LaRouche's Physical-Economic Method and a New Bretton Woods System

by Paul Gallagher

Feb. 15—Most of the world's economy is now in what has been dubbed a "manufacturing recession," provoking greater and greater dangers in the hyperinflated bubble of (especially) corporate debt resting on top of declining real production.

But in fact, the economic history of the United States and major Western European industrial countries *since the early 1970s* has been that of an extended general economic decline and continuous deindustrialization, marked by stagnant labor productivity, decline in the labor forces' share of claimed GDP, and general lack of investment in new basic economic infrastructure, let alone "science driver" missions transforming infrastructure with new technologies. Most of that 50-year period of decline has also been marked by more and more frequent financial crises and crashes. If this long decline "paused" in the 1990s, it was due to the sudden ability during that decade, brutally to loot the industrial and mineral wealth, and labor power, of Russia and the former COMECON countries; and, for a period, to exploit a large and low-wage manufacturing labor force in China.

Courtesy of the Mount Washington Hotel & Resort

Henry Morganthau, U.S. Secretary of the Treasury and Conference President, opening a session of the 1944 International Monetary Conference at the Mount Washington Hotel in Bretton Woods, New Hampshire.

This half-century since roughly 1973 has been, for the industrialized economies, entirely different from—in fact, opposite to—the previous 40 years for the United States, 30 years for Europe. The downward turning point was the abandonment of President Franklin Roosevelt's post-War Bretton Woods System of currency and credit. This fact has long been obvious but is denied by the forces of the City of London and Wall Street which broke Bretton Woods; they insist that the "floating-exchange-rate" currency speculation system they replaced it with, is the sole monetary system which can exist in modern human society.

The late economist and statesman Lyndon LaRouche forecast publicly during the later 1960s that this disastrous turning point was looming, and publicly explained why, pointing to British monetary maneuvers. Then on Sunday, August 15, 1971, President Richard Nixon announced the U.S. dollar was no longer linked to a gold reserve, Immediately, LaRouche fairly shouted from the rooftops—beginning with his "Nixon Pulls the Plug" front-page *New Solidarity* feature that week—that the turning point had arrived and unless the action was immediately reversed, deep economic austerity was coming and even threatened fascist forms of looting of the American labor force. When a leading London-trained economist then lost a major New York City College debate with LaRouche before hundreds of students and professors, about these events and what caused them, economists were warned to engage no more with LaRouche on this or related subjects.

The Bretton Woods System's strict rules featured fixed and stable exchange rates, capital controls in most

new SOLIDARITY

Full Issue on Economic Crisis

NIXON PULLS THE PLUG

Why It Happened Now

Monetary Sickness Fatal?

Preface

Crisis Numbs Liberals

Socialists Follow Suit

NCLC

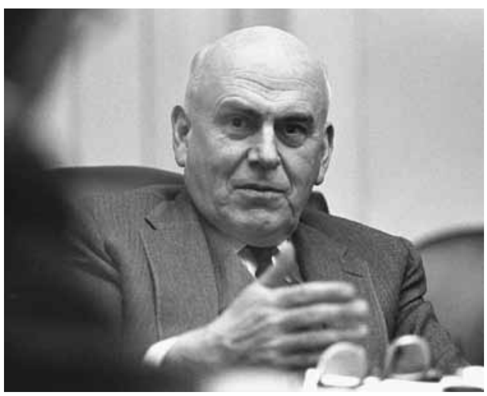
Front page of the LaRouche movement's New Solidarity *newspaper, Aug. 31-Sept 3, 1971.*

nations and exchange controls in some, and bank separation (other major industrial nations imitated the U.S. Glass-Steagall Act). Its purpose was to prevent international capital flows for speculation, and to direct them instead into capital goods exports to developing countries. The Bretton Woods System vanished within two years of Nixon's forced dollar-gold reserve split in 1971, opening the half century of deindustrialization, financial blowups, and steady disappearance of productivity growth.

Economic Day and Night

The Bretton Woods System was not fully what President Franklin Roosevelt —who died as it was being launched—had intended it to be. Its anti-speculative monetary rules led to an extraordinary *average* economic growth rate of 4%/year for the developed industrial countries from 1947 until the end of the 1960s. Newly reindustrializing countries such as Japan and South Korea grew even faster. But it has been shown (see below) that the more important "half" of the intended Bretton Woods System was the intended major technological and industrial projects in developing countries, causing capital to flow as capital goods exports to those countries. This was supposed to be centered on the World Bank (International Bank for Reconstruction and Development), which was to receive capital in issuances of gold reserve-stabilized currencies of member nations, to invest in low-cost or concessionary loans for those projects.

But it did not perform this function. After Roosevelt's death Wall Street's John J. McCloy was made its first Executive Director, and fully adopted the British view of the World Bank, that it should mobilize private international investment in developing countries, not make them itself. John Maynard Keynes had not even wanted developing nations to attend the 1944 Bretton Woods Conference. Economic growth in developing countries from 1947-70 averaged about 3%, so the expectation of high growth rates in developing nations was not met.



LBJ Library

John J. McCloy

Bretton Woods was destroyed by the rapid development through the 1960s of the City of London as a global center for speculation in sovereign and large corporate debt. This was done using capital lured out of the United States and other countries—by breaking the Bretton Woods rules, ignoring America's capital controls and interest rate limits—to issue *high-interest* loans to Third World countries and Mideast oil states. With this and other tactics warned of by Lyndon LaRouche when they were used in the later 1960s, the City and its "Eurodollar" and "petrodollar" loan markets broke the gold-reserve, dollar-centered system.

Physical-economic deterioration in the United States and Western European economies began immediately, aside from the fact that 4% average annual GDP growth has not been seen again anywhere among them since that time. In the United States labor productivity fell quickly from the 3-4% annual growth of 1935-65, to about 2% or less. Productivity increases caused by new technology fell from 2-3% annual growth or higher from 1930-70, to about 1% per year since then, according to the National Bureau of Economic Research's current approach to "multifactor productivity." Federal investment in infrastructure, fell from 2-3% of GDP during 1935-65, to 1.3% in 2010 and is less than 1%

now. The number of scientists and engineers employed in energy-related fields multiplied by 13 times from 1935-75, and has not risen since. And critically, Federal funding of research and development, which essentially did not exist before the mobilization for World War II, rose to approximately 2% of U.S. GDP from 1955-70, and has now fallen all the way back down to 0.7% of GDP.

Some of the other very negative effects of the destruction of Bretton Woods, directly flowing from those just described, are shown in **Figure 1**.

LoC

Construction work at the TVA's Douglas Hydroelectric Power Dam, on the French Broad River in Tennessee, June 1942.

Exporting the TVA

A Canadian participant in the 1944 Bretton Woods Conference, Harvard economics professor Alvin Hansen, wrote:

> This looks to be the opening for that new imperialism which one hears about these days—a TVA imperialism. The new imperialists would have as objectives, not a high return on capital, but rather a flourishing trade built up on the basis that would be created by the rising standard of living in the capital-importing country.[1]

The Roosevelt objective in Bretton Woods could be stated as *exporting the Tennessee Valley Authority* (TVA)—already during World War II becoming the most famous, probably the most successful economic and infrastructure development project in the world, and subsequently the most visited by foreign officials seeking guidance to recreate it at home. Within two weeks after the Japanese attack on Pearl Harbor, United States officials were circulating documents for post-War monetary arrangements which forecast what would become the American policy for the Bretton Woods Conference three years later. They already knew it, for a simple reason. Roosevelt's administration had been conducting this "TVA" policy *during the pre-War decade* as its "Good Neighbor" policy with the nations of Latin America, working to establish sovereign central banks in those nations, and have credit from the United States join with them in an "Inter-American Bank" (IAB) network to fund major development projects.

Undersecretary of State Sumner Welles described the IAB:

> Its principal importance will lie in investigating and facilitating rather long-term development projects in other American republics; [only secondary would be] the extension of shorter-term facilities to the monetary authorities of the hemisphere to assist them in eliminating seasonal and temporary fluctuations in their exchanges. [2]

A Harvard professor working for the Administration on developing the IAB, wrote that its projects would not necessarily produce much return on the credit invested (i.e., much of the credit would be concessionary), but

> Without these projects private investment, industrialization and agricultural diversification would be impossible, and . . . there could not be the increase in productivity and standard of

1. Quoted in Eric Helleiner, *Forgotten Foundations of Bretton Woods*, Cornell Paperbacks, 2016. p. 217.

2. *Ibid*, p. 64.

living which these basic development projects make possible.[3]

This was the task given the World Bank by Roosevelt's design for the Bretton Woods System. Richard Freeman recently described in detail in *EIR* how this task was successfully carried out between the Roosevelt Administration and Brazil during the 1930s Good Neighbor Policy period.[4] The concept of "exporting the TVA" is particularly notable in that process as he describes it.

Infrastructure Technology Breakthrough

The TVA's transformation of a four-state region in the American South has been described many times, a productive miracle by which the poorest, least educated, least healthy section of nation became more well-off than most.

At its core was a technologically revolutionary, fully interlinked and centrally controlled network consisting of 30 multipurpose dams—high dams mainly on many the tributaries of the Tennessee and Cumberland Rivers, which managed water use and flood control and produced electricity—and 17 flood control/navigation dams on the main rivers themselves. They completely controlled flooding over a very broad and very high-rainfall area watered by the Tennessee, Lower Mississippi and Lower Ohio Rivers; allowed navigation; provided irrigation if needed; and produced power. These purposes had never before all been combined in one system of dams, and this was a focus of President John F. Kennedy's frequent praise and evocation of the TVA a generation later. The TVA was developed in the same period as the Roosevelt Administration's other huge hydroelectric dam projects—the Boulder or Hoover Dam, and the Bonneville and Grand Coulee Dams—but was a technological breakthrough relative to them.

But what was the effect of these great projects and this technological advance on the entire U.S. economy, for the following generations? The economic method of Lyndon LaRouche can answer this question. This will also indicate the great potential, now, of a *new* Bretton Woods credit system initiated by the United States, Russia, China and India, which will go beyond the obvious success of the original Bretton Woods System for the industrial nations, to include Roosevelt's "export the TVA" policy for the developing nations.

LaRouche stated (here, once of many times) economic principles of Alexander Hamilton which he accepted and to which he richly added content:

> As stressed by U.S. Treasury Secretary Alexander Hamilton, there are two keys to the development of a poorly developed land area into a prosperous economy. On the one side, there is basic economic infrastructure: public transportation, water management (both latter substantially public works), and energy supplies. The other side, is what Hamilton identified as "artificial labor": the increase of the productive powers of labor (per capita, and per square kilometer) through investment in scientific and technological progress.[5]

U.S. Bureau of Reclamation

The Hoover Hydroelectric Power Dam, on the Colorado River, completed in 1936, shown releasing an outflow after a test.

3. *Ibid*, p. 119.

4. Richard Freeman, "The Good Neighbor Policy and Brazil: Roosevelt's Bold Creation of the Anti-Entropic Bretton Woods System," *EIR* Vol.46, No. 35, September 6, 2019, pp. 22-40. https://larouchepub.com/other/2019/4635-roosevelt_s_bold_creation_of_t.html

5. Lyndon LaRouche, "When Franklin Roosevelt Was Interrupted"; *EIR*, Vol. 25, No. 28, July 17, 1998, p. 23.

Hamilton said this progress is the fruit of encouragement of human inventiveness, by protective patents and by national bank credit for new "internal improvements"—infrastructures—and new manufacturing methods.

Roosevelt's great projects succeeded precisely because of the Hamiltonian intention embedded in their creation and functioning. The TVA had a profound effect on the United States production of electricity, even as the nation's rural areas were being electrified for the first time. In the period 1935-40 the share of electric power in the economy generated annually by hydroelectric dams reached 40%, from less than 15% two decades earlier; the TVA was by far the nation's largest electricity supplier with 17 gigawatts of installed power capacity at that time, all from hydroelectric dams.

LoC

A large electric phosphate smelting furnace used in the making of elemental phosphorus, in a TVA chemical plant in the Muscle Shoals area, Alabama, June 1942.

The 1930-40 surge to dominance of a new source of electric power, with a power efficiency twice that of other sources at that time, occurred because of the large-scale issuance of credit for new infrastructure, under the recovery acts and public works acts of the President and Congress and through the Reconstruction Finance Corporation. It was the Roosevelt Administration's intention to do the same thing in Latin America, especially with credits to Brazil,[6] and then it became FDR's intention for the post-War Bretton Woods system.

The result was a strong surge in the technological capabilities of the capital goods with which the American labor force worked, and in the productivity of that labor force.

The technological significance of this sudden dominance of advanced hydroelectric infrastructure can be indicated by the following:

With simple water power: Water drives a wheel with vanes (elongated cups very precisely shaped) in a circle, converting the energy of the flowing water into rotational machine power, driving factory belts, etc. Energy conversion efficiency, with overshot water wheels, can be very high (ca. 90%); the limitation is that the portion of water flow energy which reaches the vanes is very small, and a very large infrastructural system must be built to use any substantial volume of water for power.

With steam power, using any energy source (fuel): Steam likewise drives a turbine, with similar vanes, in a circle. The energy of the steam is much higher and more focused, the energy efficiency (conversion to power) much lower than with water wheels. So balanced, the two technologies—water and steam power—overlapped for much of the 19th Century.

With hydroelectric power plants, which first spread in the United States in the 1880s: Again, water moves a very large turbine with vanes in a circle. But now this is combined with the discovered electromagnetic principle (the turbine rotates magnets around a wire coil), and the resulting electricity exhibits six times the efficiency of energy conversion to power, of the water wheel. So less water was used to produce far more power. Furthermore the power grid for distribution of the electricity produced, takes up much less space than do millraces for water, and can supply large amounts of electricity to large numbers of industrial or household users per square kilometer of the nation's territory.

This efficiency of conversion of energy to the universal machine tool—electric power—can be com-

6. Richard Freeman, *op cit.*

bined with the metric of how much of that power is generated *in a given time*, say, a year, to give an idea of power efficiency—electric power generation and use in an average year relative to energy input. "Availability" here means roughly how much of the time these power sources are generating on line:

Hydropower: (energy efficiency of 80-90%) × (availability, with very conservative 2006-16 figures of 70%) = power efficiency of 60%.
Nuclear reactors: (energy efficiency of 35%) × (availability of 85-90%) = power efficiency of 30%.
Coal and oil-fired power: (energy efficiency of 37%) × (availability of 75%) = power efficiency of 28%.
Wind turbines: (energy efficiency of up to 45%) × (availability of 20%) = power efficiency of up to 9%.
Solar farms: (energy efficiency of 20%) × (availability of 20%) = power efficiency of 4%.

When we also take into account the size (and associated labor costs) of the fuel and power infrastructure which must be built to generate and transmit a given amount of electricity for use in a given amount of time, nuclear power—with large energies being emitted by extremely small amounts of fuel—surpasses coal and oil. Wind and solar become almost *de minimus* because of the large land areas required to use attenuated and intermittent fuels, and to transmit the resulting electricity for use in population or industrial centers.

By electric power transmitted per square kilometer of the power infrastructure, per unit of time, we roughly express Lyndon LaRouche's specification of the "energy-flux density" of a power source. This is related to the energy-flux density of other machine tools powered by the produced electricity, and also to the ability to give a higher, more "electrified" standard of living to a more dense population per square kilometer. LaRouche said this capacity of technology, if sufficient capital or credit is invested in it, represents a change in "potential relative population density" afforded by infrastructure incorporating new technologies.

A simple 19th-Century example illustrates this.

The Illinois and Michigan Canal, which connected the Great Lakes (at Chicago, on Lake Michigan) to the Mississippi River Valley for the first time, was completed and opened in 1848. Chicago, prior to that time, in the 1830s, is shown in **Figure 1A**. Fifteen years after the canal opened, Chicago in 1862 is shown in **Figure 1B**. When the canal made it the nexus connecting the transport of every variety of tools, machinery, agricultural production, ores, etc. between these two mighty water systems—and moreover, no longer subject to regular flooding—Chicago's *relative* population density immediately became far too low (Figure 1A) relative to the

FIGURE 1A

A postcard depicting Wolf's Point at the Junction of the two branches of the Chicago River, Chicago, Illinois, 1832.

FIGURE 1B

Chicago Historical Society

A bird's eye view of Chicago, only 25 years after the postcard above. From a lithograph by Christian Inger, based on a drawing by I. T. Palmatary, published by Braunhold & Sonne, 1857.

potential population density afforded by the geography and infrastructural technology now at hand. Not for long; it grew overnight to a major city (Figure 1B) reflecting the new potential relative population density as defined by LaRouche.

Workforce Transformation

One requirement for the rising potential relative population density of an area, or nation, is the economy's capacity to provide a rising living standard, and thus a potentially higher productivity, to the expanding productive workforce of that area or nation. This makes the relative population density a function of one part of the output of the economy, namely what LaRouche called "variable capital" or "V".

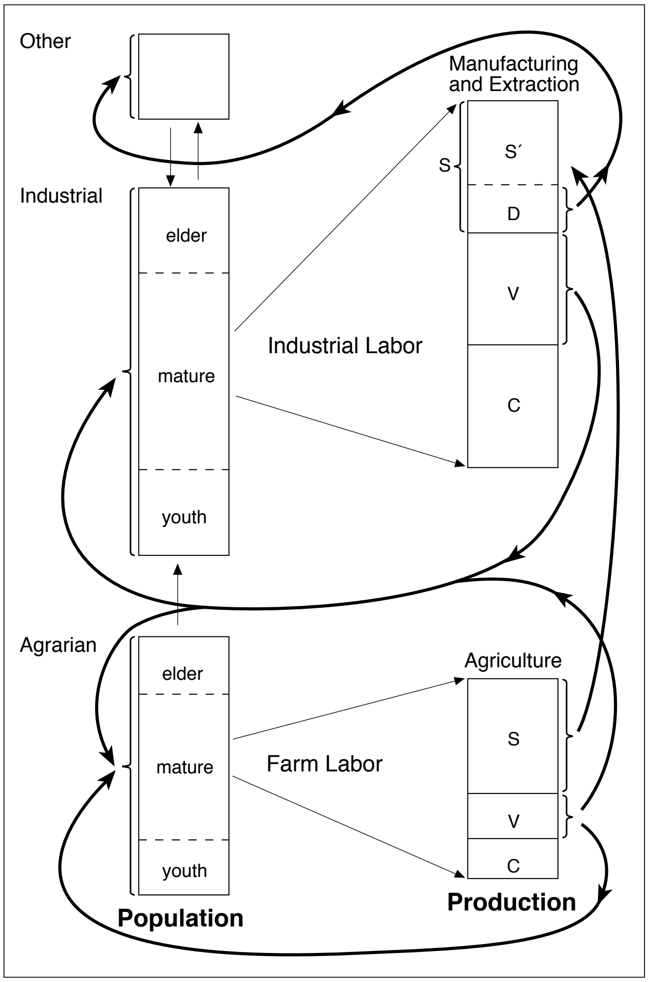
LaRouche explained, later in the same 1998 document quoted above in which he discussed Hamilton's principles:

> Take the total per-capita output of productive labor (labor directly employed in agricultural and industrial products, or, in engineering and related services essential to the physical maintenance of productive capacity and product quality): "T" = "Total." Compare . . . this total labor output with the ration of physical goods and related essential services required to maintain the labor force [itself] at the existing level of skill and productivity (the British "classical" economists' and Marx's "Variable Capital," or "V").

The suddenly dense and bustling population of Chicago in the example above could thus be taken as an indication of a dramatic increase in "V" as an output of the economy of the area, clearly resulting from the canal.

> In a similar way, compare, as capital costs, the ration of total output required for basic economic infrastructure, plus the ration required as production and closely related capital (similarly, "C" = "Constant Capital"). The latter includes the required flow of goods in intermediate states, as required to maintain current output. . . .
>
> Include "d," as the general overhead expense of society, apart from V and C. Then subtract d+V+C from T = P′ (margin of physical-economic profit).

Physical Economics Flowchart



Not financial profit, but physical economic profit or "free energy" of the productive economy. LaRouche has thus broken down the economy's total output into those portions of economic activity it supports: the portion that goes to households or otherwise maintains the working population; the portion that maintains, operates, repairs, replaces basic infrastructure and production capital at least at a constant level; the portion that supports overhead which is not involved in production but may be necessary to it, such as education and medical care; and the portion of output which constitutes "free energy" available for *change* going into the next cycle of production.

He concludes that for actual physical-economic *growth or progress*, three inequalities must be present:

> It is required: P′/(C+V) increases, as the ratio C/V increases, and the physical-economic con-

> tent of V, per capita, also increases. In part, the margin of gain of P′/(C+V) is the result of development of basic economic infrastructure; in the final analysis, all gain, including that from development of infrastructure, depends upon the impact of investment in scientific and technological progress.[7]

This sequence of "inequalities" required for physical-economic progress can be shown by the economic timetable in **Figure 2**. This is drawn to illustrate the impact on the entire economy and labor force, of the revolutions in electric power technology over 1935-75 in the American economy: First, the "TVA" jump from fossil-fuel power dominance to relative dominance of the more power-efficient hydroelectric power; and then second, the transition (briefly, unfortunately) to the still more power-efficient nuclear power. These can be called platforms of energy technology. It can be shown that the first directly made the second possible.

The table shows 110 years of power data for the U.S. economy in five-year intervals. The 1935-75 period is when the technological transitions had strongest effect—the period often referred to by economists as "the golden age of productivity" in the United States' last 150 years. The end of that period coincides almost exactly with the abandonment of Bretton Woods and establishment of the "floating-exchange-rate" system.

The absolute figures for physical-economic production inserted in the boxes are not comparable from row to row. So all of them are re-expressed—by the shading—as rates of change which can be compared. Unshaded five-year periods showed a slow increase, less than 25%; lightly shaded periods, a relatively rapid increase, by 25-50% for the five year interval; and darkly shaded periods, very rapid growth for any physical-economic parameter, more than 50%. Five-year periods of actual *decline* are indicated putting the absolute figure in *italics*.

The first two rows concern elements of what we described above as LaRouche's "energy-flux density" metric. These parameters already define 1935-50 and 1960-70 as periods of rapid increase of energy throughput and energy conversion efficiency in the U.S. economy—the surge in hydropower, and the later surge in nuclear power. Between them is a period of slow growth in energy throughput, and stagnation of energy efficiency, in which electric power expansion was in coal- and oil-fired plants—many of them again built by the TVA.

The third row is an expression of the "V" or "Variable Capital" defined by LaRouche: the size of the productive workforce in millions (manufacturing, mining, construction, transport, utilities and agricultural workers) multiplied by the Production Workers Real Wage Index published in the *Statistical Abstract of the United States (Census)* until 2005. For example, for 1970, the year in which that Index was reset equal to 1 by the Census, the number of productive workers was 28.2 million, and the product of 28.2 x 1 is shown. This row is an approximation of the varying rate of growth of "V," the economic output which was maintaining the productive workforce at a generally rising standard of living. And it defines essentially the same two periods of rapid growth above—for "V," one period of very rapid growth, which obviously includes the mobilization for World War II, but continued through its end.

The row expressing "C," or "Constant Capital" is limited to the core of that productive capital in any modern economy—electric power. The parameter is not installed power capacity, but rather power generation and use per year, in terawatt-hours. (Recall that LaRouche specified above that "C" is an economic output and "includes the required flow of goods in intermediate states, as required to maintain current output.") Here the entire period 1935-75 is characterized by very rapid growth, faster overall than the growth of "V".

Indeed, in the next row the first expression of the economic output ratio "C/V" (power generation and use per capita per year in megawatt-hours) shows the same very rapid growth throughout the period with just one brief interval of merely rapid growth. And the second, more rigorous approximation of *LaRouche's* ratio "C/V"—power generation and use per productive worker per year in megawatt-hours—shows almost the same accelerating rate of growth throughout the same period.

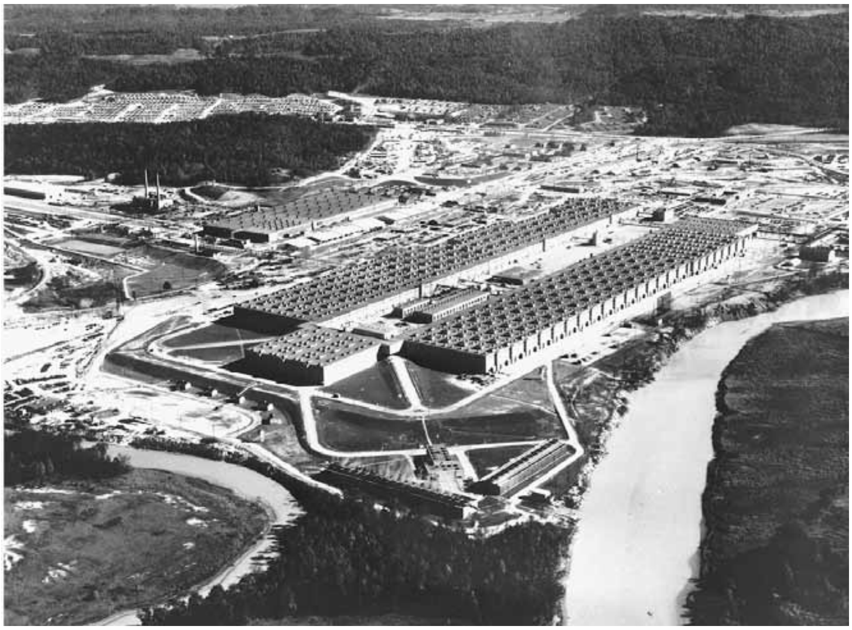
Again, for a simple approximation, we are dealing here not with LaRouche's "C" as a whole, but only with the prime modern capital good, electric power generation, transmission and use. But it is clear, given

7. Lyndon LaRouche, *op. cit.*, p. 24

the United States' ability during this period to produce the World War II allies' global logistics for the victory over fascism, and shortly thereafter to explore the Moon, that these rates of growth extended to capital goods generally, including new infrastructure in areas other than electric power.

Two of LaRouche's three "inequalities" required for physical economic growth were met during this period, which ended with the destruction of the Bretton Woods System. They are: that "V" grow at a generally increasing rate, and that "C" grow more rapidly than "V"; and therefore that "C/V" increase.

To summarize over the period 1930-50, for example, the American productive workforce grew by 50%; but power generation and use per capita per year grew by 180%; and power generation and use per productive worker grew by 160% from 4.48 Mwh to 10.58 Mwh per year. Again from 1960-75, "V" grew by 50%, "C/V" as per capita electric power generation and transmission by 140% and "C/V" as power use per productive worker by 180%.



U.S. Army/James E. Westcott

A Manhattan Project facility. The K-25 plant, at Oak Ridge, Tennessee, completed in 1945. The plant used the gaseous diffusion method to separate uranium-235 from uranium-238, to make atom bombs.

Forms of P′ in the 'TVA Revolution'

The nature of LaRouche's P′ = T−(C+V+d), where d is the growth of economic overhead, is that it can't be seen literally in the figures or rates of growth in the table. Rather, its operation is clearly shown between the periods of economic output. The productive workforce and its living standard (LaRouche's "V") could not be growing so from period to period, while capital goods output ("C") grows more rapidly and the ratio "C/V" even more rapidly, unless "P′"—productive surplus—were being produced in one period to be applied to both "C" and "V" in the next. "P′", though not nominally visible here, must be applied to hire more productive workers from the those unemployed or entering the workforce, to provide them more pay and benefits, to train them for more skilled, higher technology employment, to provide more capital goods for them to work with, and to provide "d," the economic overhead which includes educators at all levels, white collar workers in all fields, scientists in new fields, etc.

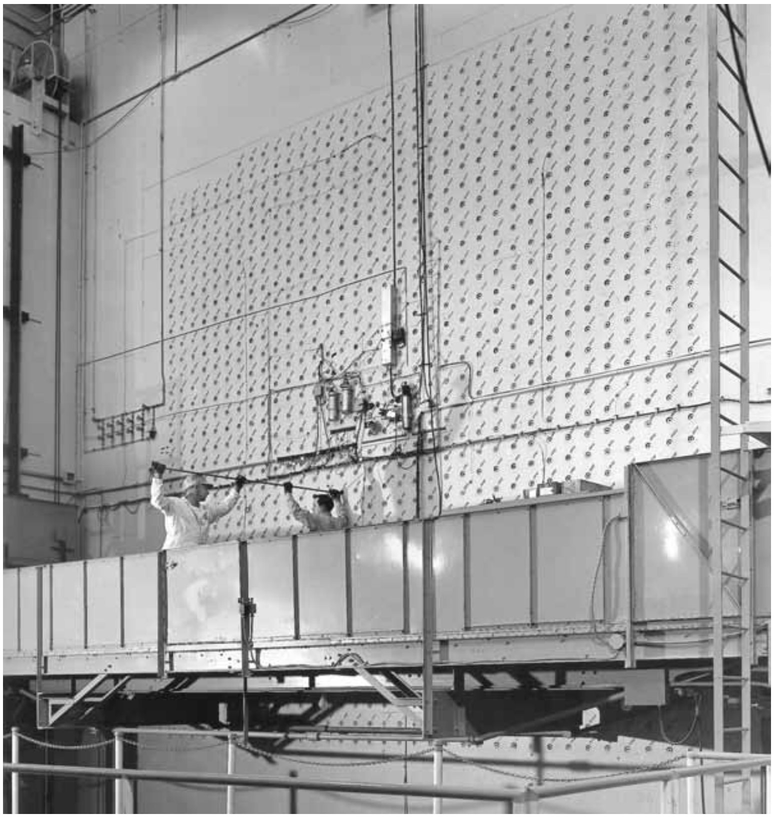
This can be seen abstractly in the second part (Productivity) of Figure 2, which shows that the period 1935-70 had a different character than these 110 years as a whole and why it is often called the golden age of U.S. productivity.

In an earlier paper, LaRouche commented:

> Taking the society (economy) as a whole, this net increase [in free energy or "P′"—pbg] is the outcome of some increase in average level of technology of the economy as a whole. This may be accomplished either by introducing new, more advanced technologies, or by replacing obsolete capital stocks with competitively modern capital stocks, or by increasing the average level of productivity of the entire labor force through productive employment of significant portions of the unemployed, or some combination of these measures. All things being equal, in the longer run, it must be based on introduction of more advanced technologies.

Can we be specific? What form does "P′" take for this period which we could call, for shorthand, the "TVA revolution" in electric power technology?

First, waves of new scientists and engineers (who



U.S. Army/James E. Westcott

A Manhattan Project facility. Workers loading uranium slugs into the X-10 Graphite Reactor's concrete face, Oak Ridge, Tennessee, ca. 1943.

in each following period of production became part of "d," existing economic overhead, or of "V," the productive workforce) to work on the *next* revolutionary infrastructure-technology platform, nuclear power. Virtually overnight from 1940-44, some 110,000 scientists, engineers and increasingly skilled workers were employed in the Manhattan Project which developed the atomic weapon and led through Manhattan Project lab reactors and then submarine power reactors to civilian power reactors. The great majority of these were employed at the Oak Ridge nuclear fuel development site in Tennessee and the Hanford Nuclear Reservation in Washington State, using huge amounts of hydroelectric power from the TVA and the new upper Northwest hydroelectric projects.

This rapid growth of "P′" in human form was repeated from 1960-70 when 400,000 people suddenly were employed in the Apollo Project, a great proportion of them engineers and scientists and mathematicians. The third part of Figure 2, at the bottom, shows this rapid 1940-75 creation of, eventually, millions of scientists and engineers beginning with the Manhattan Project, before which there were not many more than 100,000 working in the entire economy.

Second, Federal investment in scientific research and development of new technologies. This appeared as a completely new economic phenomenon during the New Deal 1930s, first ranging from 0.3-0.5% of GDP, then reaching 2.0% of GDP in the decade of the 1960s. After the destruction of the Bretton Woods System in 1971-73 came the long and steady atrophy bemoaned by the authors of *Jump-Starting America*.

Third, entirely new, electricity-intensive industries involving the creation of new forms of "C" and new levels of "V," such as the aluminum industry centered in the Northwest, and with it a greatly expanded aircraft industry; the foundations of computing and simulation technologies; relativistic-beam technologies such as radar and lasers; etc.

Fourth, the *potential* of nuclear power, and the actual creation of 100 gigawatts of this most reliable and energy-flux-dense source of electrical power, not to mention nuclear sea- and potential nuclear space propulsion.[8]

Credit in the New Bretton Woods

It was this process of physical-economic advance which Franklin Roosevelt's planned Bretton Woods System intended to bring into developing countries of Latin America (where it had already had an impact), Africa, and Asia by, in effect, "exporting the TVA."

Now after an even longer "floating-exchange-rate" period of deindustrialization, rampant financial specu-

8. With respect to LaRouche's unique concept of potential relative population density: It is clear that these electric-powered breakthroughs, with "C" overall increasing 2-4 times as rapidly as a rising "V," not only allowed continuous creation of physical-economic free energy or surplus, "P′"; they also initially left actual population growth behind, so that population density fell *relative* to its increasing potential. For the country as a whole, during the 20 years 1930-50 when kilowatt-hours per capita, per sq. km and per productive worker all rose by more than 200%, population grew just 15%, from 130 to 150 million. But in the next 20 years, 1950-70, it grew by 50 million or 33%, "catching up" to the rising potential population density as in the simple 1850s Chicago example.

lation at the expense of productive investment, and increasingly frequent financial crashes, a new Bretton Woods is urgently needed in which the mechanism of joint development credits from the initiating countries must function. Those countries must include the United States, Russia, China and India, and *not* the United Kingdom/City of London, which willfully brought down the original Bretton Woods.

These initiating nations' objective is not only to drive international industrial and agricultural progress in third countries. It is also to work jointly on the next fundamentally new infrastructure platforms, including the international crash program for fusion power called for July 9, 2019 by President Vladimir Putin of Russia, and widespread space travel and development of bodies in the Solar System.

Money credit is not part of the physical-economic process of science-driven anti-entropic growth described above. It is its necessary accompaniment and assistant. Alexander Hamilton put it in the simplest way, writing to Gouverneur Morris in 1781 that the purpose of banks is "to put the savings of the nation at the disposal of those able to use it most productively" to develop inventions and manufactures.

Horatio Stone, 1868

Statue of Alexander Hamilton in the U.S. Capitol Rotunda, Washington, D.C.

That is commercial banking. Hamilton developed the new idea of national banking—the essential liaison between government Treasury operations and private commercial banks—that its purpose is to *multiply* the savings of the nation for the same purpose, effectively leveraging the future savings and tax payments in order to provide large amounts of additional credit to drive industrial and infrastructural development.

Since his first proposal of an International Development Bank (IDB) to the Non-Aligned Nations' Colombo Conference of 1976, Lyndon LaRouche proposed that such IDBs—necessarily joint efforts of *national* banking and credit institutions—can combine their issuances of credit for the most productive "great projects" of new infrastructure and high-technology capital goods exports to developing countries. Such issuances of currency are debts of the issuing governments "to the future," ultimately to be repaid by advancing productivity.

Kremlin.ru

Russian President Vladimir Putin (front right) at the INNOPROM-2019 International Industrial Trade Fair in Yekaterinburg, Russia, July 9, 2019.

In the immediate wake of the destruction of the Bretton Woods System, LaRouche made proposals for the United States to use new currency issues to place the dollar back on a gold-reserve basis. From the 1990s until his death, he proposed the full reconstruction of the Bretton Woods System, including its fixed-exchange-rates and controls—and the Glass-Steagall bank separation principle—by these four leading science and technology powers.

FIGURE 2

Electrical Energy and Physical Economic Measures of Growth, 1900-2010

Year	1905	1910	1915	1920	1925	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
Throughput of energy (mill. BTU/capita)	125	155	178	190	195	190	150	190	230	220	235	250	300	340	335	320	340	350	350	340	335	310
% of energy which is electric power	—	—	—	—	—	10.1	8.1	12.9	15.7	16.1	15.1	16.6	21.2	25.5	30.8	32.3	35.8	36.0	38.1	38.1	38.3	38.2
V (prod. work force [millions] X real wages of prod. wkrs [1970 = 1])	—	—	—	2.80	3.25	3.40	2.75	5.10	12.6	20.3	18.1	18.0	22.2	28.2	26.8	26.2	26.9	25.7	26.5	28.0	25.5	21.2
C power gen & use (TwH/year)	—	14.16	31.04	43.33	67.75	94.65	98.46	144.9	222.0	329.0	540.0	730.0	1050	1525	2300	2350	2356	2810	2900	3,802	4,055	3,950
C/V power gen & use / capita (MwH/year)	.134	.154	.323	.436	.571	.782	.769	1.106	1.585	2.15	3.312	4.2	5.425	7.55	10.0	10.05	10.01	10.16	11.1	11.3	11.8	11.4
C/V power gen & use / prod. worker (MwH/year)	—	—	—	2.53	3.39	4.48	4.82	6.16	8.4	10.58	17.15	25.2	40.0	48.2	70.0	80.0	80.00	109.3	110.0	135.7	159.0	188.0
Year	**1905**	**1910**	**1915**	**1920**	**1925**	**1930**	**1935**	**1940**	**1945**	**1950**	**1955**	**1960**	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**

Productivity

Year	1905	1910	1915	1920	1925	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
Labor productivity (% ann. growth)	—	—	—	—	—	2.8	2.6	3.2	3.8	3.0	3.1	3.3	3.0	2.2	1.4	1.0	2.3	2.0	1.3	3.3	2.0	1.7
Multi-factor productivity (% ann. growth)	1.0	1.3	1.3	1.0	2.0	2.0	3.3	3.3	3.1	2.8	2.0	2.0	2.7	2.7	0.9	0.9	0.95	1.0	1.0	1.2	1.0	1.0

Increases & New Categories of P'

Year	1900	1905	1910	1915	1920	1925	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
D Scientists & engineers (1000s)	—	—	—	—	—	126	146	132	189	311	384	524	764	1,100	1,480	2,708	2,808	3,700	3,625	3,586	2,963	2,477	2,671
D Federal R%D spending (% of GDP)	—	—	—	—	—	—	—	0.4	0.3	0.5	0.4	0.5	1.7	2.0	2.0	1.1	1.1	1.2	1.1	0.9	0.75	0.95	1.0

The source for data from 1920-2010 is the *U.S. Statistical Abstract (Census)* in five-year intervals. Earlier data on energy throughput is from Energy Information Agency. Labor productivity is from the Bureau of Labor Statistics. Multi-factor productivity is from the Commerce Department Bureau of Economic Analysis. R&D spending data is from the Government Printing Office Historical Tables.

The absolute figures for physical-economic production inserted in the boxes are not comparable from row to row. All are re-expressed—by the shading—as rates of change which can be compared. Unshaded 5-year periods showed a slow increase, less than 25%; lightly shaded periods, a relatively rapid increase, 25-50%; and darkly shaded periods, very rapid growth for any physical-economic parameter, greater than 50%. Five-year periods of decline *are indicated by the absolute figures in* italics.