SUCCESSFUL PHYSICAL ECONOMICS

One Hundred Billion People on Earth, And Many on the Moon and Mars!

by Megan Beets

This is an adaptation of a presentation given to a Michigan audience on February 29, 2020.

> If we were to take the attitude which the United States had under the Eisenhower-Kennedy space program . . . combined with policies of investment tax credits for investments of a suitable kind, with a science enrichment program in our schools and similar kinds of things, I can assure you that—knowing what we know is important to work upon in science, in technology, knowing the kinds of projects which are the best way to express these technological improvements—if mankind of this planet had the political will to do that, we would increase the potential population density of this planet . . . [to] the order of magnitude of a hundred billion people, more comfortably, much better fed, much more secure, much freer, much less crowded than today.
>
> —Lyndon LaRouche,
> Food for Peace Conference, 1988

March 8—Contrary to the Malthusian outlook so prevalent among today's policy makers, university professors, Wall Street bankers, and global elites, not only *can* the planet sustain upwards of 100 billion people, this is an absolute *requirement* for the progress of the human species, the planet, and whatever other planetary bodies we might someday inhabit.

This leads us to a brief, but indispensable lesson in economics from Lyndon LaRouche, the most successful economic forecaster of the 20th and early 21st centuries. That lesson is this: *Economics has nothing to do with money!* If it were about money, then the great geniuses of Wall Street—who produce nothing, merely inventing fictitious financial instruments which are leveraged to astronomical "values" and traded by the microsecond—would not be staring in the face of the biggest financial collapse in human history. Though there is more "money" floating around today than ever before, the physical conditions of life for the majority of people in the United States and many other parts of the world have been collapsing.


EIRNS/Stuart Lewis

Megan Beets

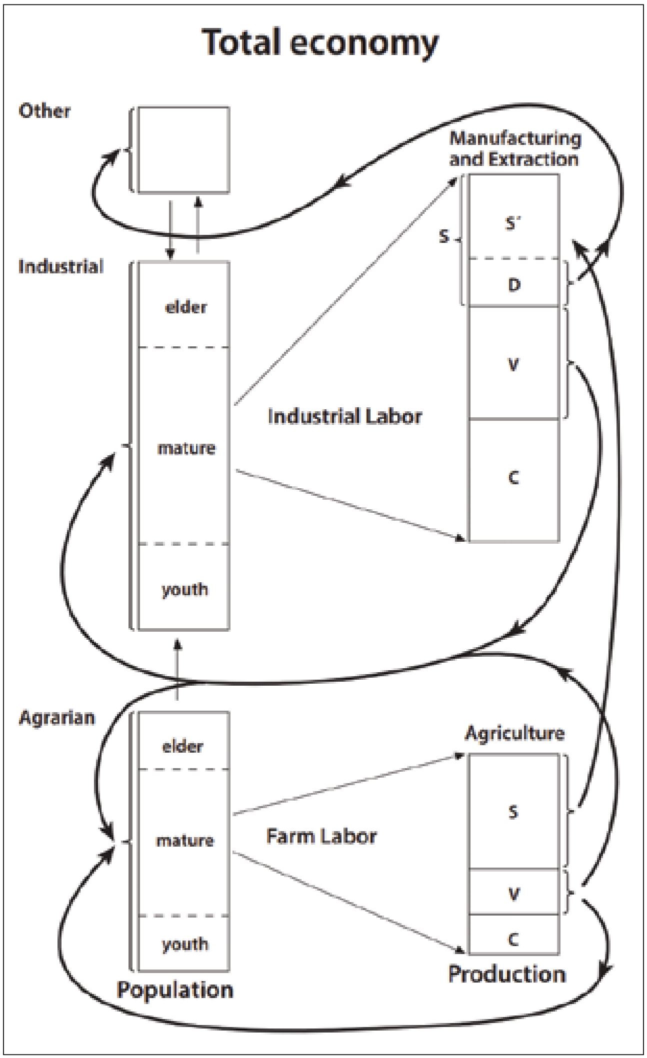
Economics is not about money; it is *physical*. What is physically required, per capita and per square kilometer, to provide a high standard of living for a population nearing 8 billion? How much energy (electrical and other), tons of raw materials, heavy machinery, water, and other supporting infrastructure are required by manufacturing, mining, and agriculture, to support the population? Extend that estimation to include what will be needed over the next economic cycle for a *growing* population.

In order to answer these questions, one can not approach the economy in the habituated way: from the bottom up, as a collection of individual businesses and actors, each with its own needs and income stream. Instead, change your thinking, and consider a national economy *as a whole*, as a unified agro-industrial firm, the survival of which depends upon producing more than it consumes, qualitatively and quantitatively.

Profit in Physical Terms

In his 1984 textbook, *So, You Wish to Learn All About Economics?*, LaRouche uses a simple schematic (**Figure 1**) of the economic activity of a national economy. The vertical bars on the left represent the

FIGURE 1



total population, separated by category of labor (agricultural, industrial, or other), divided into three segments: youth, mature (working age), and elder. The total physical goods output of the mature segment of the labor force is represented on the right side of the figure.

For purposes of illustration, focus on the output of the industrial labor force. This LaRouche divides into several categories, borrowing some basic concepts from thermodynamics: (1) V represents the portion of total physical-goods output required by households of the operatives. This includes not merely consumer goods, but transportation infrastructure, medical goods, etc.; (2) C is the total of capital goods consumed by production of physical goods, including costs of basic economic infrastructure of physical-goods production. Together $C+V$ = *energy of the system*, or that which is consumed by the operatives and industries in the process of production for one economic cycle.

Productive output that supersedes the bare minimum needs of the current production cycle, which LaRouche categorizes as S, is the only competent definition of economic profit—i.e., producing more than you "cost." From this surplus, S, we must deduct that which is necessary to support the households and activity of the *overhead expense category*, D. In this category, we have necessary overhead (doctors, teachers, necessary administration, etc.), and economic waste (unemployed persons who we wish to be employed, financial gamblers, drug dealers, etc.). Any physical goods output remaining is classified as *free energy*, S'. We will return to this very important category of output.

While this approach already frees us from the false measuring stick of money, merely dividing economic output into categories doesn't tell us much—we must put it into motion, and look at how these categories ought to change over time in a successful economy.

Productivity

The first requirement of supporting 100 billion happy, healthy human beings, is that category V must grow over time, both in quantity and quality. As V grows, the ratio of C/V must also grow, a ratio which LaRouche calls *capital intensity*. This could otherwise be described as the technological and productive might which is "backing" each person—tons of steel, kilowatts of power, miles of rail—per capita. In capital intensity terms, people in the United States today are much more expensive than a century ago, and this is a good thing! It means that as individuals, we have greater power in and over nature, than those who came before us.

As capital intensity (C/V) grows, for a successful society, the ratio of the surplus $S/(C+V)$, that is, productivity, must also grow. Another ratio interests us here: the *expense ratio*, $D/(C+V)$. As capital intensity grows, the category of (non-waste) overhead expense will naturally grow, in the form of longer periods of education for more highly skilled operatives, more complex administrative tasks, etc. The key for a healthy economy is that while the expense ratio is growing over time, productivity must grow *faster*.

Why? And how? Here is where we return to the most important economic category: S', free energy.

Science Drivers Such As Space Exploration

In thermodynamics, it is free energy—beyond the energy of the system—which is capable of doing *new* work. It is no different in human economics. The physical profit of the economy allows investment in new kinds of work—the development of new technologies, for example, and the upgrading of plant and equipment with those technologies. How we decide to direct this economic free energy will determine whether we, as a society and as a species, succeed or collapse.

Lyndon LaRouche delivered his famous half-hour television broadcast, Woman on Mars*, during the 1988 presidential campaign. In it, he presented an optimistic, realizable vision for establishing humanity's first colonies on the Moon and Mars in the first quarter of the 21st century.*

In a 1983 book, *There Are No Limits to Growth*, LaRouche provides a vision of a good use of that free energy:

> Imagine Mars fifty or sixty years from now, and so imagine yourself seeing a square kilometer thickly planted with young trees, each grown already to approximately a meter in height. Is this "science fiction?" Unless we destroy civilization with thermonuclear warfare, or, alternatively, famines and pandemics caused by neo-Malthusian policies, between A.D. 2030 and 2040, there should be a significant beginning of large-scale colonization of Mars by mankind.

Christopher Sloan

An artist's concept of Selenopolis, Krafft Ehricke's city on the Moon.

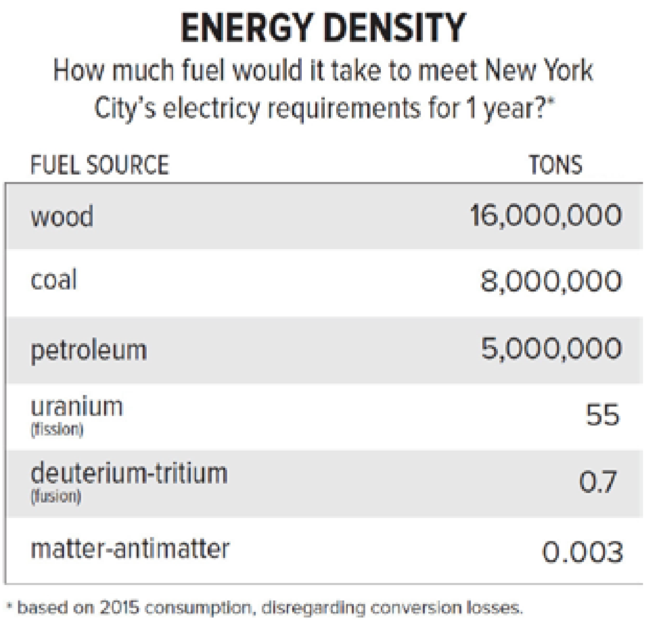
In the mid-1980s, even while under intense political attack (and later, unjust imprisonment), LaRouche ran for President. A central part of that campaign was a 40-year program for the colonization of the Moon and Mars. He presented this in, among other places, a 1986 paper, "The Science and Technology Needed to Colonize Mars," reprinted in *EIR* on April 26, 2019 (Part 1), and May 3, 2019 (Part 2); and a 1988 television broadcast, *Woman on Mars*.

The multi-phase, comprehensive program begins with the building of space stations and transportation infrastructure in Earth orbit, and the establishment of the first permanent habitation on the Moon. This is all to be completed by 2005, and built with materials from the surface of Earth. Phase two, 2000-2015, establishes an energy grid on the Moon, improved habitations, a self-sustaining supply of foodstuffs, and a mining/manufacturing operation which will begin exporting products to markets on Earth.

By the early 21st century, one million people should be living and working on the Moon's surface. In Phase 3, unmanned rover and orbital satellite exploration of Mars is followed by the placement of components for a future space station in Mars' orbit. Flotillas of spacecraft carry the first human explorers to Mars' orbit, and in-orbit assembly of vehicles for visits to the surface begins, followed by the first exploratory surface landings. This is completed by 2015. Between 2015 and 2025, a fleet of rockets for cargo and people, based on fusion technologies for powered flight, is built; the Mars-orbit space station is assembled, and materials needed for the first permanent colony are delivered to Mars' orbit. By 2026-27, humanity is ready to descend to Mars' surface and establish mankind's first permanent foothold.

So now, dear reader, imagine yourself standing among those meter-high trees on the surface of Mars, under a dome which encloses this fledgling forest.

FIGURE 2



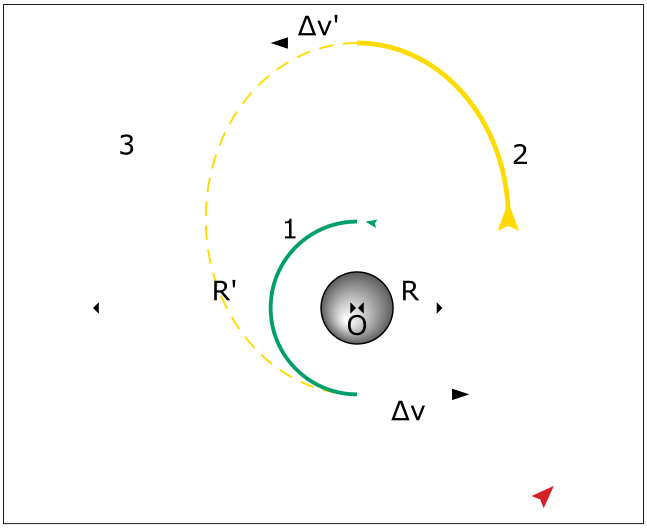
ENERGY DENSITY

How much fuel would it take to meet New York City's electricy requirements for 1 year?*

FUEL SOURCE	TONS
wood	16,000,000
coal	8,000,000
petroleum	5,000,000
uranium (fission)	55
deuterium-tritium (fusion)	0.7
matter-antimatter	0.003

* based on 2015 consumption, disregarding conversion losses.

FIGURE 3



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The Hohmann transfer, developed in 1925, is an orbital maneuver that places a vehicle on a trajectory which spans two orbits. Here, the Hohmann transfer (3) is a new, elliptical orbit the closest and farthest distances of which are the starting planet's orbit (1) and the destination planet's orbit (2). A short burn of the engines changes the craft's velocity to enter the Hohmann transfer orbit (Δv) and again to exit it (Δv') and, for example, to enter an orbit around the destination planet.

FIGURE 4

Exhaust Velocities for Different Rocket Fuels

Chemical	3,000 meters/sec
Fission	50,000 meters/sec
Fusion	100,000,000 meters/sec

Imagine the small city of scientists and workers just a short distance away. What challenges did humanity solve to get there? What discoveries were made which allowed you to stand among those trees, a resident of our first city on Mars?

Here we will touch on just two of many. First: control over energy.

The first Martians will be very expensive in energy terms. In order to sustain an Earth-like environment, energy use per capita and per square kilometer will be many, many times higher than even the most "expensive" societies today. For a rough illustration, think of what it takes in energy terms to sustain an individual at a research station in Antarctica—the energy consumed for warmth, delivery of foodstuffs, fuel for cooking, electricity generation, all take much more effort to supply than for a person living in a developed community in a temperate climate. In the deserts of Mars, only the energy-densities of nuclear fission and fusion will be able to provide enough power for a viable society. (See **Figure 2**.)

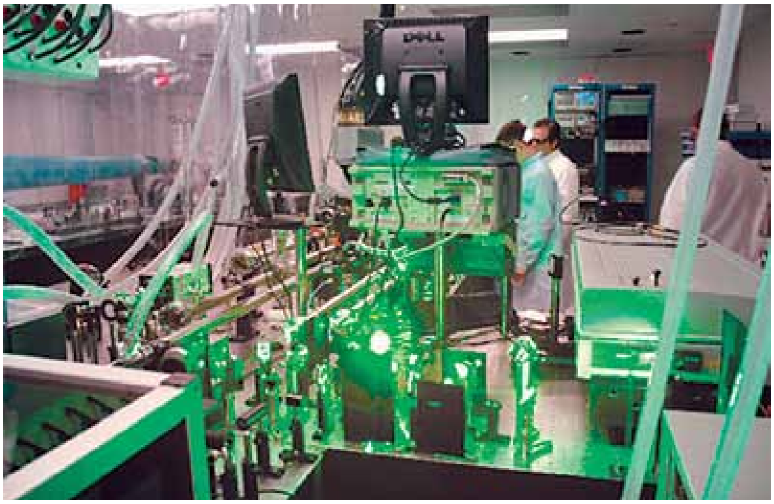
The case is similar with spaceflight. With current chemical and ion-thruster rockets, travel from place to place in space is done via Hohmann transfer orbits. (See **Figure 3**.) This is an orbital pathway on which, once the vehicle has fired its engines to enter the correct orbit, it can coast to its destination, only firing the engines very briefly for small course correction maneuvers. While very energy-efficient, travel via Hohmann transfer can take a long time. The NASA New Horizons craft, which flew by Pluto in 2015, left Earth in 2006, and used a series of multiple orbital transfers over nine years to get to its destination! For robotic craft, or short (three-day) voyages to the Moon, this is a fine way to travel, but for human beings who would be facing a months-long trip to Mars while exposed to dangerous radiation, a safer alternative must be found.

Because of the energy density of fusion fuels, a fusion-powered rocket would make it possible to carry enough fuel to fire the engine throughout the entire trip to Mars. (See **Figure 4**.) If the rate of engine firing accelerated the rocket at 9.81 meters per second per second (9.81 m/s^2, the acceleration of falling bodies in Earth's gravity), with a mid-trip switch to deceleration at the same rate, passengers could reach the Red Planet in a matter of days or weeks, and would enjoy a simulated gravitational environment—thus providing the best chances for a healthy arrival. The kind of accelerated flight we've just described will also be necessary when human beings begin exploratory trips beyond our solar system.

In addition to greater control over energy, mastering high-energy particle beams and high-power lasers will give us greater and finer control over matter. Lasers, as opposed to light from the Sun or from a lightbulb, function as beams of organized, coherent light. A laser beam, and its energy, can be focused on a specific target, and its wavelength can be fine-tuned to the material it is to interact with. **Figure 5** shows the increasing temperatures to which we could raise matter with mastery over high-power lasers.

One example of the power that lasers give us over matter is seen in the petawatt laser, already under development since the 1990s. A petawatt is 10^{15}—one quadrillion—watts. That's about a trillion times the power of your 100 watt lightbulb, and 2,000 times the power output of the entire U.S. electrical grid. Compared to conventional laser cutting, which already provides a huge leap in precision and capability over mechanical blades, petawatt laser machining enters a new realm. (See **Figure 6**.) Because with the petawatt laser, discrete pulses of energy are delivered to the material, each lasting only femtoseconds (10^{-15} seconds), quicker than it can be transferred through the material, there is no deformation and no slag in the cut. This property carries over to the medical field, allowing surgeons to vaporize a single cell with absolutely no effect on its neighbor.

Such discoveries as just described illustrate the purpose of a science-driver crash program. We must delib-

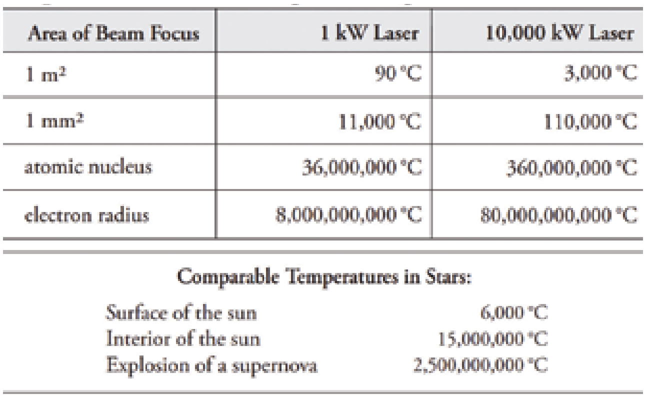


LLNL

The Texas Petawatt Laser seen here was completed with the help of teams from Lawrence Livermore National Laboratory. It is a 150 joule, 140 femtosecond laser. Currently, the laser allows scientists to study states of matter such as high energy-density plasma states, similar to those found in our Sun and in supernovae.

FIGURE 5

Temperature Increase Through Focusing of Laser Beams

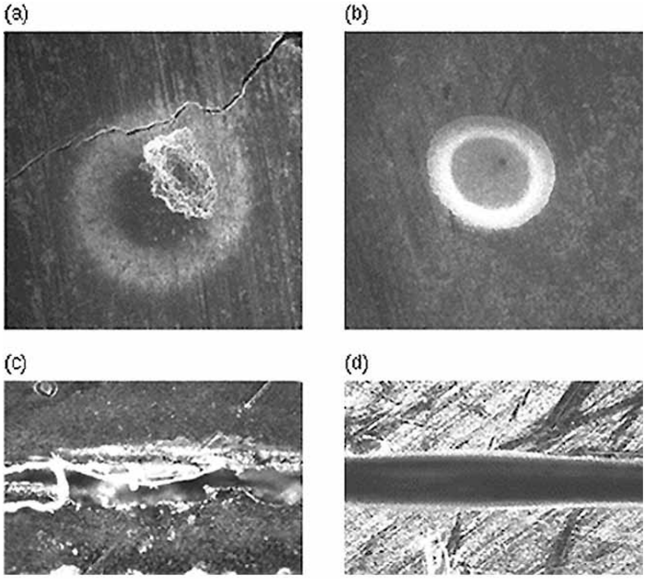


Area of Beam Focus	1 kW Laser	10,000 kW Laser
1 m²	90 °C	3,000 °C
1 mm²	11,000 °C	110,000 °C
atomic nucleus	36,000,000 °C	360,000,000 °C
electron radius	8,000,000,000 °C	80,000,000,000 °C

Comparable Temperatures in Stars:

Surface of the sun	6,000 °C
Interior of the sun	15,000,000 °C
Explosion of a supernova	2,500,000,000 °C

FIGURE 6



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A pulse delivered to a stainless steel plate by a conventional laser (a), which causes cracking and heating of the material, and by a petawatt laser (b), which produces a completely clean hole. The comparison below shows the jagged cut and slag of the conventional laser (c) versus the completely clean cut of the petawatt laser (d) erately create new powers for mankind which did not exist before. This is what allows us to ensure that S' continues to grow, and therefore it is the only competent definition of economic value.

Where Do We Stand?

On December 11, 2017, President Trump signed Space Policy Directive 1, stating:

> The Directive I am signing today will refocus America's space program on human exploration and discovery. It marks a first step in returning American astronauts to the Moon for the first time since 1972, for long-term exploration and use. This time, we will not only plant our flag and leave our footprints—we will establish a foundation for an eventual mission to Mars, and perhaps someday, to many worlds beyond.

With the issuance of this directive, work already ongoing at NASA—pieces from past, cancelled or reduced programs—were pulled together and given new life in the Artemis Program. Under Artemis, human beings will walk on the Moon by the end of 2024. The rocket that will take them there, the Space Launch System (SLS), is a heavy-lift rocket with a payload capacity slightly higher than the Saturn V of the Apollo Program. Reflecting the excitement of the restoration of such a launch capability, NASA Administrator Jim Bridenstine, in a February 2020 speech at the Stennis Space Center, said, "At Stennis we have an actual flight stage in our test stand for the first time in over 49 years."

The first SLS launch of the Artemis Program is currently planned for April 2021. This 25-day mission, Artemis 1, will lift an unmanned Orion crew capsule into orbit. The capsule will then travel to the Moon, enter lunar orbit, and return to Earth with a splashdown in the Pacific Ocean. Artemis 2, planned for late 2022, will be the first manned flight of SLS and Orion, with a four-person crew traveling to the Moon—the first time people have left Earth orbit since 1972—looping around the far side, and returning to Earth.

Before the 2024 landing, supporting vehicles must be constructed and launched—primarily for the Lunar Gateway, which will be a small station in lunar orbit from which the astronauts will descend to the lunar surface. President Trump's 2021 budget request includes $3 billion for the development of a lunar lander, which will be housed at the Lunar Gateway, awaiting its crew. Late in 2024, Artemis 3 will send four astronauts to the Gateway and down to the lunar surface. The 2024 landing will be the first foothold toward construction of a permanent base, to begin sometime around 2028.

NASA

Projected time-line for the three Artemis missions.

Though perhaps not as comprehensive as LaRouche's 40-year plan for Moon-Mars colonization, the Artemis program represents an indispensable turn back toward economic—and moral—sanity. A robust and mission-oriented American space program is not only the vehicle for new discoveries which will increase the productivity of the entire economy here on Earth, as well as in space, but is the basis for peaceful international cooperation in the common interest of all humanity.

By taking an economics lesson from LaRouche, we can ensure that our posterity—future generations of billions and billions of human beings—are living lives that are happier, healthier, more productive, and more creative than what we enjoy today. What else is an economy for?