

CHAPTER 1

An Introduction to Infrastructure Finance

The business of infrastructure will always be vibrant because without basic systems such as transportation, energy, and water, neither the economy nor society can function. No matter how you define it, infrastructure is a large and important business sector. When defined broadly, the infrastructure business includes buildings, transportation, energy, water, telecommunications, and waste management as well as the cross-cutting construction and environmental businesses. When it is defined narrowly, it focuses on the construction industry, which is a vital and important sector of the economy.

Two compelling issues drive the need to finance infrastructure systems. The first is that the systems provide the physical basis for life, whether safe drinking water, energy to stay warm, or other essential services. The second issue is the business of infrastructure, or the functioning of the private sector and government organizations that provide and sustain the essential structures, equipment, and services of infrastructure.

This chapter introduces infrastructure as a business and identifies its main issues. Chapter 2 explains how infrastructure is a composite sector and introduces its subsectors. After a chapter about each of the subsectors, a summary chapter presents a range of investment opportunities. The remaining chapters in the book explain the capital and operating finances of infrastructure and identify the driving forces and trends that will shape its sectors in the future.

WHAT IS INFRASTRUCTURE BUSINESS?

Having a clear definition is the key to analyzing the “infrastructure business.” As the reader will see, people define *infrastructure* in different ways. To view it as a business, you must focus on its financials. The definition

can be fuzzy, so it is even more important to specify what infrastructure includes.

Much of the interest in infrastructure is focused on the construction industry, but infrastructure involves more than construction. One business letter, the *Infrastructure Investor* (2009), wrote that infrastructure “covers the man-made facilities that ensure any economy can operate” and that it includes transportation (railways, roads, and airports), utilities (energy generation and distribution, water, and waste processing, and telecommunications), and social infrastructure (schools, hospitals, and state housing).

Our definition varies from this, but the idea is the same. Investments in infrastructure target basic facilities that meet the needs of society and the economy. One variation is the attention we give to the built environment itself, with its emphasis on residential and commercial buildings. If these are not included in the infrastructure sector, then a major share of construction spending is missed. Another important part of our approach is that we distinguish between infrastructure and operation of infrastructure-related services, which is important in analyzing the sector.

In the chapters that follow, the reader will see that infrastructure is a composite of sectors such as construction, transportation, energy, and water, among others. Why should anyone be interested in this composite sector when its parts, such as transportation or electric utilities, can be analyzed separately? Surely these parts are large and complex enough to deserve their own analysis. The answer is, of course, they are large and deserve their own analysis, but they have common attributes that lend themselves to analysis of the composite sector for the purposes of investors, public sector managers, and policy makers.

Investors are now being presented with new infrastructure stock funds and are told that infrastructure is an attractive sector because it is essential and solid at a time when other sectors are changing rapidly. This can seem like a new investment opportunity, and it does have new facets. However, much of what is offered comprises systems that have been around a long time.

Public sector managers are confronted with complex decisions, such as how to solve traffic congestion or when and how to renew aging infrastructure systems. Facing these issues, policy makers—such as local government elected leaders—face funding decisions that may dwarf their other financial decisions.

The general purpose of the book is to pose and answer questions that will help these three groups: investors, public sector managers, and policy makers. For the policy makers, the book opens a discussion of new forms of public-private cooperation and mechanisms to make government more efficient and responsive to public needs. For the public sector managers, it

explains the financial structures and performances of the distinct infrastructure sectors. It ranges across public and private sector systems to explain how they obtain operating and capital revenues and how the balance between demand and supply is achieved. For investors, the book explains the structures of the industries that are in the infrastructure arena, how they obtain their capital and operating revenues, and how opportunities for private sector involvement arise in the capital markets, in equities of listed companies, and in private business start-ups.

INFRASTRUCTURE THEN AND NOW

Whereas the public side of infrastructure has a high profile, the fact is that infrastructure has always had a high level of private sector involvement. Just 100 years ago, the infrastructure business was strong in the United States, railroad stocks were hot on Wall Street, the electric utility industry was new, and the public demanded more roads for its new Model T automobiles. Go back 100 years earlier, and you see that change from a rural to an urban society gave birth to the technological age that drove the need for infrastructure.

This industrialization and urbanization that led to infrastructure development started around 1800, when a private banking venture led by Aaron Burr built a new water system for New York City. At that time and for another century, bankers were important players in financing infrastructure systems as well as other high-stakes national issues, even wars.

The steam engine had been invented, and it powered the Industrial Revolution. The privately owned Erie Canal created a boom for the Northeast, and people could see the close links between transportation and economic development. The growing nation required more and more politically charged internal improvements, and infrastructure issues moved to center stage in politics as well as business.

Now we live in a different world, but the infrastructure business remains important because the public still needs rail, electricity, roads, and many other infrastructure-related public services. If you include the Internet as part of infrastructure, then it rises even higher on the agenda. In any case, we are reminded of infrastructure constantly by the media. *Time* magazine, in its March 23, 2009, cover story, reported on 2 its top 10 national trends as related to infrastructure (Lacayo, 2009). One was the evolution of smart highways that serve to organize economic activity (see Chapter 4), and the other was recycling the suburbs with updated land uses (see Chapter 3).

Not only is the role of infrastructure in the economy large, it is growing in importance. This role was high on the agenda of many economists during

the 1980s and 1990s, and they explained how infrastructure is essential to economic development, productivity, and employment (Gramlich, 2001). They also showed that infrastructure investments encourage innovation, competitiveness, and is the basis for a high standard of living (Infrastructure Australia, 2008).

During the recent financial crises, infrastructure figured prominently in national stimulus packages and the U.S. budget. Having learned from past recessions, cities have been competing to show how many “shovel-ready” projects they have on their books. Much of the response to the financial crisis has been about housing, public projects, and transportation systems, all of which are central to infrastructure policy.

America is under criticism for how it invests in infrastructure. Along with other policy questions, we as a society face decisions about how much to invest in infrastructure, even while we are confronted with tremendous “needs estimates” to rebuild highways and fix aging sewers. Some say that if the nation does not invest more, it risks having the infrastructure of a third-world country. Experts look back at past nation building and grand projects like the Interstate Highway System and ask, “Where is that vision today?” Investment analysts compare America’s infrastructure investment of 2.4 percent of gross domestic product (GDP) to Europe’s 5 percent and China’s 9 percent and point to dysfunctional transportation, choked ports and airports, road congestion, and inadequate rail track systems.

One way to view this lack of investment is as a “third deficit,” to go along with our national debt and social security deficit. On a more positive note, it is apparent that we are entering a period of massive investment to rebuild and reinvent our infrastructure, almost like the 1930s New Deal or 1950s Interstate Highway eras. In any case, the overall view among experts interviewed by the *Economist* (2008) was “It’s time to think big again.”

As we explain in the book, an important dimension of infrastructure finance is how it can be used to manage demand and raise efficiency of critical public systems and services. This challenge is aimed directly at a central question about infrastructure: Should it emphasize public or private purposes? Public purposes focus on the core needs of society, such as clean air and water and access to education and healthcare. Private purposes relate to more discretionary needs, such as housing choices and entertainment.

Infrastructure finance addresses the central questions of public versus private purposes and is thus in the crossfire of political debates about a fair society. Chapter 14 discusses how decisions about infrastructure finance align public and private purposes. It answers questions about the roles of government and the private sector and how to meet basic human needs, such as safe water, disposal of wastes, energy, and transportation to work.

Infrastructure is at the center of debates about the global problem of poverty. When basic needs are not met, *why* are they not met? Whose job

is it to provide them? Should the poor pay the same for basic services as affluent people? If basic services are not provided, who should intervene?

On a broader scale, what are society's obligations to provide infrastructure for the many displaced and disenfranchised people around the world? Hundreds of millions of people displaced by war, climate change, or lack of opportunity do not have the basic support systems provided by infrastructure.

In more affluent societies, the more urgent problem is to find ways to sustain current levels of infrastructure-related services in the face of resource and environmental limits. Doing this requires more attention to managing demand rather than constantly ratcheting up supply. Closely related to demand management and efficiency of infrastructure is the subtle but important issue of trade-offs. You will read over and over in the book about how society and individuals can make choices about using public services, and the closer we can align these choices with the obligation to pay, the better our management will be.

The other focus in the book is on the attractiveness of infrastructure businesses, whether as an investment, such as purchase of municipal bonds or stocks of listed companies or direct equity stakes, or as a business line for entrepreneurs. The controversy over privatization and use of public-private partnerships is addressed with this topic. Chapter 10 provides examples of investment opportunities, including privatization.

While people have a general idea about infrastructure, measuring its financial performance is difficult because it is hard to define and classify and it has broad public purposes as well as well-defined private purposes. Infrastructure is not one unified system but a composite of systems involving utilities, transportation systems, and environmental services, among others. Also, reports about infrastructure tend to confuse the condition of government-owned physical assets and operating performance of the organizations that provide public services.

The definition of infrastructure can seem abstract and apply to different types of systems. To avoid a fuzzy definition, the book focuses on the constructed assets in six systems: the built environment itself, transportation, communications, energy, water, and waste management systems. This definition leaves out nonphysical categories, such as economic and social infrastructure systems. It emphasizes that infrastructure services are required for people and the economy, and they are not simply based on consumer choice.

To formalize this definition, we can say that infrastructure comprises the structural assets of the built environment and its physical support networks, and it includes a great deal of equipment, such as generators, motors, and actuators. In most cases, when accounting for infrastructure, we include both structures and equipment, which are the two types of fixed assets tracked by the U.S. Bureau of Economic Affairs.

Our definition of infrastructure distinguishes between the structures of infrastructure systems and the equipment of the organizations using the infrastructure to deliver public services, such as private motor vehicles and aircraft. In the case of rail companies, infrastructure includes structures and railcars. In the case of airlines, equipment is not considered part of infrastructure in our analysis but is part of the fixed assets of private companies using public infrastructure. You could, of course, make a case to include privately owned aircraft as infrastructure, but the definition of it would require adjustment.

The concept of public and private infrastructure systems can be confusing. There are many possibilities, but our main focus in the book is on infrastructure systems that provide public services, as distinguished from those that meet only private needs, such as the infrastructure that serves a manufacturing site. In some cases, the infrastructure that provides public services also serves broad public purposes that fall outside of the direct service. For example, a privately owned toll bridge could provide the public service of access across a river, but it might be required to remain open in case emergency vehicles needed to use it. Whether the bridge owner was compensated or not for the emergency access could be a matter for negotiation when rate-setting decisions are approved by regulators.

Some of the terms used can be confusing, and this list may help clarify them:

Public infrastructure	Infrastructure that meets public purposes
Publicly owned infrastructure	Infrastructure owned by governments
Private infrastructure	Infrastructure that meets private purposes only
Privately owned infrastructure	Infrastructure owned by private entities that might be used to provide public services and meet public purposes
Private company	A company whose ownership is private and not be share held by the public
Public company	A company that is owned by the public through issuance of traded stock shares
Public service	A service provided by government to the public
Public purposes	Goals of society that benefit all citizens

Given these variables, our focus is mainly on what is called public infrastructure, but it includes privately owned systems that provide public services. Although we focus on the public infrastructure, it is difficult to

divorce the discussion from private infrastructure because it creates the main demands on public infrastructure. Private, residential, and commercial buildings are prime examples of private facilities that need public infrastructure systems.

Our definition is consistent with one used by the U.S. Congressional Budget Office (1983) and cited more recently by Dzierwa (2009) in his investment analysis of infrastructure as a sector. He emphasized that infrastructure has the common characteristics of capital intensity, high public investment by all levels of government, and criticality to the economy. The sectors included in the CBO study were about the same as ours, although we also include buildings as infrastructure because their financial needs are the largest among built facilities, and they drive needs for the other categories of infrastructure. How this is handled is explained in Chapter 2, which presents a conceptual model in which all building types form the core of the built environment, which drives demand for the other categories of infrastructure.

A SYSTEM OF SYSTEMS

In the broadest sense, infrastructure is everything in the built environment that is distinct from natural and human environments. Usually definitions are more specific and explain what infrastructure is and which categories of systems it includes. Here are a few examples of these definitions:

- The basic physical systems of a country's or community's population (InvestorWords, 2009)
- The functional modes of public works and combined infrastructure system (National Research Council, 1987)
- Physical assets that provide services used in production and final consumption (New Zealand Ministry of Economic Development, 2005)
- Assets that range from large-scale national networks to smaller community-based facilities (Infrastructure Australia, 2008)
- A collective term for services (refers to critical national infrastructure) (Parliamentary Information Management Committee, 2009)

The definitions are usually accompanied by explanations of why infrastructure is essential to the economy, to quality of life, to communities, to the environment, and to high standards of living.

In some cases, economic and social systems can be called infrastructures. For example, the U.S. Department of Homeland Security includes economic and government systems, such as emergency services, finance, food, and public safety, in its definition of "critical infrastructure" (2009). It is also not

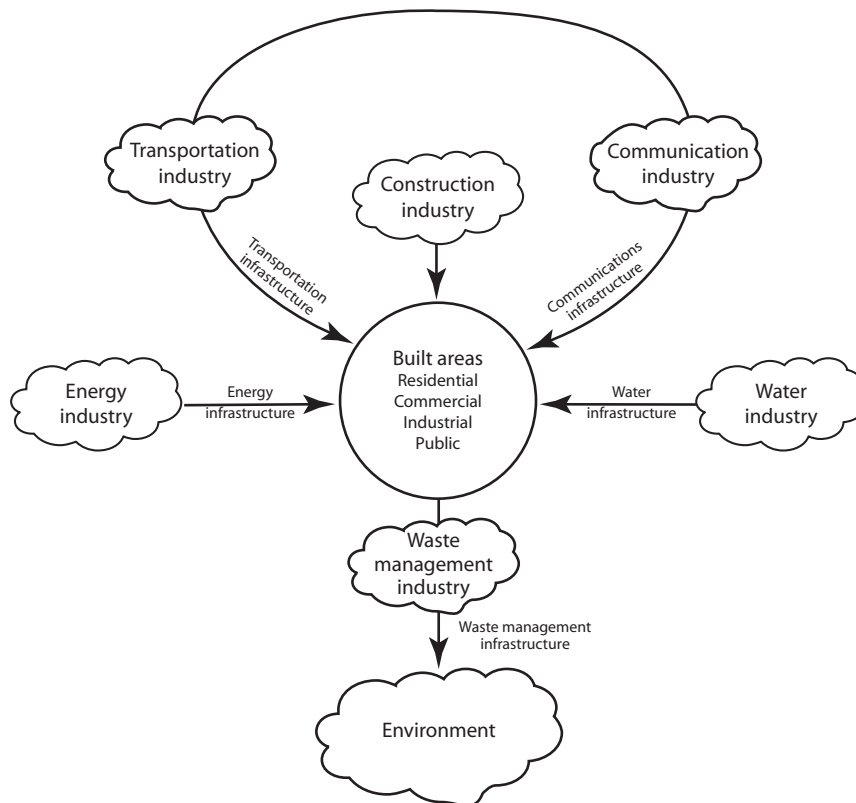


EXHIBIT 1.1 Built Environment and Infrastructure Support Systems

unusual to find social facilities, such as hospitals, schools and universities, museums, and libraries, in the definition. These definitions illustrate the dual nature of infrastructure: It can be explained as physical infrastructure or it can refer to operating sectors.

In our definition, infrastructure is limited to the buildings of the built environment and their support systems for transportation, communications, energy, water, and waste management. Exhibit 1.1 shows how these five infrastructure systems support the developed areas and corridors of the built environment.

As Exhibit 1.2 illustrates, all infrastructure systems utilize large-scale fixed assets, provide essential public services, involve both the public and private sectors, and are regulated by the government for health, safety, and performance. They include but are not limited to the services offered

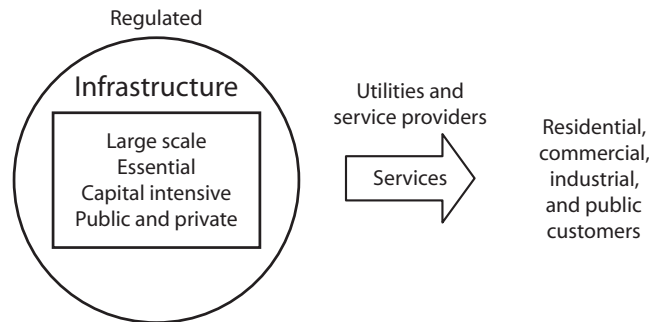


EXHIBIT 1.2 Distinctive Attributes of Infrastructure Systems

by public utilities for energy, water, and other utility services. Even with these attributes, it can be hard to say why one public service, such as road transportation, is based on infrastructure and another public service, such as police protection, is not.

The answer to this question comes through the arcane science of classification, which is explained for infrastructure systems in Chapter 2. Using a classification system, we can place police protection in a category of security services, which do not depend as much on physical assets as infrastructure-related services do.

The classification framework in Chapter 2 can be used to explain infrastructure investment needs and policies. At the highest level, the classification system starts with human systems, constructed systems, and natural systems. The classification can be taken to successively lower levels until the most basic components of the built environment are included, down to a streetlamp or water valve.

The terms *sector*, *industry*, and *system* are used interchangeably to explain infrastructure. When *sector* and *industry* are used, they generally refer to economic issues. The term *system* usually refers to physical components working together, such as a network of roads.

SECTOR STRUCTURE AND SIZE

Chapter 11 is about measuring the infrastructure sector, including both capital and operating costs. It is often difficult to separate these costs, but accounting for infrastructure must recognize that sometimes one organization provides the infrastructure (such as a roads department) and another one provides the operating services (such as transit services).

It can be difficult to compute the true annualized capital costs for infrastructure systems. For example, a buried pipe might cost \$1 million per mile to construct, but its lifetime cost is hard to measure because you do not know how long it will last. Once debt service is paid, the capital-intensive nature of the asset will not be noticed much, and it may be taken for granted. This may continue until it fails, and lead to the need for sudden large expenditures for repair and/or renewal. Just as you must know the condition of a house before buying it, discerning the likelihood of these sudden costs can be important in appraising the full costs of infrastructure.

The problem of neglect is pervasive in the infrastructure management arena. One financial manager said that the practice is to build it, forget it, and rebuild it. Out of sight, out of mind is another slogan that applies. What should an elected city council member argue to rebuild a sewer that has not yet failed, when the funds can go for another community park that might even have the names of the elected council members on a placard?

No matter how you measure it, infrastructure activity is a major part of the economy. Although it is not measured directly in national economic accounts, the infrastructure sector's size can be approximated by statistics such as construction spending, government spending, and utility revenues. Construction is 4 to 5 percent of GDP on the basis of value added. Energy costs are on the order of 8 percent, and, while it is not accounted for in an integrated way, the transportation sector is huge. If you add utilities, real estate, waste management, professional services, and government activities related to infrastructure, the percentage rises. Taking all together, the costs to build, maintain, and operate infrastructure systems and all buildings rise to around 20 percent or more of the economy. Of course, the critical issue in measuring this is what infrastructure includes.

While it is difficult to measure infrastructure's economic impact, estimates in Chapter 11 show that the value of U.S. infrastructure assets is around \$8.3 trillion for public structures and \$28.0 trillion for private structures (2007 data). Most of the public asset value is in roads, streets, and other infrastructure networks, while the private asset value is heavily weighted toward residential housing.

Expanding, modernizing, and renewing public infrastructure place heavy burdens on state and local governments as well as rate payers and taxpayers. For example, the \$8.3 trillion asset value for public infrastructure represents over \$80,000 per household in the United States, and the number is heading up as systems become more complex and need replacing with new models. The residential housing cost per household is much larger and is a principal reason for the financial crisis that occurred with the housing bubble. New management approaches are needed to deal with these large obligations while not increasing taxes and fees to burdensome levels.

ESTIMATING THE PER CAPITA COST

Although the details are complex, the overall cost of infrastructure can be estimated from the capital and operating costs for each sector. For the built environment, these would be paid as rent or opportunity cost for residential, commercial, and industrial facilities. In the transportation sector, costs would include the upkeep and capital on roads and the subsidies and fares of transit, rail, and aviation systems. The energy and communications sector revenues would be added to all charges and subsidies for water, wastewater, and waste management. The sum of all these costs would cover all debt service and operations of the infrastructure categories.

Generally speaking, if the GDP is about \$45,000 per capita and if all infrastructure costs are 10 percent of GDP, then the annual cost to provide infrastructure and related services is about \$4,500 per capita in the United States. If infrastructure costs are greater, at 15 percent of GDP, then the cost is \$6,750 per capita, or about \$20,000 for a three-person household. The numbers appear low if you consider the full cost of housing and other buildings.

As the major factor in infrastructure cost, residential housing comprises a large percentage of the estimates. For example, for a \$200,000 three-person home, the annual cost per capita is about \$4,000 (assuming a 40-year life, cost of capital at 5 percent, and maintenance at 10 percent of annualized capital cost). That amounts to an estimate of \$1,000 per month for housing for the family, which would be higher if the interest rate rose.

The costs of the other infrastructure categories add to the total cost of housing, but they cost less than the buildings themselves. For example, as Chapter 6 shows, the total national electric power and natural gas revenues for a year are around \$500 billion, or a per capita cost of about \$1,700. Adding all such related infrastructure costs to the costs of housing seems to corroborate the \$20,000-per-family range (about 15 percent of GDP) for housing plus infrastructure. In the final analysis, the per capita cost to provide infrastructure depends on its definition and how the costs are allocated. Chapter 10 presents an overall picture of these costs in the form of a scorecard for infrastructure.

NEED FOR NEW APPROACHES

It is true that infrastructure was a driving force of the Industrial Revolution, but economic challenges have shifted. Now society and the economic system are more complex. There are close links between infrastructure and

economic vitalization, and no one can afford command-and-control approaches to infrastructure development unless the systems can be financed and sustained.

Mandel (2009) saw a link between infrastructure challenges and our current need for more innovation:

Of course, no industrial revolution in the past has been based on a single technology. A combination of radio, television, flight, antibiotics, synthetic materials, and automobiles drove the productivity surge of the early and mid-20th century. The Industrial Revolution of the second half of the 19th century combined railroads, electricity, and the telegraph and telephone. (p. 34–40)

So, what about innovation in infrastructure? Can we bring better services to more people at a reasonable cost and help the triple bottom line? The links between infrastructure and quality of life are undeniable. Developed and developing countries need sustainable infrastructure to support their citizens while not damaging the environment. Success for these countries will depend on their management approaches and financing methods.

New management approaches to achieve sustainable infrastructure systems must confront their capital intensity, which presents obstacles to performance improvement and cost reduction. New approaches, such as those described in Chapter 14, can feature different forms of ownership and financing as well as new technologies and management strategies.

While it is tempting to think that a market approach of pricing infrastructure services will solve the problem, this strategy suffers from market failure, a term that explains how the private market cannot fully deal with issues of public goods. This difficult issue draws in the economic problems of managing monopolies to protect the public interest as well as many newer business issues about social equity and environmental protection.

The opposite of market failure is government failure. The government cannot manage infrastructure fully by itself without spiraling into pure socialism and waste caused by pork-barrel approaches and other public sector problems. At its best, the issue becomes one of efficiency. At its worst, corruption and criminal activity are involved.

This combination of market failure and government failure leads to a principal theme of the book: the need for improved models for public-private cooperation, or a “middle way.” In today’s parlance, these are usually referred to as public-private partnerships. They are discussed in more detail in Chapter 12.

Embedded in the discussions in the book about infrastructure finance are many new management approaches. In addition to public-private

cooperation, these include pursuit of efficiency and equity, environmental sustainability, and triple-bottom-line thinking to link infrastructure to objectives for energy conservation, environmental management, and security.

The next chapter provides an overview of the infrastructure sectors, including the built environment, transportation and communications, energy and water, and waste management. Separate chapters follow for each of these key infrastructure sectors. A chapter to summarize investment opportunities wraps up Part I of the book.

SUMMARY

Whereas infrastructure is often considered a technical sector, current issues point to the important roles of business and finance in improving the sector. Technology will continue to push new developments, but the most important changes will be organizational and financial. This section reviews important issues that confirm how these issues drive today's infrastructure sector.

Infrastructure as a Business

The infrastructure business evolved rapidly during the Industrial Revolution and is still in a period of change. The earliest public roads, railroads, water systems, electric power systems, and other facilities were private, for-profit ventures. Although it has changed, the infrastructure business will remain vibrant because it is essential to the economy, society, and the environment. Even during the Great Depression, electric power, transit, and other infrastructure services continued in operation. Although demands for infrastructure continue and grow, the nature of the business has changed so that the security of regulated returns is less certain than in the past.

Infrastructure as a Third Deficit

The large backlog of infrastructure needs comprises a third national deficit, along with the public debt and unmet future Social Security needs. Therefore, America will be challenged to invest enough in its infrastructure to meet the identified needs because it has other heavy financial obligations. Its dispersed population and standard of living create greater per capita infrastructure costs than other, more centralized nations face. The United States must develop new policies to respond to these challenges.

Infrastructure Is Not Just a Public Good or a Private Good

Infrastructure systems serve both public and private purposes, and it will always be difficult to draw a fine line between services that

can be financed through consumer choice and those that require government mandates and subsidies. This juxtaposition presents a challenge to the political and economic systems: Can the U.S. political system adapt once again to show how a representative democracy can step up to the plate to make equitable choices that serve all the people?

Infrastructure Is a Core Issue in Overcoming Poverty

Around the world, poverty and deprivation are all about lack of basic infrastructure and related services. How can people escape poverty if they lack housing, safe water, affordable energy, transportation to a job, and a healthy way to dispose of wastes? If nations and the international community are serious about overcoming poverty, they must find ways to straddle the public and private purposes of infrastructure services and deliver workable and sustainable systems to everyone.

Trends and Driving Forces

Without exception, infrastructure systems are becoming more complex, costly, and vulnerable. These attributes pose danger and opportunity. The danger occurs because infrastructure may absorb more national resources and cause distress in society when it fails, but the opportunity is to create through the private sector new products and services to address these changes. Information technology, telecommunications, smart controls, new sensors, and other technologies can help ensure more reliable and responsive infrastructure systems at affordable costs.

Management Requires Keen Insight

While it is easy to agree on the need for infrastructure and public services, defining what is meant by this can be difficult. Without a fixed definition of infrastructure and clear demand signals from the marketplace, it can be difficult to measure the financial performance of infrastructure systems. Lacking performance indicators, politicians can refuse to invest or spend on the basis that they require more evidence of the results. This dilemma afflicts infrastructure systems and creates problems ranging from financing transit buses to preventing failures of aging infrastructure systems, such as buried water lines.

Choice in Services

Providing infrastructure and its public services is not only a matter of defining needs and meeting them. It is also about giving people choices so they can decide how much of the infrastructure services to use and how to pay for them. Infrastructure finance is the key

tool to provide this choice by creating demand management systems that raise overall efficiency of infrastructure delivery systems. Infrastructure finance offers new ways to make government more effective in its management and oversight roles, including tools that have come through reinventing government and managing the price of government.

Sustainable and Attractive Infrastructure Businesses

Although the idyllic notion of a reliable investment in a regulated infrastructure service that pays unending dividends is a thing of the past, many infrastructure investments still hold attraction for stability, safety, and attractive returns. Some come with assurance of regulation, but even in the absence of regulation, municipal bonds, stocks of growing companies with strong and steady markets, and private equity investments can be very attractive. As in other arenas, picks of the most promising investments remain difficult, but infrastructure offers many opportunities for investors willing to analyze the sector in depth.

