and energy available to all species on earth. We consume more than 50% of the planet’s available fresh water. This means that every other species of plant and animal on the planet must now compete against each other for what little we’ve left.As is so well documented in Michael Tobias’ book World War III,[3] we’re currently adding a Los Angeles worth of people to the world every three weeks. In recent years, less than a tenth of a percent of the total history of humanity, we’ve experienced over ninety percent of the total growth of the human population.At the current rate of growth, we would hit 10 billion people in 2030, 20 billion by 2070, and 80 billion by 2150. But nobody expects this rate to continue: there simply isn’t enough food that can be produced. Whether what stops it will be famine, plague, natural disasters, or “good science” (such as sudden worldwide availability of and use of birth control) is a source of ongoing debate. But the fact that our current growth rate cannot continue is not in dispute.We have created this overcrowded world of overtaxed resources by consuming ancient sunlight, converting it into contemporary foods, and consuming those foods to create more human flesh.

Without this ancient sunlight, the planet could perhaps sustain between a quarter of a billion and one billion humans—the number it did support prior to the discovery of oil and coal. Without oil and coal, however, the other five billion would starve.So, how long will our savings hold out?

How much fossil fuel do we have left?

And so we enter the twenty-first century standing on a precarious ledge of survival. We are largely dependent on the continued availability of stored sunlight in the form of fossilized ocean plants, the fossil fuel we call oil. And, as it happens, the oil is running out.

Since the discovery of oil in Titusville, PA, where the world’s first oil well was drilled in 1859, humans have extracted 742 billion barrels of oil from the Earth. Currently, world oil reserves are estimated at about 1,000 billion barrels, which would last (according to the most optimistic estimates of the oil industry) “for almost 45 more years at current rates of consumption.”To those of us who hope to live another few decades, or have high hopes for our children’s and grandchildren’s futures, these numbers sound grim. That is in fact what the oil industry itself says we can expect, within our children’s lifetime.Oil company executives, however, don’t seem to think this is a problem.In an upbeat and optimistic speech presented to the Economic Club of Columbus, Ohio, in 1996, an Ashland Chemical Company executive pointed out that alternatives to oil as an energy source are “simply not cost-effective,” but that world oil reserves should last “almost” 45 years, assuming that consumption doesn’t increase at all from current-day levels.

Citing this as very good news, he concluded his speech by saying that pundits have forecast the end of our oil supplies virtually since the first well was drilled by Colonel Drake in 1859. But they’ve always been wrong in the past. In the happy view of the oil industry, he noted, “it will probably be several decades before the wolf is at the door.”Other experts in the oil industry are less optimistic about the so-called good news that we have “almost” a 45-year-supply of oil left in the ground. In fact, the Geneva, Switzerland-based international petroleum-industry consulting firm Petroconsultants points out that North American production of oil peaked in 1974.[4] (By the way, “production” is a nice Orwellian “newspeak” kind of term: we aren’t really producing oil, any more than miners “produce” silver. We just pump it out of the ground. It was produced from sunlight by vegetation 300 million years ago.) World production is expected to peak in the year 2000, when we have consumed over half the world’s oil supply.Sometime around this date, they suggest, world-destabilizing price explosions in oil-based products will begin to occur.

The Petroconsultants study points out that even with consumption dampened by worldwide reductions in oil usage because of increased price (and the probable worldwide depression which this would cause), declining supplies will cause oil supplies in 2050 to be at levels similar to 1960’s, when the planet only had 3 billion people on it. But most demographers expect that in 2050 the world population will exceed 10 billion.Imagine: 10 billion people alive, but fuel for only 3 billion. This would leave 7 billion people—more than the entire population of the planet today—living on the edge of famine.Then again, other experts suggest that the oil-industry estimate of 45 years is wildly inflated, meaning the situation is even worse than just described.

Scientist M. King Hubbert first pointed this out in 1956, when he developed the well-known “Hubbert Peak,” defining the moment when oil supplies have peaked and then begun a downhill slide. In 1956, he projected a Hubbert Peak for the US in 1970 (he was four years off: the oil crisis was in 1974), and in 1975 predicted a worldwide Hubbert Peak for 1999 or 2000. Although Hubbert died in 1989, his work was carried on by J. Colin Campbell, author of The Golden Century of Oil: 1950–2050: the depletion of a resource,[5] a book that originated as part of a study of worldwide oil supplies and consumption commissioned by the Norwegian government in 1989. In that book and other sources, Campbell and other scientists point out that oil producing countries often inflate their estimated oil reserves to qualify for higher OPEC production quotas, and so they can borrow money from the World Bank using their supposed oil supplies as collateral. He and other experts estimate that we’re already atop the halfway mark in the world’s total oil supply, and that there may be far fewer than 700 billion barrels still in the ground.It’s worth noting that it’s unlikely that we’ll be soon finding easily-accessible new pools of oil.

Most of the world has now been digitally “X-rayed” using satellites, seismic data, and computers, in the process of locating 41,000 oil fields. 641,000 exploratory wells have been drilled, and virtually all fields which show any promise are well-known and factored into the one-trillion barrel estimate the oil industry uses for world oil reserves.And, finally, the oil industry’s “optimistic” numbers say we have 45 years left at current rates of consumption. But according to data furnished by Petroconsultants (among others) world consumption of oil today is increasing at about 2.8 percent per year. If we were to project that out into the future, our 45-year oil-supply figure drops into the range of just over 30 years.Please also bear in mind that we’re adding another billion humans to the planet over the next dozen years, while China, India, Mexico, and the rest of the Third World are industrializing—adding factories, cars, building highways, and constructing oil-fueled power plants—at a growth rate that’s faster than both the United States’ or Europe’s over the past century. So our planet’s use is increasing far faster than “current rates of consumption,” and our reserves are sure not to last as long as the optimists are suggesting. According to an exhaustive scientific study conducted and released by the British power company PowerGen and reported worldwide by the Associated Press in September, 1997, “Global energy demand is forecast to double by 2020” [emphasis added], largely because of the rapid growth of the industrializing nations of Asia, particularly China.There’s obviously a collision coming between our growing population, with its increasing consumption of dwindling supplies of ancient sunlight, and our ability to sustain that population.

And even if vast new stores of oil were to be suddenly discovered (there are voices in the oil industry increasingly suggesting this will happen), or alternative sources of energy such as cold fusion or hydrogen cells became immediately and widely available, their rapid proliferation may actually accelerate the destruction of the planet and the death of billions of humans, in ways which will soon become evident. (On the other hand, there are solutions, as we’ll detail later in the book: but they have more to do with our culture than our technology.)How did it get this way? And what does history tell us about what can be done?

We’ll discuss these issues and answers in detail in future chapters. But first, let’s step back for a moment and look at an important question: if we’re headed for trouble, why isn’t it obvious?

[1] The exception to this is the bacteria and living organisms on the ocean’s floor, miles below the surface, which live off the heat of undersea volcanic vents. Even these, though, are living off energy from a sun: the core’s volcanic heat was stored when the Earth was first formed from the exploding core of a star/sun.

[2] While coal is clearly ancient vegetation, there is a debate about the origin of oil. Conventional wisdom holds that it’s also vegetative in nature, probably from sea vegetation, but another theory put forth by Cornell University astronomy professor Thomas Gold holds that oil is created by hyperthermophilic (high-temperature-living) bacteria at depths ranging from eight to 100 kilometers below the surface. While Gold’s theory—which has intriguing supporting evidence, such as the presence of helium in natural gas—would mean that oil is not “ancient sunlight,” it does not alter the central thesis of this book, since the process of bacterially producing today’s usable oil by Gold’s proposed means is also a multi-million-year-long process. Once current stores are exhausted, it will take hundreds of millions of years to replenish them. [See “The Deep, Hot Biosphere” by T. Gold, Proceedings of the National Academy of Sciences, 89:6045–6049]

[3] Bear & Co. Publishers, Santa Fe, NM, 1994

[4] In their study “The World Oil Supply 1930–2050”[5] Kluwer Academic Pub., Norwell, MA

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