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Cutting Emissions from Aviation: Is High-Speed Rail the Answer?

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Issue

Per passenger trip, aviation is the most greenhouse gas-intensive mode of transport for intercity travel in California, but there is no clear pathway for decarbonizing this sector. While electrification proves to be the dominant pathway toward decarbonizing ground travel, this pathway is not technically feasible for commercial air travel, at least with currently available technologies.

While planners and policymakers wait for breakthroughs in fueling technologies, reducing greenhouse gas (GHG) emissions from aviation will require shifting trips from the air to less GHG-intensive modes of transportation. The California High-Speed Rail project can serve this function, but funding for the full route of the Phase 1 segment — spanning from Southern California to the San Francisco Bay Area — remains unallocated. In light of the high-speed rail project's precarious funding status, more information is needed about the potential benefits of the proposed rail network, especially in the wake of the COVID-19 pandemic, which has exacerbated uncertainty around future travel demand.

To address this need, UCLA Luskin Center for Innovation staff synthesized recent literature on the environmental and economic impacts of high-speed rail (HSR) projects from around the globe (Table 1). The synthesis looked at studies that examined the effect of HSR on at least one of the following metrics: GHGs, local air pollution, noise, economic value added, employment, property values, societal cost savings, and economic integration. The synthesis also looked at the conditions under which HSR leads to net benefits, so as to potentially reproduce those conditions in California.

Key Research Findings

Based on the last decade of research, it is clear that HSR can lead to measurable environmental and economic benefits. The majority of studies support this claim. However, the benefits of HSR are certainly not guaranteed. Recent literature has also shown that HSR projects—in specific instances—can exacerbate GHGs, local air pollution, and economic inequality. Thus, the benefits of HSR are only realized when certain conditions are met. These conditions include:

- Train propulsion that is powered by an energy mix that is high in renewables and low in fossil fuels.
- High ridership on HSR routes (driven by a mode shift away from automobiles and aircrafts rather than induced demand for new trips).
- Absolute reductions in air travel following the introduction of HSR (such that freed up capacity at airports for short-haul flights isn't used to accommodate longer-haul flights).
- Cities connected by HSR play complementary roles within the broader economy (such that economic activity isn't consolidated in core cities at the expense of intermediate cities).

Impact Domain	Metric	Number of Studies That Measure HSR's Impact	Number of Studies Showing Potential Benefit from HSR*	Dominant Trend	Strength of Evidence Base*
Environmental	GHG Reductions	12	11	Positive	Robust
	Local Air Pollution Reductions	2	2	Positive	Limited
	Noise Reductions	7	6	Positive	Fair
Economic	Value Added†	15	12	Positive	Robust
	Employment	3	3	Positive	Limited
	Property Values	9	7	Positive	Fair
	Societal Cost Savings	9	8	Positive	Fair
	Economic Integration‡	4	2	Split	Limited

*Qualitative assessment based on the total number of studies documenting the impact of HSR.
†Refers to wealth generation for a particular region, usually measured through gross domestic product (GDP).
‡Refers to reduced disparities between regions connected by HSR.

Table 1. Summary of Literature from 2011 to 2020 on the Impacts of High-Speed Rail

Conclusion

Given the mixed effects of HSR on environmental and economic indicators, additional policies are needed to ensure that the California High-Speed Rail (CAHSR) project delivers anticipated benefits in an equitable manner. To inform the development of new policies (or refinement of existing ones), some high-priority questions for future research include:

- What can be done to maximize CAHSR ridership? More specifically, what opportunities exist to reduce door-to-door travel time on CAHSR, as well as the relative cost of travel on CAHSR?
- What can be done to maximize the environmental benefits of CAHSR? For example, what opportunities exist to reduce GHGs from the construction of and transport to and from CAHSR stations? What policy tools can complement CAHSR to ensure absolute reductions in air travel? And what investments are needed to mitigate noise pollution from CAHSR?
- What can be done to maximize the economic benefits of CAHSR? For example, how can complementarities between CAHSR cities be strengthened? How can land value capture programs be used as a tool for economic development in cities connected by CAHSR? And how can CAHSR be leveraged for freight transport?
- What can be done to improve the performance of CAHSR along equity dimensions? In particular, what opportunities exist to mitigate air pollution from manufacturing facilities along the CAHSR supply chain? And how can CAHSR be leveraged to improve accessibility, mobility, and travel cost-savings for low-income users?

More Information

This policy brief is drawn from the report "Brace for Impact: The Environmental and Economic Effects of Shifting Passenger Travel from Airplanes to High-Speed Rail," prepared by Jason Karpman of the UCLA Luskin Center for Innovation. The full report can be found at www.ucits.org/research-project/2021-52/. For more information about the findings in this brief, contact Jason Karpman at jkarpman@luskin.ucla.edu.

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