The challenge is deeper than technology

Author - Sagar Dhara, Published on - 31.10.2015

Humans have a unique ability to develop technology that results in conversion of energy. When hunter-gatherers adopted agriculture, they gradually increased their energy use 1,000-fold through

technology developments

such as domesticating draft animals and using fire to clear land, make bricks, and smelt metals. The emergence of industrial societies entailed another 50-fold increase.

Human beings habitually prioritize their own right to nature over other species' rights to it; energy growth has depended on this habit. It has also depended on private ownership of nature, which allows an investor—individual, enterprise, state—to make small energy investments that deliver large amounts of surplus energy. Surplus energy spurs human development and lifestyle changes, and the desire for development drives further energy growth.

Fossil fuels, with their high energy density, have played a major role in the human growth story. In 2012, the most recent year for which International Energy Agency figures are available, fossil fuels provided *82 percent of the world's primary energy*—and they are responsible, along with land use changes, for annual emissions of about 40 gigatons of carbon dioxide. Half of those emissions are not sequestered back to the Earth. This is the main cause of global warming.

What's the solution? It comes in two parts—one technological and the other political and philosophical. Both halves of the solution must be implemented if the more serious ravages of global warming are to be avoided.

Problems everywhere. First, the technological side. Human beings must quickly reduce greenhouse gas emissions. But will any of the major technological approaches to reducing emissions actually work?

One candidate solution is to derive energy from biomass, which already provides 10 percent of the energy people use. Biomass is a widespread resource and can easily be converted to provide energy services. Unfortunately, biomass is already over-harvested—people use 16 percent of the energy that plants produce each year. Further harvesting will only exacerbate the ugly environmental gashes on the planet that biomass extraction, through deforestation and other land use changes, has already caused.

Hydropower provides 2.4 percent of the world's primary energy, but 40 percent of hydropower's deployable potential has been tapped. Resistance to dams has increased because dams destroy upstream forests and agricultural land; downstream areas can flood when excess water is released from reservoirs. Hydropower is unlikely to be expanded much except in some hilly regions.

Nuclear energy, meanwhile, provides about 5 percent of human beings' energy requirements. But the world is moving away from thermal nuclear energy. It is dirty—uranium mining carries serious health consequences, and about 300,000 metric tons of highly radioactive spent fuel are stored at reactor sites around the world. It is unsafe—already there have been three major accidents at power reactors. It is open to misuse—enriched uranium can be diverted to make bombs. And it is expensive—much costlier than fossil fuels.

Next, concentrated solar power and photovoltaics, along with wind, provide about 1 percent of global energy. These sources are growing at 15 to 40 percent a year, but have several drawbacks. They suffer from intermittence. They can only be sited at favorable locations. They cannot be used directly for locomotion. They have environmental impacts that aren't often discussed. Wind facilities and photovoltaic plants require significantly more land than do fossil fuel plants. Realistic estimates suggest that deployable wind energy can satisfy only 5 percent of today’s global energy demand, and significant amounts of carbon dioxide are emitted in the manufacture of both wind and solar equipment. And these energy sources are still more expensive than fossil fuels.

What about capturing and storing carbon dioxide so it's never released into the atmosphere? For several reasons, enthusiasm for carbon capture and storage (CCS) has waned. To begin with, only 14 CCS projects are operational, with eight more under construction. Together, their capacity represents only one-tenth of 1 percent of current carbon dioxide emissions. And many of these projects are combined with enhanced oil recovery projects—which neutralize the reductions in emissions achieved by capture and storage.

Energy efficiency, meanwhile, is sometimes seen as an easy route to decreasing emissions. But there is a limit to how much can be achieved through efficiency. Moreover, the Jevons paradox comes into play—if energy availability increases due to greater efficiency, energy will become cheaper and consumption will rise.

A different approach. So far, the countries that have experienced the most success in moving away from fossil fuels are Germany and Cuba. Germany guarantees fixed tariffs to producers of renewable energy. Cuba has focused on efficiency and also organic farming, which conserves energy through its lower water requirements, reduced use of farm equipment, and rejection of fertilizers and pesticides. The German model might be replicated in developed countries, but not in developing ones. A large percentage of Germany's renewable-generator owners are individuals, cooperatives, or communities, and such entities in developing nations lack the capital to invest in renewable energy. The Cuban experience is even more difficult to replicate, as organic farming is not as remunerative as commercial cropping.

For civilization to continue sustainably, human beings must shift from fossil fuels to solar energy—despite the technical problems. And investments are needed in biotic and other low-energy innovations. But in the end, global energy consumption must be reduced by something on the order of 60 percent. This will require a number of profound non-technological changes. Energy equity must be established among the world's nations—people in wealthy countries should not, as they do today, use hundreds of times as much energy as people in the poorest countries. Ownership rights over nature must be discarded in favor of the right to use nature without destroying it. The global economy must prioritize "risk minimization for all" over "gain maximization for a few." A steady-state economy—a sustainable economy that maintains nature’s balance—must be established.

The implications of these changes are radical. The United States and Canada must reduce their energy consumption by about 90 percent; Europe, Australasia, and Japan must do so by about 75 percent. Cities must shrink drastically and energy differentials between urban and rural areas must disappear. Localism must be prioritized and governance decentralized. Uniform risk and emissions standards must be implemented for everyone.

Technological solutions to climate change will be difficult to implement, but these political and philosophical challenges will be even tougher. They can be overcome, however, if people themselves fight for the demands that many made at last year's climate marches: "Keep the climate, change the economy!"

If such demands result in quick and concrete change, hope remains that human beings can form sustainable, equitable, and peaceful societies. Otherwise, global warming will enforce its own set of extremely painful changes.

First published in

Bulletin of the Atomic Scientists