confinement (as with lasers for example) or even small amounts of antimatter.

Fulfilling the Thermonuclear Age

The fusion economy is not just a new way of acquiring power to be applied to the existing economy.

The entire history of the development of humanity has been characterized by the creation of *new economic systems*, with *new resource bases*, and *new technological capabilities*—a series of qualitative changes driven by increasing levels of controlled energy flux density. This is one of the purest expressions of the unique creative powers that separate mankind from any mere animal species.

The greatest economic revolutions have been driven by transitions to qualitatively higher levels of power sources. Fusion is now the imperative for mankind. By starting now, over the course of the next two generations the power and resource requirements of a growing world population can be met, and mankind can be set upon a new path, one actually befitting our true, creative nature.

Appendix 1: Energy Flux Density

The first evidence of a distinction between mankind and the apes comes with 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"), this increasing power drives qualitative changes throughout the entire society—creating fundamentally new technologies, new resources bases, new levels of living standards, and, actually, 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.

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 thirty-fold increase over the muscle power of a fireless society. Then the widespread use of coal throughout the economy

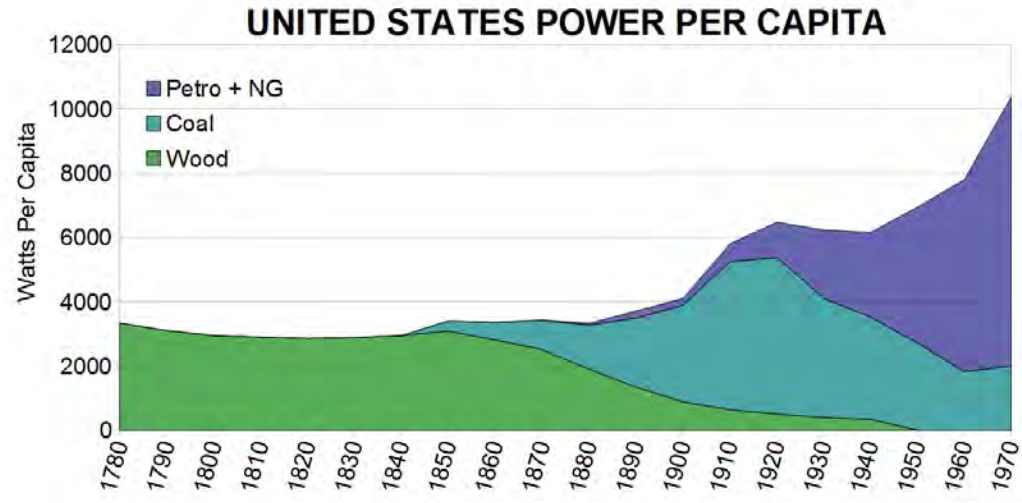
increased the power per capita to over 5,000 watts by the 1920s, and the implementation of petroleum and natural gas brought this to over 10,000 watts by 1970—100 times the per capita power of our hypothetical fireless society.

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 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.[14]

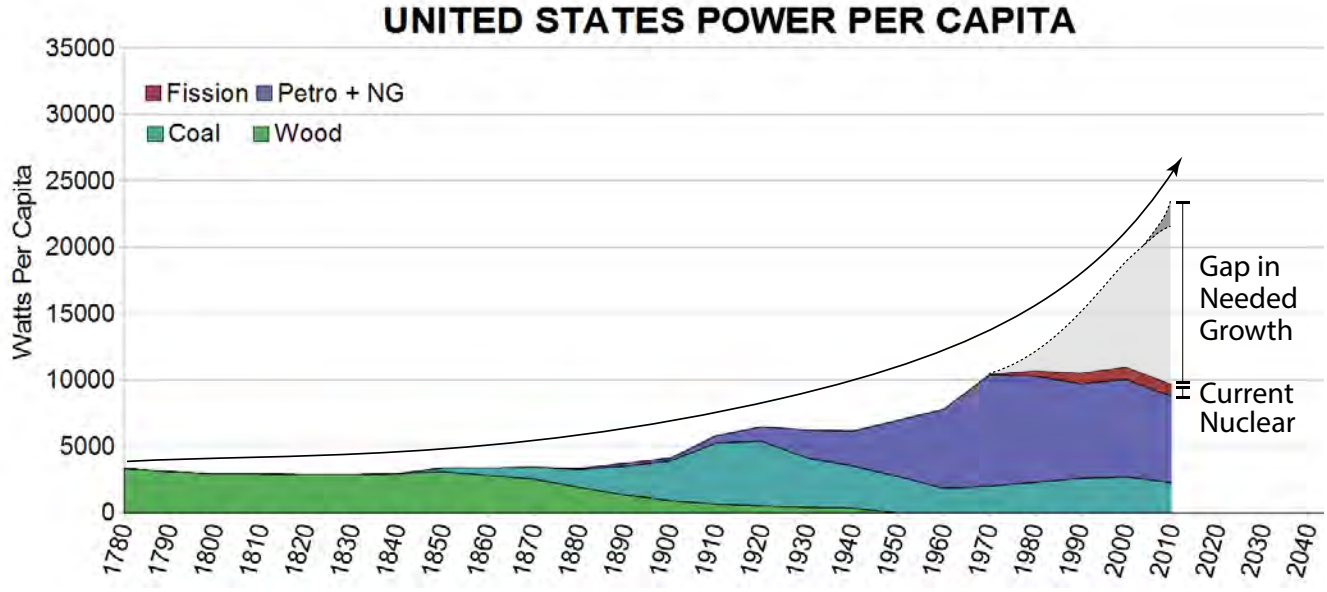
By then, assuming the nation had maintained a pro-growth orientation, as fission power was becoming the dominant power source, the beginnings of applied fusion power should have begun to emerge. With ocean water becoming an effectively limitless fuel source for fusion reactors, the U.S. economy would have been on a path to

14. 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.



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.

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

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.[15]

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

While the actual implementation of nuclear fission is seen in the red sliver, 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.

15. 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 one billion people. For example, see "Behind London's War Drive: A Policy To Kill Billions," by Nancy Spannaus, *EIR*, November 18, 2011.

Appendix 2: Our Future in and of the Stars: The High Energy-Density Physics Platform—Plasmas, Lasers, Antimatter, and Fusion

The next platform in the evolution of our human economy is the control of atomic processes like those found in our Sun, as this is to be applied to energy production, materials creation, and earthmoving, among other things. But this is not just for use here on Earth: the development of this power will be applied to conquering the entire domain of our Sun's influence, the Solar System, and will ultimately put us in range of our closest neighboring stars.

To achieve this will require the full exploitation of the dynamic relationships which currently exist between the fields of plasma, laser, antimatter, and fusion research, i.e., high-energy-density physics, where much of the work is already vectoring towards the next generation of space propulsion techniques. Only fusion propulsion can generate the 1-gravity equivalent acceleration, which is ideal for the human body, in that it both produces an Earth-like gravity environment, which mitigates some of the deleterious effects of microgravity, and reduces travel time, thus limiting exposure to harmful cosmic radiation. For example, at 1-G acceleration a trip to Mars could take as little as one week, achieving velocities of one-tenth the speed of light.

In addition to the space travel benefits of thermonuclear processes, the fields of high energy-density physics are furthering our understanding of processes occurring in stars and other cosmic phenomena, such as supernovas, widening our scope of understanding about the universe. This is opening up a renewed and necessary collaboration between astronomical, quantum, laser, and plasma physicists, where insights in one field quickly feed into the investigations of another. The physics of the lab and the physics of the stars are becoming more coherent.

Petawatt lasers, which operate on the order of 10^{15} watts of power, equal to 1,000 times the power of the entire U.S. electrical grid—a feat achieved by compressing mere hundreds of joules of energy (enough to light a 100-watt bulb for a few seconds) into pulses of trillionths of a second duration (femtoseconds)—are opening up vast new potentials for humanity. These lasers have thus far been directed towards the production of such things as: deuterium-deuterium fusion neutrons, the transmutation of gold into platinum, and the creation of anti-electrons (positrons), among other effects.

One such device is being operated by a group at the University of Michigan, where researchers have created what is being called the first table-top antimatter gun. The group has been aiming a petawatt laser at hydrogen gas, which in turn fires a stream of high-energy electrons at a thin metal foil, thereby producing quadrillions of antimatter particles (positrons). They have yet to develop