

Measuring Fire:

Energy Flux Density

by Benjamin Deniston

We begin with the first of the gifts of Prometheus, fire, from which he says man “shall learn many arts.” The earliest archaeological 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, expressed through the control over successively higher forms of fire. This started with transitions to more energy-dense forms of chemical fire, from simple wood burning, to charcoal, then to coal and coke, and onto petroleum and natural gas. Each of these new types depended upon new chemical reactions, providing not only the potential for a more energy dense form of fire, but opened up *new domains of control and utilization of matter*. Metallurgy, materials development, and physical chemistry all developed in dynamic interaction with the development of new forms of fire.

The revolutionary discoveries around the turn of the 20th century showed mankind an immense potential entirely beyond chemical reactions: the fundamental equivalence of matter and energy, as expressed in the domains of fission, fusion, and matter-antimatter reactions. Each in this series of relativistic reactions (reflecting the relationship of mass to energy developed by Einstein) operates at successively higher energy densities—and the entire set is orders of magnitude beyond the entire set of successive chemical reactions.¹ While this distinc-

tion is usefully expressed in the immense difference in the quantity of energy released in nuclear versus chemical reactions, the measured quantitative difference is the effect of a qualitatively distinct, higher domain of action.

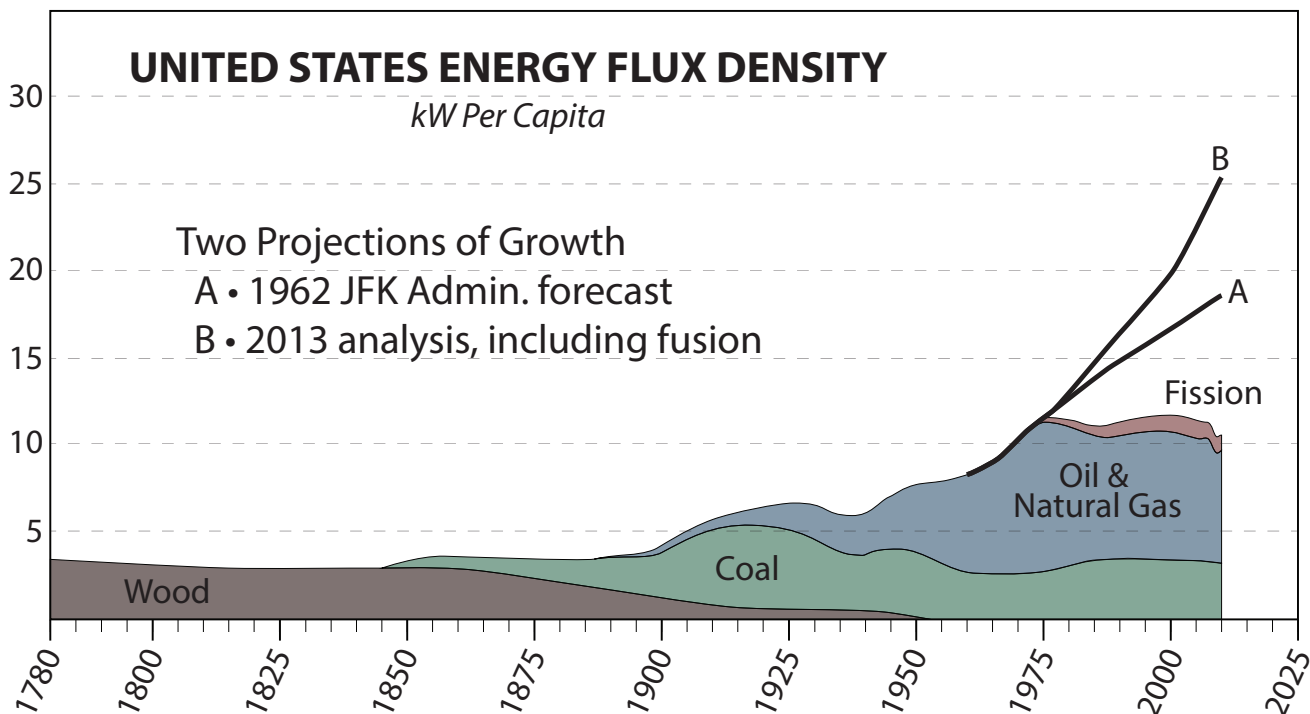
Control over higher energy densities enables the increase in what Lyndon LaRouche has identified as the energy flux density of the economy, as can be measured by the rate of energy use per person and per unit area of the economy as a whole. This increasing power is associated with qualitative changes throughout the entire society—fundamentally new technologies, new resource bases, new levels of living standards, and, what are fundamentally new economies.

Table I: 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	1.3×10^4 (full mass considered)
Combustion of H_2/O_2	1.2×10^5 (only H_2 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 Antimatter	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.

1. This is why individual nuclear explosives, even small ones, are measured in terms of thousands of tons, or even *millions of tons* of TNT. The largest thermonuclear weapon ever detonated, the Soviet Union's 1961 Tsar Bomba, was a 50 megaton explosion, meaning it would take the explosion of 50 million tons of TNT to release that much energy from chemical reactions. The Tsar Bomba was a single bomb, dropped from a single airplane (tested over an unpopulated region far north), while 50 million tons of TNT would fill 100 oil supertankers.



Graphic by Benjamin Deniston, data from U.S. Energy Information Administration and from "Civilian Nuclear Power, a Report to the President" submitted to JFK by Leland Haworth.

Per capita power consumption for the United States from 1780 to 2010, divided by the major sources of power. The general growth trend is clear, until 1970, when the zero-growth insanity took over the United States. Two projections indicate what could and should have happened. Curve A is a 1962 projection made by the John F. Kennedy administration, which focused on the then-coming role of nuclear fission power. Curve B is an estimation of what was possible if the Kennedy vision had been pursued, followed by the development of controlled thermonuclear fusion (following the 1970s realization of the feasibility of fusion). These two curves, compared with the actual levels, show the 40-year growth gap which is a major source of the current economic collapse.

A Short History of Energy Flux Density

Start with the simple rate of biological energy usage for the human body, which is, very roughly, 100 watts (corresponding to consuming 2,000 food calories a day). Assuming a hypothetical pre-fire civilization in which all work is performed by human muscle, the power employed to sustain the “economy”—the power of labor—is 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. In this wood-based economy, the effective power that each individual wielded and represented, through the active use and application of the heat provided by the burning of wood and charcoal, was thirty times higher than the simple muscle power of a hypothetical fire-less society. This was not just “more” energy, but a quality of energy that enabled people to create new states of matter and chemistry, states which could never be created by mus-

cle power alone.²

The increasing use of coal throughout the economy raised the power to over 5,000 watts per capita by the 1920s. Each individual then expressed nearly twice the power of the wood-based economy, supporting the heat-powered machinery and transportation which revolutionized the economy, and the development of modern chemistry enabled the beginnings of the greatest revolution in mankind’s understanding of and control over matter since the actions of Prometheus.

By 1970, the use of petroleum and natural gas had brought power to over 10,000 watts per capita—100 times the per capita power of our hypothetical fire-less society. With each transition, the previous fuel base declined as a power source, allowing it to be used for things other than combustion, as wood is used for construction, and petroleum should be reserved for plastics and related noncombustible products of the petrochemical industry.

2. As is exceptionally clear in the history of metallurgy, for example. No amount of muscle power can convert ore into metal.

Zeus Today

Nuclear fission power was fully capable of sustaining and accelerating the U.S. historical growth rate well into the 21st century. In a conservative estimate, based upon previous growth rates and the potential of nuclear power, fission should have brought the U.S. economy to the range of 20,000 watts per capita by some time before the year 2000.³

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 as a source for an effectively limitless fuel source for fusion reactors (deuterium), 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. Virtually every single concern over resource limitations (from food, to water, to metals, etc.) and energy limitations for all mankind, across the entire planet, would be solved with a fusion economy—and that for many generations to come.

However, this natural growth process was intentionally stopped by the resurgence of Zeus, in the form of the anti-progress, zero-growth environmentalist movement. Imposed on the United States by the exact same Anglo-

3. 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 faster.

Dutch imperial empire against which Franklin Roosevelt fought,⁴ this green policy has sent the economy on the direct path into the attritional collapse being experienced now—a collapse process accelerated by policies which lower the energy flux density of the economy.

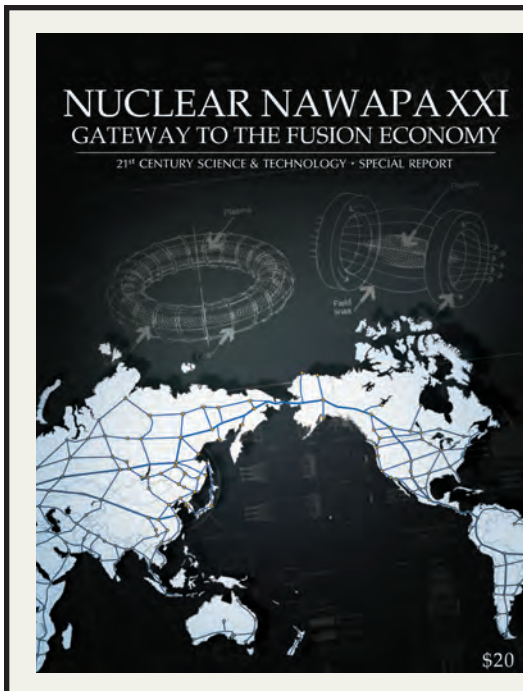
As is clear in the graph, nuclear fission power was never allowed to realize its full potential, and the energy flux density of the economy stagnated, and began to collapse.

The 40-year gap between the needed growth rate and 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.

Increasing qualities of power—of “fire”—is the essential characteristic of mankind. Either mankind continues to progress, expanding to new levels and higher platforms, or mankind will cease to exist, as Zeus demanded. This is the key to the future, and the past history of mankind.

We now treat four dimensions of physical chemistry: the physical work of metallurgy, chemical characteristics of the elements, electromagnetism, and the nuclear world, which is itself key to our future development of the great Promethean gift upon which the future existence of all mankind absolutely depends—fusion.

4. For a brief overview of the continuity of imperial-genocidal policy of the Anglo-Dutch empire, from before the American Revolution to the present day, see “Behind London’s War Drive: A Policy To Kill Billions,” *EIR*, November 18, 2011.



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