

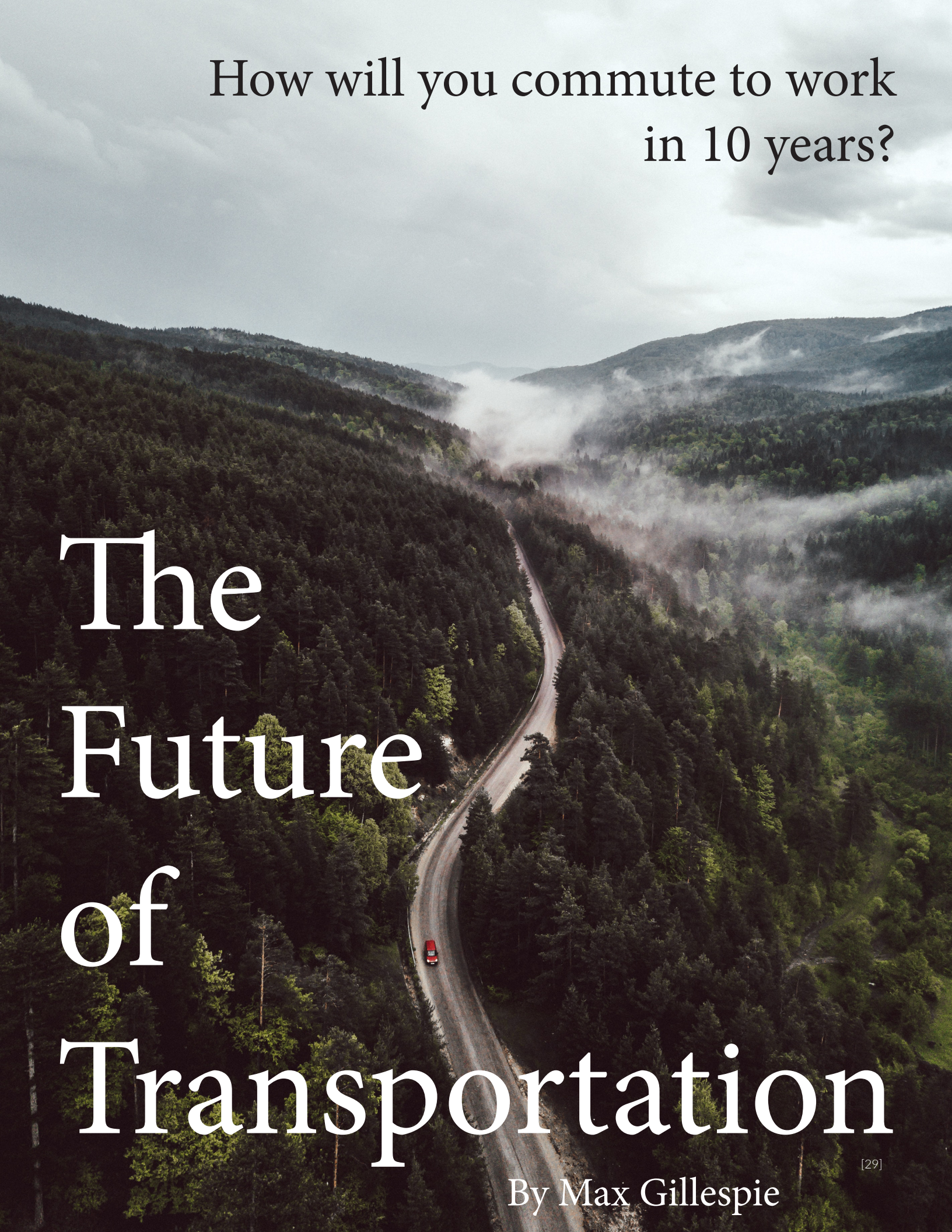
Special
Issue

POPULAR MECHANICS



THE FUTURE OF TRANSPORTATION AND HOW WE'LL GET THERE

[Max Gillespie, p. 43]

An aerial photograph of a winding asphalt road cutting through a dense, green forest. The road curves through a valley, and a small red car is visible on it. In the distance, mist or low clouds fill the valley between rolling hills. The sky is overcast with grey clouds.

How will you commute to work
in 10 years?

The Future of Transportation

By Max Gillespie

[29]



Rep. Alexandria Ocasio-Cortez Addresses Press Regarding Green New Deal [25]

A Sustainable Future

Sustainability is no longer a buzzword on the fringes of American politics – for many, it’s becoming a legitimate way of seeing the world that shapes everyday behavior and lifestyle. An increasing number of people believe that emissions are a serious issue in today’s world, and that the 2020’s and 2030’s will be a deciding factor for our collective ability to continue to grow with our planet. From workers participating in climate strikes to consumers boycotting some of the largest brands in the world, the message has been sent to multinational corporations and governments in a way it never before has been that sustainability is an issue to be taken seriously.

The good news is that as far as we can tell, the message has been received. Several of the largest car manufacturers in the world, for the first time independent of industry regulation, have announced progressive green initiatives ahead of initial schedule. Across

multiple fleets, full-electric vehicles are slated for release in the coming years to compete with companies like Tesla that have eaten into revenue. Similarly, in the luxury clothing market, upscale brands like Prada have committed to dredging all plastic sold in its products from the ocean by 2022, in response largely to boycotts of products that for years contributed to plastic polluting our oceans.

The message hasn’t just been received by companies, however; documents like the Green New Deal, drafted by Representative Alexandria Ocasio-Cortez of New York and Senator Ed Markey of Massachusetts, show that governments have taken notice of changing public opinion toward the environment. Although the Green New Deal is a sweeping document that covers many areas for sustainable development, one of its most intriguing tenets was the promise of “overhauling transportation systems in the United States

to remove pollution and greenhouse gas emissions from the transportation sector as much as technologically feasible, including through investment in ... (iii) high-speed rail [6].

Now more than ever, people are asking questions about how they can reduce their carbon footprint by changing their habits. At their simplest, answers to this question can manifest themselves in many ways. Bringing a reusable water bottle to work or consuming

meats like chicken instead of beef can reduce individual carbon footprint non-trivially over a time frame that is years, or decades, long.

While small habitual changes are helpful and will be necessary to reduce humanity's collective impact on the

earth, the idea of the Green New Deal is to think larger than simple micro-changes that play within the rules of the world we live in today.

High Speed Rail: What is it, and Why Should You Care?

One such idea for macro change that is gaining momentum is the idea of utilizing high-speed rail as a replacement to air transportation over short distances. In the United States, there is a huge disparity between the number of people who travel via air and the number of people who travel via rail each year. In 2018, there were 1.01 billion air travellers [21] compared to 31.7 million rail travellers [18]. That's a 32:1 ratio of air to rail, and it implies that every 11.7 days, the number of people who

travel every year by train in the US fly through an airport.

That ratio likely won't be shocking to many readers of this article. In the United States today, the rail system is an afterthought – the majority of movement that happens within our archaic rail network is for freight, not people, and even in areas of the country like the northeast where passenger rail is somewhat integral to infrastructure, it is

plagued by constant delays and inefficiency. Of Amtrak's 31 million riders each year, 83% travel one-way less than 400 miles [26].

The Green New Deal is trying to reimagine a world where you can travel great distances without significantly increasing your yearly carbon footprint.

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habits.



31.7M
passengers



1.02B
passengers

Although the idea of high-speed rail development is not a new one, it has grown significantly in both popularity and viability in recent years, and is one of the most achievable ways in the relatively short-term to decrease carbon footprint without necessarily decreasing productivity.

Looking forward over the next century, it is worth considering what the world may look like in 100 years, and how that world's changes will come to be. When will we reach a tipping point at which we decide we have reached too much pollution? Will inefficiency inherent to and growing price of the most popular ways that we travel today spur us to examine alternative approaches? When we do act, will we try to forge our own path, or look to international models for inspiration and warning regarding stumbling blocks?

The world is moving in the direction of sustainability. I believe that the United States has the unique opportunity to be a leader in green infrastructure development through the adoption and implementation of a cross-country high speed rail network.

In this article, I'll explore the opportunity for high-speed rail to help the United States become a leader in the worldwide sustainability initiative in transportation by investment in high-speed trains. I'll examine an analogous example of government and the private sector teaming up to make Indian households greener, discuss the return on investment for investment in high-speed rail infrastructure, and talk about other countries' strategies for changing consumer behavior away from planes and toward trains. The goal of this article is to give you a framework, or minimally a new perspective, from which to examine new ideas in transportation and green infrastructure overall.

Lighting 80 Million Homes in India

The Green New Deal, and other pieces of legislation like it, are reshaping the conversation around climate change in politics. However, changing the conversation is only a piece of the puzzle to build meaningful long-term sustainable infrastructure. The largest challenge of proving the worth of a project of this nature lies in the complicated task of calculating the return on investment for such a project and effectively anticipating and disproving arguments against it – what is the per-passenger emission for a plane, versus the per-passenger emission for a train? This is a question with an extraordinary amount of nuance.

In order to answer it fully, we need to examine at an anecdotal example from *Climate of Hope* by Carl Pope and Michael Bloomberg, a book about the economics of climate change and how in many cases climate solutions are a win-win scenario.

In India in the early 2010's, 400 million people across 75 million homes were living without electricity. Each night when the sun went down, these households used candles or kerosene for light, neither of which are ideal power sources – kerosene is the leading cause of household air pollution, which accounts for approximately 4 million premature deaths per year [27].

A natural question in that circumstance is to ask whether there is an alternative source of light that is less expensive

and less polluting for those households to adopt? Turns out, there is! Because of American investment during the mid-2000's, solar energy is at an all-time low cost for any human on the planet.

In fact, solar panels are so cheap that it was found in 2016 that solar panels, which were at the time rated to light a household for 20 years, could be installed for an average cost of \$200 per home. That meant that per year, the cost to light a home would be a mere \$10 – a cost orders of magnitude less than the amount of money required to light a home with kerosene for a year.

Why then weren't these households in rural India adopting the panels? Were they unable to gain access to suppliers? Were they disinterested in environmental conservation? Of course not! They weren't able to bear the financial brunt of an upfront installation cost. Although kerosene was (and will remain) expensive, it can be bought in daily or weekly rations,

according to a budget. This is a huge consideration for a household with no line of credit that only operates via cash [15].

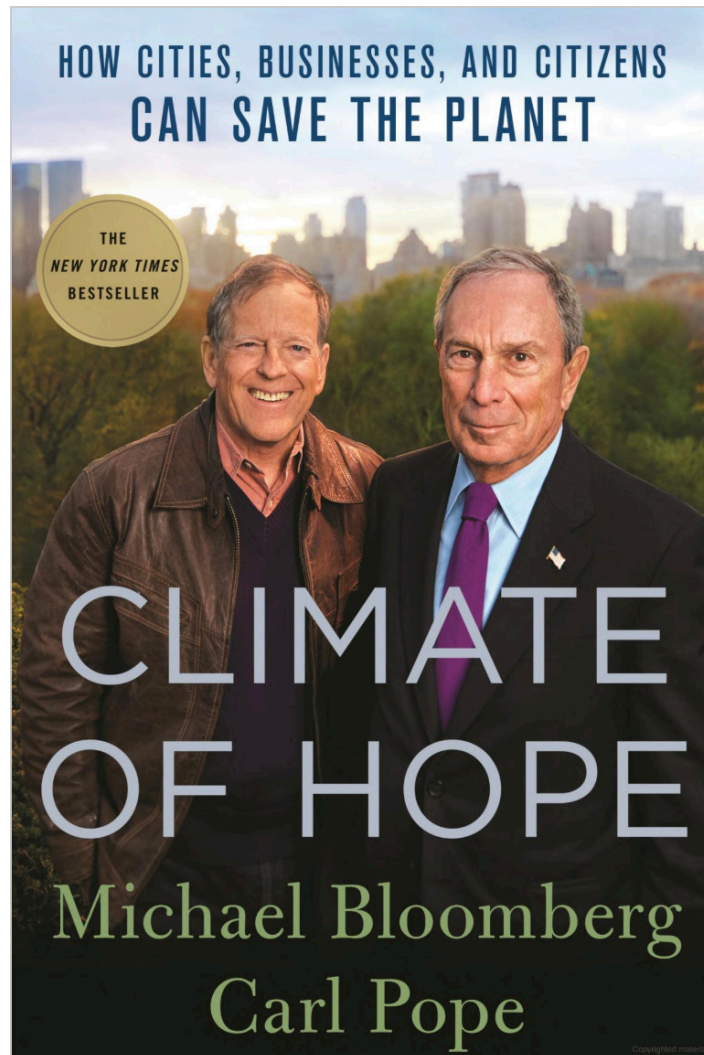
What's interesting is that there was a party at play helping subsidize kerosene for these households in rural India: the Indian Government. In 2016, the Indian government subsidized approximately \$1 billion worth of kerosene. This is a titanic number, and was actually enough money spent to install

solar panels on every rural household that is currently powerless, and be finished in three years. Something had to change.

After a detailed analysis by a private environmental consulting firm, the Indian Government decided to reevaluate its budget for helping these households get light. Following the model of the Overseas Private Investment Corporation and the Agency for International Development, which demonstrated the

willingness of the private sector to grant loans on clean energy initiatives in Africa, the World Bank and the Asian Development Bank have granted loans to work with the Indian Government to help these households finance solar networks in rural India.

In this instance, what's fascinating is that institutions within the private sector simply needed an example to be set by trail-blazing organizations that proved possible what was thought impossible. While this may seem to be an obvious conclusion, I'm not sure it is. It took more



Climate of Hope Cover [15]

than a decade of poor spending on kerosene subsidies, as well as investment within the American market to make solar energy cheaper, to reach a tipping point where poor rural households could transition to a more effective solution.

Circling back to the issue of high-speed rail investment in the United States, there is a fascinating parallel between it and lighting Indian households. In the case of rail,



Aerial Shot of Solar Panels [28]

money is spent inefficiently on solutions (air and automotive) that are ultimately less efficient and worse for the environment. The need for investment today isn't totally clear, and the return on investment is complicated to calculate. But let's give it a shot.

The ROI Of High Speed Rail

The per-passenger carbon footprint is a simple formula for planes – the fuel for jet engines burned per-flight is readily available information. However, for trains, which run on electricity, the per-passenger impact changes based on the region through which the train is running. In 2015, for instance, 42% of the power generated in Germany was renewable, whereas only 11% of the power in Poland was renewable [9]. This is an issue in the United States, wherein some states, like Oregon, 75% of utility grade energy is renewable, and in others, that number is close to 0% [10]. That being said, in a study conducted by the IFEU, an environmental consultancy firm, the carbon emission per-passenger for a plane was nearly 10 times that of a train, despite varying proportions of energy being renewable [9].

Like rural Indian households in Climate of Hope, although the ROI on high-speed rail investment is difficult to quantify in the United States, it can not be discounted as a good

investment. One of the most fascinating statistics in the book comes from a 2006 climate report, which points out that even conservative estimates predict climate change will impact global GDP negatively by 5% – 20%. The problem is that the range is often presented through the lens that climate change is a bleak inevitability. This isn't true, which the report points out – in order to minimize those impacts, the measures needed to take action would only impact the global GDP of today negatively by around 1% [14]. In other words, the math checks out on investing in climate change; legislation just needs to catch up in order to make the investment a reality.

It's challenging to frame the issue of climate change, and the need for a meaningful response, in terms of dollars and cents at the present. But that's exactly what we need if we're going to see progress made.

Inefficiency in Air Travel

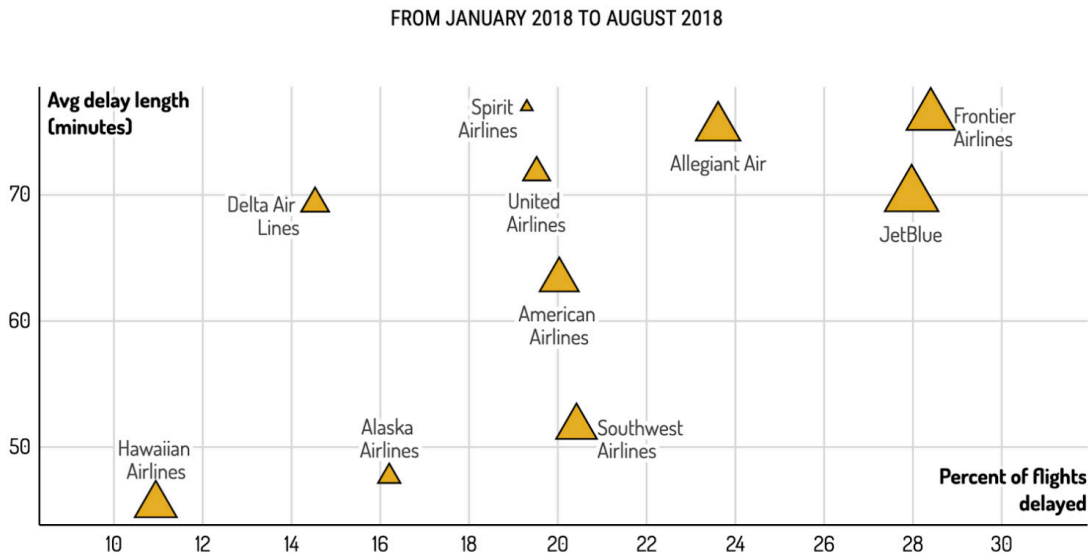
Imagine yourself in this situation. You wake up early in the morning for a flight that you bought a ticket for weeks before. You rush to the airport, move through security at what feels like a snail's pace, and hurry through the airport toward your gate, all the while worrying you'll miss your flight. You arrive at your gate minutes before the boarding time listed on your ticket, and just as you're sitting down, your gate agent comes on the intercom and announces that your flight has been delayed.

Unfortunately, for many people, this isn't some sort of twisted nightmare – it's a highly plausible situation! According to money.com, in the first 8 months of 2018, the average

domestic flight delay time was 66 minutes, with approximately 19.37% of flights being delayed [20]. In this study, a delay was counted as a flight departing more than 15 minutes past its posted departure time.

each fleet will never fly again, resulting in an epic loss for the largest stakeholding companies like Southwest Airlines, American Airlines, Air Canada, and China Southern Airlines, which own 34, 24, 24, and 22 of the 387 that have been delivered, respectively.

DELAYS: TIME, FREQUENCY, AND ACCOUNTABILITY



A delay of any nature can be frustrating, but in general we do tend to be willing to trade off an inconvenience for a promise of safe travel – sometimes, it’s simply unavoidable that an airplane must be delayed to ensure that the proper precautions and safety checks have been made before takeoff.

The prevailing opinion that speed should never be traded for safety, particularly in the case of air travel, is most brightly illustrated by the tragic, still relatively recent crashes of two Boeing 737-MAX airplanes. On March 10, after the second plane crash, all 737-MAX planes were grounded in a number of countries indefinitely. Roughly 8 months later, the planes are still grounded, and Federal investigation surrounding who, if anyone, is at fault internally at Boeing are still underway. At the time of the second crash, Boeing had received 4,912 orders for the plane and delivered 387 [21].

In the best case, there will have to be a substantial overhaul of the plane’s design done by Boeing, and in the worst case, the planes in

Delay Frequency and Duration by Airline [20]

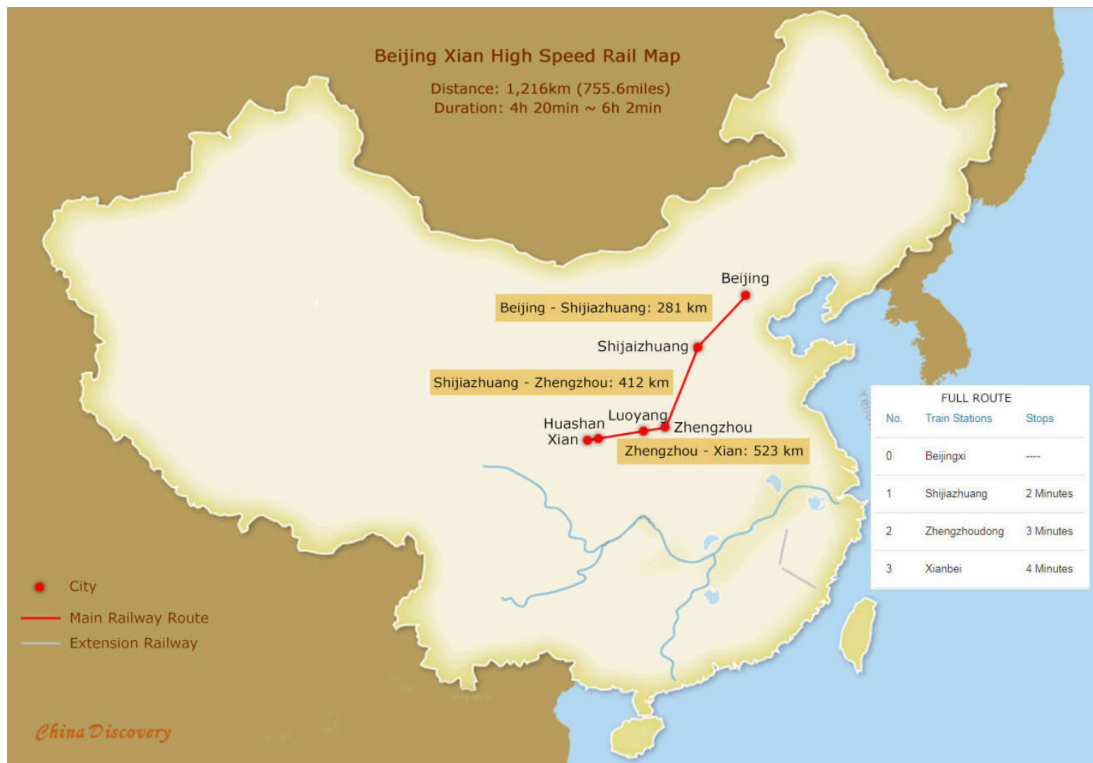
hole in many airline fleets that has made minor scheduling hiccups develop into travel nightmares that can delay trips by hours or days. At times in the past year, it has felt as though a transportation system capable of efficiency in the United States is not just science fiction, but is beyond anybody’s wildest dreams.

Status of Max 8 flights by airline as of March 13

AIRLINE	STATUS	NUMBER OF 737 MAX 8S IN FLEET
Southwest Airlines	Grounded	34
American Airlines	Grounded	24
Air Canada	Grounded	24
China Southern Airlines	Grounded	22
Norwegian Air	Grounded	18
TUI Fly	Grounded	15
Air China	Grounded	15
SpiceJet	Grounded	13
WestJet	Grounded	13
Turkish Airlines	Grounded	11

737-MAX Status by Fleet [23]

Fortunately for us, the technology to consistently travel without delay isn’t science fiction; it exists today in the form of high speed trains around the world. In China, there is a high speed train, called the “bullet train,” that connects Beijing and Xi’an, a distance only 34



Service Route for High-Speed Train in China From Xian to Beijing [18]

miles more than the distance between New York and Chicago. By plane, this journey takes 2.5 hours – by train, it takes 4.5 [13].

Four and a half hours from New York to Chicago is an incredible number, but it gets more incredible. As was mentioned in Section III, the time it takes for a plane to travel this distance is from ‘wheels up’ to ‘wheels down’, which means it doesn’t account for time taken to go through security or taxiing to and from the gate. Additionally, 2.5 hours is entirely hypothetical – depending on how often you travel, you know that there is a strong chance your plane will be delayed upon takeoff or landing, whether it be from weather at your start, destination, or the city that your plane was coming from (this stems from the lack of flexibility in the system after every Boeing 737-MAX being grounded in March of 2019).

Another thing that is interesting, and often overlooked, when comparing air travel to rail travel is the fact that many train stations are built into city centers, whereas many airports aren’t, for obvious reasons. In New York City, Penn Station and Grand Central Station allow people travelling by rail to exit

their transportation and be (presumably) at or near their destination. This isn’t true of air travellers trying to get to New York City. Regardless of whether travellers are flying into Laganardia, JFK, or Newark, they are likely to spend between 45 and 120 minutes navigating traffic in a taxi, or taking a train into one of the previously mentioned stations. With this new information, you could very conceivably construct a scenario wherein an individual travelling via air from Chicago to New York spends far longer than 4.5 hours travelling from city center to city center.



2.5 Hours



4.5 Hours

International Examples

The success of a high-speed rail system will be disproportionately predicated on two things. First, from an infrastructure perspective, we will need a willingness to adopt the technology necessary to build these systems. Second, we will need to create an ecosystem wherein consumers feel not just safe using high-speed rail, but feel as though they are making a choice better than the alternative modes of transportation.

It's fortunate for us that the technology for building high-speed trains isn't a futuristic invention waiting to be created; it's here today. The challenge, then, isn't in building trains that can go fast at all; the challenge lies in getting people around the world to stop flying so much.

The goal of changing consumer behavior in favor of rail can be accomplished in a couple of ways, but one interesting strategy is to put an additional air tax on flights when a consumer buys a plane ticket. This approach has a benefit that is two-fold. First, it serves to discourage consumers from traveling via air, and lead them to reconsider travelling by other (ideally more efficient) modes of transportation. Second, this strategy can help raise money for sustainable infrastructure financial support.

This strategy is being pursued almost exactly at this very moment in France with what is being called an 'eco-tax' on flights out of France. It is expected to raise 180 million euros in 2020, and scales in financial cost exponentially with the class of ticket being purchased; economy tickets will pay an additional 1.5 euros, business class within the EU will pay 9 euros, and business class tickets outside of the EU will pay 18 euros [7]. By getting creative with taxation, France is attempting to artificially encourage travellers to take a train, which has disproportionately less of a per-passenger carbon footprint than a plane does over a similar distance.

Government intervention in this context has a number of shortcomings however, principle among them in the last example being that if France didn't have the rail infrastructure it had, pushing consumers away from air travel wouldn't be a logically sound legislative strategy. In the case of the United States, an air tax in the relative short-term wouldn't make a lot of sense, mostly because we don't yet have the infrastructure that would encourage the average person to do anything other than drive in a gas-powered car, which depending on the distance wouldn't even result in a positive impact.

The general idea, however, is to think in broad terms in the context of the future, not strictly in terms of how the world is today. To see the opportunities past the horizon for a world where we don't have to choose between prosperity and environmental conscientiousness.

A Hopeful Future

Progress in every field – from energy projects in rural India to sustainable water bottles – requires vision. It requires someone to look at the world as it is today and dare to reimagine the world as a better place tomorrow. It also requires pragmatism, and the ability to look at the cost-benefit-analysis of its ramifications, both good and bad.

It's easy to look at high-speed rail and agree that it is better for the environment, but say they're impossible to achieve because they'll never compete with air travel.

As the issues of climate change and conservation are brought increasingly to the forefront of our politics, people across the United States and the world are asking themselves how they can reduce their carbon footprint by changing their habits. You should consider high-speed rail a contender for being the sustainable transport of the future that allows us to travel sustainably with minimal compromise in efficiency.