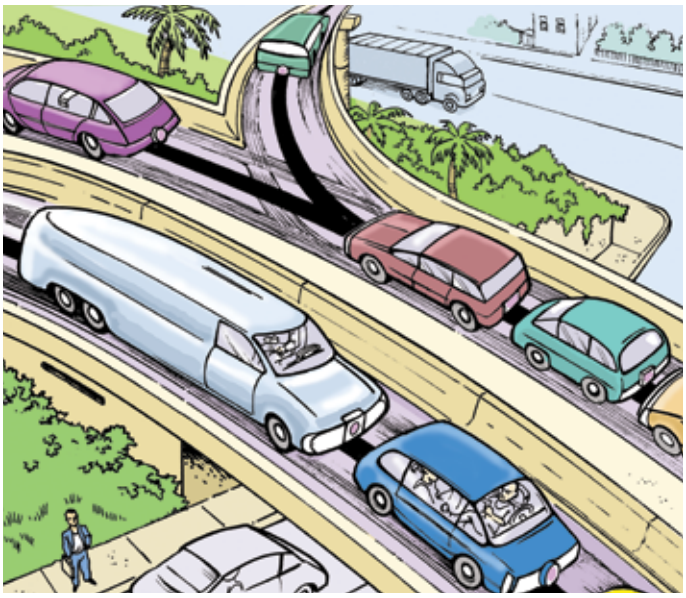
Electrical Guideways: A Transportation Solution?

by Mara Saltz



America has a transportation problem. And we're not just talking about traffic during rush hour. Motor fuel demand in the United States totals 11 million barrels per day, roughly equal to America's daily crude oil imports. Reducing those imports will require an overhaul of the country's ground transportation infrastructure, and the engineers at Texas A&M University's Center for Energy, Environment and Transportation Innovation (CEETI) believe they have one possible solution: electrified guideways.

A system of electrified guideways would allow dramatic increases in capacity and efficiency while freeing up valuable arable land. Guideways, using vehicle-to-vehicle and vehicle-to-guideway sensors, would allow freight and passenger vehicles to travel in tightly packed groups at high speeds. With a foot or so between vehicles, speeds could range from 60 miles per hour on urban routes to 200 miles per hour in rural areas. These speeds and density improvements allow for huge increases in efficiency: One guideway lane at 200 miles per hour provides the same capacity as 24 lanes of conventional roadway, and it does so by using a fraction of the energy. Indeed, a network of guideways could provide far more capacity than current transportation networks and do so with less land, less maintenance and at reasonable cost.

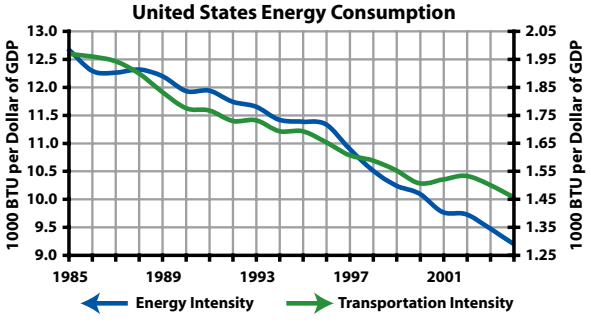
One guideway lane at 200 mph provides the same capacity as 24 lanes of conventional roadway, and it does so by using a fraction of the energy.

Investing in an electric transport infrastructure, says CEETI's director, Dr. Christine Ehlig-Economides, could allow America to address four of the most problematic aspects of our transit system: congestion, safety, emissions and fuel diversity. "At CEETI," Dr. Ehlig-Economides says, "we hope to draw attention to electrifying transportation through electric and dual-mode vehicles that can use their own power on conventional roads but that are equipped to draw their power from the road when traveling on electrified guideways." Both dual-mode vehicles and electric guideways could incorporate magnetic levitation (maglev). An evolving technology that suspends, guides and propels noncontacting vehicles above a guideway, maglev is praised for its relatively frictionless attributes, high-speed reliability and noise reduction. Although maglev has higher capital expenditures, many engineers, including Dr. Ehlig-Economides, believe its lower maintenance costs make it more desirable than alternative technologies.

From Cars to Maglev?

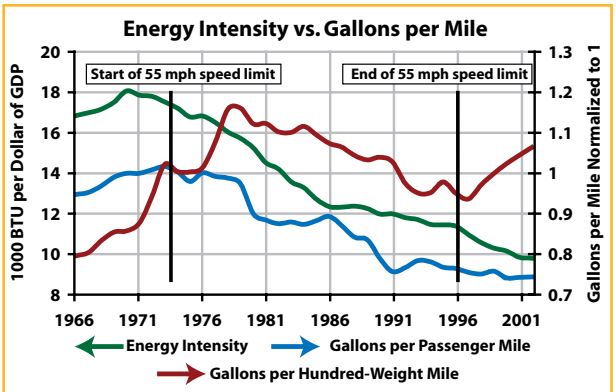
It's no secret that Americans are in love with their cars. Behavioral theory suggests that a superior product exceeding consumer expectations will be required to get people out of the cars and into a new technology, like electric guideway vehicles. The new technology must allow consumers to hop on the guideway without changing their lifestyles, which are often focused on convenience and user-friendly attributes at low costs. Charging up an electric dual-mode auto while driving on the road instead of filling up at a gas station could lead to pay-as-you-go business models that support such a value proposition.

According to Dr. Ehlig-Economides, "The dual-mode solution would let people drive their own cars as they do today,



In the past 20 years, the U.S. energy intensity fell by more than 27 percent, from about 12,600 BTU per dollar of the Gross Domestic Product (GDP) to about 9,200. This is a trend that started in the mid-1970s, prompted by the energy crisis following the 1973 Arab oil embargo. The country is becoming far more efficient in using energy, contrary to frequent laments by politicians and the press. Another way of looking at the statistics is that the fraction of the economy that goes to energy has been reduced dramatically.

Transportation energy intensity, including both passenger and freight, has also declined by about the same fraction, from 1,960 to 1,450 BTU per dollar of GDP.



This comparison reveals important distinctions in the evolution of passenger and freight efficiency. The graphs, representing gallons per passenger mile and gallons per hundred-weight mile, are normalized to 1 for the year 1974, when the federal 55 mph speed limit was imposed.

Plotted also is energy intensity (BTU per dollar of GDP) showing an almost 50 percent drop from the early 1970s to today.

Passenger mile intensity (gallons per passenger mile) shows a considerable improvement through the 1970s and 1980s with the energy intensity decreasing by at least 25 percent. The 55 mph speed limit had a considerable impact.

Freight intensity (gallons per hundred-weight mile) shows at least two trend reversals. The first trend, from 1966 to about 1980, reflects the way the nation used transportation to open up new businesses that were previously unavailable. Freight transportation intensity shows a dramatic increase during this time period as interstate freight traffic displaced the limited point-to-point transportation afforded by railroads. During this time, highway freight started connecting many more points, distributing goods previously available to far fewer urban centers and geographic regions of the country to practically everywhere in the nation.

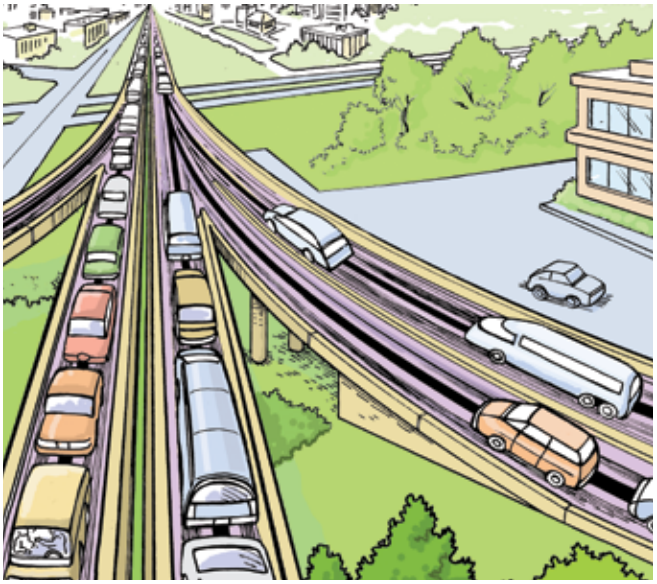
The second trend, from 1980 to 1997, parallels the downward trends observed both for passenger vehicles and for the overall energy intensity and coincides with the duration of the federally mandated 55 mph speed limit. Finally, the end of the speed limit coincides with an increasing trend in freight intensity. At the same time, the trend in overall energy intensity begins to drop at a greater rate, possibly showing that the heightened speed of commerce with increased highway speeds resulted in a sufficient productivity boost to offset greater energy used in transportation. This possibility should be evaluated before any consideration is given to reinstating the 55 mph speed limit.

while enabling safer and uncongested ground transportation. The way to start is to introduce the guideway infrastructure for driverless freight transport. Only final deliveries from a depot to a home or office would be done with a conventional truck and driver. Just getting most of the heavy trucks off our freeways would eliminate 95 percent of roadway damage and make the roads safer for personal vehicles."

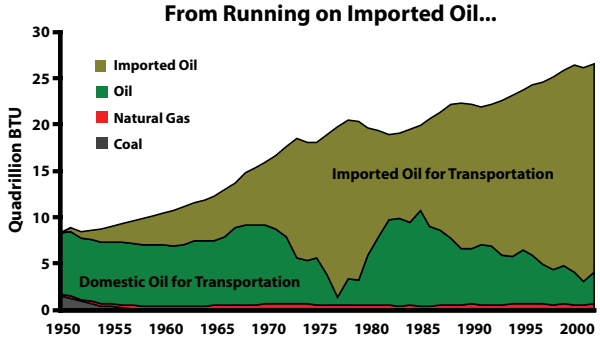
Another attribute of the guideway system is safety. Motor vehicle accidents on today's roads cost an estimated $231 billion annually. By some estimates, the savings from eliminating these accidents could fund the development of a nationwide dual-mode electric guideway infrastructure in less than a decade. Overall safety of the electric guideway would be enhanced by better safety measures based on vehicle-to-vehicle and vehicle-to-road communications designed for collision avoidance. Other safety features are inherent in the system since elevated electric guideways would be separated from animal and vehicle crossings.

Just getting most of the heavy trucks off our freeways would eliminate 95 percent of roadway damage and make the roads safer for personal vehicles.

"Mass transit vehicles, like buses, could also use the guideways," says Dr. Ehlig-Economides. "In fact, integrating mass and personal transit into the same guideway system would eliminate the underutilization frequently found in today's mass transit infrastructure." What's more, "the system's compactness and flexibility offers cities with insufficient population density the same public transportation options as major metropolitan areas."

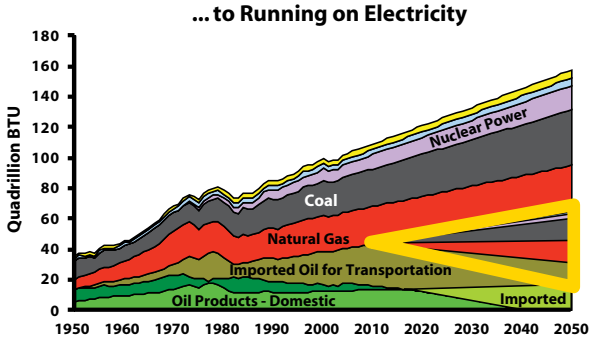


From Running on Imported Oil...



Of the 27 to 28 quadrillion (quad) BTUs that go to U.S. transportation and represent, by coincidence, 27 percent of U.S. energy needs, there is no electricity to speak of, and almost all of the energy comes directly from oil in the form of gasoline, diesel and jet fuel. In fact, the little sliver that comes from natural gas is mostly just to transport oil and gasoline in pipelines. The U.S. uses an additional 13 quads of oil for products such as polymers and plastics. However, when one superimposes the amount of imported oil on the oil used for transportation it becomes abundantly clear: One cannot talk about "energy independence" unless one addresses the use of oil for transportation.

... to Running on Electricity



Overall energy consumption involves both direct use as heating and transportation and indirect use with electricity as the energy carrier. Although transportation is virtually solely dependent on oil, electricity can be generated from the entire mix of fuels. If transportation were electrified, it, too, could draw from the diversity of fuels that supply electricity, as shown by the wedge outlined in gold. The composition of the fuel mixture for electric power generation would be subject to future economics, but the trend in the wedge would follow the overall trend. Note that extrapolating the current trends in oil imports leads to 100 percent imported oil by 2040.

This would be much safer than the current infrastructure that accounts for over 42,000 roadway fatalities per year. "The current multi-lane infrastructure supporting drivers of mini-sized vehicles competing for the same space as 18-wheel trucks is clearly responsible for much of the danger in ground transportation," says Dr. Ehlig-Economides. Traffic safety isn't the only safety issue, nor is infrastructure safety. By building redundancy into the structure, exposure to massive disruption and casualties from external attacks could be mitigated.

The engineers at Texas A&M have developed an innovative open-source approach called the CEETI Roadmap. It addresses the technological and transition steps needed to achieve the adoption of the dual-mode electric guideway vision. The open-source idea was inspired by Bruce A. McHenry, a technology entrepreneur. McHenry's open source PowerPoint presentation, located at www.DiscussIt.org, builds a strong case for electric transport and encourages collaborative thinking. The goal of the CEETI Roadmap is to define where and how a fixed guideway system should be built.

"We have yet to identify any technological demand in this system that has not already been developed. We are also evaluating this from a well-to-wheels perspective and will be comparing our results to other solutions on the table," says Dr. Ehlig-Economides. The expectation is that the CEETI Roadmap process will invite economic development from a wide range of commercial entities ranging from small entrepreneurs to major construction, auto manufacturing and consumer technology firms.

Putting It in First Gear

In College Station, CEETI engineers are gearing up for their first demonstration project. Plans for the one-tenth-size model, including rural, driverless freight and urban components, will cost about $3 to $5 million. The project will test feasibility for a variety of users and economic implications. Options to capitalize on the infrastructure, such as adding broadband services, will be examined along with new consumer business models and supply-chain opportunities for freight. Other high-speed projects will also be assessed.

The costs of a nationwide, electrified guideway system are formidable, with current estimates ranging from 1 to 4 trillion dollars. However, the savings from daily operations, lower maintenance technologies and safeguards could provide a rapid return on investment. For instance, the United States spent about $329 billion on the interstate highway system. That network took 40 years to build and has returned $6 for every $1 invested. In 1956, President Dwight D. Eisenhower announced the interstate highway system as "the National Defense Highway System."

So, let's begin a new journey. The road starts here.

If you would like more information or have questions about 21st-century transportation, energy and environment, e-mail to: questions@ceeti.org.

Mara Saltz is president of Saltz & Associates , a Houston-area management consulting firm (www.saltzassociates.com). She can be reached at mara@saltzassociates.com.