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Energy Transitions and the Next "Paradigmatic Image of the World"

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The history of humankind has undergone two major energy transitions, marked by the invention and development of agriculture and the discovery and exploitation of oil. The two energy transitions partition human history into three phases: hunter-gatherer, agricultural, and industrial. Faber et al. (1996) refer to these phases as "Paradigmatic Images of the World," because they describe the common structure of societies throughout the world. The most important question is "what is the next paradigmatic image of the world?" (Figure 1. A !Kung hunter-gatherer from the Kalahari Desert in Africa, image from here)

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Each major energy transition in human history shared a common trait: they provided society access to larger quantities of higher quality energy. An analysis of the !Kung bushmen of the

Kalahari Desert, one of the only hunter-gatherer populations remaining in the 20th century, revealed that the entire societal structure, including migration patterns, gender roles, and work schedules, was dictated by the availability of water and food (energy) (Lee 1972). The development of agriculture supplanted most hunter-gatherer populations because it focused the energy from the sun into food-bearing crops, which created much larger amounts of food per unit land area. As a result food storages accumulated, populations grew, and settlements began to flourish. The food surpluses created by the development of agriculture allowed some people to focus their attention off the farm, leading to higher education, trade specialization, tool development, etc. But even the most productive of ancient farms can't compare to the productivity of a modern, industrial farm (i.e., in terms of gross output).

The modern industrial era began in earnest in the late 19th century with the discovery of oil, and today is defined by the exploitation of the three major fossil fuels: oil, coal, and natural gas. Never before was society exposed to energy of such a high quality and in such large quantities. For example, harvesting a ton of wheat in the US at the beginning of the 19th century required 30 hours of work, but by 1970 that number had decreased to less than 2 hours (Smil 1994). The decrease in labor hours was due in large part to the use of fertilizers and mechanized farm equipment, both of which rely on fossil fuels. Exploitation of fossil fuels in all sectors of the economy led to vast increases in productivity, which was the driving force behind the transition from an agricultural to industrial society in the early 20th century. But economic theories developed during industrialization failed to reflect the value of fossil fuel energy in the transition from an agricultural to industrial economy, with theorists claiming, “The world can effectively get along without resources.” (Solow 1974)

Historically, economic theories of value have reflected the “Paradigmatic Image of the World” at the time they were developed. For example, in the mainly agrarian societies of early 18th century France, a few academics, called Physiocrats, posited that land was the ultimate source of value as they noticed how higher quality land produced more food and hence profit for the farmer. By the turn of the 19th century, European society began to industrialize, and the focus of economists switched from land to labor. These economists, called the Classical Economists, focused on labor as the primary source of wealth as they saw that the output from a factory was directly related to the productivity of the labor force. By the turn of the 20th century, a new school of economists called Neoclassical Economists, began to focus mainly on the market, and believed that the value of any object should not be measured by either the amount of resources or labor that went into producing it, but rather by the value it commanded in the market. Accordingly, the welfare of the people under the neoclassical economic paradigm was equal to the amount they could consume in the market, and as a result income became the yardstick by which human welfare was measured. Since a person’s welfare was directly proportion to their income, increasing income, or growing the economy, become the *de facto* goal of neoclassical economics.

But today’s world is much different from the world that existed during the beginning of industrialization, with far more people and countries vying for an increasingly small resource base. The failure to realize that fact is one of the reasons why the less developed nations of the world today struggle to advance out of poverty. Most of the modern development policies crafted for the less developed countries emphasize internal industrialization for export-led growth, and for numerous reasons they have often failed to meet their goals (Kroeger and Montayne 2000). Many of these less developed countries even have large endowments of natural resources, including fossil fuels, yet remain poor. Simply having access to high-energy fossil fuels does not necessarily translate into a wealthier life. Other variables, such as corruption, education, trade and investment must be accounted for when analyzing the causes of economic growth (Papyrakis and Gerlagh 2004).

The widespread adoption of the idea that economic growth will increase human welfare is essential in understanding why countries around the world continue to pollute the air, water and earth in the name of economic growth. Growth in Gross Domestic Product (GDP) above all was and still is the focus of neoclassical macroeconomic theory, and as such, it has been coveted by almost all economies around the world as the yardstick against which all must measure human welfare. But infinite growth on finite resources is not possible, and at some point, the fossil energy supply will decrease and the type of economic growth that occurred during the beginning of industrialization will no longer be possible.

Whereas past energy transitions have exploited new, larger sources of energy that enabled exponential growth in many areas of society, the reality of the geologic constraints imposed upon today's society relegate unbridled economic growth, the defining economic characteristic of the industrial era, to be a thing of the past. A new economic model is needed--one that focuses on human welfare as being separate from income, and one that focuses on the resiliency of society rather than the growth of society over the long term.

Abandoning the previous economic paradigm of growth is paramount because, unlike previous energy transitions in history, the next energy transition will most likely involve a reduction in the energy available to society. But reducing energy consumption should not be viewed negatively. There is evidence that raising the incomes of all does not increase the happiness of all (Easterlin 1995). Furthermore, people that engage in local, low-energy food programs, such as Community Supported Agriculture (CSAs) or farmer's markets, tend to have not only a healthier life but also more of a connection with the local community (Wells et al. 1999). These are very basic examples of the type of low-energy solutions that the world must begin to adopt for the next energy transition.

There are no substitutes for oil, natural gas, or coal at the scale needed to maintain the economic *status quo* into the future, and there is absolutely no reason to expect that technology will yield a silver bullet solution. However, with the appropriate mix of reducing energy consumption (by a lot) and instituting energy-saving techniques (passive solar, local food, etc), society could transition to the next "Paradigmatic Image of the World" without huge catastrophe. Whether this is possible given the current financial issues and governmental structure is another issue that I will not get into here, aside from saying that a pivotal part in beginning this energy transition will be to change the attitude and behavior of people (hence governments) around the world from the belief that the only way to happiness is through financial wealth.

The run-up in the price of oil and ensuing economic collapse of 2008 are evidence that the world is dependent upon a depleting stock of fossil fuels, and change is coming. Society has one of two options: 1) acknowledge that fossil fuels will sooner or later run-out and begin to prepare to transition to a much less energy dense society, or 2) maintain the *status quo*, hoping that the economy can grow in perpetuity as the stock of fossil fuels declines.

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