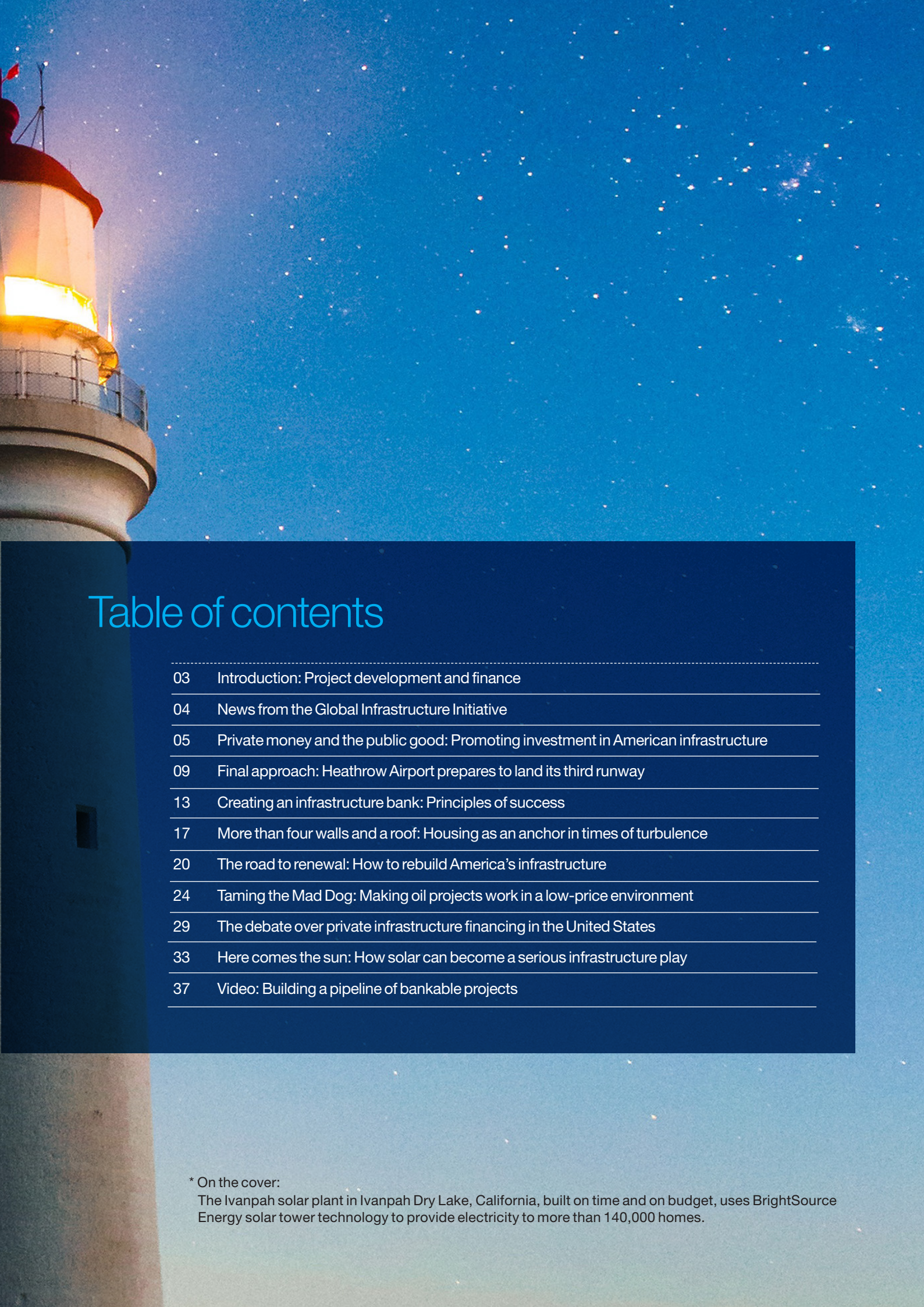
GLOBAL INFRASTRUCTURE INITIATIVE
By McKinsey & Company

Voices on Infrastructure: Insights on project development and finance

March 2017

Ivanpah Solar Electric Generating System
Mojave Desert, CA
Image source: BrightSource



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* On the cover:
The Ivanpah solar plant in Ivanpah Dry Lake, California, built on time and on budget, uses BrightSource Energy solar tower technology to provide electricity to more than 140,000 homes.

Introduction: Project development and finance

Mike Kerlin

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Welcome to the March 2017 edition of *Voices on Infrastructure*. This collection of articles by industry leaders and McKinsey experts focuses on the crucial opening phases of infrastructure projects: project development and financing. Smart development and stable financing can make the difference between a successful project and one that falls short. These elements, however, are often missing on projects ranging from toll roads in North America to renewable energy installations in Africa.

In principle, developing and financing should not be as challenging as they sometimes turn out to be. The world needs infrastructure financing: $3.3 trillion per year, or almost $50 trillion through 2030, to sustain economic growth, according to McKinsey's latest estimates. Institutional investors and banks manage $120 trillion in assets. What would it take to direct more of that capital toward the development and renewal of the world's infrastructure?

Better financial terms and conditions could help increase the flow of capital toward investment in infrastructure. These might include loan guarantees, changes to tax structures, or corporate-risk management measures such as foreign-currency hedges. We believe, however, that investors are deterred by a more fundamental problem: too many infrastructure projects offer unattractive risk-adjusted returns because they are poorly structured or make little financial sense.

We have dedicated this issue of *Voices* to ideas about how project owners and investors can overcome these challenges. The articles feature lessons on mitigating risks and boosting returns, drawn from projects such as Heathrow Airport's proposed third runway and BP's Mad Dog 2 offshore-drilling project. Our contributors also look at how governments can catalyze investment with infrastructure banks and public–private partnerships. We hope you find their insights helpful in developing and financing the large projects the world needs.

News from the Global Infrastructure Initiative

Tony Hansen

Director of the Global Infrastructure Initiative, McKinsey & Company

Thanks for the positive response to the December 2016 edition of *Voices*, on the future of real estate, which recorded the most downloads to date.

Our fourth Global Infrastructure Initiative (GII) Summit kicks off in Singapore, on May 24, at the magnificent Capella hotel. We are almost at our capacity of 200 participants, including senior leaders from across infrastructure sectors and geographies as well as across the infrastructure value chain. Our agenda is designed to present practical solutions to the most challenging issues in our industry. In addition to the main GII agenda, we will also offer site visits and sector-specific workshops for real estate, engineering and construction, and energy and mining.

On February 28, the McKinsey Global Institute launched a report, *Reinventing construction: A route to higher productivity*, with GII roundtables held in Houston, London, Los Angeles, and Washington, DC. Construction is one of the largest sectors in the world economy, with about $10 trillion a year spent on construction-related goods and services. However, the industry's productivity has stagnated for decades; doing better, the report concludes, is a $1.6 trillion opportunity.

During the second half of 2017, we will continue our popular program of innovation site visits, which explore some of world's most interesting projects, including the Panama Canal in June, the electric-road-system pilot in Sweden in September, and King Abdullah Economic City in Saudi Arabia in October. For more details, please visit our website.

I would like to take this opportunity to acknowledge our GII partners who have significantly strengthened our offerings: Macquarie, Siemens, Spencer Stuart, and Surbana Jurong. In addition, I wish to thank our institutional partners: the Monetary Authority of Singapore, Economic Development Board, and IE Singapore, and our media partner, TIME magazine. Our next edition of *Voices*, scheduled for June 2017, will focus on project delivery and execution. If you would like to comment on *Voices*, sign up for GII events, or receive more information about our activities, please contact us at info@giiconnect.com.

Private money and the public good: Promoting investment in American infrastructure

Karl Kuchel of Macquarie Infrastructure Partners believes the United States could become a much bigger market.

Karl Kuchel

Chief executive officer, Macquarie Infrastructure Partners

Karl Kuchel is chief executive officer of Macquarie Infrastructure Partners, which manages more than $8 billion in US and Canadian infrastructure assets, including regulated utilities, toll roads, ports, renewable energy, midstream oil and gas, power, waste, and telecommunications. In this interview with McKinsey, Kuchel discusses the future of private investment in US infrastructure.

McKinsey: *What are the barriers to increasing private investment in US infrastructure?*

Karl Kuchel: In the United States, private-sector investors have invested significant capital in many infrastructure sectors, including energy (regulated utilities, power, midstream oil and gas, renewables), ports, rail, wireless towers, and fiber networks. These investments may be held via listed companies or unlisted vehicles. The primary consideration for these investments is generally whether they are able to deliver reasonable risk-adjusted returns

There are a number of additional challenges for private capital looking to invest in US infrastructure, relating to toll roads, airports, and social infrastructure that traditionally have been developed, owned, and managed by the public sector. In many cases, there is political and public skepticism over public–private partnerships (PPPs), privatizations, or other innovative solutions involving the private sector. This can make it tough for governors or mayors to convince their constituencies of the merits of taking this route to deliver major infrastructure assets. Questions can arise regarding how the project will be operated, the level of risk-transfer benefits, and the profits that will be earned by the private sector. It is incumbent on the private sector to assist in educating politicians and the general public on these matters.

Also, in many cases, the lack of a systematic approach to procurement, negotiation, and implementation of potential transactions involving the public sector can increase execution risk and may reduce the private sector's interest in a given project. These challenges are not new. There has been progress in addressing them over the last 10 to 15 years. The Trump administration's focus on infrastructure investment could help to accelerate private participation in traditionally publicly owned infrastructure assets.

McKinsey: *Interest rates have risen recently in the United States. How will that affect infrastructure pricing, development, and acquisitions?*

Karl Kuchel: In general, the broad infrastructure asset class performs better on an absolute basis in a stable and improving macroeconomic environment. This is because the operating performance of many infrastructure assets is correlated with major macroeconomic trends. This can be due to revenue being linked to consumer-price-index escalators; regulation that allows higher costs to be passed on to customers; or simply from higher demand for the services provided. These higher earnings offset the debt service costs and required returns on equity associated with higher interest rates—and help to support asset valuations.

Higher interest rates will most adversely affect the valuation of infrastructure assets that have bond-like characteristics. These kinds of projects typically have very stable, low- growth cash flows. Given that these assets look like bonds, they should trade like bonds—that is, inversely with interest-rate expectations.

The public sector has missed an important opportunity to improve infrastructure through borrowing over the past five to seven years, when interest rates were at record lows.Higher interest rates, alongside current public-sector funding constraints, should help drive a greater degree of private-sector collaboration and more opportunities for infrastructure investment.

McKinsey: *Will global currency volatility affect capital flows into infrastructure?*

Karl Kuchel: Global capital flows into the infrastructure asset class have been robust over the past few years, with investors seeking assets that provide stable returns and long- term, dependable cash flows. Clearly that underlying investment performance can be materially influenced by currency volatility.

Infrastructure investors must consider the impact of currency when investing outside their home jurisdiction and consider using suitable hedging, either on an individual investment basis or across their entire investment portfolio.

We have seen this with recent US dollar strength and the impact it has had on the relative valuation of overseas infrastructure assets held by US investors on an unhedged basis. We also continue to see very strong interest from global investors in US infrastructure, as many are underweight and also because of the dollar's role as the world's primary reserve currency.

McKinsey: *Are there new financing approaches that the United States should consider?*

Karl Kuchel: Yes. One is a variation on Australia's successful Asset Recycling Initiative, which provides incentive payments for state and local governments to fund infrastructure growth. In the United States, the federal government could offer state and local governments incentives to sell or lease their brownfield assets on the condition that the proceeds are reinvested in new infrastructure. This type of incentive would help politically "de-risk" public–private deals for state and local governments. The federal government could also expand the use and availability of private activity bonds for public projects.

The US has 31 large hub airports with a combined asset value worth billions of dollars. This untapped equity could be used by cities and states to fund other infrastructure needs. The US Federal Aviation Administration's Airport Privatization Pilot Program and related tax provisions could be altered to encourage local officials to pursue these concession transactions.

Finally, as part of implementing its grant or incentive programs, the federal government should also encourage states to include PPPs in their approach to delivering infrastructure.

McKinsey: *Where are the brightest prospects?*

Karl Kuchel: In North America, energy infrastructure is likely to continue to provide the largest number of investment opportunities, by deal quantity and dollar value. This should include supply-related midstream assets as well as gas-fired power plants and renewables to replace the retirement of coal-fired power plants. Investors' risk appetite will determine which opportunities within this sector are most attractive.

The sale of high-quality, low-risk infrastructure assets in the United States is expected to continue, although in some cases, considerations such as regulatory approvals will affect the level of competition for assets.

In general, for investors looking to build a diversified infrastructure portfolio, patience and discipline will be required to find projects across different sectors that meet their risk-return requirements.

Final approach: Heathrow Airport prepares to land its third runway

How and why Europe's largest airport plans to manage a major expansion.

Emma Gilthorpe

Executive director, Expansion, Heathrow Airport

Heathrow Airport handled more than 75 million passengers and 470,000 aircraft movements in 2016. But its two runways are crowded. Since at least the early 1970s, studies have suggested expanding the airport. Last October, the British government gave its approval, and this year Parliament will vote on the project. Planning approval will take an estimated four years and construction another five. When it is finished, the new runway and the associated projects will transform Europe's largest airport. In this interview with McKinsey, Emma Gilthorpe, executive director, expansion, discusses the challenges of delivering and financing the £16 billion expansion plan.

Gilthorpe joined Heathrow in September 2009 as regulatory director. She later became strategy director, and was appointed to her current position in January 2017. She was previously BT Group's director of industry policy and regulation and has held a number of other senior regulatory and public-policy roles.

McKinsey: *What needs to happen this year to keep the third-runway project on course?*

Emma Gilthorpe: Having announced its support for a third runway, the British government is consulting stakeholders on plans for the airport expansion. A final vote is expected in Parliament this year, which will set out the policy framework and mitigation measures.

In parallel, Heathrow will launch its own phase-one consultation to gather feedback on options for the northwest-runway scheme. This will form the basis of a preferred master plan, which will then be refined during a phase-two consultation in the summer of 2018. A final planning application is expected to be submitted in the summer of 2019, with a final decision in 2020.

McKinsey: *This project has been under consideration for decades, and it is controversial, for environmental, social, and political reasons. How is Heathrow working to deal with them?*

Emma Gilthorpe: Heathrow has a strong track record of delivering major infrastructure projects. Indeed, over the past decade, the airport has been transformed by an £11 billion private-investment program. The runway project will build on this success.

We've created a program team to respond directly to each challenge. For example, I have a direct report who is responsible for ensuring that we're building an airport fit for future passengers. Another leads the planning process related to environmental mitigation. I also have someone responsible for delivering on our promises to local communities, and someone else works directly with our biggest customers to ensure we're delivering expansion affordably. One of the team works to create a supply chain capable of exploiting this investment opportunity and to keep the project on time and on budget. Finally, I have a direct report responsible for developing skills and leaving a world-class legacy for future generations.

This is an experienced leadership team with its eye on every aspect of Heathrow's expansion plans. It's what we're good at. The country is counting on us to succeed, and I'm confident we'll deliver.

McKinsey: *Why is expansion necessary?*

Emma Gilthorpe: Expanding Heathrow will keep Britain at the heart of the global economy. When it opens in 2025, the new hub capacity will connect Britain to more than 40 new long-haul destinations in fast-growing markets across the globe, making Britain the best-connected country in the world. It will also double the number of domestic routes served and ensure that every part of the United Kingdom can access global markets.

McKinsey: *Does the Brexit vote affect the case for expansion?*

Emma Gilthorpe: Heathrow is Britain's largest port; it's a fundamental plank in the nation's trading infrastructure. Every year, more than £100 billion worth of goods travel through the airport right underneath passengers' feet in the cargo holds of aircraft. An expanded Heathrow secures our existing trading routes, opens up new long-haul destinations, and gives Britain a competitive position from which to increase trade. To secure this opportunity sooner, from 2021, we are looking to add 25,000 more annual "Brexit Boost" flights on our existing runways—four years before a new runway opens. We anticipate we can squeeze out the extra capacity on our existing runways through a variety of operational measures and additional investment.

McKinsey: *When do you expect the third runway and the rest of the projects to be operational?*

Emma Gilthorpe: Aircraft will be taking off and landing from Heathrow's third runway in 2025. We will take a phased approach to building additional terminal capacity and other facilities to match passenger demand.

McKinsey: *How will Heathrow finance the £16 billion expansion project?*

Emma Gilthorpe: We will finance expansion in the same way we financed previous capital programs, through a mixture of debt and equity rather than as a separate project. Each year, we raise hundreds of millions of pounds in cost-efficient debt, in six different currencies, in both public and private markets.

McKinsey: *What mechanisms will there be to keep to the budget and time schedule?*

Emma Gilthorpe: We've taken a two-pronged approach. First, we've established a full governance mechanism that provides a line of sight from the Heathrow board right down to individual projects. Second, we've established a monthly management status review that will monitor how the program is delivering against key cost and time metrics so that we can take early action if needed.

McKinsey: *Heathrow has recently completed major projects at Terminals 2 and 5. What approaches will you adopt on the expansion project, with respect to financing and delivery?*

Emma Gilthorpe: Our program delivery model for expansion is very much a combination of the ones we used for those projects.

One direct result of our previous experience is to ensure that one member of the leadership team has a strong operations background. We build with the end in mind. That means that from day one the facilities must be efficient and easy to operate. The "operator" on the team holds the golden thread—from planning through construction to operational readiness—and keeps us focused on that end point.

While our financing plan is more of what we have already successfully done, we would expect that the scale of the expansion project will allow us to raise money in new areas. That could include increasing our profile in the United States and issuing securities in new currencies, such as the Australian dollar, which is known to be infrastructure friendly.

The sheer scale of the development is also something that we're planning for. We are "modularizing" the design to build as much as we can off-site. We will then transport elements to Heathrow using the UK's rail network. This will accelerate construction and increase quality; it is also more cost effective. And because there will be fewer vehicle movements, the environmental impact is reduced.

McKinsey: *How will you ensure that work on the expansion does not undermine existing operations?*

Emma Gilthorpe: We know our airport, and we know that building in a working facility requires close collaboration with the operations and development directors. Our recent Terminal 2 project was a perfect example. The Queen's Terminal was built between the world's two busiest runways and did not result in a single operational stoppage. In some ways, the new runway will be easier, because it is situated to one side of the existing airport's footprint.

Creating an infrastructure bank: Principles of success

The key is to ask, and answer, the right questions.

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The next 15 years are shaping up to be an exceptional period of opportunity for infrastructure finance. According to the McKinsey Global Institute, the world needs to invest almost $50 trillion in infrastructure by 2030 just to keep up with economic growth. The private sector is beginning to step up. Pension plans and insurance companies find infrastructure assets appealing because they provide long-term, inflation-hedged revenue streams. Credit-worthy projects have little difficulty attracting finance from commercial banks.

Moreover, in addition to budget-financed and bond-financed public infrastructure investment, many governments are considering infrastructure banks and funds that can help attract and direct private capital. Australia, Britain, Colombia, Mexico, and Poland have all done so; and others are considering the idea.

Infrastructure banks are not suitable everywhere. We have found that they are most helpful in countries where existing mechanisms, for whatever reason, do not support the creation of a strong pipeline of projects; they can help to direct capital efficiently to the most promising projects. To be effective, any infrastructure bank must ask and answer a series of questions.

What do we want to achieve?

Articulating a clear vision is critical to ensuring that an infrastructure bank fills a need. This mission should be defined in such a way that it does not crowd out existing financing sources; at the same time, it cannot be so different that it fails to find a market. This aspiration can be broader than just financing new projects. It can also include the following:

- mobilizing more private-sector financing
- maximizing socioeconomic outcomes, such as job creation or economic growth
- improving the environment
- assisting cash-strapped subnational governments
- supporting a specific industry, such as energy, transport, or water
- helping to streamline the approval and review process

For example, the well-established Mexican infrastructure bank Banobras has defined its mission as enabling the creation of infrastructure with high social returns, propelled by the federal government through innovative financing schemes, with a long-term vision that expands the role of the private sector. The founding president of Polish Investments for Development defined his agency's mission as bringing in "the first, or the last, zloty, alongside the private-sector money, to enable projects that would otherwise not take place."

If an infrastructure bank has several aspirations in mind, it needs to decide an order of priority. Then it should create metrics, such as the average time needed to reach financial close or the ratio of private to public capital, to assess its progress. Setting targets can be uncomfortable, but doing so is critical to promoting accountability and efficiency, and to selecting the right projects.

What types of projects should we finance?

There are many ways to frame this question. Some infrastructure banks will only finance projects in which there is "additionality"—meaning that the project would likely not have happened without their support. Others focus on impact, requiring that projects meet explicit standards, such as creating a certain number of jobs or building a specified number of miles of roads or gigawatts of power. Two other options are to prioritize projects based on risk-adjusted returns, to avoid the perception of "picking winners," and to use a portfolio approach, mixing high-risk, high-reward projects with less exciting ones.

The principle to keep in mind is that the bank's aspiration should provide the framework to choose what projects to select. For example, if the highest priority is to improve access to infrastructure for low-income households, then a water, energy, or transport project in a poor community might get priority over a highway interchange in a wealthier one.

How can we help to improve the project pipeline?

Infrastructure banks can help to create investment-worthy projects in several different ways:

- setting bankability standards, so that sponsors know what would-be investors need
- providing technical assistance, such as advice on risk allocation, construction-cost management, and user tariffs
- offering competitive project-development grants
- working with governments to create a list of worthwhile projects
- allocating below-market cost equity to improve the risk-adjusted returns of a project

Finally, an infrastructure bank can become a partner at the table on the highest-priority projects.

What financial products should we offer?

Many infrastructure banks start with senior debt for risk reasons, but they may be able to achieve higher impact and additionality with subordinated debt, guarantee, mezzanine, construction, and even equity or subordinated-equity finance. These products de-risk the

senior debt that private-sector infrastructure investors contribute and so play an important role in keeping the money flowing.

How can we ensure that we operate efficiently?

Sad but true: even if a bank chooses the right projects and provides the right products, it can still fail if its operations fall short. Avoiding the traps of bureaucratization and inefficiency starts with governance. Specifically, the bank should consider having a majority of the board from outside the government to create a degree of independence. Decision making should be delegated to credit and investment committees that meet regularly to review short, simple presentations. These committees should discourage "shadow" approval processes in which investment and credit officers have to make the rounds of committee members to campaign for their support.

Finally, infrastructure bank staff should adopt lean principles, such as the following:

- requiring less documentation for smaller, less risky, or simpler projects setting bankability standards, so that sponsors know what would-be investors need
- working in cross-functional teams oriented around projects in the same sector or geography
- ensuring accountability at every stage by clarifying who is responsible, who approves, who supports, and who is consulted on any decision
- building a culture of continuous improvement

How far does our responsibility go?

The short answer is that it never really ends. The work of an infrastructure bank is not finished once it approves an investment. In addition to keeping an eye on compliance and repayment, a bank can help to ensure that projects stay on time and on budget. Specifically, it can work to cut the time between investment approval and closing and help to connect clients to other sources of financing. An infrastructure bank can act as an honest broker between project sponsors and regulatory agencies and provide technical assistance and training in design and construction procurement and management.

Finally, it can take a page from high-performing private-equity firms, which can spend as much time improving the performance of portfolio assets as they do sourcing new deals.

All this is far easier said than done, but establishing an infrastructure bank may still be a good option. The best of them are neither cash machines nor government charities but true strategic investors.

More than four walls and a roof: Housing as an anchor in times of turbulence

Singapore shows how an effective housing program can promote social and political stability.

Wong Heang Fine

Group CEO,
Surbana Jurong

On every continent, there are pockets of political turmoil, driven in part by economic resentment. At the same time, the world is inexorably urbanizing. More than half the global population already lives in cities, and the figure will be two-thirds by 2050. To cope, and also to strengthen their own legitimacy, governments need to address their citizens' concerns. Housing is at or near the top of the list in many places.

In this regard, the experience of Singapore is worth considering. Even before it became independent in 1965, Singapore considered housing a high priority. Many people were living in unhygienic slums and squatters' camps, and new immigrants were adding to the strain. On the basis that widespread home ownership would foster social stability, the government took concerted action to improve matters.

By any measure, it has succeeded. More than 90 percent of households own their residences, up from 59 percent in 1980, and they are well maintained, with social, commercial, transit, and recreational facilities readily available. In 2010, Singapore's Housing and Development Board (HDB) won the UN-Habitat Scroll of Honour Award for "providing one of Asia's and the world's greenest, cleanest, and most socially conscious housing programs." A survey of residents of HDB units in 2013 found that 91.6 percent were satisfied with their homes and 92 percent with their neighborhoods. The provision of quality affordable housing has tethered Singaporeans to the dream of a more equitable future; it is a core part of the country's national pride and identity.

Every country and city is unique, but the basic issue is the same everywhere: to craft policies that enable housing projects to be developed and financed to suit the needs of all levels of society. In addressing that question, Singapore, in effect, turned the problem of housing inside out, recasting it as an opportunity to build both the economy and the society.

As the government saw it, the state would not only be building homes but also a sense of community and national identity. That was important for a new, multiethnic country. Economically, the public-housing program sought to make the home an asset, thus creating and managing a sustainable national housing market. Socially, the housing authorities envisaged building spaces that would encourage different ethnic groups to interact and to allow for multigenerational households.

In the early 1960s, Singapore was a developing country struggling to find its feet. In this context, providing every household with a decent home was a challenging goal. But by demonstrating its commitment to the population, the government hoped also to create a spirit of responsible citizenship and thereby contribute to political stability.

Making it work

For the program to succeed, land had to be acquired, homes had to be built at a reasonable cost, and people needed to be able to own them. To solve the first

challenge—particularly acute in a land-scarce city-state like Singapore—in 1967, the Land Acquisition Act empowered the government to acquire private land at market prices.

With respect to building, HDB was set up in 1960 to be the sole independent agency in charge of planning and executing the housing program. Since its early days, HDB has earned a good reputation for creating self-sustaining, high-rise town-planning designs, complete with social and commercial amenities and efficient public transport. It continues to be highly regarded for its innovative planning and design. To give one example, as people's expectations have risen, planners have worked to design each new township with a distinctive identity. For another, HDB uses the most modern construction techniques, such as precast and prefabricated volumetric construction. HDB has also embraced the concept of sustainable design, integrating highly efficient energy, water, and waste- management systems in its townships. The Treelodge@Punggol HDB project in northeast Singapore, designed by Surbana Jurong and completed in 2010, is an award-winning eco- development. Since 1960, the HDB has built more than a million units; these house more than 80 percent of Singapore's citizens.

How was all this paid for? The Central Provident Fund (CPF) has been critical. Established in 1955 and revised several times since, this compulsory savings plan for every working Singaporean and permanent resident is funded by individuals and their employers and

helps to pay for retirement, healthcare, and housing. Citizens can draw from their CPF at low interest rates and use the money to buy their homes. The CPF therefore actively supports home ownership and ensures that public housing is within reach of the population, so that less than a quarter of a first-time buyer's monthly household income is used to pay for his or her mortgage installment.

Increasing urbanization and aging, growing populations will test the ability of many societies to develop the housing and social amenities that future populations will both aspire to and be able to afford. Political and social environments vary considerably. Even so, it is clear that Singapore's public-housing record is one that city planners and world leaders can learn from. Government policies and programs—specifically the creation of a single independent agency accountable for results, and the steady financial resources derived from the CPF— have been the basis of this success. Singapore has shown that the provision of affordable housing for all can be a force for stability. Given the turbulent times, that may be the most important lesson of all.

The road to renewal: How to rebuild America's infrastructure

America's approach to planning, financing, building and maintaining public infrastructure is fragmented and inefficient. Here is how to improve it.

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Ride America's highways, byways, and rails, and one thing becomes clear: in many places, the country's transportation infrastructure is aging and declining in quality. The same could be said of the country's sewers, ports, and electric grid. Overall, the American Society of Civil Engineers gives US infrastructure a grade of D+. And things will not necessarily get better, because population and economic growth are putting more stress on everything from dams to airports.

Inadequate infrastructure not only affects Americans' quality of life; it is also bad for business. McKinsey Global Institute estimates that for the United States to sustain its economic growth, an additional $120 billion needs to be spent in 2017 alone—and $150 billion more per year by 2030.

Money is necessary, but it is not enough. Here are four steps that could help transform infrastructure delivery.

Establish a clear point of accountability within the federal government

There are many overlapping federal agencies, processes, and roles with oversight into how projects are approved, managed, and funded. The situation is different for every asset class. Overlapping and competing regulations and processes can extend schedules, increase costs, and reduce investment returns. For example, according to the US Department of Transportation, it takes an average of 13 years to build a major highway project, from idea to completion.

There is an opportunity to learn from how other democracies have improved decision processes to move projects through the pipeline at much greater speed, while ensuring projects are properly reviewed and environmental concerns are mitigated. The national government of Australia, for example, created a national infrastructure body, Infrastructure Australia, and charged it with reducing regulatory burdens while still prioritizing environmental and safety considerations. Australia cut the number of procedures for obtaining a construction permit from 25 to 14 and the average permit processing time from 150 to 112 days. In other countries, similar entities can be found at the state or provincial level; Canada's Infrastructure Ontario, for example, has built more than 30 hospitals on time and on budget.

The US federal government could also help catalyze better performance from the construction industry. Meanwhile, US construction labor productivity is lower today than it was in 1968, even as all other major industrial sectors have experienced impressive gains. A national effort to implement programs and incentives that could systematically unlock productivity-enhancing innovations would clearly improve the current situation.

Focus on outcomes; define performance metrics

Infrastructure can be an incredible enabler of such aspirations as economic growth, greater access to jobs and healthcare, increased interstate commerce, or access

to broadband. It is through such an outcome-focused lens that the federal government could identify nationally significant projects. Today's approach, however, focuses almost exclusively on inputs, such as planning, procurement, and permitting.

To set priorities and better evaluate potential outcomes, the federal government could set a formula for calculating projects' economic and social impacts, and a system for measuring and reporting performance. The cost of each project can then be compared with these benefits, in turn helping determine the order of priority. This would help ensure the right projects are supported from all levels of government and the private sector.

A transparent pipeline of well-planned projects, with appropriate risk-adjusted returns, could help to attract public and private investment. Moreover, this predictability and clarity could reduce the rate of return private investors require in order to make infrastructure investments, lowering the cost of capital.

Large-scale, multistate projects often bring the biggest payoff. However, these can also be especially difficult to deliver. Costs are shared unequally, regulations can vary, benefits may not be evenly distributed, and there are likely multiple stakeholders with varying interests. One example is the Gateway Program, which aims to double rail capacity between urban centers in New York and New Jersey, ultimately improving rail service from Boston to Washington DC. Gateway could improve mobility and foster enormous economic benefits for the whole region. Given how critical urban areas are to the US economy, and the New York region in particular, this could also be seen as a national imperative. The fact that there are many stakeholders, however, makes it difficult.

The federal government could also establish a common set of performance measurements for major infrastructure projects, applied using a central system for reporting and public disclosure. Experience in other countries shows that when the costs and progress of large capital projects are more transparent, costs come down.

Empower and support state and local experiments

Some of the most notable recent infrastructure projects were led by local leaders. They succeeded in spite of the challenges, including cumbersome and inconsistent procurement and permitting processes, skills gaps in the workforce, and limited sharing of best practices.

The federal government could partner with state and local governments to overcome some of these issues. For example, it could collect and share examples of best practices and innovations that are working in different sectors or regions. It could also draw from the private sector, where companies have made significant advances in areas from procurement efficiency to the application of advanced analytics to evaluate user experiences.

Besides better building, there is an opportunity to operate and upgrade existing assets more efficiently. The federal government could provide financial and regulatory incentives for states and cities to more rapidly deploy smart solutions like demand-based pricing and the

use of Internet of Things technology to evaluate problems, improve the physical quality of assets, and manage performance in real time.

Improve funding and financing processes

Private investors, such as insurers, pension funds, and sovereign wealth funds, manage approximately $120 trillion in assets, and they are looking for solid long-term investments. Yet many have avoided investing in US infrastructure, seeing the sector as complex, uncertain, and risky. We expect that more capital would flow if investing in infrastructure were simpler, faster, and more transparent. The three previous steps could help get there.

Additionally, the federal government could consider providing an incentive to states that monetize existing infrastructure assets and invest the money in new projects. This can take many forms—some may be sold entirely, others may incorporate revenue-generating features such as tolls, and others might be partly sold or change their financial model. For example, the government could rent out space in under- or unutilized buildings. The incentives could be financial or even in the form of opportunities, such as the chance to take part in a new pilot program or receive funding for a new technology.

There is a massive amount of public equity tied up in existing assets that could quickly be deployed to advance new projects. Australia has spurred significant increases in infrastructure investment since its federal government began offering a 15 percent premium to states that monetize an asset, as long as the proceeds go to new infrastructure.

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Our research suggests that every dollar of US infrastructure investment can raise GDP by an additional 20 cents, as long as the investment is sound. An outcome-focused approach to America's national infrastructure could help ensure the investment is directed toward projects that offer significant economic and social benefits and that are planned, built, and operated efficiently.

Taming the Mad Dog: Making oil projects work in a low-price environment

BP's Starlee Sykes discusses the future of deepwater development.

Starlee Sykes

Vice president global projects, Offshore at BP

Laura Borland

Consultant, Houston, McKinsey & Company

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In December 2016, BP approved investment for Mad Dog 2, a new oil platform in the Gulf of Mexico that is projected to produce up to 140,000 barrels of oil a day from 14 wells. It is expected to come on line in late 2021. The decision to greenlight Mad Dog 2, when the global oil price was about $50 a barrel, was an important signal for the deepwater industry. In 2013, even when oil prices were around $100, the project was postponed after development costs ballooned to $20 billion, leading some to question the role of offshore oil as a source of future supply growth.

BP and its partners, BHP Billiton and Chevron, cut the project costs to $9 billion and now it seems that, due to engineering and commercial innovations, the prospects for offshore oil could be looking up. In this interview, BP's vice president of global projects (offshore), Starlee Sykes, discusses how Mad Dog 2 has changed how BP thinks about developing deepwater projects. She spoke with Kassia Yanosek and Laura Borland, who work in McKinsey's Global Energy and Materials Practice.

McKinsey: *What are your thoughts on the attractiveness of deepwater assets at this point in the oil-price cycle, especially compared with unconventionals?*

Starlee Sykes: All deepwater is not equal. When you look across various basins, some deepwater is better than others in terms of prospectivity, fiscal terms, and the necessary infrastructure. In general, though, deepwater has a ways to go.

Looking back, we have built four big deepwater projects in the Gulf of Mexico: Mad Dog, Holstein, Thunder Horse, and Atlantis.[1] These were all approved when oil was at less than $20 a barrel, with development costs that provided attractive returns. When we had the concept of Mad Dog 2, we were sitting at more than $100 a barrel. I was the vice president of our Gulf of Mexico developments at the time. It was really just a bit of a sense check to say, "There must be a better way to do this. Time out."

McKinsey: *What was the problem?*

Starlee Sykes: We were chasing barrels. The focus was on volume over value. With Mad Dog 2, we were looking at a project that was barely economic at $100 oil. When my colleagues and I were preparing to take our investment case to the board, we just looked around the room and said, "Look, this doesn't feel right. Doing the project this way is not a good idea." So, we went back to the drawing board.

McKinsey: *What was the problem?*

Starlee Sykes: We looked for analogies to what we had done before and focused on the Atlantis project in the gulf, which came online in 2007, and its semisubmersible-platform design concept. Atlantis was, and is, viewed as a very economic, very good development.

1 Holstein came onstream in 2004, and BP divested the platform in 2012. BP operates four large production platforms in the Gulf of Mexico: Thunder Horse, Atlantis, Mad Dog, and Na Kika.

We decided to adopt this simpler design concept. Compared to the original Mad Dog 2 stacked-deck spar design, the semi-submersible is flexible for building future capacity, while fulfilling minimum technical requirements. That was the big idea around Mad Dog 2. Rather than designing for a future that may not happen, the principle was to build what we need at day one, and then allow for the expansion later. So, for example, we did not install all of the water-injection capacity that we needed on day one. It's a more incremental approach.

Another thing we did was focus on industry-led solutions. BP had previously used the same standards globally, so that we would be consistent on things like metallurgy. But the reality is that in some global locations like the North Sea, you only have consistent access at certain times of year to paint or do maintenance because of the weather. The Gulf of Mexico is different, with a calmer climate allowing for continuous access for painting and maintenance. The standards applied should be fit for purpose. So we asked our suppliers to let us know when we had gone above and beyond what we needed to. We looked at every bit of every system to identify appropriate technical standards.

McKinsey: *What was the most important single factor in making this change of direction?*

Starlee Sykes: I think it was the leadership saying, "Schedule is less important than getting this right," and then giving the team the freedom to act. That was the catalyst. If we tried to keep the original concept and just worked around the edges, we wouldn't have gone very far.

McKinsey: *Initially, the estimated investment for Mad Dog 2 was $20 billion. Under the new strategy, it is $9 billion. Where did the savings come from?*

Starlee Sykes: Every element of the project has gone through a rigorous review. Roughly, I would say it's probably two-thirds reengineering and one-third negotiating with suppliers. We originally said we would produce 90 percent of Mad Dog 2's resources at 65 percent of the original cost, but we are now actually planning to produce 100 percent of the resources at less than 50 percent of the cost.

McKinsey: *How did you negotiate with your suppliers?*

Starlee Sykes: We acted as the catalyst by opening the discussions with our own ideas. Some of these were deliberately aggressive as we believed it was important to demonstrate how serious we were about working differently to bring down the cost. We asked if there was anything that we could do with them to help get the price down without compromising safety and integrity. Some of the contractors were very quick to come to the table and give us ideas that would save us both money. And there were others that essentially said, "It is what it is. Take it or leave it." It took a while for all of them to realize this was not just our problem, that it was an industry problem, and that we needed their help.

On the floating production unit, for example, we changed our contracting strategy. We were going to sole-source the engineering, but we weren't getting a competitive outcome. So we decided to open up the engineering. We told the fabricators to partner with whomever they wanted on the engineering side. That was a big deal.

McKinsey: *How did you ensure the design met high standards for quality, health, safety, and environmental safeguards, given that you have cut your costs by more than half?*

Starlee Sykes: That was really important to us, as you can imagine. For our critical engineering technical practices—anything that has to do with loss of primary containment or with the instrument and safety systems—there is no compromise. Our experts reviewed the proposals from suppliers to make sure that there was no loss in quality. But we were open to things around operability. The Mad Dog 2 field has a design life of 35 years. That doesn't mean every washer is going to last that long. It's OK if we change some out. So it's a more pragmatic approach to design life, maintenance, and metallurgy.

McKinsey: *Recently, there have been a number of mergers in the oil and gas supply chain. Is that a risk or opportunity for deepwater?*

Starlee Sykes: I think it is both. One thing we are talking about is how to redefine our supplier relationships, and how to work with the new, more integrated service companies. There are different kinds of projects. Mad Dog 2 is big, complex, and expensive; another project may be simple. So I think there is something to be done around developing contracting strategies that support different types of projects.

McKinsey: *What are the biggest risks to meeting your production and cost goals? What keeps you up at night?*

Starlee Sykes: We feel pretty good about production because Mad Dog 2 is in a known reservoir. In terms of execution, I worry about the supply chain. With the oil industry in a downturn, there is plenty of capacity and everyone is cooperative. If that changes and things get tight again, what compromises will the supply chain make?

McKinsey: *What are the lessons for the industry?*

Starlee Sykes: As a whole, the industry is becoming more collaborative. The majors are looking to learn from the independents, and vice versa. That is new. It used to be the majors were here and the independents over there. Now there is more of an attitude of "Here's a problem. How do we work together to get a better solution?" There is also more listening to suppliers. The oil companies used to have the mentality of "We have all the history and all the knowledge. We're going to create the perfect design, then bid it out and dictate how to build it." That mind-set is changing. Instead, we're saying, "Here are our technical requirements. What do you think?"

We can also work more with suppliers to reduce costs. Here's an example. With the supplier, we looked at how many different valve diameters that one of our main valve suppliers had created for us over the last 15 years or so. It was not a good story—we were using nonstandard sizes of 8.63, 9.06, 9.25, 9.31, and on and on. So we asked, "Wouldn't the American Petroleum Institute standard bore size of 9 work for everything?" The answer is, in the vast majority of cases, it could.

This kind of thing just doesn't come to light unless you're looking for it. BP's competitive advantage is in our relationships and in our ability to see the full value chain. It's not in designing a valve. Other people can do that.

McKinsey: *What is BP's thinking about the future of deepwater development?*

Starlee Sykes: For BP, Mad Dog 2 changed the way we think. In a sense, it's how we think about all of our projects now. We are getting away from the model of "We build the biggest, most complex things in the world." That is true. We do. We've built some amazing projects. Just because we can do the big projects, though, doesn't mean that we should. So, in the Gulf of Mexico, we're looking for smaller resource pools. It's a matter of leveraging the infrastructure we have in place. These projects may not be as sexy, but the economics can be very competitive. We're getting more confident that we know where we can find value, instead of thinking everything has to be designed from scratch as a brand-new widget.

The debate over private infrastructure financing in the United States

Financing costs are higher, but the results are worth it.

Brian Budden

President and CEO,
Plenary Group

The public-private-partnership, or private-finance-initiative, model has been used since the early 1990s to finance and procure infrastructure projects around the world. In Australia, Britain, Canada, parts of continental Europe, and, more recently, in the United States, the use of private-sector capital and expertise has helped to fund many high-quality infrastructure assets.

Plenary Group, for example, is successfully delivering a government-accommodations facility in Canada, a highway project in Queensland, Australia, and a comprehensive university-development project in California.

But the private model is not without controversy. Specifically, while projects procured as PPPs have delivered high-quality infrastructure to taxpayers, the higher cost of financing PPPs—the difference between the government's cost of borrowing and the cost of private capital—remains a topic of public debate.

It is fair to ask what taxpayers get for this financing premium. Do the benefits of PPPs outweigh the extra financing costs? Without a proper analysis of this question, getting a PPP program off the ground is likely to be challenging.

In Australia and Canada, such analysis has been carried out. Essentially, agencies in both countries have concluded that, while private finance is more expensive, the government gains private-sector innovation, transfers substantial risk, receives efficient whole-of-life treatment of the asset, and, ultimately, generates more value than if the government financed the project itself. Partnerships British Columbia and Infrastructure Ontario, which are responsible for the vast majority of Canadian PPP projects, as well as Infrastructure Australia, have published comprehensive methodologies that compare the private-financing premium with the value of the benefits that PPPs can provide. All three agencies have found that using PPPs or alternative financing and procurement methods can be cost effective.

While the financing model is sound, the delivery of big and complex public infrastructure projects in the United States under publicly run models is characterized far too often by construction delays, cost overruns, and longer-term performance failures. Even cost overruns of 10 or 20 percent—a level widely accepted as "success"—can compromise a government's ability to deliver its agenda and meet its communities' infrastructure needs. Contrast that with the record in Ontario, North America's most active PPP market. According to an independent report commissioned by Infrastructure Ontario in 2014, the region delivered 36 of 37 recent PPP projects under budget.

There is now general consensus in the United States of the need to improve infrastructure delivery. There is also growing recognition that PPPs maintain public ownership while allowing for the full transfer of infrastructure asset risk away from the taxpayer. Done right, experience has proved that PPPs can provide delivery and operational certainty, protecting the public purse throughout construction and well into operation.

As PPP interest builds in the United States, the questions now focus on how to effectively mitigate project risks compared with other public delivery models and whether the associated private-capital premium is justified.

To understand the answers, it is useful to think of the incremental cost of private finance in a PPP, at least in part, as a guarantee against the risks of poor design, budget and schedule overruns, and deferred or inadequate maintenance, and also as a warranty on overall asset performance. In a traditional procurement, taxpayers pay more if these risks materialize. In a PPP, the private partner assumes these risks in exchange for returns on invested capital.

Also, the private partner has an incentive to not abandon a challenging project because the cost of delivery is financed up front and only repaid if and as the asset performs over time. As a result, and in order to efficiently bid for a project and still protect their long-term investments, private-capital providers take a whole-of-life view and provide an important oversight function not present in a traditional procurement.

Of course, the actual cost of this risk transfer—the premium paid—must be right. In a mature PPP market like Canada, where investors have developed confidence in PPP developers and their teams, the premium ranges from 130 to 220 basis points relative to pure public financing. The figure depends largely on the robustness of the project structure and state of the private-debt markets.

Although the PPP market in the United States is not as developed, the spreads between public and private finance have been comparable. This is particularly impressive given the depth and historically low costs of the US public-finance market. This includes products such as general obligation bonds; private activity bonds (PABs); certificates of participation; 63-20 financing, for not-for-profit corporations; and credit-assistance programs, such as the Transportation Infrastructure Finance and Innovation Act (TIFIA) and the Water Infrastructure Finance and Innovation Act. What is essential is that the projects have sufficient private equity at stake to ensure successful project management and long-term risk transfer.

While PPPs are still far from the norm in the United States, Plenary is already delivering five projects using different financing structures, including TIFIA, PABs, and taxable bank and bond debt—in each case backed by Plenary's equity investment. These projects are the Long Beach Civic Center; campus development for the University of California, Merced; the US 36 Managed Lanes road in Colorado; the Pennsylvania Rapid Bridge Replacement Project; and the State Street Redevelopment Project in Indiana.

In the end, PPP projects are good value for taxpayers. They pay a relatively small finance premium in return for high-quality infrastructure, and they are delivered faster, at a fixed time and price, and with full asset-life guarantees and warranties from the private sector. Governments in the United States can use the lessons learned from other countries, as well as recent local success stories, to help advance the public discussion and ensure all stakeholders understand the value that private finance can bring to infrastructure delivery.

Ultimately, I am confident that history will judge the use of PPPs in North America favorably, based on the scale, quality, and speed of infrastructure delivered and the lower whole-of-life-costs that can be achieved.

Here comes the sun: How solar can become a serious infrastructure play

The market for solar power is growing faster than ever, but profitability has been lagging. The keys to improvement are better capital and operational efficiency.

David Frankel

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Solar energy is becoming a force to be reckoned with.

Last year, China and the United States installed a record 34.5 and 14.6 gigawatts of solar, respectively, and in 2015, investors poured $161 billion of capital into the sector, the largest amount for any single power source.

The world is building more solar-power plants because they are getting cheaper. Since 2009, the total installed costs of solar have fallen by more than 60 percent around the world. New power-purchase agreements frequently fall below $100 per megawatt-hour, with some reaching less than $30. That price puts solar at or below the cost of a new natural-gas plant.

Although the future is bright, in the present, many solar companies are struggling, with falling valuations and dull profits; relatively low oil and gas prices have not helped. In terms of technology, the solar industry has done well and will only get better. As we see it, the larger challenges have to do with project finance and development.

Project development. Solar system design can be sadly unsystematic, typically designed from the bottom up. Each power plant or roof gets the perfect answer, a process that translates into high costs for labor and production. It doesn't help that the solar supply chain is immature, and the technology itself is still evolving rapidly. As the industry scales up, players should develop systems based on prefabricated components that are a very good, but not perfect, fit for a wide range of sites and that will integrate easily in the field—an approach known as "design for constructability." In addition, automation and aerial site assessments can speed up design prototyping and help firms make more accurate estimates before they put boots on the ground—or the roof.

In the case of large utility-scale projects, better up-front assessments of ground conditions can minimize rework for pile driving or trenching. Developers could prefabricate off-the-shelf units, making it possible to install them in hours rather than days for rooftops, or in weeks instead of months for large ground-mounted systems. To achieve this goal, firms will have to overhaul their supply chains to ensure that components can work with one another and should collaborate closely with engineering, procurement, and construction companies to create and deploy cost-saving ideas. The automotive industry, which uses standard designs over and over for different models, is a helpful analogy.

In general, solar players need to manage costs better. A detailed cost road map can help to reduce costs and develop a realistic forward cost curve against which developers and sales teams can bid for future projects. An effective cost analysis begins with setting goals, based on the levelized cost of energy for each market. Then, each cost component should be mapped, targets set, and a portfolio of improvement initiatives developed and tracked. It would also be more than helpful to shorten the cash cycle. The lag time from order to installation to grid connection to cash can be six months or more for a job that takes a day for residential customers and, at most, a few weeks for commercial or industrial ones. Project-delivery models, built on standard designs and construction excellence, must be developed and then scaled up.

Project finance. There's a Catch-22. Prudent solar companies cannot afford to scale up beyond the strength of their balance sheets but most have relatively weak ones. Only by getting bigger and thus having more collateral in the form of projects can they bolster their financial positions and scale up. Solar companies must therefore find new ways to attract long-term capital from institutional investors (through either public markets or private placements), improve capital efficiency, and forge prudent growth strategies.

One approach is to unlock long-term capital markets. Completed solar projects are attractive for investors seeking dependable long-term cash flows. The challenge is how to resolve the lower cost of capital (less equity, more debt) for an operating plant with the higher cost of capital (more equity, little debt) for developers. One approach has been the use of "YieldCos"—entities that purchase completed projects and have balance sheets separate from the development company. Assuming they are focused on delivering low- risk, stable cash flows, these entities should enjoy a much lower cost of capital and higher levels of leverage, and thus could provide the liquidity that developers need to grow. Similarly, solar-development companies, or "DevCos," should be equity focused, with low levels of debt.

But for various reasons, YieldCos have not met the needs of institutional investors, and many are valued well below their initial-public-offering levels. Similarly, when DevCos take on significant levels of debt, problems can occur, because the cash flows associated with project sales are inherently less predictable.

Institutional investors want a healthy yield at low risk; solar developers want a dependable way to liquidate higher-cost equity capital to reinvest it in the next project. A "YieldCo 2.0" should be developed to meet the needs of both parties, with a transparent, simple governance structure that provides both an attractive home for long-term capital and sufficient flexibility to project developers. Similarly, a pure-play "DevCo 2.0" should be focused on equity, without a great deal of debt.

Several new ideas, including private "PoolCos" that invest on an asset-by-asset basis, look promising but have yet to be fully tested. Such innovative solutions to the industry's financing challenges could bring substantial rewards. We believe markets will test and scale new ways to meet the industry's capital needs.

Another priority is to improve capital efficiency: every dollar deployed needs to achieve maximum impact. Companies that hope to succeed must carefully choose the parts of the value chain and the customer segments and geographies they want to play in, so that capital doesn't get locked up in low-margin uses for long periods. They should also pursue forms of low-cost financing, such as project debt and trade credit (for example, from module manufacturers) to leverage equity returns.

At the same time, solar developers must manage their cash and overall cash-to-cash cycle—a task not for the faint of heart. For example, companies should track expected

cash inflows and outflows at a very detailed level and resist the temptation to push out payment dates, particularly if smaller vendors may not be able to cope with stretched-out payments. Finally, it's important to have a systematic yet flexible approach. For example, utility-scale developers may find that some projects earmarked for long-term ownership should be sold earlier to fund equity checks needed to complete other projects.

Getting back to fundamentals

Meeting these challenges will not be easy, but it is essential if solar is to live up to its potential not only as a source of power but also as an infrastructure asset to be reckoned with.

In 2015 and 2016, the solar industry saw significant value erosion, and matters could get worse before they get better. But the sector has proved its resilience before, and the trends that favor the continued growth of solar power—falling costs, improving technology, and regulatory support—are gaining strength. It is certainly possible that before too long, investors will see solar as routine a feature of their infrastructure portfolios as roads, bridges, and power plants. For that to happen, though, developers will need to be as disciplined and creative on the capital and finance dimensions of the industry as they have been on the technology.

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