CHAPTER 1

Infrastructure – An Overview

High investment and maintenance costs for infrastructure assets are a heavy burden on public budgets. As a result, over the last four to five decades all OECD (Organization for Economic Cooperation and Development) countries have steadily reduced their level of infrastructure investment both in absolute and relative terms. This situation is enhanced by the consequences of a severe global financial crisis and the enormous challenges facing infrastructure assets caused by climate change.

In response to this situation, a number of governments have sought to identify new ways of financing adequate infrastructure facilities despite (or even because of) this dearth of state funding, demonstrating a change in attitudes. In almost all of the countries concerned, the outcome has been cooperation with the private sector with a view to ensuring continued domestic economic productivity even in the face of growing populations and insufficient public budgets. Ultimately, the quality of a country's available infrastructure is a vital factor in its future economic growth and, hence, must have first priority.

Already today, around the world, a significant proportion of infrastructure assets are in private hands. This is especially true for the telecommunications sector, to a lesser extent for power generation, transmission and storage and even less for transport, water, waste, and social infrastructure. It is expected that private money will continue to flow into these sectors because governments lack the means to finance and maintain publicly-owned and operated infrastructures, owing to pressure on budgets and tax-raising capacity. At the same time, in an ongoing low interest rate environment, investors will keep looking for attractive, long-term, low risk investment opportunities as presented by many infrastructure assets.

Most Western countries as well as several emerging economies in Asia, the Middle East and Eastern Europe, have implemented extensive legislation to open up the possibility of infrastructure investments by the private sector. For its part, the private sector has recognised the financial benefits of funding, constructing and operating/holding infrastructure assets, whether in the form of long-term concessions or by way of permanent ownership.

Before infrastructure is defined and its general characteristics addressed in some detail, the following section provides a brief overview of the size of the infrastructure market and its investment requirements.

1.1 DEMAND FOR INFRASTRUCTURE

Significant demand for investments in both economic and social infrastructure assets exists around the world. This is because public infrastructure projects/assets in areas such as traffic, supply and disposal, health and social care, education, science and administration are some of the key location factors and growth drivers of any economy. Although governments are responsible for investments in new and existing infrastructure assets, and hence are in a position to influence positively the economic development of their countries, the combination of economic upturn, insufficient investment in these sectors and the inadequate, even most basic, maintenance of existing ageing facilities over the past decades has led to a considerable imbalance between supply and demand when it comes to infrastructure assets. This has been exacerbated by population growth and an increased demand for constructing, modernising or replacing existing assets, which in turn leads to higher costs. The global investment shortfall in infrastructure is estimated to be at least US$1 trillion per annum (WEF, 2014a). The World Bank estimates this excess demand at 1.3% of global gross national product (GNP) (World Bank Database, 2015). Meanwhile, the gap between the need for infrastructure investments and the ability of national budgets to meet this demand is continuing to widen throughout the world.

In less prosperous developing countries and emerging economies, demand for infrastructure investments continues to focus on primary care and utilities in particular. Funding for the development and operation of such projects, most of which are constructed on greenfield sites, has always been scarce. In the past, these requirements have largely been financed with the assistance of development subsidies and multilateral sponsor organisations, while private investors rarely got involved. However, this situation is changing dramatically at least for those emerging economies with dynamic economic growth. In countries such as China and India, infrastructure projects financed with private investment are becoming increasingly common as a means of meeting the vast capital requirements for the construction of basic infrastructure. The same applies to the transitional economies of Eastern Europe, where initially the main focus has been on privatising state-owned enterprises.

Yet, established industrialised nations are also facing growing financial challenges when it comes to providing efficient infrastructure facilities. Their existing infrastructure (brownfield), which is generally well constructed, must be operated, serviced, maintained, modernised and adjusted to meet current requirements, including environmental and social standards. These assets often entail new construction, renovation, expansion or conversion measures. Due to demographic change, this sometimes even requires the dismantling and fundamental redesign of the relevant assets.

One particular challenge is financing the construction and operation of international, cross-border infrastructure facilities that are extremely important for the integration of international economic communities, as evidenced by the examples of the Trans-European Transport Network (TEN-T), the Trans-European Energy Network (TEN-E), and the Trans-European Telecommunications Network (eTEN).

All country types – developing, emerging and industrialised – have a financing gap of some sort that they need to close. However, there are considerable differences in terms of the political, legal and economic conditions and requirements for closing this gap with the aid of private capital. One particular consideration is the substantial variation in economic growth combined with the national debt and existing tax and contribution ratios of the respective countries. Industrialised nations often show low levels of growth and rapidly dwindling scope for financing infrastructure via new borrowing or further increasing the burden on taxpayers and users. Therefore, it is important for these countries to realise efficiency benefits through the expansion, maintenance and operation of the existing infrastructure. As a consequence, these countries can only get hold of extra cash by making savings in their bureaucratic structures, in other words they need to cover future expenses by reforming their already overburdened administrative machinery and adjust their budgets accordingly. In this context, value-for-money comparisons (effectiveness and efficiency) – both between infrastructure assets of the same kind and/or in the same sector as well as conventional procurement vs. private-sector participation/partnerships – play a decisive role. This is even more crucial once governments aim to attract private capital to fill the financing gaps.

In contrast, the financial liquidity aspect is considerably more important in high-growth countries, because the required infrastructure needs to be available for use as quickly as possible – 'whatever the cost' – in order to not only meet urgent needs but also further support economic growth. In a scenario reminiscent of the post-World War II economic boom in Germany, the aim here is to offset the resulting new (government) debt with growing revenues generated in other areas. In both cases, though, the acquisition of private capital to supplement governments' efforts is one of the primary objectives.

Building on this qualitative analysis of the demand structure, the following paragraphs aim to quantify the costs for these infrastructure requirements to some extent.

According to estimates by the World Bank, global operating and maintenance costs for existing infrastructure assets alone amount to 1.2% of global GNP, almost equal to the excess demand for new investments of 1.3% mentioned earlier (World Bank Database, 2015). These costs may be due in part, although by no means exclusively, to overall rising raw material costs.

The growth in healthcare costs and pension obligations owing to an ageing population accompanied by reduced tax receipts has led to a further deterioration in the financing options available to governments. In high-tax countries, such as Germany or Scandinavia in particular, tax increases are not a feasible option for funding infrastructure assets. Using fixed-income securities as alternatives has a negative impact on the public purse and the financial rating, plus it can be used to finance only an extremely limited number of projects. In short, the current public policy and regulatory and planning frameworks in most countries appear inadequately equipped and structured to tackle the multifaceted challenges facing infrastructure development in general and sustainable infrastructure in particular over the next 25 years.

According to the comprehensive two-volume *Infrastructure 2030* OECD study published in 2006/2007 – this is still the only study of its kind to which all newer studies keep referring – government spending on infrastructure in OECD countries amounted to 2.2% of GNP between 1997 and 2002, compared with 2.6% in 1991–1997 (OECD, 2006, 2007). Figure 1.1 illustrates this development, broken down by a selected number of OECD countries over a period of 30 years from 1970 to 2002. With the exception of the US in 2002, the ratio of government infrastructure spending to total spending in the respective countries declined or stagnated over the same periods. A more recent OECD report on transport infrastructure only shows that investment rates for OECD countries have decreased even further from 2002 to 2011, floating between 0.8 and 0.9% of GNP (OECD/ITF, 2013).

Figure 1.2 compares the key European Union (EU) countries as well as all 15 EU countries over a 30-year period. It shows a substantial downward trend in public investment in the EU from 1970–2003 as well, not only in relative but also in absolute terms. A 2015 report illustrates a continuation of this trend with public investment in infrastructure for the (now) 28 EU countries in 2013 down by a further 11% compared to 2010 (Ammermann, 2015).

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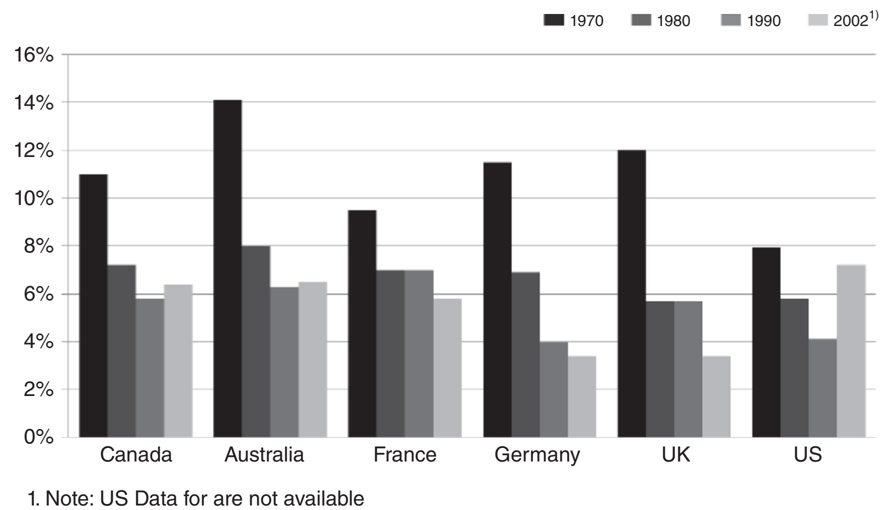


FIGURE 1.1 Government infrastructure investments as a percentage of total outlays in OECD countries
Source: OECD (2006)

According to estimates contained in the *Infrastructure 2030* OECD study 2006/2007 and a 2013 report by McKinsey (McKinsey Global Institute, 2013), the need for infrastructure investments – including additions, renewals and upgrades – has increased so significantly at a global level that investments totalling some US$60 trillion will be required between 2013 and 2030 in order to improve the key infrastructure facilities around the world in line with requirements. This corresponds to around 3.5% of global GDP annually. Although the OECD

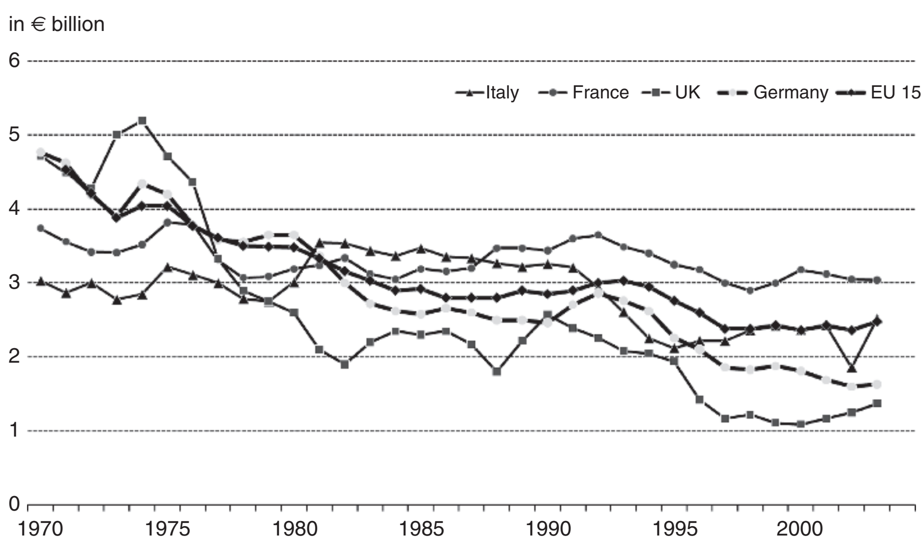
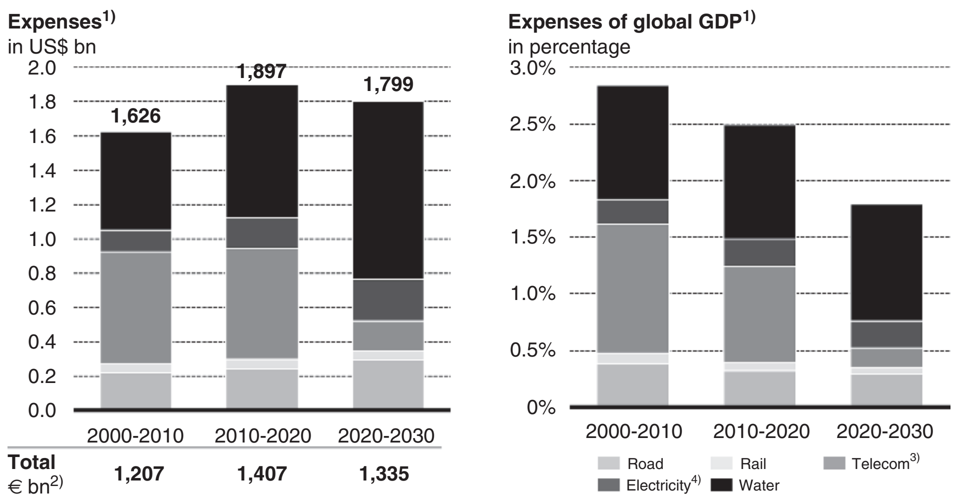


FIGURE 1.2 Infrastructure investments of EU governments
Source: OECD (2006)

study fails to provide details of the assumptions underlying these estimates and whether the investments constitute a politician's wish list or essential requirements in the respective countries, there is no reason to doubt the prevailing trend. According to the study, the 30 OECD member states have to invest more than US$600 billion a year in electricity, road, rail and water infrastructure from 2005 to 2030. Infrastructural improvements in the energy sector alone were forecast to total around US$4 trillion over the next 30 years. The modernisation and expansion of water, electricity and transportation systems in the cities of Western Europe, the US and Canada are expected to cost some US$16 trillion. In developed countries, there will also be a need to completely replace existing facilities and make additional new investments to meet rising demand.

Figure 1.3 presents the estimated spending requirements on infrastructure over time in the OECD and BRIC countries broken down into selected sectors.



1) Only OECD countries, Russia, China, India, and Brasil are considered here
2) Exchange rate US$ to € (30. June 2007): 0.742
3) Estimates are related to the years 2005, 2015, 2025
4) Only transmission and distribution

FIGURE 1.3 Estimated average annual infrastructure spending in OECD and BRIC countries (new and replacement investments) in selected sectors, 2000–2030, in US$ billion as a percentage of global GDP
Source: UBS (2006)

In high-growth countries, the imbalance between capital supply and demand is many times greater. Estimated annual investments of 5–9% of GDP would be necessary to maintain the projected growth in these countries and facilitate the projected investment needs of US$460 billion over the coming years. According to the OECD, none of the countries concerned will be able to implement these measures without the support of the private sector. Globally, infrastructure investments will need to increase by 60% over the next 18 years to meet demand, following the 2013 McKinsey report cited above. A 2014 report from Swiss Re estimates that annual global infrastructure spending needs to increase from US$2.6 trillion in 2011 to around US$4 trillion by 2030 (Swiss Re, 2014).

There may be some debate as to the precise investment volumes needed. The high level of global demand for infrastructure investments and the inability of governments to cope with

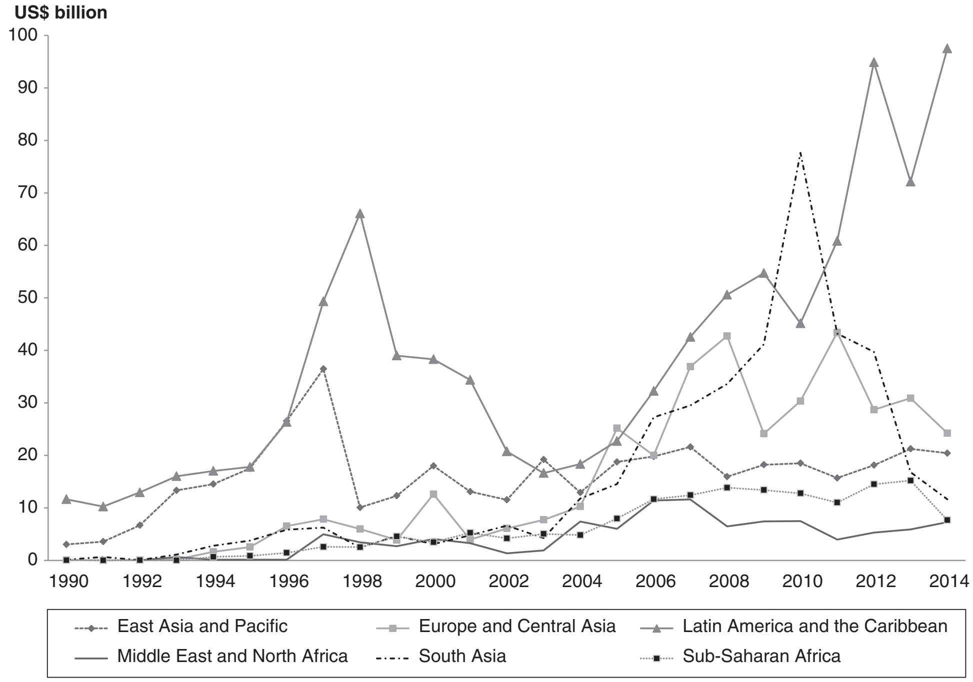


FIGURE 1.4 Investment commitments to infrastructure projects with private participation by region, 1990–2014
Source: Private Participation in Infrastructure Project Database (2016)

the level of capital and expertise required are undeniable. While public spending in essential infrastructure has been reported to continuously decrease, the share of private infrastructure investments has increased steadily. Over recent years, the volume of private investments in infrastructure in general, and especially in variants of public–private partnership (PPP) models, has risen across most regions (Figure 1.4). This is particularly evident in more recent years. It illustrates the general investment commitment to infrastructure projects with private participation, according to PPIAF (Public-Private Infrastructure Advisory Facility). Privatisation of state assets has been an important driver of this development. Since the 1980s, more than US$1 trillion of assets have been privatised in OECD countries and infrastructure has consistently taken centre stage. Aggregated figures for the period from 1990 to 2006 demonstrate that almost two-thirds of all privatisations in the OECD area related to utilities, transport, telecommunications or oil facilities. Over a similar period, some US$400 billion of state-owned assets were sold in non-OECD countries, approximately half of which were infrastructure-related (OECD, 2006, 2007).

Another indicator for the growing interest of private infrastructure investments is the share of private investments in listed infrastructure assets, the total stock of which increased fivefold from US$465 billion in 2000 to US$2.3 trillion in 2013 (Elliott, 2009; AMP Capital, 2014) – see Section 2.3.1 for further information.

Commitments to unlisted infrastructure funds are a further indicator. According to an infrastructure report by Probitas Partners, annual fundraising increased rapidly from US$2.4 billion in 2004 to US$39.7 billion in 2007 before dropping to US$10.7 billion in 2009 following the financial crisis (Probitas, 2014). Since then, annual investing has recovered strongly.

According to Preqin, a provider of infrastructure market data, 144 unlisted infrastructure funds were seeking aggregated capital commitments of $93 billion as of January 2015 (Preqin, 2015a).

Although investments in European infrastructure have not returned to pre-financial-crisis levels (US$7.5 billion in 2014 compared to US$10.1 billion in 2007) (Preqin, 2015a, b), the region still remains a global giant with respect to infrastructure investment offerings. Based on a recent report by Linklaters, investments have been strongest in the UK and northern Continental Europe while in southern Europe private infrastructure investment has crumbled since the financial crisis (Linklaters, 2014). Yet, foreign investors quadrupled their investment activity in European infrastructure from 2010 to 2013 (especially investors from Canada, China/Hong Kong, the Golf Cooperation Council [GCC] region, Japan and South Korea). Canada alone has invested over US$13 billion in Europe's infrastructure in the last three years. Notwithstanding, European investors still accounted for almost 75% of infrastructure acquisitions on the Continent during the same period. The report also notes that Europeans' share in global infrastructure investing has diminished from more than half in 2006 to just a quarter in 2013.

Funding investments of the magnitude stated above via tax increases is neither feasible nor sensible. By governments cooperating more often with the private sector, which is obviously interested in getting involved, the necessary repairs, modernisation work, operating, maintenance and new construction of infrastructure assets can be largely achieved in the medium to long term without significant tax hikes or additional borrowing for societies. Needless to say, private investors alone are not the solution. A long-term shift in the spending priorities of governments, increased user finance and more efficient infrastructure management will have to happen in parallel. Here, too, greater cooperation between the public sector and private investors will make an important contribution.

1.2 SUSTAINABILITY AND INFRASTRUCTURE

Sustainability and infrastructure share a common goal: to meet the current and long-term needs of society. It is not surprising that in a world of increasing resource scarcity, social unrest, population growth, ageing societies and climate change, sustainability and infrastructure are intrinsically interconnected. How we select, design and manage infrastructure systems today will play a key role in how such systems affect society and the environment now and for years to come. This in turn will have consequences for the exposure of infrastructure assets themselves to environmental, social and governance (ESG) risks.

Environmental risks relate to, for example, physical damage to infrastructure assets from climate-change-induced environmental hazards such as storms or floods, pollution and environmental degradation, changing regulations to curtail CO_2 emissions and the contamination of the environment. Violations of human rights, consumer protection rights, rights of indigenous populations, operational health and safety regulations and unfair competition are examples of social risks potentially affecting an infrastructure project or asset. Governance risks result from unethical behaviour (e.g. corruption), a lack of the rule of law in a country and governance structures or management systems that create conflicts of interests between the management and stakeholders of an infrastructure project.

The growing importance of sustainability considerations presents investors with new risks and opportunities. ESG factors are increasingly relevant both for shaping corporate reputation as well as for determining the long-term financial viability of infrastructure assets. At the same

TABLE 1.1 Quick reference guide to sustainability content

Section	Title	Page	Topics covered
1.2.1	Sustainability and sustainable development – a brief history	8	Background and key milestones for sustainable development
1.2.2	The need for sustainable infrastructure	9	Facts and figures supporting sustainable approaches to infrastructure development
2.2	Sustainable infrastructure investing	56	Introduction to sustainable investing and ESG factors, including examples of ESG assessment and benchmarking tools
4.1–4.7	Characteristics of selected infrastructure sectors and subsectors	114–258	Summaries of *sustainability considerations* at the end of each infrastructure sector sub-section
5.2.4	Environmental, social and governance (ESG) risk	270	Discussion of ESG risks (especially climate change) in infrastructure investments
5.2.5.2	Renewable energy regulations	280	Risk of changes in renewable energy regulations on clean energy investments
5.2.5.3	Stranded (fossil-fuel) assets	281	Risk of climate change policies on the valuation of fossil-fuel assets
5.4	Sector-specific risks	291	Sector-specific ESG risks

time, sustainability-themed, investable infrastructure assets such as renewable energy plants, resource-efficient water supply facilities and climate-change-resilient transportation systems and buildings all have a positive impact on sustainable development.

Given the key role of sustainability for the centuries and societies ahead of us, we will re-address sustainability aspects and considerations throughout this entire second edition in order to illustrate ESG (risk) factors to investors and help them incorporate them into their infrastructure investment decision-making process. Table 1.1 provides a quick reference guide for locating all sustainability (ESG) related content throughout this book.

1.2.1 Sustainability and sustainable development – a brief history

In the realms of ecology, sustainability describes how biological systems (such as watersheds, ocean fisheries and forests) remain diverse and productive over time. Yet, since its early beginnings, the concept of sustainability has encompassed more than just the need to preserve nature. By the start of the 18th century, intensive logging for the mining industry and smelting of ores had resulted in an acute scarcity of timber, threatening the livelihood of thousands in Saxony (today's Germany). The region's mining administrator, Hans Carl von Carlowitz, fought this threat by introducing the principle of sustainability that limited the felling of timber to the number of trees that were expected to grow back. This became the first clearly formulated concept of sustainability in forestry, acknowledging the intrinsic relationship between natural resource management, human well-being and economic prosperity. In more general terms, it recognised the interconnections between the environmental, social and economic aspects of sustainability.

It was not until the late 1900s, however, that the term 'sustainable development', that is the relationship between human development and environmental sustainability, was defined on an international level. In 1987, the World Commission on Environment and Development (WCED), under the chair of the former Norwegian prime minister, Gro Brundtland, famously defined the sustainable development:

> *'Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' (WCED, 1987).*

Over the last two decades, there have been a number of international agreements and declarations addressing the need for sustainable development.

- In 1992, the United Nations (UN) Conference on Environment and Development in Rio de Janeiro (the Earth Summit) adopted two milestone frameworks for sustainable development: *Agenda 21*, an action plan related to sustainable development, and the *Convention on Biological Diversity*, which focused on the conservation and sustainable use of biological diversity.
- The *Kyoto Protocol* of 1997 committed industrialised nations to binding targets to reduce CO_2 emissions by 5% compared to 1990 levels by the year 2012.
- In 1999, the UN launched the initiative *Global Compact*, which embraced guiding principles for human rights, labour and environmental protection and established a system of sustainable principles for business enterprises.
- In 2000, the UN adopted the *Millennium Declaration* (or *Millennium Development Goals*), with the aim of ensuring the well-being of future generations. A new set of UN *Sustainable Development Goals* are currently being developed to replace the Millennium Goals, which expire in 2015.
- The UN Climate Change Conferences in 2009 and 2010, which had all governments in attendance, including those of the US and China, committing to the goal of limiting global warming to 2°C above pre-industrial levels and to take further measures to combat climate change.
- Lastly, in November 2014, the Intergovernmental Panel on Climate Change's (IPCC) *Fifth Assessment Synthesis Report* warned that 'climate change is a threat to sustainable development' and that avoiding such a threat will require 'substantial emissions reductions over the next few decades and near zero emissions of CO_2 and other long-lived GHGs [greenhouse gases] by the end of the century'.
- In December 2015, the COP21, also known as the 2015 Paris Climate Conference, reached an agreement to pursue efforts to limit the global temperature increase to 1.5°C.

1.2.2 The need for sustainable infrastructure

Progress in sustainable development will depend in large part on the development of sustainable infrastructure. It is estimated that by 2050 the world population will reach 9–10 billion (UN, 2015a). By then, three billion people (40% of today's global population) will be brought into the 'middle class' (Bloomberg Business, 2012). This will result in a significant demand for new energy, water, social and transportation infrastructure.

To this end, the OECD estimates that the current, business-as-usual approach to infrastructure development will lead to unsustainable increases in both water consumption (55%) and energy demand (85%), ending in a potential collapse of the global water supply and dangerous

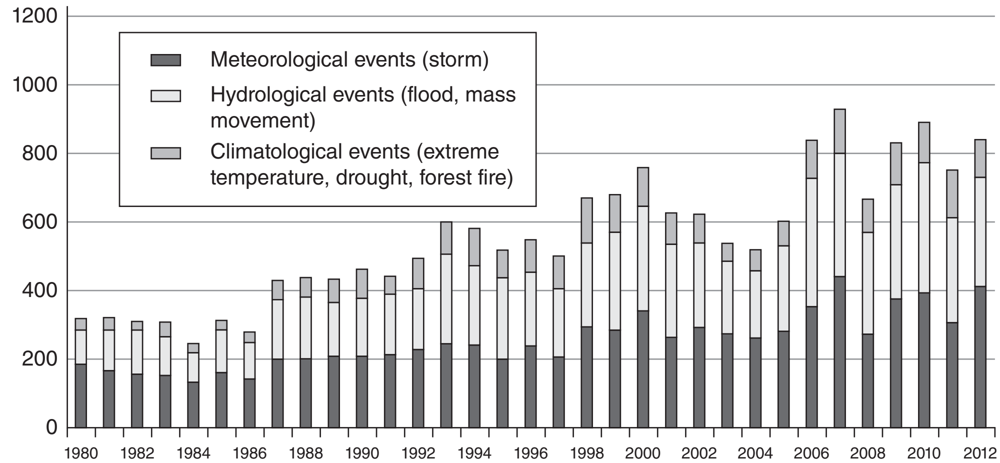


FIGURE 1.5 Weather-related catastrophes worldwide 1980–2012
Source: Munich RE (2013)

climate change-driven events, such as extreme heatwaves, increased frequency and severity of storms, increased river flooding and rises in sea levels (OECD, 2012). In fact, environmental risks such as water scarcity and weather-related catastrophes have been on the rise over the last several decades. For example, Figure 1.5 illustrates the rapid surge in weather-related catastrophes over three decades. Such extreme weather events can lead to increased risks to the physical integrity and functionality of infrastructure systems (see Section 5.2.4.1).

In conclusion, constraints from economic development, global population growth, resource scarcity, human rights and labour issues and climate change will require a 'change of strategy', a shift towards consequent sustainable infrastructure development. A condition for this to happen is that investors in infrastructure integrate sustainability considerations as a matter of course in any decision-making process. See Section 2.2 for further discussion on this topic.

1.3 DEFINITION AND CHARACTERISTICS OF INFRASTRUCTURE

The term 'infrastructure' was originally used in the military context to refer to military assets such as barracks and airfields. Relatively recently, it has come to mean the necessary organisational backbone supporting an economy. However, a huge variety of definitions has been suggested by national agencies, national and regional governments, academia, dictionaries and of course the financial community, and infrastructure can, as a result, encompass all things to all people. This approach is hardly a useful way to define infrastructure, but instead clouds the ability of investors, governments and their citizens to understand, advocate and direct capital towards these assets (Fulmer, 2009). Therefore, this section provides an overview of various definitions of the term with the aim to reach a single definition to be used in this book.

One of the broadest definitions of 'infrastructure' can be traced back to Jochimsen (1966), who focuses on infrastructure's role in the development of a market economy. To this end, he considers not only economic and technological elements but also social and cultural aspects in the equation. Accordingly, he describes 'infrastructure' as:

> *the sum of all material, institutional and personal assets, facilities and conditions available to an economy based on the division of labour and its individual economic units that contribute to realising the assimilation of factor remuneration, given an expedient allocation of resources. The term material infrastructure stands for the sum of all physical assets, equipment and facilities and the term institutional infrastructure points to the norms and rules, which develop and are set in a society over time; in addition, the term personal infrastructure is used to encompass the number and qualities of people in a market economy.*

With this definition, Jochimsen refers back to the works of List (1841) and Malinowski (1944/2006). Jochimsen focused on these issues because a central question in economic policy was, and still is, to determine the conditions necessary for the development and growth of a market economy as well as the various required types of infrastructure.

In turn, the narrowest definition (or understanding) of infrastructure is found within the financial industry. Given the focus of this book, this definition is of particular interest and therefore is addressed in more detail here.

The key factor for any investor is ultimately not the specific infrastructure sector or supply characteristics of a physical infrastructure asset but rather its specific risk-return profile, which largely depends on the various characteristics of the respective investment opportunity. For this reason, the financial industry took it upon itself to define infrastructure on the basis of certain economic and financial characteristics (see Section 2.1). However, the characteristics they introduce effectively only apply to a small subset of the universe of real infrastructure assets in existence, namely the conservatively structured ones. These characteristics are:

- *Key public service.* Infrastructure assets meet key public requirements in everyday life, such as the provision of water, energy, mobility, communications, education, security, culture or healthcare, making them a basic prerequisite for economic growth, prosperity and quality of life.
- *Low elasticity of demand.* Owing to their fundamental functions, demand for such infrastructure services is relatively independent of industry cycles and economic performance even when prices increase (e.g. owing to inflation adjustment regulations), stable (i.e. subject to low volatility) and predictable (e.g. due to long-term contracts).
- *(Quasi-)monopoly situation with high barriers to market entry.* Infrastructure assets are hard to duplicate on account of the high start-up investment costs for the construction of a water, electricity or telephone network, for example. After commissioning, the cost of providing each additional service/product unit (e.g. a new connection to the water supply or an extra unit of electricity supply) is comparatively low. This combination of circumstances means the barriers to market entry are high. Accordingly, these kinds of infrastructure assets have little or no competition.
- *Regulation.* In situations with little or no competition, regulatory authorities perform a corrective function on the market (e.g. by fixing prices or providing minimum payments guarantees). However, a regulated market per se does not necessarily eliminate the market risk for the provider. The best example of this is the telecommunications market.

- *Long service life.* Infrastructure assets have service lives of as much as 100 years or more. There are many historical examples with significantly longer lives, such as the Roman aqueducts. In addition to the physical and technical life of an asset, however, a key factor is its economic life, which may be even less than five years in the case of laboratory or medical facilities. For investors, the amortisation of their investments over the economic life of the asset is important.
- *Inflation protection.* Infrastructure assets may provide a natural hedge against inflation, because revenue from infrastructure investments is often combined with inflation adjustment mechanisms, whether through regulated income clauses, guaranteed yields or any other form of contractual guarantees. Project income generated via user charges (e.g. toll roads, public utility plants) rather than availability payments is usually tied to GDP or the consumer price index (CPI).
- *Regular, stable cash flows.* Infrastructure assets that possess the characteristics listed above generally have stable, predictable and in most cases inflation-adjusted long-term revenues that can survive economic downturns and cycles and support a significant credit burden.

Although these generalised characteristics serve as an indicator of the potential attractiveness of infrastructure investments as a whole, only *some* infrastructure assets of the available universe conform strictly to these characteristics. There are just as many ‘real’ infrastructure assets that meet them only in part. In other words, infrastructure assets *may* have the comparatively low-risk, in some cases bond-like, characteristics highlighted by the financial industry. Not every real infrastructure asset, however – be it greenfield or brownfield – possesses these characteristics, and in particular the associated risk-return profile. Notwithstanding, they are all infrastructure assets.

This inconsistency – not to say misrepresentation – has led to considerable confusion among investors who – in real life – are effectively confronted with all kinds of infrastructure assets, the characteristics of which go unsurprisingly beyond the financial industry’s ‘definition’. In the opinion of the authors, this definition is not only short-sighted but also risks misleading investors who are less familiar with infrastructure as an asset class.

Hence, what the financial community needs is a realistic, practical and pragmatic definition of infrastructure that considers all kinds of assets and all the aspects mentioned above rather than denying their existence.

Further, it would be salutary at this point to remember that the modern general linguistic usage of the term ‘infrastructure’ identifies it with *material* infrastructure, that is *physical* assets such as roads, ports, utilities and the like (Frey, 1978). Although Buhr (2007) generally agrees with the practical focus on material infrastructure, he classifies it by initially concentrating on the physical and social needs of human living, in order then to deduce the required infrastructure output (e.g. water, energy, heat, light) and the associated physical assets (material infrastructure).

Following a similar line of thought, Fulmer (2009) finds that ‘inconsistencies and sector-specific biases abound … common threads run through the myriads of definitions. Nearly all mention or imply the following characteristics: interrelated systems, physical components and societal needs’. A sample definition is:

> *‘The infrastructure supporting human activities includes complex and interrelated physical, social, economic, and technological systems such as transportation and*

> *energy production and distribution; water resources management; waste management; facilities supporting urban and rural communities; communications; sustainable resources development; and environmental protection (American Society of Civil Engineers, 2015).'*

Aiming to come up with a practical definition that integrates the common themes of systems, physical assets and societal needs, Fulmer (2009) concisely suggests:

> *'the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions'.*

Following this brief overview of the variety of definitions and understandings of infrastructure prevalent in the market, this book also seeks to address 'only' material infrastructure and its underlying structures, organisations, business models, rules and regulations. This includes all physical assets, equipment and facilities of interrelated systems and their necessary service providers offering related commodities and services to the individual economic entities or the wider public with the aim of enabling, sustaining or enhancing societal living conditions (see Figure 1.6).

Economic infrastructure				Social infrastructure
Transport	**Energy**	**Water**	**Communication**	
Land – Roads – Rail networks – Public local transport **Water** – Inland waterways – Sea – Canals (e.g. Suez) – Ports **Air** – Airport services – Airline services – Air traffic control **Multimodal** – Inland terminals (road/rail-freight) – Cruise terminals	**Generation Conventional** – Coal – Oil/gas – Nuclear **Renewable** – Solar – Wind – Water – Biomass – Geothermal **Transmission/Distribution** – Electricity – Gas – Oil/fuels **Storage** – Electricity – Gas – Oil/fuels **District Heating**	**Supply** – Domestic – Industrial **Sewerage** – Rain water – Domestic wastewater – Industrial wastewater **Waste** – Domestic waste – Industrial waste	**Telecommunication** – Fixed networks – Mobile networks – High-speed internet – Towers (cell & broadcast) **Space** – Satellite network – Observation **Other services**	**Health** – Diagnostic – Therapy/treatment – Care – Rehabilitation – Elderly housing **Education/Culture** – Schools – Student housing (campus) – Libraries – Theatres – Museums **Sport** – Recreational – Professional **Public administration** – Offices – E-government **Security** – Prisons – Police – Defence

FIGURE 1.6 Infrastructure: sectors and subsectors

1.3.1 Differentiation of terms: project – asset – facility

Infrastructure projects, assets and/or facilities exist in the form of strictly public, public and private or private ownership structures. By definition, private investors may only invest in infrastructure projects or assets in the public/private or pure private space. An investment in a newly founded public/private partnership usually takes the form of a project (e.g. a PPP-project) whereby the private partner obtains a concession, a licence or any other kind of PPP-contract from the public partner (and owner) for a specific period. In a purely private structure, the focus is on assets or facilities whereby one or several private partners (will) own the infrastructure asset in question. The following explanation serves to explain why and how this book differentiates between these three terms: project, asset and facility.

The terms ‘asset’ and ‘facility’ represent the physical objects of the ‘material infrastructure’ (i.e. the physical road, power plant, school, etc.). As such, they form part of the ‘built environment’ of the economic and social infrastructure, and the investor becomes a full or partial owner of the existing (or future) asset/facility. The difference between asset and facility seems to be more a question of use of language in different professional disciplines. Whereas architects and engineers, especially in real estate, tend to talk about facilities, the finance industry seems to prefer the term ‘asset’. Because this book forms part of the finance literature, it predominantly, but not exclusively, uses the term ‘asset’ rather than ‘facility’.

Investment in infrastructure projects primarily differ from those in infrastructure assets as in the former, the investor does not necessarily become the full or partial owner of the assets in question. Rather, the investor invests in or finances the provision of an asset – i.e. the development and construction as well as its operation and maintenance – and in exchange is granted either the revenues generated by the project or a regular payment (for example availability payment) from the principle during the course of a clearly defined project. In PPP projects, for example, the private investor usually ‘only’ becomes shareholder of a ‘project company’, which in turn is responsible for the provision of the assets for a certain period. The ownership of the assets remains with the public partner. In addition, projects have a time limit by definition. Accordingly, the investment in an infrastructure project ends with its termination determined by the project contract.

As a consequence of the particular ownership status of the private investor and its defined time limit, infrastructure projects require a structure with which private investors can generate sufficient revenue during the project life to satisfy their return requirements. They cannot sell the assets at the end, because they typically do not own them in the first place. In contrast, investments in assets don’t have such a defined ending and hence do not have this formal requirement. While their official lifetime may come to an end, the asset remains (physically) in existence and the investor remains the owner of the asset, with which it can do what it wants.

Unfortunately, in the general linguistic usage, the terms ‘project’ and ‘asset’ are not as neatly differentiated. Irrespective of ownership and a defined termination, the term ‘project’ is often used during development and construction of an asset. Once the asset is (physically) built and goes into operation – which often coincides with the point in time it is sold on to investors – the same project (asset) is labelled ‘asset’ from then on. Needless to say, this makes matters complicated and sometimes confusing. The confusion goes on with the term ‘project company’, which is often also used in situations where the term ‘asset company’ (which does not exist as such), ‘company’ or ‘SPV’ (special purpose vehicle) would have to be used to be precise. This book cannot solve this problem but tries to be consistent by referring to ‘project company’ only, when the term is used in the narrower sense. Otherwise, it refers to ‘(project) company’, ‘company’ or ‘SPV’.

This book cannot ignore the general linguistic usage of the term altogether. Hence, it aims to find a middle way while being as precise as possible.

1.3.2 Characteristics

On the basis of this broadly accepted definition of infrastructure outlined above and a short explanation as to how to differentiate the terms ‘project’, ‘asset’ and ‘facility’, Figure 1.7 shows how infrastructure in that sense can be further broken down on the basis of its country-specific, sector- and subsector-specific and project/asset-specific characteristics.

Country-specific characteristics generally describe the legal, political, institutional, economic, financial and entrepreneurial framework and the conditions of competition with a tangible influence on any asset, and hence any investment in such assets. These may vary significantly from country to country and therefore cannot be discussed in detail in this book. However, the various international examples discussed throughout the book are intended to provide at least an insight into them. In addition, sectors or subsectors and their specific structural, regulatory and contractual conditions and, in particular, the project/asset- and transaction-specific characteristics are extremely important.

The sector- and subsector-specific characteristics, listed in Figure 1.6, may vary considerably from country to country. Certain aspects, however, apply to all sectors alike and hence may be addressed on a cross-sector basis, as it is done in this chapter from Section 1.3.3 onwards. In Chapter 4, these and other characteristics are discussed in detail on a subsector level.

In addition to the country- and sector-specific characteristics, notable project-, asset- and transaction-specific characteristics and risks may influence the risk-return profile of an individual infrastructure project/asset in a particular sector and country. These are addressed in detail in Chapter 5 and Chapter 6 in conjunction with the discussion of the most important

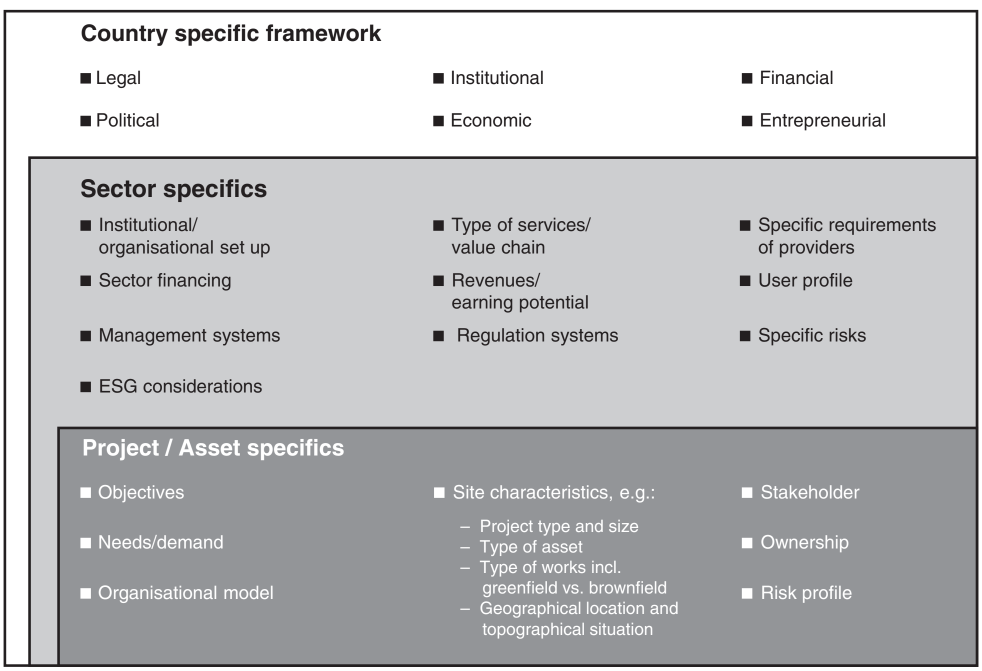


FIGURE 1.7 Country-, sector- and project/asset-specific characteristics

risks facing infrastructure assets (Chapter 5) and the project finance structures that are most commonly used or required to finance direct investments (Chapter 6).

The following sections provide an initial insight into the universal, cross-sectorial aspects of infrastructure provision and some key determining factors behind investments in infrastructure.

1.3.3 Cross-sector characteristics

Figure 1.6 (Section 1.3 above) gives an overview of the most important infrastructure sectors and their subsectors. Each of these infrastructure sectors – and often also their subsectors – are subject to individual structural, regulatory and contractual conditions with which investors should intensively familiarise themselves prior to any investment (see also Figure 1.7). A knowledge of the responsibilities and the distribution of functions within the public administration, the existing financing structures and sources of revenue, the existing privatisation models and their structures and procedures and the specific legislative framework, norms, standards and other rules and regulations, which may vary significantly between the individual sectors and subsectors and from country to country, is essential for a successful investment. In addition, investors must examine the individual infrastructure elements or value chain elements of a sector in terms of their consistency with the investors' overriding investment strategy, the corresponding revenue and earnings structure and the compatibility of the interfaces with other components within the integrated value chain. Examples include the network, passenger and goods transportation services and stations owned by railway companies. The transportation services are often privatised, whereas the network and the stations remain in the hands and under the control of the government. This requires a precise definition of the allocation of functions, responsibilities, risks, mutual requirements and interfaces. Potential investors should also be aware of the specific competitive structures in the respective sector, including any regulatory systems that may be in place.

1.3.4 Types of infrastructure companies

Financial investors (such as pension funds, insurance groups, and sovereign wealth funds) generally invest in infrastructure via companies offering infrastructure-related products and services, which operate as self-contained entities. As such, they are primarily interested in the profits generated by such companies and the risks to which they are exposed. In addition to the return on capital employed, strategic investors (corporations from e.g. the construction, real estate, and telecommunications sector) examine the profits from additional value to their own core operations.

Infrastructure companies can be broken down into three types: (i) project companies, (ii) operating companies and (iii) service companies, depending on their typical business purpose.

Infrastructure project companies have a business purpose that is closely linked to a specific project in terms of location, timing and functions. A typical example would be a PPP road project between points A and B, under which the construction, financing/investment and operation is transferred to a company that is specially formed for this purpose for a period of, for example, 30 years under the terms of an agreement with the characteristics of a contract for work and services, with ownership returning to the public-sector principal at the end of the contractual term.

This company may have an exclusively private-sector shareholder structure or may have both public- and private-sector shareholders. Typical (first-time) investors include strategic investors such as construction groups or infrastructure operating companies (discussed below), which expect to generate a profit from their core operations in addition to the return on their capital. Financial investors often – though not always – invest after the ramp-up phase, replacing the strategic investors in part or in full. Ownership of the infrastructure assets commonly remains with the public-sector principal or is transferred to the company only for the term of the contract. The remuneration structure, that is the future sources of revenue from the company (for the investors), may include one of the following:

- *Fixed availability fees:* to be paid by the principal, usually the government, via the state budget depending on the performance of the contractual services, under which the investors are exposed solely to performance risk.
- *User fees:* the project company obtains a concession granting it the right to levy fees in order to finance the contractual services – including the investments – via the users of the asset or services provided; in this case, investors are exposed to demand risk as well as performance risk, although this may be cushioned to a greater or lesser extent by government guarantees, depending on the respective circumstances and contractual agreements.
- *User-driven payments:* availability payments by the principal, paid from the public budget and linked to usage (e.g. frequency and/or intensity of use, see also Section 3.3) or a combination of availability fees and user fees in order to align incentives and optimally meet project service quality and/or financial viability.

During the tender process of a new project, which is still partially or fully owned by the public sector, investors are in competition for this project. Once any single or group of bidders win the tender, their project company is likely to face little or no competition on the open market. In case such project companies are subject to direct-user payments, projects are usually fee-regulated in order to protect users from a potentially monopolistic situation. Infrastructure project companies are becoming increasingly common around the world, with examples found in practically all infrastructure sectors.

In contrast to pure project companies, *infrastructure operating companies* have an essentially unlimited scope in terms of timing and location. Rather than concentrating on a specific project or asset, they generally focus on one (e.g. utilities) or several (e.g. multi-utility companies) infrastructure sectors. These purely private or mixed-ownership companies invest in infrastructure assets and perform comprehensive infrastructure services on their own account and their own responsibility with a direct (contractual) relationship with the users, who ensure that the asset and/or service is financed via user charges. They also invest in infrastructure project companies. In contrast to project companies, operating companies are established as permanent entities and generally also own at least those infrastructure assets that they are permanently responsible for operating; as such, they are exposed to both performance and demand risk.

Private infrastructure operating companies often arise from enterprises that were originally in the public sector, whether as the result of an initial public offering (IPO) or the auction of some (partial privatisation) or all (full privatisation) of the shares in the existing enterprises by way of a public tender. Privatisation is often driven by the need for additional capital to renovate or expand the company's existing infrastructure assets. The involvement of private investors also seeks to achieve more efficient structures and improved performance on the part of the company. These companies are, in most instances, in direct competition with other similar companies on the market. Where monopoly situations exist, the respective companies are subject to regulation with regard to the services they need to offer and the pricing policy they need to follow in the respective markets at the very least. Notable examples include power suppliers, such as E.ON and EDF; water suppliers, such as Veolia and Suez; waste disposal companies, such as Sita (Suez) and Remondis; and telecommunications companies, such as Vodafone and Telefonica, as well as global providers of transport infrastructure, for example toll roads (e.g. Vinci, Abertis), airports (e.g. AviAlliance, Fraport) or port terminals (e.g. APM Terminals, Hutchinson Port Holdings).

Infrastructure service companies focus on one or more service categories in one or more infrastructure sectors and perform these services in exchange for contractually agreed fees. Examples include consulting, construction and facility management companies and other companies or service providers, for example Techem, which specialises in recording data on energy and water consumption in Germany. Generally speaking, this type of company does not invest in infrastructure in its own right, does not perform any cross-lifecycle infrastructure services and hence is not exposed to any of the corresponding performance or demand risks. However, their service range is always subject to a relatively large degree of pressure from competing companies.

Following the definition of infrastructure outlined above, in this book infrastructure service companies are not considered part of the 'asset class infrastructure'. They are described only in order to clearly delimit them from the other types of infrastructure companies.

As can be seen above, any infrastructure investment decision must take into account the type of company in question and its specific infrastructure involvement. It is also important to examine the infrastructure sector in which the company is primarily active. To this end, it is essential to become familiar with the characteristics of the individual infrastructure in order to be able to assess in particular the specific risks arising as a result. This is especially important for infrastructure project and infrastructure operating companies, owing to the particularly long term of their involvement and the fact that they are usually backed by a substantial amount of initial equity. It is somewhat less crucial for infrastructure service companies, which can be replaced or move in and out of a project relatively easily.

1.3.5 Role of the private sector

A growing number of infrastructure assets are being operated by or in cooperation with private investors and operators, for example energy transmission assets or assets under long-term (PPP) concession agreements. However, the nature and extent of the private sector's involvement and the individual business models vary significantly between the different infrastructure sectors and subsectors. Private-sector participation in 'public functions' involving private investment may range from PPP models based on long-term contractual arrangements through to full material privatisation, under which private providers operate an asset on a permanent and independent basis in competition with other private-sector or, in some cases, public-sector providers.

Certain sectors are naturally unsuited to the full range of privatisation models (for a detailed description and discussion of the different privatisation models – formal, functional and material privatisation, see Section 3.1). In the road sector or certain fields of social infrastructure, for example, there are practically no examples of full privatisation anywhere in the world; instead, a highly diversified range of PPP models exists. Publicly dedicated roads, military and police facilities, correctional service facilities and educational establishments are usually owned by the public sector and required to remain as such by law. The energy and telecommunications sectors, in contrast, both have been fully privatised in a number of countries. The large number of airports privatised over the past 15 to 20 years use both PPP models and full or partial material privatisation models. In some sectors, private and public structures exist alongside each other at every stage of the value chain, for example where individual private operators use the public rail network in exchange for track charges, individual private port terminals are granted concessions by the public-sector operators of the main port facilities, or waste water is transported via the public sewer system to a private sewerage treatment plant. In the waste sector, however, these priorities are harder to distinguish. For example, although the private sector's involvement in Spain and Germany focuses on waste disposal, particularly in the form of incineration plants, waste collection in Sweden is largely performed by private companies and disposal is primarily organised by the public administration (PSIRU, 2006).

As well as the boundaries and opportunities inherent to the system, aspects such as tradition, public-sector mentality and existing structures that are often difficult to change may serve to promote or restrict the use of the full range of existing organisational models, or even prevent the possibility of private investment in public infrastructure altogether.

This discussion makes apparent the significant sector- and country-specific variations in the models used for private-sector investment. There is very little standardisation with regard to the chosen business models or even the underlying contractual models. On the contrary, some of the models and structures that have evolved have their own terminology and are essentially impossible to compare. An internationally understood and accepted, cross-sector standardisation would be highly desirable, not to mention extremely useful to investors. To this end, Chapter 3 of this book in particular systematically records, defines and classifies the known privatisation, partnership, business, contractual and financial models that can (or indeed should) be combined and structured to an overall organisational model for every individual infrastructure project/asset.

1.3.6 Value chain elements

The individual elements of the value chains of the various infrastructure sectors can be broken down into two types: (i) movable and immovable assets belonging to the service range offered by the respective subsector and (ii) the service range itself.

Movable assets, such as locomotives and carriages in the rail sector or ships in the water transport sector, and immovable assets, that is fixed buildings and physical structures, represent the actual investable assets as independent elements of the value chain. These are combined with additional elements such as planning, construction (erection and provision of equipment), financing, and constructive and operational maintenance (comprehensive overhaul measures and ongoing maintenance respectively). Constructive and operational maintenance are often aggregated as the operation of infrastructure assets.

The elements associated with the realisation and operation of movable and immovable assets exist to a greater or lesser extent for every type of infrastructure service and differ only in terms of the type of asset involved. The providers of such services include engineering offices, construction firms and facility managers for the performance of technical functions, and financiers, that is investors and banks, for investment and financing. These parties frequently offer cross-sector services rather than specialise in a specific type of infrastructure. For example, larger engineering offices and construction firms may perform planning and construction services for roads, airports and railways as well as hydropower plants, water mains and sewage treatment plants.

Investors can be broken down into pure financial investors, primarily interested in the return on the equity or debt they invest (also called institutional investors), and strategic investors, who expect, in addition to a financial return, various forms of value chain elements from the aforementioned services. Accordingly, financial investors largely invest across various sectors, primarily driven by risk and return considerations (for further detail, see Section 1.3.8), whereas strategic investors tend to limit themselves to those sectors that are strategically relevant to them. As such, the latter group derives its total return from a mixed calculation.

The associated services – often provided by the strategic investors themselves – can vary significantly from sector to sector and require wide-ranging knowledge and expertise. Depending on the perspective adopted, entire sector- and subsector-specific elements of the value chain can be broken down into individual elements or combined to form a value chain in a more or less aggregated or differentiated form. For example, the water sector consists of water supply, waste water disposal and, owing to its environmental relevance, watercourse maintenance and expansion. In turn, the supply of (drinking) water is composed of the elements of catchment, collection, storage, preparation, distribution (to the domestic or industrial supply point) and billing. Each of these individual elements can also be broken down further. As such, the differences between the service ranges offered by each infrastructure company are just as pronounced.

For investors, this knowledge and the resulting opportunities for structuring their investments are important, because different individual or combined service ranges can allow them to leverage different elements of the value chain, and hence access a different risk level and related return or yield potential. Investments may also seek (i) to leverage additional upside potential by expanding or, in some cases, (ii) concentrating the activities of the company itself. Expansion or concentration processes may relate to a specific region or customer base or to the value chain as a whole and are usually structured following three diversification principles.

In the first case, known as *horizontal diversification or integration*, companies offering the same or similar elements of the value chain are combined with a view to expanding market share, that is realising economies of scale and increasing market power. Returning to the example of the water sector, horizontal integration is particularly relevant because of the existence of natural monopolies. With almost no exceptions, business combinations are implemented with the aim of expanding regional service areas.

In the second case, known as *vertical diversification or integration*, a company expands its activities to deepen its value chain by incorporating additional elements. This may affect the depth (e.g. expansion of capacities for the realisation of components/services within a production or service process that were previously procured externally) or breadth (e.g. expansion of product or service range) of the value chain or the number of steps in the value chain (e.g. the upstream or downstream integration of individual consecutive elements in the value chain).

A further option in the infrastructure sector is *lateral diversification*, in which companies connect elements of entirely unrelated value chains. Common examples include multi-utility companies in the private sector and public or semi-public utilities, which may offer a wide range of supply, disposal and transport services or bundle all three service areas. In particular, the network infrastructures for water, electricity, gas, transport, telecommunications, etc., and the potentially largely identical customer bases of these otherwise extremely different sectors, may offer significant synergy potential and hence provide a strong incentive to bundle services in this way.

Financial investors may also want to apply general corporate objectives, which are pursued typically by strategic investors when considering whether to make an investment. Strategic investors principally make investments in order to achieve one of the following:

- Meet additional (internal or external) demand/requirements (new and/or expansion investments).
- Compensate for technical and/or economic obsolescence (overhaul/replacement investments).
- Leverage additional efficiency potential within an element (streamlining investments).

They base their investment decision either – in the case of a PPP project – on the corresponding tender requirements or – in the case of a pure private project/asset – on internal considerations. Depending on the maturity of a project or asset, one or multiple objectives may apply in the course of a certain contract period.

1.3.7 Greenfield versus brownfield investments

In the context of infrastructure investing, a distinction is usually made between greenfield and brownfield investments, otherwise known as 'project development and operational assets' or primary and secondary projects respectively. These classifications reflect the specific (project/asset) risks associated with their different development stages. Investors tend to assume that the risk of a greenfield investment is always higher than that of a brownfield investment. As we will see, this is generally a safe assumption to make. In specific cases, however, it may be surprising to learn that selected greenfield investments have a level of risk similar to that of brownfield investments (see also Weber, 2009).

This book defines greenfield (or primary) projects as assets that are constructed for the first time at a specific site. They may be in the planning, development, financing or construction stage. In contrast, brownfield or secondary projects/assets are already operational and/or have a predecessor of some description at the same location. These projects may involve the reconstruction, renovation or expansion of existing assets. In other words, the key differences lie in the maturity of the asset and the available asset-specific experience, which is significantly less in the case of greenfield projects. This may lead to a considerably higher degree of uncertainty and risk on the cost and revenue side.

The cost-side risks of greenfield projects primarily relate to planning, development, the receipt of approvals and environmental permits, public acceptance and construction and operation, particularly where new and unproven technologies are used; compare the construction of a new hydropower plant with the expansion of an existing plant to install additional turbines, for instance. On the revenue-side, demand and price uncertainty constitute the primary risks. This applies in particular to user payment projects (see Section 1.3.9 and Section 3.3). They can only be fully identified once the facility has been taken into operation. For example, toll roads in comparatively undeveloped areas are considered significantly more risky than comparable projects, which replace existing road connections with proven high volumes of traffic. Even in the latter case, however, the acceptance/usage and price risk remains if the previous road was toll-free and there is a corresponding lack of historical data with regard to price sensitivity of users. The revenue risk of greenfield projects with revenues, which are covered partially or entirely by public funds and/or guarantees from trustworthy institutions should ideally be eliminated by way of the project (contractual) structure (again, see Section 1.3.9).

By contrast, brownfield projects relate to existing, operational assets that have already gone through the greenfield/development phase. All the risks related to the development phase or to environmental issues, public acceptance, the approval process, commissioning, technology and initial demand will have been dealt with already at the brownfield stage. The main residual risks are operational risk, regulatory risk and market risk, to a lesser extent geographical, political, legal and ESG risk. However, some of the typical greenfield risks may reappear if extensive replacement or expansion measures become necessary, such as the demolition and reconstruction of an existing facility.

As a matter of principle, existing assets are comparatively easy to evaluate (e.g. in terms of demand, operation and maintenance, ESG issues) on the basis of historical data and past experience. However, certain risks, which, for example, may result from operating an asset, such as contamination or hidden defects may become highly relevant for investments in brownfield infrastructure assets.

A further important difference between greenfield and brownfield investments is that investors in greenfield projects do not generally return a profit on their investments in the first years of the development and construction phase but instead are merely required to make payments. Initial capital is only returned when the respective facility is operative (resulting in a so-called ‘J curve’, which is typical of cash flows from private equity investments). Investors, which are predominantly interested in (increasing) the IRR accept this J curve and the generally higher risk associated with greenfield compared to brownfield investments because they can participate in the potentially high appreciation of value of the asset in this phase and possibly generate higher returns as a result (see also Section 1.3.8).

By contrast, brownfield assets in good condition with long-term contracts will ideally offer stable, predictable current cash flows from the very start in the form of dividends or interest payments in a similar way to real-estate or fixed-income products. As a result, they tend to be particularly suitable for risk-averse yield-driven investors, whereas greenfield projects are more appropriate for capital-gain or growth-style investors who are prepared to take additional risk (see also Section 1.3.8 and Chapter 2).

However, it would be a mistake to conclude that necessarily every brownfield investment has low-risk, bond-like returns. The risk profile of brownfield assets exposed to full market risk (demand or price) or in poor condition – for example owing to their age, inadequate maintenance, weak management, heavy usage and/or financial distress because of, for example, high leverage or no long-term contracts – may be quite high and the return/cash flow profile very unpredictable and unstable. In this case, the aim is to generate additional value through signing long-term contracts, which reduce or even eliminate the market risk or through operational improvements, repairs and capacity expansions, new forms of use or financial and/or contractual renegotiations and restructuring, for example.

1.3.8 Yield-driven versus IRR-driven investors

All investors in infrastructure generally share certain financial goals, they do not form a homogeneous group by any means and their individual interests may differ when it comes to investing in infrastructure assets.[1] In addition to differing individual risk-return profiles reflected in the selection of certain countries, sectors, stages of entry, currencies and the like, the targeted cash flow profiles, which are mostly closely linked to the investors' investment horizon for such assets, may differ as well.

When making infrastructure equity investments, strategic and financial investors generally pursue one of two overriding financial objectives, or a combination of the two: (i) ensuring a stable, high level of current income (yield) and/or (ii) ensuring the greatest possible return on equity (see also Sections 1.2 and 7.1). To this end, a distinction can be made between primarily yield-driven and IRR-driven investors.

Yield-driven investors, which include insurance companies, private and corporate pension funds, sovereign wealth funds, charitable foundations and so on, typically have a long-term (buy-and-hold) investment horizon with no short- or medium-term intention to sell the asset in question. They rely purely on the current yield in the form of dividends and interest on shareholder loans, e.t.c. They will be referred to as 'yield investors' throughout the book. Typically, IRR-driven investors have a short- to medium-term time horizon of two to approximately seven years. Such investors include the resale value of the asset at the exit into their overall return calculation and are – mostly – prepared to forego early and/or current cash flows while holding the asset. Development and construction (greenfield) assets are a case in point. This category of investor includes strategic investors, investment funds managed by professional investment managers as well as any institutional investor with a similar short-term investment focus. They will be referred to as 'IRR investors' throughout the book. Naturally, this categorisation provides an indication only; combinations and exceptions exist in either group of investors.

Among the reasons for these differing investment interests is that yield investors tend to need a stable, long-term income in order to match the maturities of their assets with the maturities of their liabilities (e.g., pension obligations, life insurance), not least due to the strict requirements of the financial authorities and the regulatory bodies (see also Section 1.2). Typical approaches include investments in long-term government bonds with a term of 10, 20 or even 50 years, as well as real estate. However, government bonds are comparatively unattractive – if not simply insufficient from a return perspective – in periods of low interest rates and flat yield curves. Equity investments in conservatively structured, long-term infrastructure may offer an alternative with an acceptable risk level (sometimes they entail even primarily sovereign risk) and a current income (yield) superior to that of government bonds and/or real estate. Long-term (high-yielding) infrastructure bonds are another alternative (i.e. see Section 7.3. 'Debt').

Short- to mid-term oriented, return maximising IIR investors in contrast, require, and hence are attracted by, the possibility of an early exit (an investment horizon of two to seven years). For IIR investors to invest in an asset, they need the option to sell their interest in it after a certain date prior to e.g. the end of the project lifetime or prior to the repayment of the debt, without jeopardising the long-term success of the entire project/asset or the financing, if any. As a matter of principle, the following exit strategies may come into consideration for equity investors in infrastructure: sale via the secondary market, a trade sale or an IPO (see Section 7.1 for further detail).

[1] To this end, Section 6.3.2.2 'Equity providers' discusses the, in some cases differing, *strategic* objectives of strategic investors and institutional financial investors. This section continues by focusing on the differing *financial* objectives of equity investors.

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Recently, financial investors are increasingly involved in the development, structuring and implementation of infrastructure from the very start (see also Section 6.3.2.2 'Equity providers'). Their early involvement brings additional structuring expertise to the table, particularly with regard to financial considerations, and is instrumental in making the realisation of many new projects possible. It also increases the likelihood of a smooth sale from strategic investors to financial investors at a later point in time of the investment because the structure will be generally suitable for financial investors.

1.3.9 Sources of revenue and financing

Revenue of some sort is required in order to finance infrastructure investments and the subsequent operation of the respective assets, whether from public or private sources. In most countries, financing and operational functions of infrastructure are housed with different public-sector offices depending on the infrastructure asset in question. In a purely state-based system, revenue is generated from taxes and duties that may be sector-specific (e.g. motor vehicle tax in the road transport sector) or general (e.g. income tax) as well as direct-user payments, which are naturally sector-specific in their nature (e.g. tolls, water charges, waste collection charges). In general, government revenue/expenditure systems are based on the principle of general budget appropriation, meaning that all sources of revenue are initially aggregated – in the form of the public budget – before being allocated to the individual area-specific budgets on the basis of corresponding negotiations. This applies equally to general and sector-specific taxes, duties and user charges. Irrespective of the principle of general budget appropriation, some countries earmark certain proceeds for a specific purpose, for example revenue that can be directly allocated to a specific sector – whether in the form of taxes, duties or user charges – is also dispensed in the same sector, that is on a sector-specific basis. Such revenue does not reach the general public budget, but instead remains in the budget of the respective sector. One typical example is road funds, which are generated from fuel duty, motor vehicle tax and, where applicable, toll revenue, that is without being fed into the wider public budget at any point.

The clearest case of earmarking is when a government grants a private infrastructure investment operator the long-term right to apply the user charges from a project directly to cover any project costs (investment costs, current expenses, interest on capital, repayment of debt and equity), and to generate a return. In this case, it could be said that the earmarking is not only sector-specific but also project-specific. This sums up the government's perspective.

For private infrastructure investors, there are two basic sources of revenue: user finance or, where this does not exist on a project-specific basis or is unavailable to the investor, budget finance paid by a public-sector principal as a regular fee (see also Figure 3.5 in Section 3.3). Internationally, a number of subsectors are largely user-financed, particularly water and power supply, but also public transportation by rail, sea or air. The disposal sector is less clear-cut, because some countries still do not charge for waste or wastewater disposal.

Opinions also differ when it comes to the road transport infrastructure. User charges are traditionally levied in a number of countries, at least for high-priority roads. A distinction is made between mileage-based tolls and time-dependent charges in the form of vignettes (toll stickers). User financing for social infrastructure facilities is a further sticking point. Although users in some countries pay charges to a greater or lesser extent, such as school and university tuition fees in the education sector or direct fees charged by doctors, hospitals or other institutions in the healthcare sector, such facilities are mostly financed only by cost allocation systems that frequently pose problems in terms of collection when it comes to the private (re-)financing of individual facilities. Even in the case of (mass) sport and cultural institutions, the revenue generated is almost always insufficient to cover the costs incurred. In certain sectors, such as the administrative, security/military and penal systems, such kinds of revenue streams are unthinkable in the first place.

There is no need to rule out the possibility of private investment just because a user-financed approach is impossible or inadequate. However, such assets must ultimately be financed by the public budget, for example in the form of PPP measures. These regular service- and/or performance-based payments by the public sector, acting as a principal of its project-executing agency, to the private operating investor of a PPP project are also referred to as 'availability payments' (see Section 3.3.1).

User finance naturally entails a great financial risk for private investors, particularly if the revenue risk is passed on to the investor in full. These risks result from the uncertainty that is inherent in the long-term revenue forecasts. As such, it is important to make an accurate estimate of future volumes and demand (e.g. traffic or refuse volumes, power or water demand), as well as future prices and charges. In infrastructure markets, the long-term development of both of these parameters is influenced by a number of factors over which private infrastructure investors naturally have little or no control. For example, volume development is generally determined by macroeconomic and economic policy factors or changes in legislation rather than by user behaviour falling within the investor's sphere of influence, and prices are often driven by the applicable regulations and not by the operator's pricing strategy.

These revenue risks do not apply if the private operator and investor are remunerated in the form of availability payments from the public budget. In this case, the relevant factors are the operator's performance with respect to the contractually agreed standards and, in particular, the creditworthiness of the public-sector principal in terms of its ability and willingness to meet its payment obligations. Payments by the public-sector principal are generally governed by a complicated set of funding instruments that varies significantly from country to country. However, it is sometimes difficult or impossible to reconcile the specific subsidy conditions associated with the respective 'pots' with private investment. This naturally also entails risks for the investor that must be identified and actively managed to the greatest possible extent. In some cases, it may even be necessary to amend legislation or administrative regulations in order to enable the required compatibility.

1.3.10 Competition and regulation

Whenever there is a fear of market distortion or even market failure in an economic sense, for example natural monopolies or other forms of restriction on competition of common assets, the government can and must intervene in the form of regulation. Market regulation therefore describes the body of all rules and regulations used by the government to this end. This is achieved through the issue of statutory provisions and ordinances that serve to limit the effect of market forces while ensuring legal security and reducing information and transaction costs. In other words, it is important to achieve a suitable degree of regulation and employ the right systems and methods. These responsibilities are generally assigned to regulatory authorities.

A regulatory authority is a government body involved in determining competition policy in a similar way to an anti-trust authority, but with more extensive duties. Anti-trust authorities are usually responsible for the ex post control of markets, whereas regulatory authorities are primarily created for ex ante control of economic sectors in which ex post control is insufficient to maintain the required degree of competition. Regulatory authorities are characterised by far-reaching instruments of ex ante control, such as price and product approval, they operate on an industry-specific basis and are generally found in markets with a tendency for monopoly situations, such as line- or network-based sectors in which the creation of parallel networks is either undesirable or economically unfeasible. This typically includes the telecommunications, post, rail, broadcasting, gas and power markets. Regulation is also essentially indispensable in the water and aviation markets as well as the toll road sector.

Within the European Community, the national regulatory authorities are obliged to implement the relevant EU directives.

At a global level, a distinction is made between various regulation systems based on their impact:

- *Volume regulation:* where the number of competitors in the market or the production volume is controlled by the number of licences and concessions that are required for market entry, for example. Service obligations and prohibitions on activity are also used in order to increase the attractiveness of a market by determining its scope.
- *Price regulation:* which seeks to achieve a specific price level. Fixed prices and price floors and caps are used to set absolute limits. Potential measures also include cost tariffs that specify the relevant price calculation procedures and the imposition of individual prices that cannot be changed without the approval of the responsible regulatory authority.
- *Rate of return regulation:* which sets a limit on the return on capital employed.

Additional regulatory procedures, some of which are sector-specific in nature, are described in detail in Chapters 3 and 4.

This introduction to infrastructure definitions and characteristics illustrated the most important general, non-sector-specific characteristics of infrastructure assets, including some of the financing issues that are relevant for investors. As such, it forms the basis for investments of institutional investors, and in particular financial investors (in contrast to strategic investors).

In the following chapter, the first objective is to explain and position infrastructure as an asset class. To this end, various research reports are analysed and discussed, focusing on risk and return as well as portfolio diversification issues. Second, the concept of sustainable infrastructure investing in general, and in sustainable infrastructure in particular, is presented along with an introduction to ESG (risk) factors and benchmarking. The final section of that chapter discusses the wide range of different investment approaches – with a focus on unlisted infrastructure funds – and concrete tools for their evaluation.