Future of major high-speed rail project looks green

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A study co-authored by an Arizona State University engineer says California's ambitious plan for a high-speed rail system can become a sustainable and environment-friendly transportation alternative. Credit: Photo courtesy of the California High-Speed Rail Authority.

(Phys.org) -- California has reason to be optimistic that the state's proposed high-speed rail project, due to begin construction next year, can prove to be a viable transportation alternative from environmental and sustainability standpoints.

That's the conclusion of research by Arizona State University engineer Mikhail Chester and University of California, Berkeley, engineer Arpad Horvath reported in a study published today in the journal Environmental Research Letters.

Chester is an assistant professor in the School of Sustainable Engineering and the Built Environment, a part of ASU's Ira A. Fulton Schools of Engineering, and has a joint appointment in ASU's School of Sustainability.

Horvath is a professor of civil and environmental engineering at Berkeley and the study's co-author.

California lawmakers three weeks ago authorized $7.9 billion in local and federal funds for the high-speed rail project, which promises to link Sacramento, San Francisco, Los Angeles and San Diego with trains traveling at a top speed of 220 mph.

The bill, signed into law by California Gov. Jerry Brown last week, allows initial construction on the 768-mile rail system to begin next year.

Chester and Horvath compared the future sustainability of high-speed rail with that of competing modes of transportation, namely automobiles and air travel. They determined that in terms of energy consumption and greenhouse gas emissions, a mature high-speed rail system wins out when it deploys state-of-the-art trains powered by greener electricity. This was true even after accounting for the emergence of more fuel-efficient airplanes and automobiles.

"We're showing that if this high-speed rail system is deployed, it is likely that California will reduce its transportation environmental footprint," Chester said. But to reap those environmental benefits, the state will have to wait until the system becomes fully operational, which could take an estimated 20 to 30 years after groundbreaking.

"What had been missing from the public debate is this long-term planning horizon," Horvath said.

"Comparable high-speed rail systems in Europe and Japan have been in place for 30 to 50 years. Why would we expect California's system to provide a return on investment in a short period of time?" Horvath said. "I would compare where we are now to circa 1950, around the start of commercial air travel. Did anybody know then how many passengers Los Angeles and San Francisco airports would eventually see in a year? Air travel has since grown into a massive industry."

To assess sustainability, the researchers conducted an exhaustive life-cycle assessment that inventories the full range of environmental effects associated with each mode of transportation. Included in the analysis are the cradle-to-grave environmental costs associated with extracting, manufacturing and distributing the materials – such as concrete, steel and asphalt – needed to build and maintain the vehicles, freeways, tracks, stations and other integral components of the travel systems.

The researchers considered different scenarios, such as varying levels of ridership and renewable energy use, when calculating emissions of greenhouse gases and conventional air pollutants, acidification and impacts on human respiratory health.

Assuming that the electricity needed to operate the high-speed rail system comes from renewable sources, a goal set forth by the California High-Speed Rail Authority, the bigger impact of the project comes from infrastructure and supply chain processes. For instance, approximately 67 percent of infrastructure emissions attributed to high-speed rail are the result of cement production for concrete used in construction.

"If the high-speed rail project uses low-CO2 concrete, it could reduce the infrastructure's environmental footprint by 15 percent," said Chester.

The new study updates a 2010 analysis by Chester and Horvath with newer, more realistic system descriptions, data and projections.

The difference in the new analysis is the allowance for smaller, more energy-efficient trains, such as those already in use in Germany as the ICE high-speed trains, which can be deployed based upon passenger demand. Instead of running a 1,200 passenger train at half capacity, for instance, the system could run smaller, more energy-efficient 400-passenger trains during non-peak travel times. The authors also have used forecasts for cleaner future electricity.

When calculating the future energy consumption of cars, the researchers used the federal fuel economy standards goal of 35 mpg by 2020. They accounted for a 54.5 miles per gallon standard proposed for 2025 by the U.S. Environmental Protection Agency and the National Highway Traffic Safety Administration.

The researchers also accounted for next-generation aircraft that are expected to enter production within the next two decades. Such planes offer up to 20 percent savings in fuel consumption.

The findings indicate that when the proposed high-speed train is occupied by 80 to 180 passengers on average over its lifetime, it would result in as many greenhouse gas emissions on a per-passenger-kilometer-traveled basis as a 35 mpg sedan carrying 2.2 people. The greenhouse gas emission-equivalent for a typical airplane carrying 116 passengers would be a train carrying 130 to 280 passengers.

"There are tradeoffs," said Chester. "Depending on ridership, sometimes high-speed rail is better with greenhouse gas emissions and beats out cars and planes. For respiratory impacts, cars are typically the worst offenders, followed by high-speed rail and then airplanes. Overall, what we're showing is that the trains are looking pretty good."

Horvath pointed out that they matched existing state-of-the-art trains against cars and planes that are still emerging. If more energy-efficient

trains or rail technology emerge, the environmental benefits would be even greater.

"It's not clear what technologies will be available for high-speed rail in the future," Horvath said. "We considered the best available technologies now, but there is nothing to say that it will be the best 10, 15 or 20 years from now. I'd be very surprised if best practices weren't improved upon by then."

Chester said that while their analysis shows environmental benefits to high-speed rail, "this is not the answer to the state's greenhouse gas goals. This is a tiny piece of the puzzle."

Chester and Horvath say planners and policy makers ultimately need to consider various factors beyond environmental impacts in developing California's high-speed rail system. Changes in travel time, productivity, congestion, safety and urban development opportunities are some of the factors to be considered , the researchers say.

More information: • Tracking High-Speed Rail's Energy Use and Emissions (*Berkeley Transportation Letter*, Spring 2010)
• California High-Speed Rail Authority website: www.cahighspeedrail.ca.gov/

Provided by Arizona State University