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(From Richard Alley's "EARTH: The Operators' Manual", published by Norton as the companion to the ETOM TV series.)

We humans have always used energy and always will. We now rely greatly on fossil fuels, which promise to make our lives much harder before they run out. But, there are plenty of ways to get rich and save the world by remaking our energy system.

Power On

More and more of us are living better than ever before. In most of the world, an expectant mother can be reasonably confident that she will deliver a healthy baby, who will parent the next generation and live long enough to help educate the generation after that. Wars continue, but the all-out disaster of World War II is ancient history for many of us, and a fading memory for the rest. With our accumulated knowledge and wisdom, and the things we've built, we have converted a world that might support a few million hunter-gatherers into home for over 7 billion of us, heading for 9 or 10 billion. When problems arise, we usually invent and cooperate to solve them. We have never fully agreed on the purpose of our existence (and we are not likely to agree in the near future!), but if you approve of any form of "The greatest good for the greatest number", then this really may be the best time in history.

And yet, we can easily believe we are cursed to live in these interesting times, with disasters waiting at every turn. Perhaps a billion or more people—one in six of us—exist in such poverty or violence that they cannot reasonably expect their children to live long and prosper. Various accounting methods suggest that we are using, and often using up, nearly half of everything that the planet makes available to us and to all other species, with rising population and expectations pushing us rapidly towards using 100%.

We have removed perhaps 90% of the large fish from the ocean—we have no idea what a natural ocean ecosystem looks like, because we fished out so many species before scientists learned to really see what is going on. Roughly 1/3 of the land surface not covered by ice sheets is now used for cropland or grazing, with logging extending our impact. Water is essential to us, but in many places a large fraction of the water we

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use is not being replaced, as we pump it out of old deposits in the ground or melt it from old deposits in glaciers much faster than new rainfall or snowfall supply more. The soil that grows our crops is being washed away far faster than nature can produce more, so farming is becoming more difficult, especially as we use up the “easy” deposits of phosphate for fertilizer.

With human population expected to increase, many of us not getting even the minimum that most civilized people believe is needed for a proper life, and almost everyone hoping to improve their lot, it takes an optimist to believe that the demands on the planet will “only” double. If our use is already approaching half of everything supplied by the Earth, where will the rest come from? And what does our growing use mean for the other species that share the planet with us, and their ecosystems on which we rely?

A pessimist can easily look past our successes in advancing knowledge and skills and infrastructure and healthy people, and see the history of disasters, wars, environmental refugees, starvation and failure. Humanity has more than enough successes to show that we can succeed, but more than enough failures to show that success is far from guaranteed.

If water runs out, we can desalinate and pump. If soil runs out, there are people growing crops hydroponically without soil, or we might dig the dirt out of the reservoirs behind dams and spread it back on the fields while adding key nutrients, much as a home gardener builds raised beds. If phosphate becomes scarce, we can mine lower-grade ores, and use our knowledge of chemistry to enhance them.

But, desalination uses energy, and lots of it. So does building a hydroponic system, or mining a low-grade ore. So do plowing and shipping, heating and cooling, flying and driving, and so many other things we do. We are relying heavily on energy use to solve our problems already, pulling water out of the ground with pumps to grow our crops, digging phosphate with huge shovels and shipping it—often great distances—to the farm fields to be spread by tractors, and much more. And, our energy use is arguably the most unsustainable thing we do. Roughly 85% of the world’s primary energy production today is fossil-fueled, relying on oil, coal and natural gas, with only 15% from nuclear, hydropower, wind, or other sources. We are using the fossil fuels approximately a million times faster than nature saved them for us, and they will run out.

We apply cheap energy to almost all our problems, a “silver bullet” to slay the dragons that trouble us. But, if we continue on our present course, we will run out of silver bullets. Our current energy system cannot last. Worse, the byproducts of that energy system threaten to change the planet in ways that will make our lives much harder—if we burn all of the fossil fuels before we learn how to use new energy sources, we will have greatly increased the difficulty of our education.



Fortunately, we have a golden bullet in our pocket—our collective cleverness. The amount of energy that the Earth makes available, sustainably, dwarfs the amount that we now use, and dwarfs demand for the foreseeable future. Sunshine from just the desert floors of Arizona would power the whole US, and the Sahara could power the rest of the world’s people, with huge amounts left over. The technologies required are not science fiction—in fact, they already exist or soon will, and some of them are decades or centuries old.

But, big projects take a long time. In 1971, then-President Richard Nixon of the US declared war on cancer. He proclaimed “The time has come in America when the same kind of concentrated effort that split the atom and took man to the moon should be turned toward conquering this dread disease. Let us make a total national commitment to achieve this goal.” Almost 40 years later, although the goal remains elusive, huge progress has been made. But, the first decade or two of this “war” did not produce the heady victories we hoped for. Very simply, cancer proved to be a hard problem.

I believe that energy supply will prove easier to conquer than cancer ...But, the effort required is easy to underestimate. Our oil and coal companies are so good at what they do that we easily forget the sheer immensity of their achievements. Only on occasion when an oil well blows out or a supertanker runs aground in an ecologically sensitive area are we reminded of the near-impossibility of quickly containing the oil from even one spill, yet drill rigs and tankers are at work continuously. The efficiency with which some coal-mining companies change the very face of the Earth to extract the energy stored beneath is mind-boggling, removing the tops of mountains, filling valleys with the non-burnable rocks, and moving on.

An oil tanker, or any big ship, turns slowly. By the time the pilot sees a problem, mutters “Oh, (very bad word)”, and tries to make a correction, it may be too late to avoid a collision. When the *Titanic* sighted the iceberg, it was already too late to steer to safety: “We had the order, ‘Hard-a-starboard,’ and she just swung about two points when she struck.”

A remarkably wide range of thinkers, scientists and engineers now see the ship of our energy use on a collision course that will seriously harm our future, unless a correction is begun soon. The change is still possible—we are not the *Titanic*, doomed to hit and sink—but the longer we wait, the harder the change will be, and the more damage we’ll do as we side-swipe the unpleasant reality. As our younger daughter Karen says to her crew when sailing her Sunfish sailboat in much more pleasant times: “Prepare to come about”.



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