McKinsey Global Institute
McKinsey Infrastructure Practice




January 2013

Infrastructure productivity: How to save $1 trillion a year

The McKinsey Global Institute

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The McKinsey Infrastructure Practice

Infrastructure is a cornerstone of a stable and productive society. The right approach to delivering and maintaining transport, housing, energy, water, and communication infrastructure is essential to create a strong and competitive economy and provide social services. While infrastructure presents unique challenges, it also offers opportunities for both the public and private sectors.

The McKinsey Infrastructure Practice helps clients to determine what to build, how to do so more quickly and cost efficiently, how to invest in infrastructure, and how to enhance the value of existing infrastructure. The practice serves infrastructure planners, builders, owners, investors, and operators.

Over the past four years, the team has advised private companies and public entities on more than 850 projects. The practice is active in all geographies, asset classes, and project stages from planning and financing to delivery and operation. Worldwide, more than 70 consultants work closely with colleagues in practices including those relating to travel, transport and logistics, the public and social sector, corporate finance, and operations.

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Infrastructure productivity: How to save $1 trillion a year

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The infrastructure challenge

$57 trillion
global infrastructure investment needed in 2013–30

$101 billion
annual cost—in excess fuel costs and time—of road congestion in the United States

4 years
average time to obtain complete permitting for a power infrastructure project in Europe

70%
of water in Nigeria is "non-revenue" (unmetered or stolen)

$2.5 trillion
additional infrastructure financing by 2030 if institutional investors meet their target allocations

0
gain in construction sector labor productivity over the past 20 years in Japan, Germany, and the United States

...and opportunity

$1 trillion
annual savings from a viable 60 percent improvement in infrastructure productivity

35% proportion of infrastructure projects rejected upon scrutiny by Chile's National Public Investment System

15% potential savings from streamlining infrastructure delivery

20% reduction in Denmark's road maintenance costs through a total cost of ownership approach

30% potential boost in the capacity of many ports through more efficient terminal operations

$1.2 billion
overall net present value of Stockholm's congestion-charging scheme

Executive summary

The litany of infrastructure challenges confronting nations around the world is well known and much discussed. Advanced economies face the challenge of maintaining extensive transport, power, water, and telecommunications networks and upgrading and modernizing them as growth flags. In the developing world, countries dedicate a large proportion of their national income just to meet basic human development needs—access to water and sanitation, electricity, and all-weather roads, for instance—and still cannot cater to large swaths of their populations. The challenge in these countries is becoming even more daunting as rapid growth fuels demand for infrastructure to support economic and social development.

The McKinsey Global Institute (MGI) estimates $57 trillion in infrastructure investment will be required between now and 2030—simply to keep up with projected global GDP growth. This figure includes the infrastructure investment required for transport (road, rail, ports, and airports), power, water, and telecommunications. It is, admittedly, a rough estimate, but its scale is significant—nearly 60 percent more than the $36 trillion spent globally on infrastructure over the past 18 years. The $57 trillion required investment is more than the estimated value of today's worldwide infrastructure.[1] Even then, this amount would not be sufficient to address major backlogs and deficiencies in infrastructure maintenance and renewal or meet the broader development goals of emerging economies. Moreover, the task of funding the world's infrastructure needs is more difficult because of constraints on public-sector budgets and commercial debt in the wake of the financial crisis, higher and more volatile resource costs, and the additional costs of making infrastructure resilient to climate change and less harmful to the environment.

The size of the infrastructure "gap" and the undoubted challenges there are in finding the financing necessary to close it dominate political and public discussion on this topic. Yet this focus diverts attention from what we believe is just as compelling and urgent an issue—how the world can get more, better-quality infrastructure for less. This report focuses on rethinking how governments, together with the private sector, select, design, deliver, and manage infrastructure projects, and make more out of the infrastructure already in place. We argue that there is an emerging opportunity to raise the productivity of infrastructure investment by a substantial margin.

Based on McKinsey & Company's work with governments and private-sector infrastructure players around the world, an extensive literature review, and drawing on insights from more than 400 case examples, we project that if infrastructure owners around the world were to adopt proven best practice, they

1 We have arrived at an estimated value of today's infrastructure first by estimating the value of the capital stock for 13 countries using the methodology described in the technical appendix. This value is after depreciation but also includes capitalized maintenance. We then extrapolated from these 13 countries to the global level.

could increase the productivity of infrastructure investment to achieve savings of 40 percent. Put another way, scaling up best practice could save an average of $1 trillion a year in infrastructure costs over the next 18 years. While a 40 percent saving is an extrapolation that uses several simplifying assumptions, we believe a productivity boost of this magnitude is achievable in many countries if they are willing to invest in a systematic approach to infrastructure that drives improvement across agencies and private-sector owners and contractors. The measures that we discuss are not about inventing a completely new approach to infrastructure—what we propose is simply rolling out proven best practice on a global scale.

In this report, we begin by sizing the global infrastructure investment challenge. We then present a road map for improving infrastructure productivity, which we define broadly to include making better choices about which projects to execute, streamlining the delivery of projects, and making the most of existing infrastructure. These three main levers can result in annual savings of $1 trillion. In the final chapter, we discuss critically important improvements to infrastructure governance systems that can enable the capture of the potential to improve productivity. By implementing the reforms and best practice that we discuss, the world's governments can reduce the anticipated infrastructure challenge to a more manageable size, avoid paralysis, and build the foundation for continued economic growth and development.

The world needs to increase its investment in infrastructure by nearly 60 percent over the next 18 years

Simply to support projected economic growth between now and 2030, we estimate that global infrastructure investment would need to increase by nearly 60 percent from the $36 trillion spent on infrastructure over the past 18 years to $57 trillion over the next 18 years (see Box 1, "Estimating global infrastructure investment needs"). This baseline estimated investment requirement, which is equivalent to 3.5 percent of anticipated global GDP, would be sufficient to support anticipated growth, maintaining current levels of infrastructure capacity and service relative to GDP. It does not account for the cost of addressing the large maintenance and renewal backlogs and infrastructure deficiencies in many economies. Nor would it raise the standard of infrastructure in emerging economies beyond what we would expect as part of a normal development trajectory. In short, while access to basic human services such as water, sanitation, electricity, and all-weather roads would continue to expand, this would happen at current, often inadequate, rates. The World Bank estimates that on current trends, universal access to sanitation and improved water is more than 50 years away in most African countries.[2] Our projection also does not take into account the costs of making infrastructure more resilient to the effects of climate change or the higher cost of building infrastructure in ways that have less impact on the climate and the environment.

2 Vivien Foster and Cecilia Briceño-Garmendia, eds., *Africa's infrastructure: A time for transformation*, International Bank for Reconstruction and Development and World Bank, 2010.

Box 1. Estimating global infrastructure investment needs

We have used three approaches to calculate our baseline infrastructure need that together produce a range of $57 trillion to $67 trillion from 2013 through 2030 in 2010 prices, covering road, rail, ports, airports, water, and telecoms, but excluding social infrastructure such as schools or hospitals (Exhibit E1).

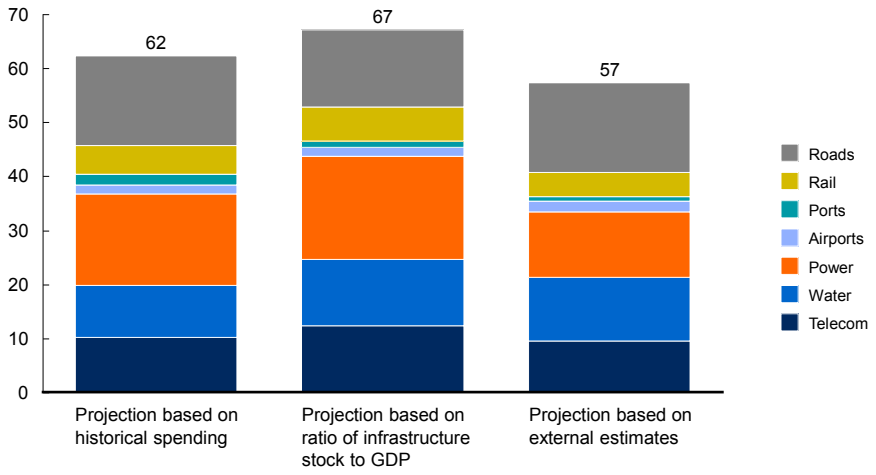
Historical spending on infrastructure. First, we looked at historical infrastructure spending for 84 countries that account for more than 90 percent of global GDP, using data from the International Transport Forum (ITF), IHS Global Insight, and (GWI).[1] This historical spending pattern indicates that global investment on roads, rail, ports, airports, power, water, and telecommunications infrastructure has averaged about 3.8 percent of global GDP—equivalent to $2.6 trillion in 2013. Applying that 3.8 percent ratio to IHS Global Insight's GDP projections (which estimate growth of about 3.3 percent a year) suggests a total investment need of $62 trillion from 2013 through 2030, or an average annual investment of $3.4 trillion.

Exhibit E1

We use three methods to derive similar estimates of need

Estimates of needed infrastructure investments, 2013–30

$ trillion, constant 2010 dollars



SOURCE: Organisation for Economic Co-operation and Development (OECD); International Energy Agency (IEA), 2011; International Transport Forum (ITF); Global Water Intelligence (GWI); McKinsey Global Institute analysis

Stock of infrastructure. Second, we examined the value of infrastructure stock using a perpetual inventory model for 12 countries for which comprehensive historical spending data are available across asset classes.[2] This analysis shows that, with a few exceptions such as Japan (arguably an "over-investor" in infrastructure), the value of infrastructure stock in most economies averages around 70 percent of GDP. This 70 percent "rule of thumb" approach has limitations but provides one workable basis for estimating the infrastructure needed to support growth.[3] For infrastructure to remain at an asset-to-GDP ratio of 70 percent, $67 trillion of investment would be required from 2013 through 2030.

Projections of future need. Finally, we looked at independent estimates of future need by infrastructure asset class, including those of the Organisation for Economic Co-operation and Development (OECD), the International Energy Agency (IEA), and Global Water Intelligence (GWI). In combination, these estimates suggest a requirement of $57 trillion of infrastructure investment, or $3.2 trillion a year between 2013 and 2030, with roads and power accounting for almost half of this need.

1 Although we have tried to use the same databases for consistency, we used national account data for transport asset classes for Nigeria and South Africa since these data were not available from ITF; data for Brazil provided courtesy of Dr. Armando Castelar. We also used data from the African Development Bank for African countries for 2005 (the only year available) if such data were not available from another source.

2 Gerhard Meinen, Piet Verbiest, and Peter-Paul de Wolf, *Perpetual inventory method: Service lives, discard patterns, and depreciation methods*, Department of National Accounts, Statistics Netherlands, 1998.

3 The 70 percent rule of thumb is in line with other estimates such as those derived from capital stock data in US national accounts (capital stock data in the US national accounts helps us estimate US infrastructure stock at around 61 percent of GDP, while our perpetual inventory model calculates it at 64 percent of GDP). However, we acknowledge that this benchmark has limitations. Beyond the fact that infrastructure spending data are often inconsistent or unreliable, there is not sufficient historical data to apply perpetual inventory methods for as long-lived an asset class as infrastructure.

Infrastructure investment faces a number of challenges including constrained public budgets, shortages in lending capacity, and more stringent regulation in the banking system. But failure to meet infrastructure needs will stifle growth in GDP and employment around the world and compromise a range of human development efforts in less-developed nations. Our analysis also suggests that an increase in infrastructure investment equivalent to 1 percent of GDP would translate into an additional 3.4 million direct and indirect jobs in India, 1.5 million in the United States, 1.3 million in Brazil, and 700,000 in Indonesia. While private finance can help, it is no panacea. Public private partnerships (PPPs) account for only a small share of total infrastructure investment—zero to 12 percent in the European Union (EU) in 2006 to 2009, or up to 22 percent in the United Kingdom if the country were to achieve its very ambitious goals between 2011 and 2015. If institutional investors were to increase their allocations for infrastructure financing to their target levels, this would result in an additional $2.5 trillion in infrastructure investment capital through 2030. This is a sizeable amount, but still only a fraction of global infrastructure investment needs. We therefore need to look elsewhere for a complete solution—increasing the productivity of global infrastructure investment.

Boosting infrastructure productivity could save $1 trillion a year

By scaling up best practice in selecting and delivering new infrastructure projects, and getting more use out of existing infrastructure, nations could obtain the same amount of infrastructure for 40 percent less—or, put another way, deliver a 60 percent improvement in infrastructure productivity. Over 18 years, this would be the equivalent of providing $48 trillion (excluding telecom, which we don't cover in our case studies of best practice) of infrastructure for $30 trillion—a saving of $1 trillion a year (Exhibit E2). We base this estimate on a review of more than 400 case studies of best practices—over 100 of which have quantified the savings they have achieved—and our subsequent global extrapolation of their impact (see the technical appendix for details). Achieving these productivity gains will not require groundbreaking innovation, but merely the application of established and proven practices from across the globe.

The potential to boost productivity is so large because of failings in addressing inefficiencies and stagnant productivity in a systematic way. On the whole, countries continue to invest in poorly conceived projects, take a long time to approve them, miss opportunities to innovate in how to deliver them, and then don't make the most of existing assets before opting to build expensive new capacity. In many countries, the process of selecting, building, and operating infrastructure—and the governance systems that could force improvements—has not changed for the better in decades. In the construction sector, for instance, labor productivity has barely moved for 20 years in many developed countries despite steady and significant gains in the productivity of other sectors.

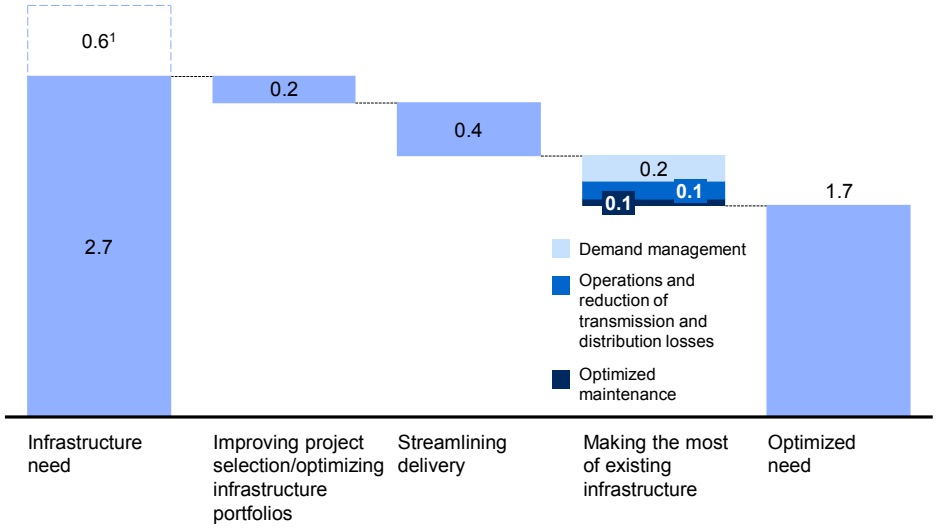
Exhibit E2

The $1 trillion-a-year infrastructure productivity opportunity

Global infrastructure investment need and how it could be reduced

Yearly average, 2013–30

$ trillion, constant 2010 dollars



1 Telecom investment need beyond the scope of this paper.

SOURCE: McKinsey Global Institute analysis

All too often, a surprisingly stable status quo persists in which inaccurate planning and forecasting lead to poor project selection. A bias among public officials to build new capacity, rather than make the most of existing infrastructure, is common, leading to more expensive and less sustainable infrastructure solutions. A lack of incentives, accountability, and capabilities as well as risk aversion has prevented infrastructure owners from taking advantage of improvements in construction methods such as the use of design-to-cost and design-to-value principles, advanced construction techniques, and lean processes. Infrastructure authorities frequently lack the capabilities necessary to negotiate on equal terms with infrastructure contractors, rendering them unable to provide effective oversight and thereby drive performance.

Our analysis finds that pulling three main levers can deliver the potential savings.

IMPROVING PROJECT SELECTION AND OPTIMIZING INFRASTRUCTURE PORTFOLIOS

Our analysis of global best practice indicates that one of the most powerful ways to reduce the overall cost of infrastructure is to optimize infrastructure portfolios—that is, simply to select the right combination of projects. All too often, decision makers invest in projects that do not address clearly defined needs or cannot deliver hoped-for benefits. Equally often, they default to investments in additional physical capacity (for example, widening an arterial road into a city) without considering the alternatives of resolving bottlenecks and addressing demand through, for instance, better planning of land use, the enhancement of public transit, and managing demand. Improving project selection and optimizing infrastructure portfolios could save $200 billion a year globally. To achieve these savings, owners must use precise selection criteria that ensure proposed projects meet specific goals; develop sophisticated evaluation methods to determine costs and benefits; and prioritize projects at a system level, using transparent, fact-based decision making.

For example, to guide its selection of transit projects, the government of Singapore has a clear metric: to support its broad socioeconomic goal of building a densely populated urban state, any project must contribute to the specific objective of achieving 70 percent use of public transit. In Chile, the National Public Investment System evaluates all proposed projects using standard forms, procedures, and metrics, and rejects as many as 35 percent of all projects. The organization's cost-benefit analyses consider, for instance, non-financial costs such as the cost of travel time, and a social discount rate that represents the opportunity cost for the country when its resources finance any given infrastructure project. Final approval rests with Chile's finance ministry, which allocates funding based on a combination of these cost-benefit analyses and national goals.

STREAMLINING DELIVERY

Streamlining project delivery can save up to $400 billion annually while accelerating timelines materially. Speeding up approval and land acquisition processes is vital given that one of the chief drivers of time (and time over-runs) is the process of acquiring permits and land. In India, up to 90 percent of road projects experience delays of 15 to 20 percent of the planned project timeline because of difficulties in acquiring land. England and Wales in the United Kingdom have, for instance, implemented one-stop permitting processes. In Australia, the state of New South Wales cut approval times by 11 percent in just one year by clarifying decision rights, harmonizing processes across agencies, and measuring performance. Both the United Kingdom and Australia have implemented special courts to expedite disputes over land acquisition.

A key source of savings in project delivery is investing heavily in early-stage project planning and design. This can reduce costs significantly by preventing changes and delays later on in the process when they become ever more expensive. Bringing together cross-functional teams from the government and contractor sides early in the design process can avoid the alterations that lead to 60 percent of project delays.

Owners can structure contracts to encourage cost-saving approaches, including design-to-cost principles that ensure the development of "minimal technical solutions"—the lowest-cost means of achieving a prescribed performance specification, rather than mere risk avoidance. Contractors can also be encouraged to use advanced construction techniques including prefabrication and modularization—facilitated by having the appropriate standards and specifications—as well as lean manufacturing methods adapted for construction. Strengthening the management of contractors, a weakness of many authorities, can also head off delays and cost over-runs. Finally, nations should support efforts to upgrade their construction sectors, which often rely heavily on informal labor (a situation that often contributes to corruption), suffer from capability gaps and insufficient training as well as from ill-conceived regulations and standards, and under-invest in innovation. Enhancing construction industry practices is necessary to raise the productivity, quality, and timeliness of infrastructure projects.

MAKING THE MOST OF EXISTING INFRASTRUCTURE ASSETS

Rather than investing in costly new projects, governments can address some infrastructure needs by getting more out of existing capacity. We estimate that boosting asset utilization, optimizing maintenance planning, and expanding the use of demand-management measures can generate savings of up to $400 billion a year. For example, intelligent transportation systems for roads, rail, airports, and ports can double or triple the use of an asset—typically at a fraction of the cost of adding the equivalent in physical capacity. Reducing transmission and distribution losses in water and power (which can be more than 50 percent of supply in some developing countries) often costs less than 3 percent of adding the equivalent in new production capacity and can be accomplished significantly faster.

Maintenance planning can be optimized by using a total cost of ownership (TCO) approach that considers costs over the complete life of an asset and finds the optimal balance between long-term renewal and short-term maintenance. By one estimate, if African nations had spent $12 billion more on road repair in the 1990s, they could have saved $45 billion in subsequent reconstruction costs.[3] To optimize maintenance programs, nations should assess and catalog needs. London, for instance, has a 20-year model for pavement deterioration. Denmark has reduced the expense of maintaining its roads by 10 to 20 percent by adopting a total cost of ownership approach.

Finally, governments need to make more aggressive use of tools and charges that allow them to manage demand. Advances in technology are broadening the range and improving the effectiveness of such demand-management approaches. To fully capture the potential of demand management, governments need to take a comprehensive approach and use all available tools. The city of Seoul, for example, is dealing with congestion by combining improved bus operations, access restrictions, and electronic fare collection with an integrated traffic-management system. Congestion pricing, widely regarded as the most effective measure to reduce congestion and reduce the need for capacity additions, especially in advanced economies, can be paired with intelligent traffic solutions to achieve even greater benefits.

Infrastructure governance systems need to be upgraded in order to capture potential savings

To boost the productivity of infrastructure and secure the considerable savings that we have identified, the infrastructure governance and delivery system needs to be upgraded in four important practical ways. First, there needs to be close coordination between the infrastructure authorities responsible for the different types of infrastructure, guided by a common understanding of broad socioeconomic goals and the role of each asset class in achieving them.[4] Switzerland's Department of Environment, Transport, Energy, and Communications, for instance, develops a national infrastructure strategy by unifying approaches in the full range of relevant sectors including the country's policies on air travel policy and the information society, its spatial development report, its plan for the transport sector, and its energy strategy. Second, a

3 *World development report 1994: Infrastructure for development*, World Bank, June 1994.

4 We include roads, rail, airports, ports, water and sanitation, power, and telecoms as infrastructure asset classes.

clear separation of political and technical responsibilities for infrastructure is necessary; politicians and government leaders set policy goals but should let technical experts create the specific projects and plans to meet these goals. This separation can take different forms. Hong Kong's Mass Transit Railway Corporation and Infrastructure Ontario in Canada both have organizational autonomy, while Singapore's Land Transport Authority relies on a very clear delineation of roles.

Third, governments must spell out how they divide roles and responsibilities between the public and private sectors, establishing clarity on market structure, regulation, pricing and subsidies, ownership, and financing. Many countries are realizing value by expanding the participation of the private sector in infrastructure beyond financing and delivering it to include an active role for private players in identifying and scoping projects. Some have developed frameworks to encourage and manage unsolicited proposals. In short, government should look beyond project-specific PPPs toward much broader public-private cooperation. Fourth, there needs to be trust-based engagement of stakeholders throughout the process to avoid suboptimal solutions and unnecessary delays.

Finally, an effective infrastructure system needs two critical enablers—reliable data on which to base day-to-day oversight and long-term planning, and strong public-sector capabilities across the value chain of planning, delivery, and operations.

In the private sector, companies, too, have a role to play on three main fronts. They can drive productivity within their own operations, engage in a productive dialogue with public-sector stakeholders on constraints and improvement ideas, and develop business and contracting models to benefit from today's shortcomings.

□ □ □

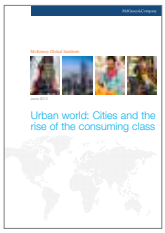
Meeting the world's large and growing infrastructure challenges is vital for growth and development. How those challenges are met will have a huge impact on all of our daily lives. It will determine how many of the world's citizens will have access to water, who has a job, or how long people are stuck in the daily traffic jam. It is no exaggeration to say that there is a moral imperative to improve the way that infrastructure is planned, delivered, and operated.

Our analysis finds that a range of practical steps can boost the productivity of infrastructure by 60 percent—and save $1 trillion a year. In short, there may be more cause for optimism than this subject usually generates. At a time of fiscal constraint and rising demand, the world needs to focus not only on the magnitude of the infrastructure gap and the resources required to fill it, but also on the many ways that it can get more, higher-quality infrastructure for less.

Related MGI and McKinsey Infrastructure Practice publications

Investing in growth: Europe's next challenge (MGI, December 2012)

Private investment was the hardest-hit component of Europe's GDP between 2007 and 2011—but it can also be a major driver of the region's recovery. Even in the face of weak demand and high uncertainty, some investors would start spending again if governments took bold measures to remove barriers that now stand in the way.



Urban world: Cities and the rise of the consuming class (MGI, June 2012)

In cities, one billion people will enter the global "consuming class" by 2025. Around 600 million of them will live in only around 440 cities in emerging markets expected to generate close to half of global GDP growth between 2010 and 2025. Catering to demand will require annual physical capital investment to more than double from nearly $10 trillion today to more than $20 trillion by 2025, the majority of which will be in the emerging world.

Resource revolution: Meeting the world's energy, materials, food, and water needs (MGI and McKinsey Sustainability & Resource Productivity Practice, November 2011)

Meeting the world's resource supply and productivity challenges will be far from easy—only 20 percent of the potential is readily achievable and 40 percent will be hard to capture. There are many barriers, including the fact that the capital needed each year to create a resource revolution will rise from roughly $2 trillion today to more than $3 trillion.

Keeping Britain moving: The United Kingdom's transport infrastructure needs (McKinsey Infrastructure Practice, March 2011)

The United Kingdom's strategic roads, railways and airports are some of the most congested in the world and demand is set to increase significantly. The nation therefore faces a period of unprecedented investment to maintain and enhance the quality of its transport assets. McKinsey & Company estimates that the cost of maintaining, renewing and expanding the United Kingdom's transport infrastructure will be around £350 billion over the next two decades– a 45 percent increase on average annual spending since the turn of the 21st century.

Releasing the pressure on road agencies (McKinsey Infrastructure Practice, February 2011)

Road agencies will have trouble meeting rising demand. However, adopting new tools and processes can produce big improvements in capital productivity and operating cost efficiency.

Building India: Accelerating infrastructure projects (McKinsey Infrastructure Practice, July 2009)

If past infrastructure investment trends continued between 2008 and 2017, India could suffer a GDP loss of $200 billion or around 10 per cent of GDP in fiscal year 2017. Inefficiencies in implementing infrastructure projects exist at all stages in the process but there are a few key initiatives could help address bottlenecks and reduce the time taken and costs incurred in infrastructure projects.

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