

Atlanta Urbanist Book Group

How Infrastructure Works: Inside the Systems That Shape Our World

By Deb Chachra

How Infrastructure Works: Inside the Systems That Shape Our World is 283 pages with 11 chapters, not including acknowledgments, notes, an index and a list of further readings. It was published in 2023.

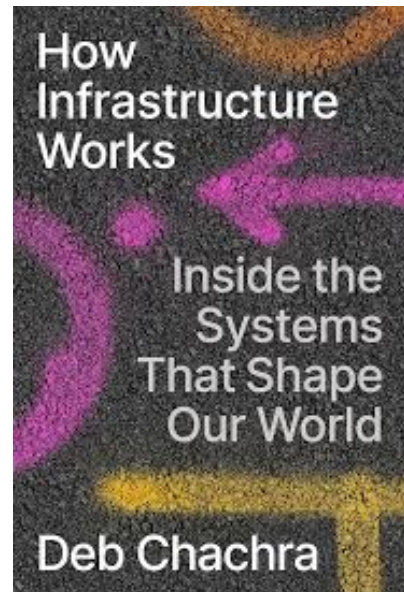
Deb Chachra is a professor of engineering at Olin College of Engineering in suburban Boston and a frequent writer about technology and society.

This book has three aims: To help readers see the infrastructure systems around them—roads, transit, water, sewer, electricity, the internet and so on—help them appreciate the importance of these systems in our lives and show the challenges ahead. The greatest challenges: adapting these infrastructure systems for climate change as we transition them to new sources of energy.

This sounds dour, and some of the book is about the monumental problems we face and failures we've seen. But it concludes on four strikingly optimistic notes. First, Chachra writes, we really do know how to make the transition to carbon-free energy. Second, as we make the transition, we will learn that there's an abundance of renewable sources, far more than is needed for current energy uses or any conceivable increases in demand.

Third, once the systems are built out, renewables will produce energy so cheaply that incremental costs will decline sharply. This opens the door, she adds, to whole new uses of energy. Finally, this transition gives us an opportunity to think about whether existing infrastructure truly serves us well. Do we want more cars, even if they are electric powered? Or do we want the kinds of neighborhoods and cities that transit, cycling and pedestrian travel make possible?

It is a bold and surprising view of the future of energy, which, as Chachra explains, is involved in every form of infrastructure. Her boldest message: We will come to think of energy in whole new ways. "Rather than focusing on *reducing* our energy usage—a scarcity mindset—we instead can focus on *increasing* the amount of energy that comes from renewable sources," she writes.



And those sources, she goes on, are both infinite and cheap. If you wanted to power every household in the world with the same amount of energy that households and industries in North America consume, you would need to produce 2.4×10^{21} joules of power per year, she calculates. (A joule is a unit of energy equivalent to the effort needed to create one watt of power for one second.) That, she continues, would be 10 times the amount of energy that is generated worldwide today.

How much radiant energy does the sun bath the Earth in today? It's 5.5×10^{24} joules each year, Chachra says. This is less than one-tenth of one percent of what we could ever conceivably use. And this counts only solar energy and not other renewables like wind, water and geothermal.

If it's possible to change our infrastructure systems and if these changes would result in a more stable climate AND much cheaper energy, why aren't we moving as fast as possible toward creating carbon-free infrastructure systems? Because, she says, there are major economic and political interests that will lose in this transition. It is in their interest to deny the need for change, cast doubt on its feasibility or say the fault for climate change lies elsewhere.

So, what would it take to rally the political, civic and social forces to take on these interests and make the transition? It would help if we could picture the scale of change that's ahead of us and the benefits it will bring. For that, Chachra suggests, you must begin by understanding how infrastructure systems work now and how these systems shape our lives. The first half of *How Infrastructure Works* is about these things.

It turns out, there's much to learn about infrastructure and especially the economics of infrastructure systems and networks. First is that, in general, these systems cost a great deal to build but little to operate (their "incremental costs"). That's partly by design—water and sewer systems operate, for instance, through gravity in most cities—and because of the longevity of pipes, roads, train tracks and bridges. And it's partly because of the economies of scale.

Second, once an infrastructure system is built, it costs relatively little to add connections. And the denser the locations, the cheaper the cost. The great expense in the early 20th century was building electric power stations and stringing power lines along streets. Adding service to a single-family house was a minor expense by comparison. Adding connections in an apartment building that housed a dozen families was even less per household.

Third, infrastructure works on standards. It's how electric utilities share power across large distances. Or highways are built so you can drive from one state to another hardly noticing the difference. Or how global commerce operates today using containers that move from trucks to ships to rail and back again to trucks without the goods inside ever leaving their enclosures.

Fourth, public infrastructure is "nonexcludable" and "nonrivalrous." This means, Chachra explains, it is designed so anyone can use it at little cost. And as they use it, so can others. Drinking water is a good example. Anyone can have the water he needs for drinking, cooking or cleaning (as long as he pays his bill). And as he does, his neighbor can have the water she needs. One use does not preclude the other. If anything, it tends to bring down costs for everyone.

Finally, there are two basic types of infrastructure, Chachra says. What distinguishes them is their "directionality." Many of the things we associate with infrastructure—water and sewer systems, electric and natural gas utilities and cable TV—are one-way systems. That is, they flow from a central place to your workplace or home.

But some infrastructure—telephones, streets, transit, mail, the internet—connects people. For that reason, "connected" infrastructure tends to grow in value as the system adds users. If Atlanta's water system never added another customer, it would not change your use of water. But if MARTA added new rail stations and bus lines—connecting new places—the value of transit to you would increase greatly.

This explains the operations and economics of infrastructure, but why did we need all these expensive-to-build, inexpensive-to-operate systems in the first place? For “agency,” Chachra says, a term that refers to an individual’s ability to do more things or do them faster, cheaper and better. To show how this works, she takes us into her apartment as she prepares dinner and, one chore at a time, shows us how having electricity, water, trash pickup, sewer connections, internet service and music on a stereo saves time and expense and makes everyday life more enjoyable.

If understanding and appreciating infrastructure takes up the first half of *How Infrastructure Works*, the second half focuses on problems and opportunities—and a path forward.

The problems are substantial. Already mentioned are climate change’s likely impact on existing infrastructure and the need to rapidly move toward renewal sources of energy. Both are important and urgent, she says. “It’s like having an overflowing bathtub,” Chachra writes. “Yes, you absolutely need to start mopping up the floor to keep the water from getting into the walls and creating permanent damage, but your first priority has to be turning off the faucet.”

But even if we did not have an epic global crisis staring us in the face, our infrastructure needs attention, and it is not getting it. The American Society of Civil Engineers does a survey of U.S. infrastructure every few years, state by state. In its most recent survey, it gave the U.S. overall a C minus, which Chachra calls “downright dismal.”

And dangerous, because infrastructure can fail, sometimes spectacularly. We’ve seen it in the Atlanta area, with sewer systems that polluted the Chattahoochee River for years and water systems whose leaks created giant sinkholes. We’ve seen interstate highways collapse in Atlanta and Philadelphia and a bridge fall into the Mississippi River in Minneapolis, killing 13 people and injuring 145.

The cause of these failures is the lack of inspection and maintenance, Chachra writes. When an interstate collapses or a bridge falls into a river, state governments spend hundreds of millions of dollars rebuilding it. And, she goes on, “there’s a strong incentive for large contracting firms to bid on projects like these, and to pay lobbyists to help make sure they get funded and built. In contrast, the financial benefits of routine inspection, maintenance and renewal are diffuse—anyone directly involved might make a steady salary, but no one is likely to make a windfall profit. That society bias toward making and novelty and away from caregiving and maintenance is reflected in who makes money and how.”

How, then, do we build support for maintenance and repair as we create new forms of energy and harden new and existing systems? Chachra has some engineering advice: Make infrastructure resilient through redundancy, build for flexibility, be sure all are served and consider government or cooperative ownership of some privately owned systems.

But she has little to say about mustering the civic and political will to do all these things. These are some of the things we will consider as the Atlanta Urbanist Book Group discusses this book.

When the Atlanta Urbanist Book Group meets, we'll discuss Deb Chachra's book about the challenges of infrastructure in a changing climate.

Our meeting will be **March 4, 6:30 to 8:30 p.m.** at **1788 Ponce de Leon Ave. NE, Atlanta GA 30307.**

There's more information about this discussion at the [Atlanta Urbanist Book Group website](#).

How to get your copy of *How Infrastructure Works*:

- You can purchase a copy from a local bookstore like [Virginia Highland Books](#).

Preparing for the discussion

Here are some questions we'll consider in our discussion:

1. What are "big ideas" in this book that you think could work in Urban Atlanta (that is, Atlanta and its suburban cities)?
2. If these big ideas were adopted, how could they make Urban Atlanta better?
3. What are some obstacles that might prevent these big ideas being adopted in Urban Atlanta? Are there assets that would help with their adoption?
4. Are there things government officials, civic leaders, neighborhood leaders or citizens could do—collectively or individually—to overcome these obstacles, using our assets?

- You can download an e-book edition from the Amazon, Barnes & Noble or Apple websites.
- You can borrow a copy from the [DeKalb County Public Library](#).