

Our Finite World

Exploring how oil limits affect the economy

Humans Left Sustainability Behind as Hunter-Gatherers

Posted on [December 2, 2020](#) by [Gail Tverberg](#)

Many people believe that humans can have a sustainable future by using solar panels and wind turbines. Unfortunately, the only truly sustainable course, in terms of moving in cycles with nature, is interacting with the environment in a manner similar to the approach used by chimpanzees and baboons. Even this approach will eventually lead to new and different species predominating. Over a long period, such as 10 million years, we can expect the vast majority of species currently alive will become extinct, regardless of how well these species fit in with nature's plan.

The key to the relative success of animals such as chimpanzees and baboons is living within a truly circular economy. Sunlight falling on trees provides the food they need. Waste products of their economy come back to the forest ecosystem as fertilizer.

Pre-humans lost the circular economy when they learned to control fire over one million years ago, when they were still hunter-gatherers. With the controlled use of fire, cooked food became possible, making it easier to chew and digest food. The human body adapted to the use of cooked food by reducing the size of the jaw and digestive tract and increasing the size of the brain. This adaptation made pre-humans truly different from other animals.

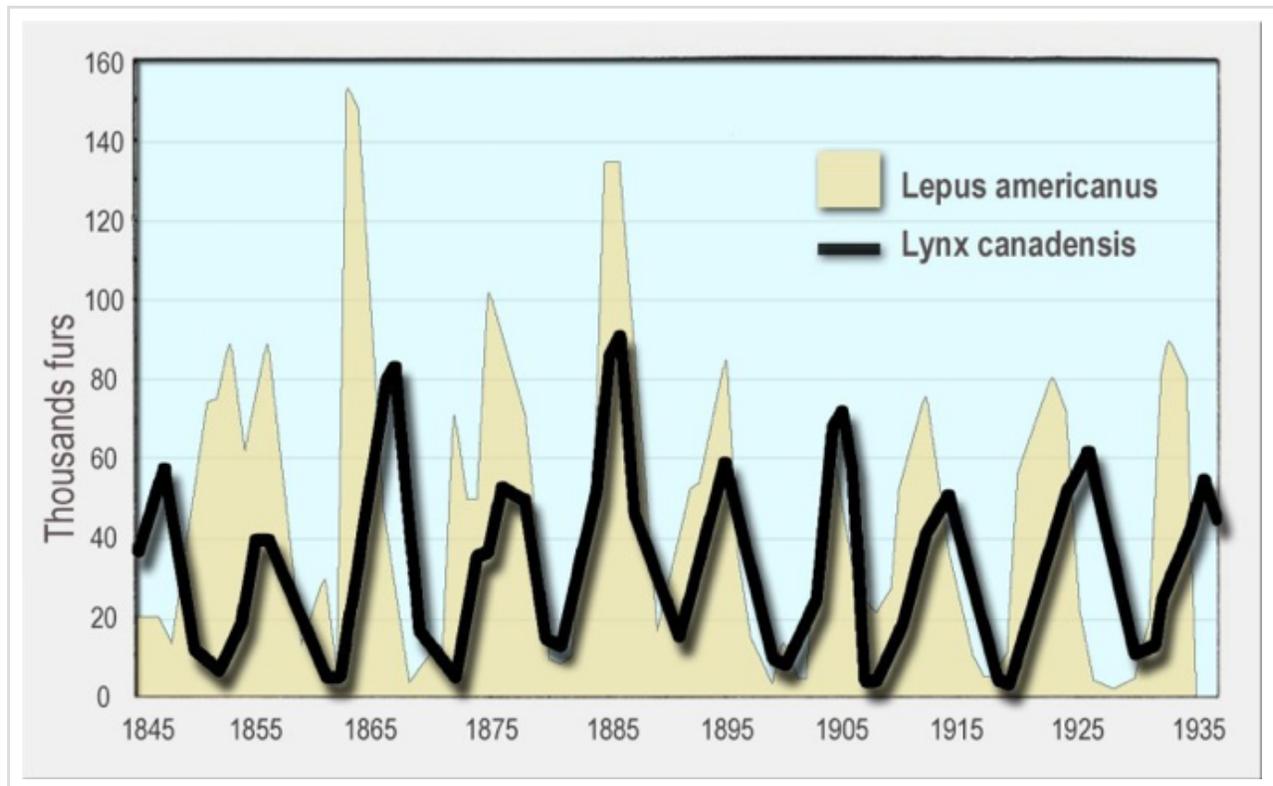
With the use of fire, pre-humans had many powers. They spent less time chewing, so they could spend more time making tools. They could burn down entire forests, if they so chose, to provide a better environment for the desired types of wild plants to grow. They could use the heat from fire to move to colder environments than the one to which they were originally adapted, thus allowing a greater total population.

Once pre-humans could outcompete other species, the big problem became diminishing returns. For example, once the largest beasts were killed off, only smaller beasts were available to eat. The amount of effort required to kill these smaller beasts was not proportionately less, however.

In this post, I will explain further the predicament we seem to be in. We have deviated so far from the natural economy that we really cannot go back. At the same time, the limits we are reaching are straining our economic system in many ways. Some type of discontinuity, or collapse, seems to be not very far away.

[1] Even before the appearance of hunter-gatherers, ecosystems around the world exhibited a great deal of cycling from state to state.

Many people are under the illusion that before the meddling of humans, the populations of different types of plants and animals tended to be pretty much constant. This isn't really the way things work, however, in a finite world. Instead, the populations of many species cycle up and down, depending on particular conditions such as the population of animals that prey on them, the availability of food, the prevalence of disease, and the weather conditions.



— Figure 1. Numbers of snowshoe hare (yellow, background) and Canada lynx (black line, foreground) furs sold to the Hudson's Bay Company. Canada lynxes eat snowshoe hares. Image by Lamiot, CC BY-SA 4.0, Wikimedia Commons. [Link](#).

Even forests exhibit surprising variability. Many undergo regular cycles of burning. In fact, some species of trees, such as the giant sequoias in Yosemite, *require* fire in order to reproduce. These cycles are simply part of the natural order of self-organizing ecosystems in a finite world.

[2] A major feature of ecosystems is "Selection of the Best Adapted."

Each species tends to give birth to many more offspring than are necessary to live to maturity if the population of that species is to remain level. Each of the individual offspring varies in many random ways from its parents. Ecosystems are

able to keep adapting to changing conditions by permitting only the best-adapted offspring to survive. In favorable periods (suitable weather, not much disease, ample food, not too many predators), a large share of the offspring may survive. In less favorable periods, few of the offspring will survive.

When selection of the best adapted is taken into account, a changing climate is of little concern because, regardless of the conditions, some individual offspring will survive. Over time, new and different species are likely to develop that are better adapted to the changing conditions.

[3] The downsides of living within the limits provided by nature are easy to see.

One issue is that every mother can expect to see the majority of her offspring die. In fact, her own life expectancy is uncertain. It depends upon whether there are nearby predators or a disease against which she has no defense. Even a fairly small injury could lead to her death.

Another issue is lack of shelter from the elements. Moving to an area where the weather is too harsh becomes impossible. Our earliest pre-human ancestors seem to have lived near the equator where seasonal temperature differences are small.

Without supplemental heating or cooling, humans living in many places in the world today would have a difficult time following the way of nature because of weather conditions. As we will see in later sections, it was grains that allowed people to settle in areas that were too cold for crops in winter.

In theory, there are alternatives to grain in cold climates. For example, a small share of the population might be able to get most of its calories from eating raw fish, as the Inuit have done. Eating raw fish is not generally an option for people living inland, however. Also, in later sections, we will talk about the difference between the use of root vegetables and grains as the primary source of calories. In some sense, the use of grains provides a stepping stone toward big government, roads, and what we think of as a modern existence, while the use of root vegetables does not. Eating raw fish is similar to eating root vegetables, in that it doesn't provide a stepping stone toward a modern existence.

[4] Animals make use of some of the same techniques as humans to compete with other species. These techniques are *added complexity* and *added energy supply*.

We think of complexity as being equivalent to added technology, but it also includes many related techniques, such as the use of tools, the use of specialization and the use of long-distance travel.

Animals use many types of complexity. Bees build hives and carry out tasks divided among the queen bee, drone bees, and worker bees. Many birds fly to another continent in winter, in order to gain access to an adequate food supply. [Chimpanzees use tools](#), such as waving a stick or throwing a rock to ward off predators. Beavers build dams that provide themselves with an easy source of food in winter.

Some members of the animal kingdom, known as parasites, even leverage their own energy by using the energy of other plants or animals. Such use of the energy of a host is subject to limits; if the parasite uses too much, it risks killing its host.

While animals other than humans may use similar techniques to humans, they don't go as far as humans. Humans employ a variety of supplemental materials in their tools. Also, no animal other than humans has learned to control fire.

[5] Pre-humans seem to have [learned to control fire](#) over 1 million years ago, allowing humans to gain an advantage in killing wild beasts.

Richard Wrangham, in [Catching Fire: How Cooking Made Us Human](#), makes the case that the controlled use of fire allowed the changes in anatomy that differentiate humans from other primates. With the controlled use of fire, humans could cook some of their food, making it easier to chew and digest. As a result, the teeth, jaws and guts of humans could be relatively smaller, and the brain could be larger. The larger brain allowed humans to compete better against other species. Also, cooking food greatly reduced the time spent chewing food, increasing the time available for making crafts and tools of various kinds. The heat of fire allowed pre-humans to move into new areas with colder climates. The heat of fires also allowed pre-humans to ward off some of the impact of ice-ages, which they were able to survive.

James C. Scott, in [Against the Grain: A Deep History of the Earliest States](#), explains that being able to burn biomass was sufficient to turn around who was in charge: pre-humans or large animals. In one cave in South Africa, he indicates that a lower layer of remains found in the cave did not show any carbon deposits, and hence were created before pre-humans occupying the cave gained control of fire. In this layer, skeletons of big cats were found, along with scattered gnawed bones of pre-humans.

In a higher layer, carbon deposits were found. In this layer, pre-humans were clearly in charge. Their skeletons were much more intact, and the bones of big cats were scattered about and showed signs of gnawing. Who was in charge had changed! We know that human controlled fires can be used to scare away wild animals, burn down entire forests if desired, and make sharper spears. It shouldn't be surprising that humans gained the upper hand.

[6] Grains, because of their energy density, portability, and ability to be stored, seem to have played a major role in the development of governments and of cities.

Scott, in *Against the Grain*, also points out that early economies that were able to grow grains were the economies that were able to place taxes on those grains, and with those taxes, were able to fund governments offering more services. Grains are a storable form of energy for humans. They are portable and energy dense, as well. It was grains that allowed people to settle in areas that were too cold for growing crops in winter. The year-to-year variability in production made storage of reserves important. Governments could provide this function, and other functions, such as roads.

If we analyze the situation, it is apparent that the existence of grain crops provided a subsidy to the rest of the economy. Farmers and their slaves could grow far more grain than they themselves required for calories, leaving much grain for trading with others. This surplus could be used to feed the population of cities, [such as Rome](#). It was no longer necessary for everyone to be hunter-gatherers or subsistence farmers. There could be new occupations such as merchants, teachers, carpenters, and sailors. Many more goods and services in total could be produced, and the population of cities could grow.

Cities, themselves, provide benefits, because they allow economies of scale, and they allow people with different skills to mix. Geoffrey West, in his book [Scale](#), notes that larger cities produce disproportionately more patents. Thus,

technology is advanced with the growth of cities.

It might be noted that root crops, even though they could provide most of the same food energy benefits for humans as grain crops, did not help economies grow in the same ways that grain crops did. This, likely, was part of the reason that they were not taxed: They produced no excess benefit to give back to the government.

Root vegetables are not as helpful as grains. They are less energy dense than grains, making them heavier and bulkier for transport. They do not store as well as grains. In early days, root crops could be about as efficiently grown by individual families as by farmers specializing in such crops, making it hard to leverage the labor that went into growing root crops. In fact, there was less real need for government with root crops: There was no way to store supplies of root crops in case of poor harvest, and there was little need for roads to transport the crops.

[7] The added energy benefits of grain crops created a situation where the grain was “worth” far more to customers, and to the economy as a whole, than what would be indicated by their cost of production.

There is a belief among economists, and among much of the population, that the selling price of a commodity will be determined by its cost of production. In fact, the example given in Section [6] indicates that back in the early days of grain production, grain's selling price could be far greater than its direct cost of production, with the difference going into taxes that would benefit the government and the economy as a whole.

In fact, there was a second way that the usage of grain was helpful to governments. The efficiency of grain production, transport, and storage reduced the need for farmers. Former farmers could offer services not previously available to citizens, often in cities. Income from the new jobs could also be taxed, to give governments another stream of income.

[8] The use of coal and oil also produced situations where the value of energy products to the economy was far higher than their direct cost of production, allowing these products to be heavily taxed.

Tony Wrigley, in his book [Energy and the English Industrial Revolution](#), indicates that with the use of coal, farming became a much more productive endeavor. The crop yield from cereal crops, net of the amount fed to draft animals, nearly tripled between 1600 and 1800, which was the period when coal production ramped up in England. Coal allowed the use of far more metal tools, which were vastly superior to tools made from wood. In addition, roads to mines were greatly improved. Prior to this time, few roads were paved in England. These improved roads helped the economy as a whole.

Oil is known today for the [high taxes it pays to governments](#). The governments of oil exporting countries are very dependent upon tax revenue relating to oil. When the selling price of oil is low, this results in a crisis period for oil exporting countries because they have no other way of collecting adequate tax revenue to support the programs for their people. For a short time, they can borrow money, but when this alternative fails, governments are likely to be overturned by their unhappy citizens.

[9] The economy tends to move further and further away from the natural order (described in Sections [1], [2], and [3]) as more energy consumption is added.

Even though the natural order would be sustainable, it doesn't represent a situation that most people today would like to live in. In fact, most humans today could not live on completely uncooked food, even if they wanted to. While a few people today eat "raw food" diets, they often use a food processor or blender to reduce the amount of chewing and digesting of raw foods to a manageable level. Even then, their weights tend to stay low.

If energy products are available at an affordable price, humans find many ways to use them, to stay away from the natural order. Some examples include the following:

- To provide transportation, other than walking.
- To pipe clean water to homes.
- To make growing and storage of food easy.
- To allow homes to be heated and cooled.
- To allow medicines and vaccines.
- To allow most children to live to maturity.

[10] Because energy consumption is important in all aspects of the economy, the economy seems to reach many kinds of limits simultaneously.

There are many limits that the world economy seems to reach simultaneously. The underlying problem in all of these areas seems to be diminishing returns. In theory, these issues could all be worked around, using increasing energy consumption or increasing complexity:

- Too little fresh water for an increasing population.
- The need to keep increasing food production, with the same amount of arable land.
- Increased difficulty with insect pests, such as locusts.
- Increased difficulty in dealing with viruses and antibiotic-resistant bacteria.
- Overfished oceans so that farmed fish are required in addition.
- Ores of metals of ever-lower grade, requiring more processing and leading to more waste.
- More expensive techniques required for the extraction of fossil fuels.
- Many unprofitable businesses; much debt likely to default.
- Too few jobs that pay well enough to support a family
- Governments unable to collect enough taxes

Energy and complexity work together to leverage human labor, in a way that the economy can make more goods and services in total. Unfortunately, we cannot use complexity to make energy. Technology (which is a form of complexity) can convert energy to useful work and, through efficiency gains, increase the percentage of energy that is available for useful work, but it cannot make energy. If we add more technology, more robots, and more international trade, we likely will need more energy, not less.

The net impact of all of these issues is that to maintain our economy, we really need an ever-increasing quantity of energy. In fact, energy consumption likely needs to grow more rapidly than population simply to keep the system from collapse.

Wind and solar certainly cannot meet today's energy needs. Together, wind and solar amount to about 3.3% of the world's energy supply, based on BP estimates for 2019. Furthermore, wind and intermittent solar certainly cannot be sold at a price high above their cost of production, the way grain, coal and oil have been sold historically. In fact, wind and solar invariably need the huge subsidy of being allowed to "go first." They actually are reliant on a profitable fossil fuel system to subsidize them, or they fall completely "flat."

[11] The problem, as the economy reaches limits, is too few goods and services being produced to satisfy all parts of the economy simultaneously. The parts of the economy that especially tend to get shortchanged are (a) governments, (b) energy producers, and (c) workers without special skills who are selling their labor as a form of "energy."

When economies are doing well, the price of energy products tends to be high. These high prices allow very high taxes on energy products. They also allow significant funds for reinvestment for the energy companies themselves. Indirectly, these high prices allow a significant share of the goods and services made by the economy to be transferred to these sectors of the economy.

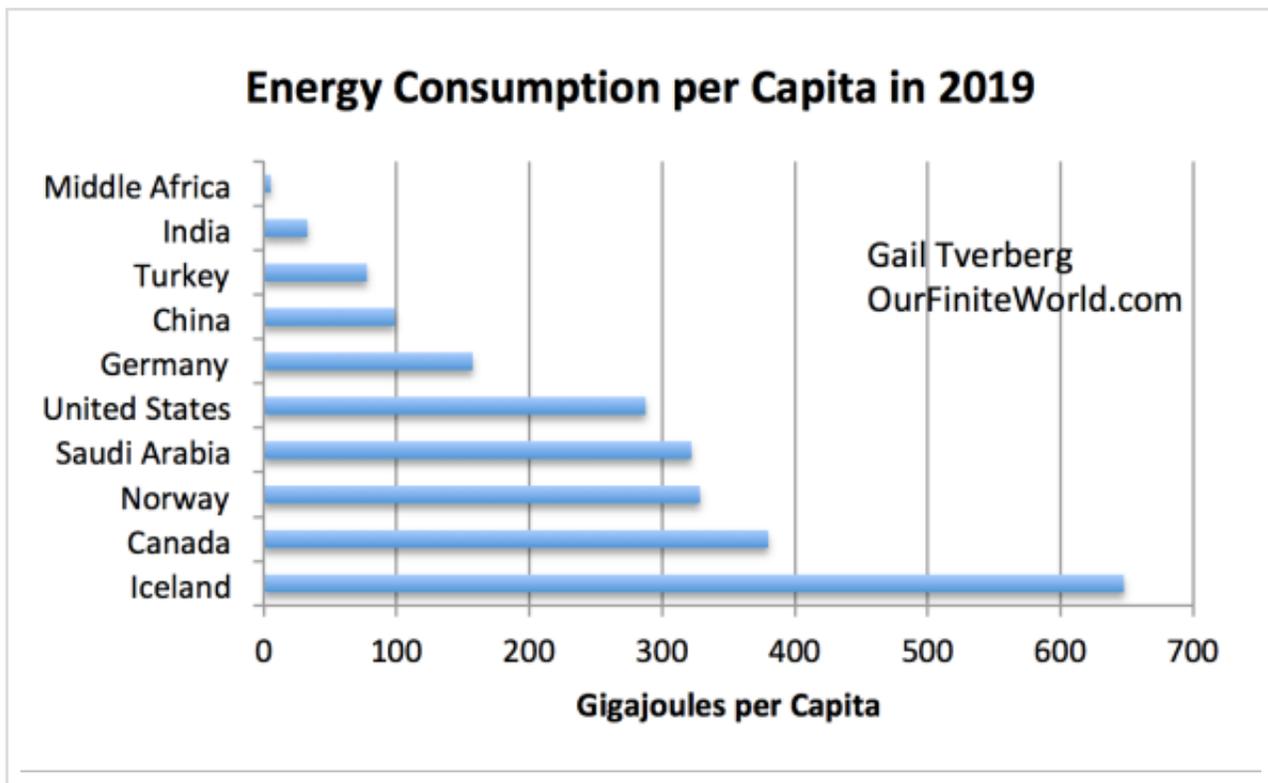
In addition, energy products allow non-farm workers in many areas of the economy to produce their goods and services more efficiently, thereby helping push up the wages of common laborers.

As economies reach limits, there is, in some sense, a need for more energy in many sectors of the economy. The catch is that the "wages" and "profits" needed to purchase this energy aren't really available to provide the demand needed to keep energy prices up. As a result, energy prices and production tend to fall. Government-imposed limitations, intended to stop the spread of COVID-19, may also keep energy demand down.

Governments often fail, or they get into major conflicts with other governments, when there are resource shortages of the kinds we are currently encountering. Today is in many ways like the period of the Great Depression, which preceded World War II.

[12] Perhaps warm, wet countries will be somewhat more successful than cold countries and those without water, in the years ahead.

I showed a chart in my most recent post, [Energy Is the Economy](#), that illustrates the wide range of energy consumption around the world.



— Figure 2. Energy consumption per capita in 2019 for a few sample countries based on data from BP's *2020 Statistical Review of World Energy*. Energy consumption includes fossil fuel energy, nuclear energy and renewable energy of many types. It omits energy products not traded through markets, such as locally gathered wood and animal dung. This omission tends to somewhat understate the energy consumption for countries such as India and those located in Middle Africa.

If fossil fuel energy falls, I expect that the parts of the world with cold temperatures will experience particular difficulty because they tend to use disproportionately large amounts of energy (Figure 2). Their citizens cannot get along very well without heat for their homes. Winter becomes very dark, if supplemental lighting is not available. Walking long distances in the cold becomes a problem as well.

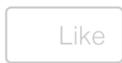
The warmer countries have a better chance because they do not require as complex economies as cold countries. They can feed at least part of their population with root crops. Walking is a reasonable transportation option, and there is no problem with months on end of darkness if supplemental lighting is not available. For these reasons, warm countries would seem to have a better chance of passing through the difficult times ahead while sustaining a reasonable-sized population.

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About Gail Tverberg

My name is Gail Tverberg. I am an actuary interested in finite world issues - oil depletion, natural gas depletion, water shortages, and climate change. Oil limits look very different from what most expect, with high prices leading to recession, and low prices leading to financial problems for oil producers and for oil exporting countries. We are really dealing with a physics problem that affects many parts of the economy at once, including wages and the financial system. I try to look at the overall problem.

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736 THOUGHTS ON “HUMANS LEFT SUSTAINABILITY BEHIND AS HUNTER-GATHERERS”



Harry McGibbs
on [December 7, 2020 at 9:19 am](#) said:

“Have markets overestimated the cocktail of stimulants?

“...it is reasonable to ask whether investors have got ahead of themselves. It would be remarkable if they had not, given the cocktail of stimulants markets have imbibed over the past month.”

<https://www.telegraph.co.uk/business/2020/12/07/have-markets-overestimated-cocktail-stimulants/>

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Harry McGibbs
on [December 7, 2020 at 9:28 am](#) said:

Mac10 certainly thinks they have. These are his predictions for 2021 (trigger warning – he doesn't like Trump; I'm not endorsing his politics etc.):

“The first order event is an impending “correction” from record overbought levels and this persistent delusion that 2021 will bring a global recovery – both of which are central bank sponsored