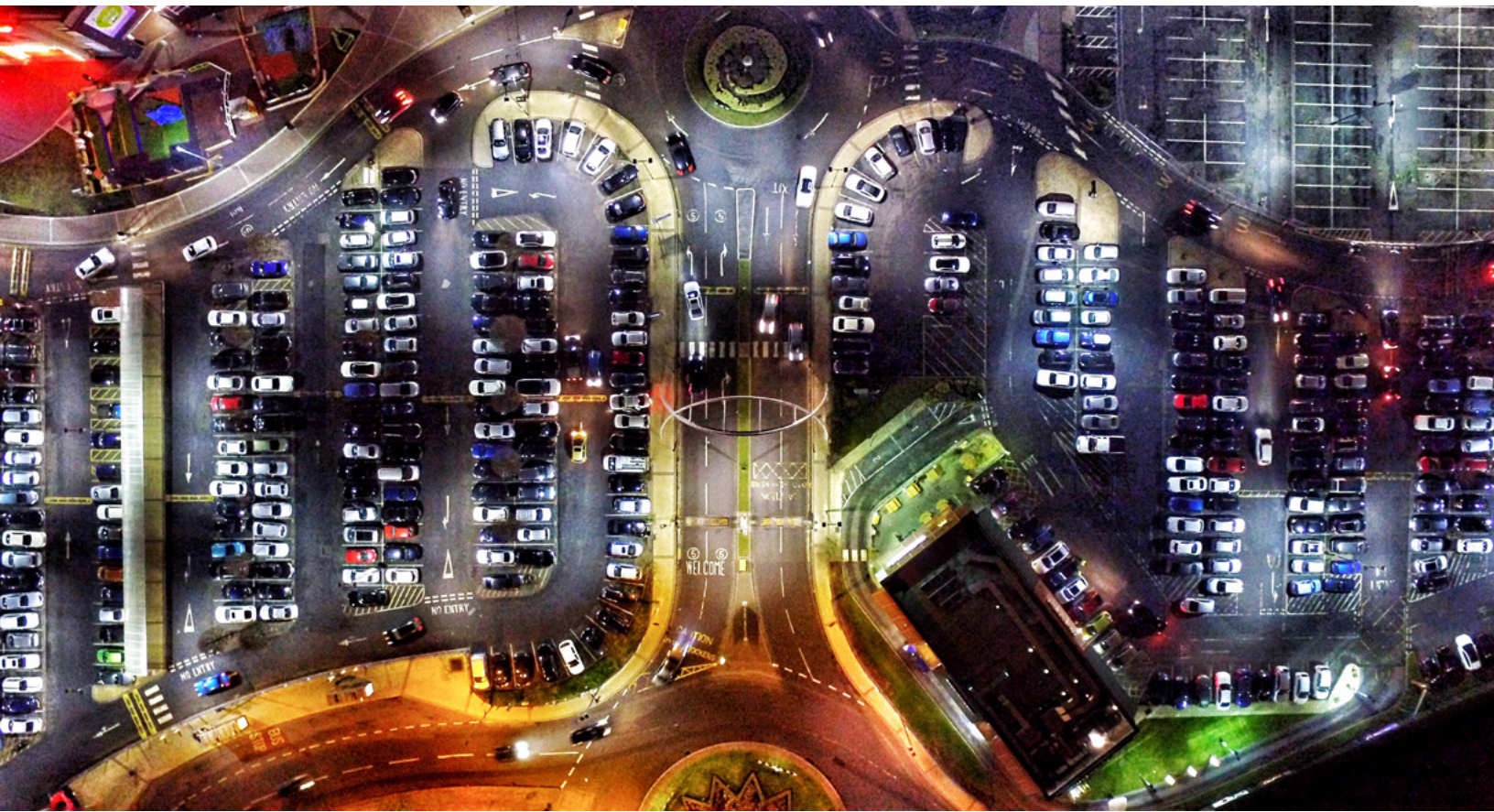


High stakes: How investors can manage risk in the new infrastructure environment

Technology is disrupting construction on multiple fronts. What are the consequences for infrastructure-investment managers?

Fredrik Dahlgvist, Alastair Green, Paul Morgan, and Robert Palter



With technology transforming how we live and work, infrastructure investing is becoming more complicated. Self-driving cars, now undergoing on-road testing, could reduce the need for passenger railways or metros. As 3-D printing gains traction and manufacturing becomes distributed, ports may require fewer storage terminals. And electronic monitoring systems, which are already available on many roads, could render toll booths obsolete. For general partners raising investment funds or direct infrastructure investors, such as pension plans and sovereign-wealth funds, such changes could affect returns on the power, water, transportation, and telecom assets that were expected to provide predictable cash flows for many years.

In tandem with these shifts, technology is opening many important opportunities for investors by stimulating the need for infrastructure that wasn't on the radar a decade ago. The potential for drone deliveries, for example, could stimulate construction of docking stations, while the growth of electric vehicles (EVs) could ultimately make charging facilities as common as today's gas stations. What's more, technology is improving how construction gets done. New digital tools are emerging, including 3-D-mapping applications, virtual reality, and real-time performance dashboards. More companies are also using advanced analytics to improve performance and boost productivity, making it easier to stick to the original budget and time lines for capital projects.

These technologic shifts come at a time when many new investors are entering the infrastructure market, increasing competition for assets. The key to success involves understanding how technology is influencing the way assets are built and operated. It's also crucial to take a long-term view of technology's potential impact, since many infrastructure assets have a lifespan of 50 or more years. Any investment decisions made today will have lasting repercussions.

To help investors deal with disruption, we explored recent developments in the infrastructure-investment landscape, with a focus on technological advances that are changing both asset value and how assets are delivered.¹ Since there is still much uncertainty about how certain trends will play out, we also propose a structured approach for evaluating the risks and opportunities in specific asset classes as technology influences the market.

How is the infrastructure-investment landscape changing?

Infrastructure has been a rock of stability for investors, generating consistent inflation-indexed returns even during tough economic times. With construction soaring in both emerging markets and developed economies, the value of privately owned infrastructure assets—those not traded on public exchanges—rose from approximately \$99 billion in 2007 to about \$418 billion by June 2017 (Exhibit 1). Fundraising was remarkably fast and successful in 2017, with the average fund closing more rapidly than any year since 2009. Many funds also exceeded their target size by a large margin.

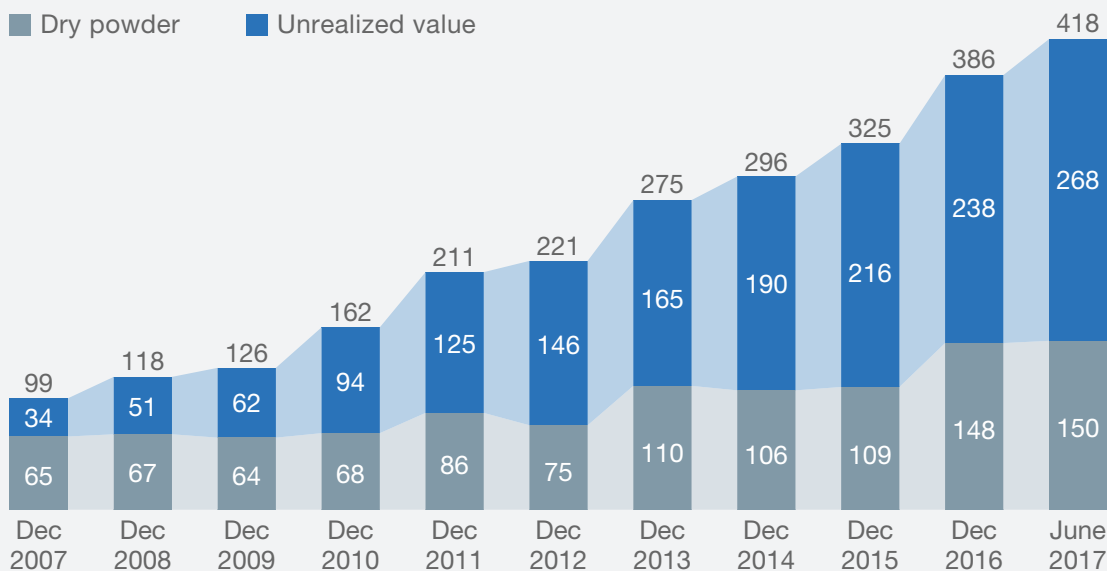
A more active role for investors

The surging infrastructure market has attracted new players who want to capture value, including private-equity managers that want to expand their fund offerings and pension-fund managers that formerly limited their investments to infrastructure funds. While the potential for good returns still exists, the increased competition for traditional brownfield infrastructure assets is leading to higher entry multiples and lower overall returns.

In this competitive market, infrastructure investors are broadening their focus. Traditionally, they concentrated on core assets—those that are highly regulated in terms of pricing and access, such as water utilities or power generation. Now, their investing targets increasingly include noncore assets, such as port operations or rolling stock,

Exhibit 1 Privately owned infrastructure assets reached a value of about \$418 billion by June 2017.

Unlisted infrastructure assets under management, total value, \$ billion



McKinsey&Company | Source: Preqin

which may not be regulated. Investors look for noncore assets with higher barriers to entry, in the form of capital intensity, long contracts, and very robust client needs at specific physical-access points.

The management approach for core and noncore assets is a study in contrasts. With core assets, investors typically look at potential deals, estimate their returns, and fund those that promise to produce free-cash flow annually and appreciate over time—a traditional buy-and-hold approach. For noncore assets, investors have the potential for higher returns, but also more volatility. They can maximize return by taking an active role in strategy, operations, risk management, organization, and

capital planning—an opportunity that they should seize but which will require new capabilities.

The growing impact of technology

In addition to the forces just discussed, many other factors are reshaping infrastructure investment, but technological advances are potentially the most important (see sidebar, “Beyond technology: Other shifts that could affect infrastructure investment”). Although it is difficult to single out the most important technologic shifts, we have identified several that may have a particularly dramatic impact. First, companies across industries are increasingly relying on big data and advanced analytics during the construction process, which

significantly decreases costs and timelines. Similar benefits come from automating manual tasks or using robots. Other technologic stand-outs include the development of fully autonomous vehicles, also called self-driving cars or level-five vehicles, which could alter demand for transportation-related assets, and the increased interest in distributed renewable energy, which could change the infrastructure needed to generate and store power.

But how will these changes, as well as other technologic advances, affect infrastructure investment? To get the most complete view, we looked at technology from two angles: its influence on asset value and its ability to improve the construction process.

How is technology changing asset value?

Many long-term investors, including the most experienced players, haven't yet determined how technologic advances will affect demand for infrastructure—both traditional assets like railway stations and innovative structures that weren't on the radar ten years ago, such as vertiports for drones. Here's what they need to know about both categories.

Rethinking traditional infrastructure assets

Even if investors have long received reliable returns from traditional infrastructure assets, technology could upend these expectations. Take parking garages. These structures have typically been a solid investment, but a combination of two trends could reduce their appeal: the growth of ridesharing

Beyond technology: Other shifts that could affect infrastructure investment

Technology isn't the only force bringing big changes to infrastructure. Investors must heed the following trends, which are altering both geographic demand patterns and the types of assets being built:

- **The growth of emerging markets.** Through 2030, emerging markets are expected to account for about 60 percent of demand for infrastructure.¹
- **Urbanization.** McKinsey Global Institute estimates that large cities generate about 75 percent of global GDP today, and that figure could rise to 86 percent by 2030, increasing capital projects in these areas.
- **Increased brownfield investment in developed markets.** Many developed countries are now confronting major infrastructure issues after years of underinvestment and poor maintenance, prompting governments to increase funding.
- **Consumer preferences.** Members of the millennial generation often prefer to borrow assets rather than making a purchase. This trend could eventually influence infrastructure and construction trends if they seem disinclined to purchase homes.

¹For more information, see "Bridging global infrastructure gaps," McKinsey Global Institute, June 2016.

services and advances in autonomous vehicles. If fully autonomous cars become a reality within the next 15 to 20 years, ridesharing services might rely on them. After dropping off their passengers, the cars would immediately leave to pick up their next fare, potentially reducing, or even eliminating, the need for parking in some areas.

But this potential trend doesn't mean that infrastructure investors should entirely write off parking garages—they just need to take a more nuanced view of the risks and opportunities. For instance, infrastructure investors have typically forecast demand for parking garages and other assets based on factors like population size, economic growth, local industrial activity, the number of available parking spaces, and a few other variables. Now they'll need to go much further than a rudimentary supply-and-demand analysis by examining additional variables, including those from new data sources, such as vehicle-tracking data that show the typical routes for local journeys or information about new government policies designed to support use of autonomous vehicles.

The new algorithms must also account for factors that could be disruptive over the long term, including the projected growth rate for self-driving cars or ride-sharing services on a location-by-location basis. Investors might also need to consider whether other technology trends could affect demand or revenues. For instance, the rise of parking apps could direct drivers to garages with capacity. And garage owners could potentially see a big jump in margins if they use software programs that allow them to predict demand and adjust prices accordingly.

After their analysis, investors might determine that demand for parking is so low that their garages should be repurposed or provide a broader set of services. As one example, garages that have off-curb parking could be transformed into service centers

for e-commerce package delivery or turned into vertiports for delivery drones.

Evaluating new infrastructure assets

An even more difficult puzzle involves determining how technology trends will increase demand for—or affect the value of—unconventional assets. Consider charging stations for EVs. In an age where most cars use gas, demand for these facilities is relatively low. But EVs are becoming more popular in many major markets, with registration increasing 70 percent in China and 37 percent in the United States from 2015 to 2016.² Over the long term, farsighted private-management firms that invested early in charging stations could receive greater returns than those that focused on traditional infrastructure.

With so much uncertainty ahead, investment firms should consider a range of scenarios when estimating the value of unconventional assets. For instance, the market for renewable energy, including wind and solar power, is increasing. But there are still many uncertainties regarding the extent of their growth and the amount and type of infrastructure assets required to support them.

Consider one recent innovation related to renewables—the development of liquid-air storage. Using this technology, energy-storage plants use off-peak or excess energy to clean and chill air until it becomes liquid. It can be stored in large tanks until needed.³ Such plants might be critical to the success of renewables like solar and wind power, which have supply peaks and troughs. These facilities are in their early stages, and it's not yet clear how popular they will become or how their infrastructure needs might change as the technology advances. Investors will need to manage these uncertainties by developing scenarios in which technology, market growth, and infrastructure requirements evolve in different ways.

How is technology changing the construction process?

In addition to affecting asset value, technology is also transforming basic construction processes. Construction-technology firms received \$10 billion in funding from 2011 through early 2017, and they've used this capital to develop and scale a host of innovative technologies to assist with tasks ranging from off-site fabrication to portfolio management to yard inspection. Automation is streamlining multiple manual processes, such as productivity monitoring, just as it has in many other industries. And companies have improved decision making by applying advanced analytics to a much broader range of data than they did in the past. For instance, project leaders that want to determine the most efficient time, location, and strategy for land moving can now analyze geologic surveys, equipment-demand projections, and forecasts about when they'll meet project milestones.

When experimenting with new, untested tools, companies may sometimes be disappointed, since it is difficult to predict which ones will succeed. The cost outlays for each tool can be significant, and a bad choice could reduce the bottom line for years. What's essential for success is an expert view of digital tools and their potential—one that helps investors sort through the confusion and focus their investment in the most promising areas.

To develop this perspective, investment firms must replace speculation about a tool's potential with a fact-based analysis. They'll need to conduct extensive research that cuts through the hype regarding tools and realistically consider risks, such as the potential for hackers to seize control through cyberattacks. For companies that make the right investment decisions, the rewards can be great. McKinsey research shows that capital-project leaders that select a strong assortment of digital tools can reduce project costs by up to 45 percent.

Even greater benefits may be possible when the tools are applied across all projects—and this will further widen the divide between digital adopters and those who stick with traditional processes.

Although all infrastructure projects face unique challenges, certain ideas and solutions offer universal benefits. For example, 5-D building information modeling (BIM)—the combination of 3-D physical models of buildings with cost, design, and scheduling data—is now sophisticated enough to be applied to most projects, and has proven results for improving execution. Digital twins—virtual models of a process, product, or service—allow teams to address problems before they escalate, identify opportunities to reduce costs or timeline, and conduct simulations that assist with planning. Drones and virtual-reality tools are fundamentally altering traditional inspection and surveying methods on construction sites. Other solutions, such as artificial intelligence or 3-D printing, could have radical implications if deployed at scale.

With so many tools on the market, some investors may be uncertain where to begin, especially if they have multiple problems that digital tools could potentially improve. In those cases, they should consider applying tools to three areas in which they have extensively demonstrated their value: risk management and project planning; field productivity; and collaboration and decision making.

How can infrastructure investors truly estimate the impact of technology?

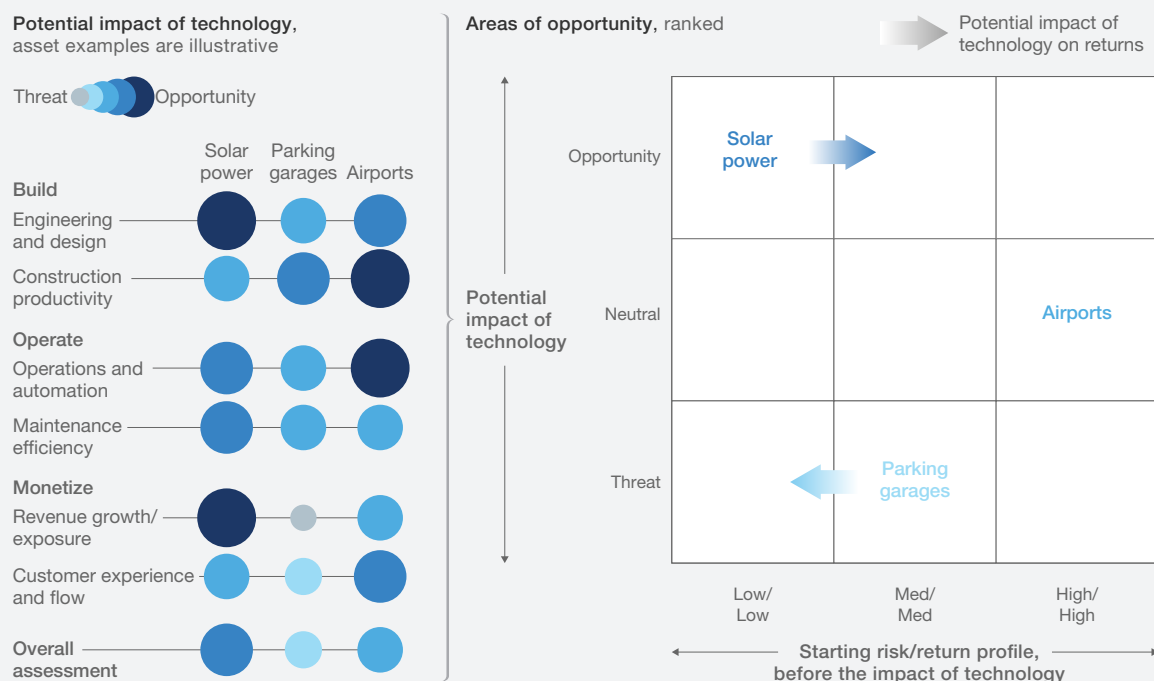
Many private-investment infrastructure firms have leaders whose backgrounds have given them relatively little exposure to technology, such as engineering or construction. To fill in their knowledge gaps, many are now working with an ecosystem of partners, including companies with specific technology expertise. When we analyzed how investors have capitalized on recent technology

As investors venture forward, they should take a more structured approach when evaluating technology's impact to ensure that they don't overlook any risks or benefits. One possible framework, shown in a simplified example in Exhibit 2, examines two variables. First, it considers the original risk/return profile for each asset, or what investors could expect to achieve in the absence of technological advances, either inside or outside of construction. Next, the framework quantifies technology's potential impact on the building, operation, and monetization of assets. Within building, for instance, investors would

have to determine if new technologies could cut costs and timelines for engineering and design, or if they could improve construction productivity. For monetization, investors would have to determine if new technologies, such as drones, could increase an asset's revenues by stimulating demand.

Using the framework, we classified solar-power assets as an important opportunity for multiple reasons. For instance, technologic improvements will create new opportunities for localized generation and distribution of energy, which could increase demand. Improvements in grid balancing—the ability to match energy supply with demand—are also increasing revenue growth for solar-power assets. By contrast, airports received a neutral rating. Although advanced analytics and greater

Exhibit 2 Leaders should evaluate technology's impact on projects through a more structured approach.



automation could support more efficient operations, it's not yet clear whether this will have a significant impact on revenue generation. We also determined that technology would have a negative impact on parking garages, because autonomous vehicles might decrease demand.

Since the framework only looks at technology issues, investors would have to assess the impact of other trends separately to determine the best path forward, and that could alter their perspective. Let's return to the parking-garage example. These assets might seem relatively unattractive if viewed solely through a technology lens, but investors might still see some potential if they consider how increased urbanization could stimulate demand.

For this framework to be valuable, leaders will have to increase their investment in data collection and analytics. Otherwise, they risk over- or underestimating technology's impact. Their investment will pay off, however, since investors with the best knowledge might become the "go to" groups for certain asset classes. Government agencies might be particularly interested in hearing their perspectives, which could increase the potential for public-private partnerships.

Of course, investment firms need to apply the framework using the most current data, and their perspective may change as new information becomes available. If they fail to make updates, they may overinvest in tools or systems that soon become outdated, just as the telecommunications industry did with 3G connectivity back in the early 2000s, when no one predicted that it would be eclipsed by later generations in fewer than 20 years.



Investors may be frustrated by the uncertainty ahead. But in selecting their investments, they must consider the inevitability that technology will alter

the investment landscape. Likewise, they need to understand how technology is fundamentally changing every phase of construction, from planning through completion. A solid in-house view of digital change won't guarantee success, but it's a major step in the right direction. ■

¹ Most infrastructure investment comes from direct investors. We use the term "investors" to refer to both general partners and direct investors.

² Patrick Hertzke, Nicolai Müller, and Stephanie Schenk, "Dynamics in the global electric-vehicle market," July 2017, McKinsey.com.

³ Katia Moskvitch, "Tesla's lithium ion battery tech gets a cool rival: Frozen liquid air," *Wired*, June 7, 2018, wired.com; Adam Vaughan, "Pioneering 'liquid air' project can help store excess electricity," *Guardian*, June 5, 2018, theguardian.com.

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