Energy-Flux Density

by Benjamin Deniston

This article appeared as Appendix 1 in the 21st Century Science & Techology Special Report, "Nuclear NAWAPA XX1: Gateway to the Fusion Economy."

The first evidence of a distinction between mankind and the apes comes with the first appearance of ancient fire pits, used to control the power of fire for the betterment of the conditions of life of those wielding that new power.

From that time onward, mankind could no longer be characterized biologically, or by biological evolution—the evolution of the creative mental powers unique to the human mind became the determining factor. Biology took a backseat to the increased power of thought wielded by the human species.

This is the secret—and science—of economic growth, and is expressed in the control over successively higher forms of fire. This started with transitions to more energy-dense forms of chemical combustion, from wood-burning (and charcoal), to coal (and coke), to petroleum and natural gas. The developments around the end of the 19th Century showed mankind an immense potential beyond chemical reactions: the fundamental equivalence of matter and energy, as expressed in the domains of fission, fusion, and matter-antimatter reactions, each with qualitatively higher energy densities.

Control over higher energy densities drives the increase in what Lyndon LaRouche has identified as the energy-flux density of the economy, as can be measured by the rate of energy use per person and per unit area of the economy as a whole. As is illustrated in the accompanying articles ("A Call for An International Crash Program: Creating the Fusion Economy" and "Nuclear Agro-Industrial Complexes for NAWAPA XXI," in the Special Report cited above), this increasing power drives qualitative changes throughout the entire society—creating fundamentally new technologies, new resource bases, new levels of living standards, and, actually, new economies.

For example, start with the simple rate of biological energy usage for the human body, about 100 watts (as sustained by eating a standard 2,000 calorie diet). Assuming a hypothetical pre-fire civilization in which everything is done by human muscle, the power employed to sustain the "economy"—the power of labor—is only 100 watts per capita.

Compare this with the growing per capita power usage throughout the history of the United States. At the time of the nation's founding, the wood-based economy provided around 3,000 watts per capita, a 30-fold increase over the muscle power of a fireless society. Then the widespread use of coal throughout the economy increased the power per capita to over 5,000 watts by the 1920s, and the implementation of petroleum and natural gas brought this to over 10,000 watts by 1970—100 times the per capita power of our hypothetical fireless society (**Figure 1**).

With each succession, the previous fuel base declines as a power source (allowing it to be used for things other than combustion, as wood is used for construction, and petroleum should be used for plastics

TABLE 1

The Energy Density of Fuels

FUEL SOURCE	ENERGY DENSITY (J/g)
Combustion of Wood	1.8×10^4
Combustion of Coal (Bituminous)	2.7×10^4
Combustion of Petroleum (Diesel)	4.6×10^4
Combustion of H_2/O_2	1.2×10^5 (only H_2 mass considered)
Combustion of H_2/O_2	1.3×10^4 (Combined mass considered)
Typical Nuclear Fuel	3.7×10^9
Direct Fission Energy of U-235	8.2×10^{10}
Deuterium-Tritium Fusion	3.2×10^{11}
Annihilation of Anti-Matter	9.0×10^{13}

Fuel energy densities. The change from wood to matter-antimatter reactions is so great that progress must be counted in orders of magnitude, and the greatest single leap is seen in the transition from chemical to nuclear processes.

and related non-combustible products of the petrochemical industry).

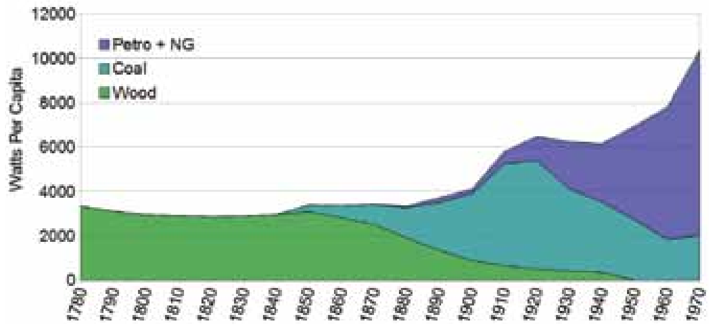
Following the post-World War II developments, nuclear fission power was fully capable of sustaining this growth rate into the 21st Century. In a conservative estimate based upon previous growth rates and the potentials of nuclear power, this should have brought the U.S. economy to a level in the range of 20,000 watts per capita by some time before the year 2000.[1]

By then, assuming the nation had maintained a pro-growth orientation, as fission power was becoming the dominant power source, the beginnings of applied fusion power should have begun to emerge. With ocean water becoming an effectively limitless fuel source for fusion reactors, the U.S. economy would have been on a path to an energy-flux density of around 40,000 watts per capita, and beyond, in the first generation of the 21st Century, four times the current value of 10,000 watts. Again, this would not simply be more power for the same economy, but a fundamentally new economy.

However, this natural growth process was halted with the takeover of the anti-progress environmentalist movement, a shift, then, which sent the economy on the direct path into the attritional collapse being experienced, now—a collapse process accelerated by imposing policies which lowered the energy-flux density of the economy.[2]

As is clear in **Figure 2**, nuclear fission power was never allowed to realize its full potential, and the energy-flux density of the economy stagnated and began to collapse.

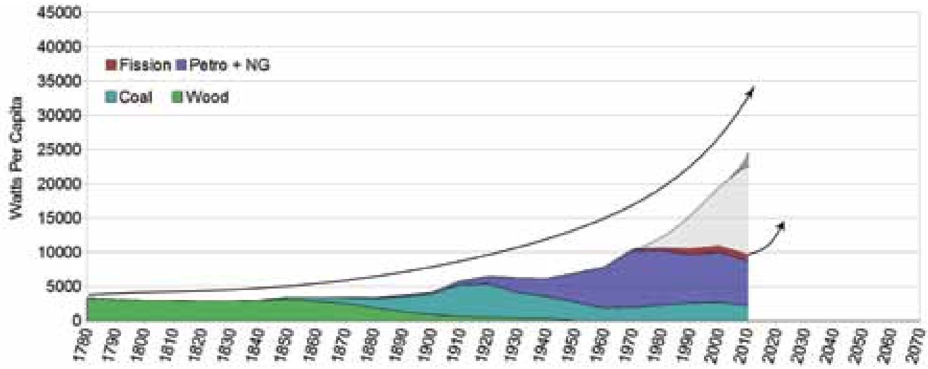
FIGURE 1
U.S. Power Per Capita 1780-1970



Based on data from the U.S. Energy Information Administration's "2011 Annual Energy Review."

Per capita power consumption for the United States from 1780 to 1970. "Other" power sources, such as hydropower, or so-called renewables, have been left out because of their minimal impact on the total per capita values.

FIGURE 2
U.S. Power Per Capita with a Fission/Fusion Economy



Per capita power consumption for the United States from 1780 to 2010. The general growth trend is indicated by the long arrow on top, with the gray wedge representing what needs to happen with a fission economy and the beginning of a fusion economy. The lower arrow on the right shows the direction of the path which must be started today to overcome the 40-year growth gap. This requires a crash program for the development of fusion.

While the actual implementation of nuclear fission is seen in the narrow red band (Figure 2), the role it needed to play is indicated in the gray wedge above, a projected value which keeps with the natural growth rates of a progressing human economy, and includes the beginnings of a fusion economy as well.

The 40-year gap between the needed growth rate and the present levels expresses the source of the current economic breakdown, and demonstrates the immediate need for a crash program to develop and implement the next stage, the fusion economy, to overcome decades of lost time by creating a new economy at a higher level than ever before.

1. If a serious economic policy had governed the nation following World War II (as was intended by Franklin Roosevelt, but reversed by the Presidency of Harry Truman), a higher level could have been reached more quickly.

2. This was not some happenstance change, but resulted from the top-down strategic intention of the Anglo-Dutch Empire, whose leaders have been explicitly and openly operating on a policy intention of reducing the world population to less than 1 billion people.