Why Electrified Rail Is Superior

A.P. Yates/Library of Congress

This 19th Century steam engine was photographed on May 10, 1893, in Syracuse, N.Y., when Engine 999, drawing the Empire State Express, made the record speed of 112.5 mph.

by Richard Freeman and Hal Cooper

TGV

France's TGV high-speed electric train. Nearly 80 percent of France's electricity is supplied by nuclear energy, and supports its nationwide grid of electrified railroads.

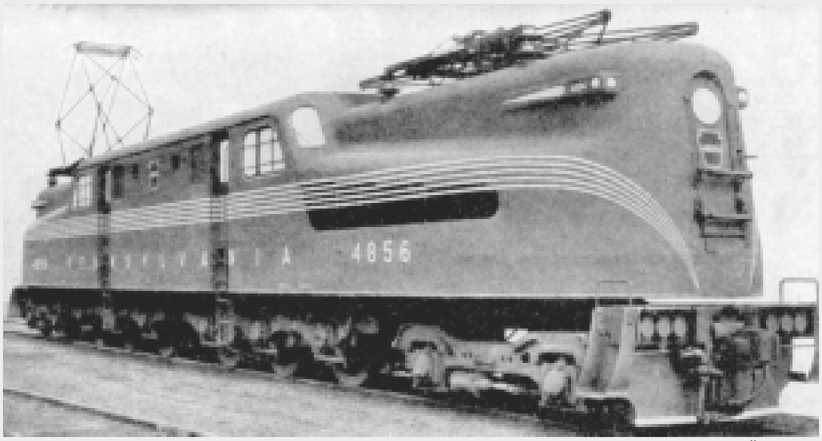
The fight to electrify the American rail system has been waged for more than 100 years. The superiority of electric-driven locomotives over steam-powered locomotives, and over the hybrid diesel-electric locomotives that are used today, is undeniable. A comparison of electrified rail to steam-powered rail, at the peak of the powers of each, brings out the stunning superiority and method of operation of electrified rail.

The steam-powered locomotive, an invention of the 1820s and 1830s, works on the following basis: On the locomotive of the train is a "firebox" into which coal is fed. The firebox heats a water boiler, making super-heated steam, which is under very high pressure. The super-heated steam is passed to cylinders (by a suitable valve arrangement), where it drives pistons. The moving pistons turn a main rod, which in turn, moves connecting rods that are attached to the locomotive's driving wheels. (This whole arrangement utilizes a system of gears.)

Five limiting features are obvious. First, the train can only achieve a certain speed. The best steam locomotives in the 1940s, using super-large cylinders, and in some models operating two parallel sets of super-large cylinders, could only achieve top speeds of 125 miles per hour, without a load of cars. Second, on a steep grade, a steam locomotive could lose as much as half of its pulling power. Third, a steam locomotive could be in the shop for as much as 40 to 50 percent of the time. Fourth, it must drag its own fuel and water supplies (for boiling into super-heated steam) along with it, usually in a "tender car." The steam locomotive must haul many tons of coal and 2,500 gallons of water or more. Fifth, the steam locomotive is inefficient: It consumes nearly two times as many BTUs of energy to carry a ton-mile of cargo freight as does an electric locomotive.

At the dawn of the 20th Century, electrification of rail had been introduced in the United States, poised to become a reality. It grew in small steps, so that by the early 1930s, 3,000 route-miles[1] had been electrified, at least several hundred of them through the assistance of President Franklin Roosevelt's Public Works Administration.

An indisputable advantage of electrified rail is that it does not carry its own power generator/power supply with it. The system begins with a stationary electricity-generating plant far away from the locomotive, which can use any source of fuel—say, nuclear—to generate the electric power. The electricity is transmitted by transmission lines to a set of wire lines that hang overhead of the train track, called the catenary lines. A device on top of the locomotive—called a pantograph—makes continuous contact with the catenary system, transmitting electricity continuously into the locomotive. (A transformer steps down the voltage). The electricity is directed to motors which are attached to the wheels, and power them.



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An early 1940s U.S. electric locomotive. By the 1930s, U.S. rail had 3,000 route-miles electrified—three times today's electrification. The pantograph and catenary line can be seen at upper left.

The electrified train system produces benefits of great significance: First, one leading system, the French TGV, cruises at 180 mph (290 kph), a speed closely approximated by electrified systems in several other European nations and Japan. Second, the electrified train system uses no petroleum. Third, several electrified trains can use "regenerative braking systems" (by essentially transforming the motors into generators) which capture electricity when braking, save great wear and tear on brake shoes, and so on. Fourth, the electrified train uses half as many BTUs to carry a ton-mile of cargo freight as do steam-powered locomotives, and maintains a sizable energy efficiency over other transport systems.

The close of World War II marked the end of the dominance of steam-powered locomotives—a demise that should have come a half-century earlier. Certainly, the bright prospect of the United States moving toward electrified rail was beckoning. But this move never occurred; it was sabotaged by Wall Street banking interests.

The Post-World War II Highway Detour

In the period after World War II, an alliance of the Anglo-American bankers, the oil cartel, and the Morgan/Dupont-controlled General Motors organized to stop the electrification of U.S. rail. First, they worked to pass the Interstate and Defense Highways Act of 1956. Ostensibly the product of a Presidential task force on this subject headed by General Lucius Clay, the Act was to provide a centralized series of corridors for the continental movement of goods during war and other emergencies. However, the above alliance shaped it to spread suburban sprawl, suburban real estate bonanzas, and the explosive growth of the petroleum-consuming car and truck market, which came to dominate the nation's transportation system.

The Act created an enormous annual flow of government money into highway building, so that during the past 50 years, $2.5 trillion has streamed into building and repair of U.S. highways and roads, while Amtrak must beg to get a paltry $1.8 billion per year barely to survive. In 2004, some 8.75 million trucks were turned loose on the highways, carrying 25,000- to 100,000-pound loads. The heavier the trucks become, the more they rip up the highways—as the damage increases geometrically with heavier trucks—requiring greater repair. The surge in truck traffic, in particular, and also passenger cars, has grown to such unwieldy proportions, that for hours of each day, the highways don't function. Various urban planners now propose building highways with six lanes in each direction.

In 1943, during World War II, 73 percent of America's intercity freight traffic (by tonnage) travelled by rail, and only 5 percent travelled by truck—and the system worked. By 2001, the percentage of freight moved by rail plummeted to 42 percent, while truck freight rose to 28 percent. Except for the coal moved by the railroads, trucks today carry more goods.

The bank/oil cartel/automotive alliance carried out a second assault in the post-World War II era. It dismantled much of the existing electrified rail, leaving less than 1,000 electrified miles in America. As steam-powered locomotives were phased out, there was a shift toward diesel-electric hybrid locomotives, which now comprise 99 percent of the U.S. fleet.

Diesel-Electric Locomotives

There are two most important points about diesel-electric locomotives. First, think of putting a diesel engine onboard just to power a generator for an electric locomotive. The same thing could be done simply, without the diesel engine, by transmitting outside electricity into the locomotive. Second, consider that a diesel-electric locomotive has a 450- to 500-gallon diesel fuel tank. Collectively, these hybrid locomotives consume *3.8 trillion gallons* of fuel per year. Thus, the electric locomotive has been reduced to an appendage of the burning of petroleum.

The rail system has been both technologically and physically degraded, especially since the Staggers Act of 1980 deregulated the industry, and the sharks and asset-strippers moved in. There was a ferocious "rationalization" of rail lines. In 1980, Class I railroads operated 164,822 route-miles, but by 2004, that was reduced by 40 percent, to 99,000 route-miles. In the same period, the railroads settled on a survival strategy: Loading up on the transportation of coal. Coal is a legitimate fuel source for electricity generation, but its role and use should not be exaggerated. In 2004, 43 percent of all tons shipped on the rail system were coal. This ties down the rail system. The transport of other goods is lagging. Over the past three decades, the rail industry's shipment of non-coal goods, per household, has fallen dramatically.

A Great Project Approach Is Needed

The long-suppressed electrification of America's dilapidated rail system is an undertaking which could only be achieved by the fight for and adoption of Lyndon LaRouche's April 13 emergency proposal to the U.S. Senate,[2] which called for a retooling of the auto sector to deploy the immense volume of advanced machine tools and hundreds of thousands of skilled workers it still commands, to produce the goods for the electrification infrastructure.

We present here the crucial elements, which, being done in tandem, put great demands on the economy. Consider the bill of materials for the tremendous array of goods that would go into each element.

(1) *Electric locomotives:* In 2003, the Class I railroads (the nation's largest railroads)[3] operated 20,711 locomotives, all of them diesel-electric. About half these locomotives (10,350) travel on the most heavily travelled 42,000 route-miles cited above. An attempt could be made to retrofit the diesel-electric locomotives into all-electric locomotives, but that is a complicated procedure. Thus, the retooled auto plants would have to take the lead in building 10,350 all-electric locomotives.

(2) *Catenary lines and transmission lines:* To electrify these routes, requires building an overhanging system of catenary lines above the tracks, to transmit the power to the trains. From electric power plants, electricity would be carried by transmission lines to the catenary lines. This means 42,000 miles of catenaries, and tens of thousands of miles of transmission lines.

(3) *Substations:* These bring power from high-voltage levels to lower voltages, and also act as phase-breakers, because when current travels more than 40 miles, there are severe voltage losses. More than 1,000 substations would be built, one every 40 miles.

(4) *Double-tracking:* When trains come from opposite directions on a specific route sharing the same track, both must slow down at some point, using a side track to clear one another. If that happens several times on a route, the overall trip speed is considerably slowed. A double-tracked route provides a set of tracks for travel in each direction. Of the 42,000 route-miles selected for electrification, only 10,000 to 12,000 are double-tracked, but heavy usage makes virtually all of them candidates for double-tracking, calling for tens of thousands of miles of new track. The bill of materials to lay each new mile of track is: 370 tons of steel, 535 tons of cement, and so on. Also, steel is required for the culverts.

(5) *Nuclear power generating plants.* The 42,000 route-miles of electrification would require a complete overhaul of America's energy policy: Its inadequate energy grid now suffers blackouts and shortages. To electrify these route-miles would require adding new electric-generating capacity of 50,000 megawatts (MW) in order to generate 383 trillion kilowatt-hours of electricity during the course of one year. This would represent a 5.3 percent increase of the U.S. installed (summer) generating capacity.

To do this, the United States would have but one choice: to move forward with a vigorous nuclear energy policy. This cries out for mass-production techniques for nuclear power production. Retooled auto plants could make several of the components.

Gearing Up Physical Production

We have briefly examined five elements that are indispensable for the electrification of America's rail system. Needless to say, there are many more elements of importance that could be considered: signalling systems; grade separations (underpasses and overpasses to cross the track); passenger cars, hopper cars, and intermodal cars; train stations; components such as couplers, cooling systems, etc.

The most important thing is getting physical production geared up to produce the critical features of this great infrastructure project. Its production will employ at minimum 250,000 workers, most of them skilled, in producing the array of goods from the final locomotives and transmission lines, to the semi-finished goods like steel, copper, and aluminum, and the components like cooling systems, to the final on-site construction. There is a price attached to each element; for example, the cost of an electric locomotive is about $3.5 million, so that 10,000 such locomotives would cost $35 billion. Preliminary projections are that the entire project would cost in the range of $400 to $500 billion, and take 10 to 15 years.

However, the system will permit the economy to leapfrog ahead technologically. Electrified high-speed rail passenger travel will occur at 150-190 mph; freight will travel at approximately 90-110 mph (for safety's sake, coal and a few other commodities are best served travelling at lower speeds). By contrast, 75 mph is the legal limit of passenger cars and freight-carrying trucks, and in reality, in traffic, they travel at a fraction of that speed. The electrified system will radiate these benefits, and the associated higher productivity, through the main corridors of every part of the nation.

Given the speed and other advantages of electrified rail,[4] it will be possible to take trucks off the road in two ways. First, there are categories of freight that are best shipped by rail. Second, in a process that is in its infancy: Trucks can do short-haul via railroad. A truck picks up a product, drives to a railroad, is strapped onto a rail flat car, and shipped to

another city, where the driver and truck disembark to make the delivery. By these two processes, within 15 years, one-third of truck traffic could be shifted to rail.

However, the production of goods for electrification of 42,000 rail route-miles cited above, is based on working to accommodate the current volume of rail freight, and factor in a small annual increment. Were we to succeed in transferring one-third of truck freight to rail, this would require a *second round* of increased production for electrified rail.

Magnetic Levitation

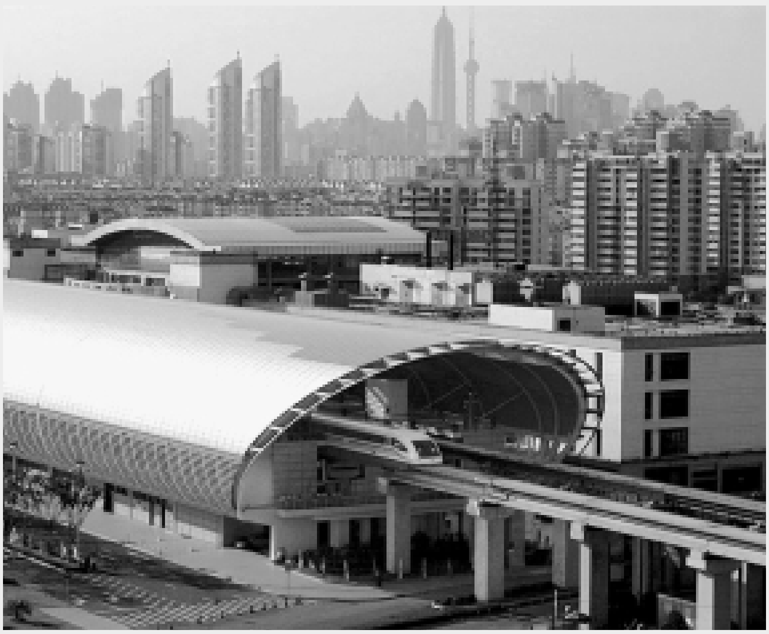
As forceful as the effect that rail electrification would have in transforming the economy, there is still a higher level: magnetic levitation. In "maglev," the magnetic forces generated by the interaction between the bottom of the transport vehicle and the rail, lift, propel, and guide a vehicle along a guideway, so that it "flies" on a magnetic cushion. This eliminates wheel-on-wheel friction, which slows all traditional modes of railroad transport. Current generation maglev systems cruise at speeds of 245 mph (392 kph), and can reach top speed of 300 mph (492 kph), four times the current average speed of U.S. freight and passenger travel.

Maglev would start in the 5,000 miles of corridors that are the most densely populated. It would require a *third round* of rail production gear-up, including an additional 25,000 to 50,000 gigawatts of nuclear-generating capacity, meaning that with electrification and maglev, the nation's generating capacity would have to increase an impressive 10 percent.

Railroad electrification, including maglev, becomes possible only when the economy is mobilized and the mammoth production capability represented by the retooled auto sector, is brought into play. Without this capability, electrification of this scope would not be possible.

Such a mission will emerge from a political fight. Adoption of LaRouche's emergency proposal would save the auto sector in precisely such a manner, as to generate a technological revolution in rail and cascading productivity that will aid in reconstructing the nation.

Richard Freeman is on the economic staff of the Executive Intelligence Review, *and is working with Hal Cooper in elaborating a national railway policy.*



Transrapid

This 225-mph magnetically levitated train operates between Shanghai and its airport, a distance of 20 miles. The design is the Siemens Transrapid.

Notes

1. A route-mile is a mile of actual route that a train travels. A route of 50 miles represents 50 route-miles. This route may be double-tracked, thus having a total of 100 miles of track (and even more track in sidings, and yards), but still have only 50 route-miles.
2. LaRouche's Emergency Memo to the U.S. Senate can be found at www.larouchepac.com.
3. Class I railroads have $277 million or more of revenues per year. In practice, each of America's Class I railroads has more than 10,000 miles of track.
4. A truck consumes nearly 2.5 times as many BTUs of energy to carry a ton-mile of cargo freight, as does an electric locomotive.