Energy, Everyday Life and the Environment: Inconvenient Facts Still Remain After the Fukushima Disaster

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Summary

After the recent tsunami knocked down several nuclear reactors in Fukushima, the inevitable fact still remains: We still need energy if we are to live in a modern world. The fact also remains that the generation of inanimate power comes with unintended consequences on the environment and ultimately human life in general. This essay critically examines the intricate issues linked to power generation.

The essay discusses the attributes of energy that have to be understood first. This essay begins and revolves around the fact that energy cannot be created or destroyed; it is only transformed from one form to another.

In this essay, economic history is narrated briefly along with the development of technology that made possible the harnessing of energy especially for industrial and transportation use. This development in inanimate sources of power was extrication from the limiting use of animate power. Later developments in technology and science allowed for the transformation of energy from fossil fuels that gave life to the machines of economic production and trade. This latter great discovery of using inanimate sources of energy came with inevitable harmful by-products: pollution. Matter (in this essay, fuel) cannot be destroyed, after all; it was merely transformed to another form to another (carbon dioxide and harmful other substances). And in the process (combustion) energy was generated.

The search for cleaner alternatives to sources of energy still poses great challenge to modern society. The generation of energy in nuclear plants once again proved destructive and the "green" sources turn out to be limited as well. There are social and environmental issues with hydroelectric dams and biofuels.

If the environmental problems are to be minimized, more innovation is needed on the demand and supply sides. That is, cheaper techniques for energy generation have to be discovered that do not rely on fossil or nuclear fuels. Until that is not discovered and implemented, modern society has to balance economic growth and the level of accompanying pollution.

Introduction

Without electricity, modern living proves to be difficult. With no electric lights, the night is charcoal black and people have to repose early. If appliances do not function, summer days are sweltering hot, food items do not stay fresh for a longer period of time, and the latest news cannot be heard on the television. Subway trains stop as well. And the litany continues endlessly.

The incapacity of some nuclear reactors in Fukushima has significantly decreased the supply of electricity to the Kanto region of Japan and its consequences are being felt. For example, the economy as a whole was adversely affected as firms cut production. Also, resources had to be devoted for the reconstruction of the affected areas up north.

Despite the nuclear debacle that Japan is currently facing, the fact remains that we still need energy if we are to live in a modern world. The fact also remains that we are still dependent on fossil fuels as our primary source of energy. But the "inconvenient fact" is that along with the generation of energy by fossil fuels or nuclear technology inevitably come unintended and unwanted consequences on the environment and human life. These make up the conundrum we currently face.

Energy, Technology and History

Energy is neither created nor destroyed; it is only transformed from one form to another[1]. Also, energy cannot be stored; thus, it needs to be generated constantly if it is to be used constantly. In a coal plant, for example, coal is burned, producing heat energy. The heat boils the water and the process produces steam which turns the turbine. This mechanical energy is consequently transformed into electrical energy which makes electric trains run; air conditioners cool the room, etc. If the feeding of coal stops, so do the boiler and the turbine and consequently, all machines depending on electricity for power.

This paper regards electrical energy as the "great transformer" (in the light of the spirit of the essay). From the plant, electrical energy is transmitted and distributed to households and firms. Let us take a typical household as an example. Suppose, it is winter and night is approaching. The mother switches on the lights; electrical energy is transformed into light energy. It is getting cold and she switches on the heater; electrical energy is transformed into heat energy. The father returns home from work and turns on the television; electrical energy is

[1]In this essay, power and energy are most often used interchangeably.

transformed into sound (and light) energy. In the nearby subway train station, the driver accelerates the train and electrical energy is transformed into mechanical energy.

It is the technology that transforms a form of energy to another that describes an aspect of modern civilization. Ancient civilization may be described as the phase of history whereby energy was generated from animate sources, including humans. Even in Medieval Europe, carriages were pulled by horses. With technological improvements in windmill and watermill technology, an innovation in Medieval Europe was the harnessing of inanimate power. (It must be noted, though, that wind power had already been harnessed to sail ships.) But the mechanical energy generated by these more complex machines was limited both in quantity and extent of transformation. Mechanical energy, generated through the movement of water and wind, was simply used to generate another form of mechanical energy, that is, when tools hammered and crushed objects.

The invention of the steam engine in England by James Watt was a remarkable technological improvement in the history of machines. (The consequence on production and exchange of goods was equally dramatic.) This time, inanimate energy was generated by burning fuel to produce heat which in turn rotated the turbine. And that made the train run. A remarkable aspect of this invention is that the usage of fuel that can be extracted, stored and used at will on engines. This particular attribute of the modern machine is not to be found in its forbears. With waterpower, water has to flow from a higher ground for there to be movement which turns the watermill. The navigators during the time of European world exploration had to come to terms with the vicissitudes of the blowing wind for there to be any movement by the ship. The introduction of the steam engine to ships revolutionized sea transportation. It was during this time that technology finally made it possible for fuel to "give life to the machines" in the narrow sense that they were able to move. (The engine may be likened to the human or animal heart.)

Fossil fuels have become the "food" of the moving machines. Like the human or animal body that give off carbon dioxide and other biological waste materials as by-products of metabolism, so do engines emit carbon dioxide and other pollutants during combustion. These latter waste products are definitely directly harmful to animal and human life.

Energy, Technology and the Economy

It is widely held that the invention of the steam engine ushered the first industrial revolution. Energy make the machines run which in turn produce goods in great amounts more cheaply as compared when produced by hand. The great improvement in transportation has made the exchange of goods cheaper as well. It goes without saying that the production of more affordable goods benefits every consumer.

The second industrial revolution also came with the development in electric power generation with the innovations of Volta (electric battery), Siemens (self-excited generator), and Tesla (polyphase motor), among others.

The progress in technology and science has enabled man to build for himself inanimate helpers, the machines, to do his work. These machines are powered by the engines that consume fuel. Modern agriculture, for example witnessed the replacing of the ox-plough by the tractor which is a lot more efficient and effective than its live counterpart.

More machines came to life as electrical technology and engineering advanced. This time, the energy that powers the machines can be transmitted from a distant source. The technology of electrical energy transmission made more convenient the transformation of electrical energy into various forms.

Energy, the Economy, the Environment and Life

Engines replaced horses and sails. But just as horses needed grass for nutrition and energy, these new machines needed fuel in order to generate energy. This was how the problem arose: Aside from the generation of energy, pollution was emitted in the process.

The shift from animate (and other traditional inanimate sources) to inanimate source of power called for the use of fossil fuels. Until now, fossil fuels account for a large portion of energy source. The International Energy Agency (IEA) calculates that in 2010, fossils fuels accounted for about 81% of total energy production supply in oil equivalent[2].

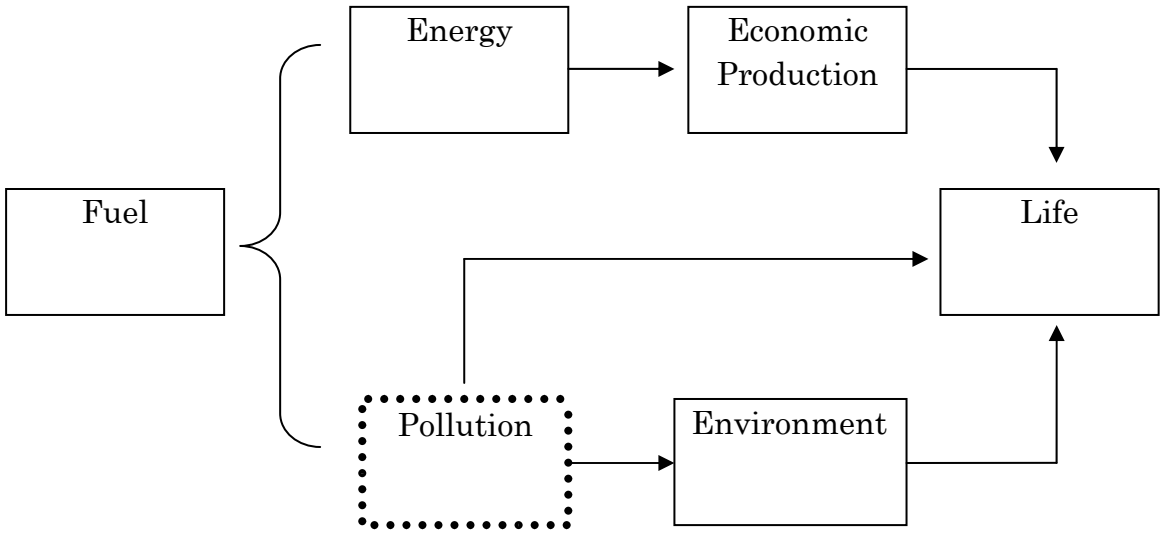
Pollution, the unwanted by-product, is called negative externalities in economic parlance. A negative externality is a cost imposed by, say a polluter, on someone else but that the latter is not compensated. Thus, negative externalities tend to be over-produced because costs (to other people) are not internalized by the polluter.

[2]International Energy Agency.http://www.iea.org/

As argued by economists, this is a justification for government intervention[3]. For example, taxes can be imposed on the polluter.

The traditional generation of energy as it is now known involves the burning of fossil fuels. Coal plants still abound. Factories still have chimneys that spew black smoke. These are negative externalities that harm the environment and human life in general. The pollutants that are released in the air finally enter human respiratory system and that is damaging to the health. Acid rain is just one of the many consequences of burning fossil fuels.

The relationship among the traditional sources of energy (fossil fuels), economics and the environment can therefore be graphically shown as follows.



The burning of fuel generates energy that is used for economic production, the end of which is consumption that is supposed to increase economic welfare. However, in the process, pollution is inevitably emitted, which harms the environment and human life as well.

Without energy, the machines of modern economic production cannot run. Modern machines, like the tractor, now run on inanimate power as compared to the plough pulled by animal of the olden times. This evolution from animate to inanimate source of energy has revolutionized economic production whose resulting products sustain modern living. This comes at a great cost, though.

[3] Ronald Coase, though argues for the proper assignment of property rights: Define who owns the right, the polluter or the victim. If property rights are properly defined, the market solution will be efficient. If the potential victim owns the right, the polluter can buy the right to pollute. If the polluter owns the right, the potential victim can pay the polluter some amount so as not to pollute.

Matter is not destroyed. If fossil fuels are burned, they are simply turned into harmful substances, and in the process, generate energy. Pollution is unwanted and if it is to be taken out of the equation, the mode of energy generation has to be changed. This is the challenge posed to modern science and technology.

The Search for Alternative Sources and Respective Issues

Table 1 below shows the world total primary sources of energy. In 2009, energy supply doubled from its 1973 level. From the figures, it can be seen that in 2009 fossil fuels still account for roughly 80% of the world's supply in terms of oil equivalent, barely a reduction from 86% in 1973. Nuclear energy increased six-fold after quarter a decade while energy from hydroelectric source less than doubled. The supposed "green sources" of energy, biofuels and the like only accounted for 11% of the world's total energy supply in 2009.

Table 1: World Total Primary Energy Supply

Source	*1973*	*2009*
	As % of 6, 111 Mtoe	As % of 12, 150 Mtoe
Oil	46.0%	32.8%
Natural Gas	16.0%	20.9%
Nuclear	0.9%	5.8%
Hydro	1.8%	2.3%
Biofuels and Waste	10.6%	10.2%
Other	0.1%	0.8%
Coal/Peat	24.6%	27.2%

Source: International Energy Agency.*Key World Energy Statistics*.http://www.iea.org/
Notes: Mtoe stands for million tonnes of oil equivalent.
Other energy sources includes geothermal, solar, wind, heat, etc.

Fossil fuels are non-renewable sources of energy. Unless other energy generation techniques are discovered, the "energy Malthusian trap" is a self-fulfilling prophesy.

The diagram above describes how pollution is inevitably produced as a result of the choice on the source of energy. Taking out the fossil fuels out of the equation means discovering alternative sources of energy. Hydroelectric dams were already constructed before the oil crisis of the 1970s but fossil fuels simply cannot be easily substituted for. Until now, automobiles still run either on petrol or diesel. Petrol or diesel still gives life to the engines that move vehicles and like machines.

Hydroelectric dams, although deemed clean sources of energy, actually also have adverse environmental and social impacts. Relocation of communities, usually tribal and a minority group, has caused social unrest. The damming also blocks fertile sediments from being carried away to the lowlands. This drastically reduces the fertility of downstream farmlands. The ecosystem is also altered as migrating fishes have no way of swimming upstream.

The source of traditional sources of energy, fossil fuels, has created issues on energy security. Equally important with the source of energy itself is energy security. The Organization of Petroleum Exporting Countries (OPEC) controlling world energy supply, and consequently, prices in the 1970s, the world felt the consequences. The issue, thus, was not only economic but also political in nature. If there were no control in the supply of oil, the market solution to energy security would have been possible.

The great advance in science and technology has paved way to generating energy by from other sources. In particular, nuclear energy came to be utilized in generating electrical energy. But rather than a substitute to the other sources, it was more of a supplement as energy demand kept increasing.

Japan does not have many natural resources including fossil fuels. Consequently, it had to import much of its source of energy. According to the IEA's 2011 country report on Japan, Japan is currently the third largest net importer of oil and largest in terms of liquefied natural gas (LNG) and coal[4]. The same report adds that in 2008, nuclear energy only accounted for 11% of Japan's total energy consumption and renewable energy only 4% (hydro and other sources).

Nuclear energy was claimed to be safe and clean. It does not produce any visible pollution unlike fossil fuels. In addition, it also provides an answer to the issue of energy security.

Challenges Still Remain

The supposed alternative to fossil fuels, nuclear energy that Japan developed and sought to promote still has problems that need to be dealt with. But the latest nuclear disaster, the knocking down of the Fukushima nuclear reactors by the tsunami, has once again manifested the enormous damage done by unforeseen circumstances. History has seen such in Chernobyl and Three Mile Island.

The recent nuclear fallout in Fukushima has once again demonstrated the importance of energy security for sustained economic growth. At the same time it

[4]International Energy Agency.*Country Analysis Briefs: Japan*. http://www.eia.gov/cabs/Japan/pdf.pdf

has shown us that to date a perceived alternative source, nuclear energy that is supposed to reduce the level of pollution produces pollution in its own that may even be of greater immensity.

In order to drive home the point and grasp the issue more clearly, let us imagine two simplified states of affairs to do a replaying of history in fast forward fashion. One is ancient society where the level economic production is very minimal and consequently man-made pollution is very minimal as well so that nature can easily handle it. This state is fairly simple. The other is the modern world as we know today where economic production is vibrant and appliances and amenities for comfortable and convenient living are produced en masse. Let us say that the ancient society wants to evolve into a modern society and enjoy its benefits. Let us also say that it has acquired the technology to be able to do so. However, the evolution comes with complications as the required machines that facilitate economic production and exchange need energy to run, the generation of which, however, comes with unwanted by-products.

This world could be have been made simpler were we in wonderland where we can ride on broomsticks, that is to say, if machines can move on their own so that there would be no need of the engine. Consequently, pollution would not be a problem. But there has to be a mover. For potential energy to be transformed to kinetic energy there has to be an initial cause. The statistics presented above shows that fossil fuels still command a large share of those sources of initial movers. Let us take an automobile as an example.

Without push or pull, a car cannot move an inch. If this were a coach, a horse would suffice. But the horse is limited in speed and strength. If we put a gasoline engine to an engineered coach, we have a car that can run much faster than the horse and carry much heavier load. But for the gasoline engine to move there has to be combustion inside which unfortunately gives off unwanted by-products.

Biofuels which are supposed to emit significantly lesser pollutants are seen as alternatives to gasoline or diesel. However, biofuels have to be processed from certain agro-industrial products like corn or sugar. That translates to clearing more forests for plantations which is environmentally harmful as well, not to mention the effect on food supply. Still, no omelette can be made without breaking the eggs.

Let us take the train as another example. Steam and diesel engine trains give off pollutants. The alternative to such trains are electric trains. However, electricity has to be generated elsewhere. And electric energy generation can either be by coal plants, hydroelectric dams or nuclear reactors. Just the same, coal plants give pollution so they are no different from the diesel and steam engines.

Hydroelectric dams are socially controversial but among the cleanest. Nuclear energy appears to be clean but the recent experience in Fukushima has again demonstrated that great risks are associated with nuclear plants.

The Demand Side

The above discussion so far has looked largely into the supply side of energy as the source of the problem. It is the source of energy that is seen problematic: fossil fuels give off greenhouse gases and nuclear reactors can also go berserk. A partial solution to the problem lies in the behaviour of energy consumers, the firms and households. For this matter, science and technology again play an important part. Man's intelligence allowed him to give life to the machines but without intending to damage his environment. Given his modern knowledge of physics and chemistry, his next task is to take into account the environment and discover ways of generating "clean" and cheap energy. Until that is discovered, he has to contend with the present state of affairs.

Firms are a large consumer of energy. The challenge for firms is to be able to produce the same quantity of products with less energy or to produce more goods with the same amount of energy as before. Modern appliances also have to be redesigned and reengineered such that they use less electricity. Automobile companies seem to have made a progress in manufacturing cars that utilize less fuel.

The behavioural aspect of the reduction of energy is something that civil society as a whole has to play an important part. Common sense tells that we ought to turn off the lights when not in use. This is a simple behavioural solution that is a part of the larger picture of energy "conservation".

Summary and Conclusion

The problem simply starts from the fact that energy cannot be created or destroyed; it is only transformed from one form to another. In transforming potential energy to kinetic energy pollution is released, the level of which depends on the source of fuel. Unlike the other sources of energy, hydroelectric dams and other renewable sources like wind simply take advantage of kinetic power to move the turbines, thus, they do not suffer from pollution problems. However, hydroelectric dams are socially unpopular and they constitute a small fraction of the world's total energy supply. Recently, nuclear power was seen

environmentally dangerous as well as events in Fukushima transpired. With these, we are pressed back again to greater fossil fuel dependence.

Given the recent problems on the supply side of energy, modification in consumer behaviour offers a partial solution to the problem. However, as long as demand for oil increases, supply should catch up as well. This has implications on the economy and the environment as well.

If we were to go back to the original state of affairs, the ancient world of Stone Age, there would be no environmental problems caused about by the combustion of fossil fuels or radiation from damaged nuclear plants. But we only want the clean environment of the Stone Age and the high quality of living of the modern world. Given the present state of technology on energy generation, the issue will centre on the balancing of economic growth and the level of pollution that comes along with it. As in taxation, that balancing is an art of plucking the goose so as to obtain the largest amount of feathers with the least possible hissing. For the time being, this poses for us an uncomfortable fact.