ISBN 978-92-64-03131-9
Infrastructure to 2030 – Vol. 2
Mapping Policy for Electricity, Water and Transport

Chapter 2

A Cross-Sectoral Synthesis on the Long-Term Outlook for Infrastructure Business Models

by
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This chapter takes a cross-cutting view of the five infrastructure sectors examined in this book – electricity, water, rail freight, urban public transport and road transport. The purpose is to arrive at some broad insights and conclusions on how infrastructure development should be addressed in future. The chapter assesses and draws out implications from the expert chapters on appropriate economic and business models for the successful implementation of infrastructure projects in the future and what role may be played by public and private actors.

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1. Introduction

This chapter takes a cross-cutting view of the five infrastructure sector chapters in this book. The purpose is to arrive at some broad insights and conclusions on how infrastructure development should be addressed in future. More specifically, the chapter assesses and draws out implications from the expert chapters on appropriate economic and business models for the successful implementation of infrastructure projects in the future and what role may be played by public and private actors in the future.

In addition to the main findings contained in the five expert chapters, account is also taken of the conclusions reached in the first two phases of the project (the content of which was published by the OECD in July 2006 as an interim report *Infrastructure to 2030: Telecom, Land Transport, Water and Electricity*). Moreover, special attention is given to the role of information and communication technologies (ICT) as an enabler in infrastructure development and management, and as a possible substitute for some infrastructure services (*e.g.* for transport).

Throughout this chapter, the term "business model" signifies "economic and business models". This is partly for the sake of convenience and partly because the use of the term "economic model" could be confusing, as the general understanding of economic model is quite different from the definition used here. In the context of this chapter, the term "business" is given a broad interpretation which extends beyond purely private activities. However, it focuses on the same quest as that in the business world, *i.e.* how to create value for money.

This chapter contains four main sections:

- Section 2 introduces the concept of business model and explains its potential usefulness in the formulation of public policy for infrastructure development.
- Section 3 assesses the strengths and weaknesses of the business models that currently prevail in the five sectors examined in this book, focusing on their capacity to meet a broad range of economic, social and environmental objectives. The assessment is based on consideration of the key technical and institutional factors that shape the design of these models.
- Section 4 examines how such an assessment may be modified in the coming decades under the influence of major drivers of change. These drivers may have impacts not only on the future viability of existing business models, but

also on the balance of objectives that policy makers are likely to pursue (*i.e.* some objectives are likely to become more or less important; and the balancing of a new configuration of multiple policy objectives in the future may raise new issues).

- Section 5 outlines some of the lessons that may be drawn from the analysis conducted in Sections 3 and 4 for the future design of business models and related supportive measures.

2. Business models and infrastructure development: basic concepts and key features

This section introduces the concept of business model and explains its potential usefulness for the formulation of public policy for infrastructure development.

2.1. Business models in a business context

The concept of business model has become popular in business literature in recent years in various contexts. For instance, with the emergence of e-commerce, much attention has been given to the formulation of business models that are more suitable for cyberspace than the traditional models, which were mostly designed to meet the needs of "real space". Indeed, the new reality of B-to-B (business to business) and B-to-C (business to customer) e-commerce has forced firms to go back to square one and fundamentally rethink their overall business strategy. In this context, the "business model" has been one of the main conceptual tools used, and completely new models have emerged (*e.g.* Google).

In a *business context*, business models primarily provide an overall description of the nature of the business at hand, that is, how the entrepreneur is trying to create value so as to generate profit. This includes consideration of the nature of the product, how it is produced and at what cost, why it is expected to generate value that customers are prepared to pay for, who the potential customers are, and what revenue streams may be expected. Business models also identify the various actors who have a bearing on the outcome of the activity and describe how such actors interact with one another.

The key objective for the entrepreneur is to create "value for money", *i.e.* to create a product or service that customers recognise as valuable and are prepared to pay for in a way that generates sustainable and profitable revenues.[1] Profits are maximised by using resources as efficiently as possible. Hence, the main purpose of the business model is to define a business that is both *effective* (creates value) and *efficient* (maximises profits).

2.2. Business models and infrastructure development: basic concepts

While it is originally a business tool, the business model can also be applied usefully to public policy making. This is notably the case when such policy relates to the provision of services (whether public or private) which have a strong economic dimension and require large investments over long periods of time, such as infrastructure services. Like business entities, governments should be interested in the effective and efficient creation of value in a sustainable manner, even though their definition of "value" and their motivation for creating such value may differ.

More specifically, in the public policy context of infrastructure development and management, the business model should contain at least four elements:

1. ***Economic logic.*** The business model should give details of the nature of the services provided, how those services are produced and for whom, who the key players are, and how they interact with one another. The model should clearly specify how *sustainable revenue streams* are generated to finance the maintenance and development of the infrastructure, so as to ensure its durability. Such revenue streams may not necessarily be profitable and may have to be complemented by sustainable public funding. Or the financing could be entirely public and the service provided free of direct charge.
2. ***Value created.*** The business model should describe the value provided to society at large, where value is not defined in monetary terms, but in terms of the policy objectives pursued by the government (*e.g.* economic, social and environmental objectives). For example, an infrastructure service that is more environmentally friendly could be preferable from a collective public policy perspective (*e.g.* public transport), even if it may be judged inferior by individual users who may prefer the flexibility and time-saving feature of private transport.
3. ***Public oversight.*** The business model should spell out whether the infrastructure is under public or private control, what type of regulation is applied, if any, and how.
4. ***Allocation of risks.*** When several actors are involved, including private ones, the business model should also describe how risks are allocated amongst the different actors. Typically, risks should vary inversely with oversight; the greater the freedom of action given to a particular actor, the greater the share of the risk assumed.

2.3. Business models and infrastructure development: key features

Two main elements need to be clearly spelled out in the formulation of business models for the development of infrastructure: *a)* the policy objectives that are being pursued (as they provide the general rational for infrastructure development and shape the overall architecture of the model); and *b)* the main building blocks of this overall architecture and the way they relate to one another.

Policy objectives

Whereas in private business models, the main objective for the private firm is to make a profit, public decision makers typically need to take into account a multidimensional mix of policy objectives that need to be carefully balanced in the light of the overall public policy agenda. This is the case for infrastructure development because infrastructure services cannot generally be considered as purely private goods. In this context, the fine-tuning of policy objectives is particularly important, given the central role played by infrastructure in our society.

A broad range of objectives needs to be considered in the development of infrastructure:

1. ***Economic objectives.*** The provision of services needs to be effective, efficient, reliable and resilient, and should also contribute to improving the competitiveness of the economy (*e.g.* electricity supply, rail and road transport).
2. ***Social objectives.*** The service provided may have a strong social dimension either because it is essential for life (*e.g.* clean water), and/or it has strong positive externalities (*e.g.* urban public transport).
3. ***Environmental objectives.*** The provision of services may have an adverse environmental impact which needs to be taken account (*e.g.* road transport, electricity).

The various objectives to be pursued may not be mutually supportive. For instance, the social objective of extending the provision of clean water needs to be balanced against the objective of limiting water withdrawals, so as to protect ecosystems and reduce the impact of water use on the environment. In addition, in the case of transport, the objective of providing increased mobility for economic and social reasons need to be balanced against the objective of limiting the environmental effects of increased traffic.

The mix of policy objectives may also induce governments to make arbitrages between different types of infrastructure or encourage particular forms of infrastructure over others (*e.g.* attempts to favour rail over road; to encourage the development of renewables, even if they cost more; to encourage the use of public transport even if individual travellers prefer private transport).

Even when the service provided by the infrastructure may be considered a purely private good, public scrutiny may be justified if large components (typically the network components) are subject to substantial economies of scale, hence subject to market failures as natural monopolies.

Main building blocks

It follows from the previous discussion that the formulation of business models for the provision of infrastructure services is a rather complex affair and that particular attention needs to be given to key building blocks of the models.

What is to be produced? In a private business environment, what is to be produced is what potential customers are prepared to pay for.[2] This is not the case in infrastructure where what is to be produced (the operational objective) is what best meets policy objectives. This means that changes in policy objectives may have a major bearing on the business model that is used. For instance, in urban public transport, the operational objective of the authorities in the past may have been to increase road capacity so as to improve mobility (policy objective). However, as concentration and traffic keep rising, increasing physical road capacity may no longer be a viable proposition, and a more holistic approach to infrastructure development may need to be adopted. In this context, the policy objective may be to increase accessibility (new policy objective) through the pursuit of an appropriate mix of public and private transportation (operational objective). In such a case, the business model needs to be extended to cover both public and private transport and the interaction between the two. It may even be extended to land use management because of its impact on the geographical distribution of economic activities, and hence on traffic flows.

How is output produced? Since we are dealing with networked infrastructure, one segment of the sector at least is subject to large economies of scale, justifying some degree of public oversight and regulation regarding access rights. Upstream and downstream activities may be unbundled and open to competition. However, this may not be an appropriate solution if there is a strong need to co-ordinate closely the operations of all segments of the sector along the value chain, *i.e.* if there are strong economies of vertical integration. Moreover, the presence of economies of scope may result in cross-subsidies between different services and may complicate the regulatory process in a context of regulated competition, since it is not easy in such a case for the regulator to assign costs to specific network services when attempting to establish equitable access charges.

By whom? Whether a particular infrastructure is public or private will depend on the degree of public oversight deemed necessary to meet public policy objectives and how this oversight is to be exercised. This, in turn, will depend on the economic nature of the service and the conditions of production.

A complicating factor is that the concept of "public oversight" is multidimensional. At the national level, several ministries may have a legitimate claim to oversee a particular infrastructure (*e.g.* health and environmental authorities over water infrastructure). Oversight may also be exercised at various levels of government (regional, local, and also transnational in some cases).

Between the two polar cases of purely public and purely private models, a broad range of mixed models can be considered, reflecting various degrees of involvement of private actors and different forms of oversight.

How is production and investment financed? A broad range of options is possible (from general public funding, earmarked public funding and public debt to fees imposed on direct and indirect beneficiaries and private debt). These options involve different allocations of the risks between the main actors. In some cases, advertising may also be a source of funds (*e.g.* most public broadcasters and subway systems, among others, use advertising as a complementary source of revenue).

Typology of business models

The traditional typology is based on the role assigned respectively to the public and private sector (public models, mixed public-private models and private models). However, this only gives a partial picture. Perhaps more importantly, one needs to take into account the nature and extent of the public oversight (*total*: public department under direct political control; *heavy*: public corporation or private company under rate of return regulation; *heavy to medium*: private company under price-X regulation; *medium*: regulated competition; *light*: application of standard competition rules). Typically, the policy objectives to be pursued should dictate what degree of public oversight is required, which in turn has a bearing on ownership. This also influences the allocation of risks: the heavier the public oversight, the greater the share of risks assumed by the public sector; inversely, more freedom of action for the various private players means also more risk assumption on their part. Together with expected returns, the balance between freedom of action and the degree of risk assumed will be a major determinant in the decision of private actors to participate or not in the development and management of infrastructure.

From a public policy perspective, the mere fact that a company is in a monopoly position does not automatically imply that it should be subjected to strong public oversight or transformed into a public monolith. The risks of "private failure", *i.e.* abuse of dominant position in the case of a private monopoly, need to be balanced against the risks of "public failures" (*i.e.* public mismanagement) in the case of a public monolith.

The concepts of "business model" adopted in the sectoral chapters

The five sectoral chapters have adopted different approaches to the definition of business model. Some definitions are explicitly spelled out; others are merely implicit, but may be inferred from the way the term is used. On balance, they are all generally consistent with the approach adopted above.

Although Morgan (2007) uses the term a lot, he does not give a formal definition of "business model" in the context of the *electricity* supply industry. One may nevertheless conjecture that he thinks of business model at the industry level rather than at the firm level. His main focus is on industry structure, operation and ownership, thus he adopts an industrial organisation approach to business models.

Regarding the *water* sector, Palaniappan *et al.* (2007) are more explicit, but their definition is narrower: "by a 'business model', we mean the actors that provide water services (water supply, wastewater, or storm water/flood control)". The authors readily admit that it is indeed a narrow definition that excludes the context within which the actors exist. However, this multidimensional context is described later in the paper (*e.g.* water-quality regulation, water-rights law, sources of capital). According to the authors, "the dimensions can be thought of defining the space or 'stage' on which the actors perform. Changes in technology, policy, and other drivers, can open up or make more attractive parts of the stage that were not previously accessible or desirable for the business models".

Thompson (2007) adopts a more traditional definition of "business model". For him, it determines how the assets will be deployed in meeting the market and social demands placed on the *railways*. He notes that railway business models are broadly defined in two dimensions: structure and ownership. Again in broad terms, there are three types of structural organisation: *integral*, where infrastructure and all operating services are operated under unified control (this is often called "the monolith"); *owner-tenant* models, where the owning dominant operator remains integrated with the infrastructure, and the minority tenant operators pay for their access to the infrastructure; and, *separated* models where (in principle) the infrastructure is separated from the operator or operators. Further variants of the separated model deal with whether or not the "separation" is merely an accounting separation or an actual institutional separation, and with the level of separation among the operators (there may be an integrated operating company, or the passenger and freight operators may be separated into distinct entities).

Like Morgan, Crozet (2007) does not provide a formal definition of "business model" in the case of *urban public transport* (UPT). However, one may infer from his analysis that he views business models as conceptual tools for describing the overall institutional architecture of the infrastructure (including who designs the infrastructure, who operates the infrastructure, who funds the infrastructure and who uses the infrastructure) and the relationships that exist between the different key actors.

Mackie and Smith (2007) point out that in *road transport* "precise definitions of 'business models' in this sector, which is still evolving, are not standard or universal". But in essence, their definition is similar to the one adopted by

Crozet to the extent that the main focus is on the institutional arrangement and the relationships that may exist between the key actors. Mackie and Smith propose five categories of business model ranging from the purely public sector model to the purely private sector model.

In summary, despite various wordings, all the authors in this book adopt a rather similar definition of business model that does not depart fundamentally from the approach taken above. The key questions are: who are the key actors; how do they relate to each other; and how are they organised to create value.

3. Strengths and weaknesses of existing business models

This section assesses the strengths and weaknesses of the business models that currently prevail in the five sectors in terms of their ability to meet a broad range of economic, social and environmental objectives, on the basis of a consideration of the key technical and institutional factors that shape the design of these models.

At first sight, this may seem an overwhelming task when one considers the very different circumstances that prevail across countries and across sectors.

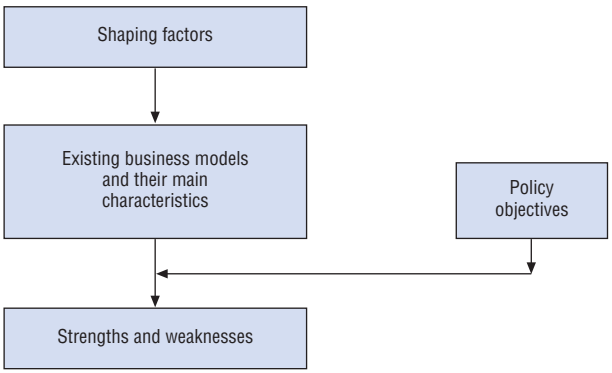
However, the range of the business models that currently exist is in fact rather limited because such models are largely determined by a relatively small number of "shaping factors". Some of these factors reflect *technical* conditions of production (*e.g.* economies of scale) and hence apply across countries, while others relate to *institutional* arrangements which are likely to vary from country to country, but still follow relatively predictable patterns.

In a way, business models may be thought of as possible solutions to problems raised by technical conditions of production and institutional arrangements for achieving particular objectives. Strengths and weaknesses reflect how well (or how poorly) the solutions provided by the business models meet the objectives being pursued.

From an analytical perspective, it is possible to use such shaping factors as a guiding thread for identifying the main business models that currently exist, their key characteristics as well as their strengths and weaknesses, when such characteristics are measured against a set of *policy objectives*. This approach is illustrated in Figure 2.1 below.

The shaping factors that are considered here include the nature of the service provided by the infrastructure, economies of scale, economies of scope, vertical co-ordination/integration, technology and institutions. Moreover, the role of public and private actors and financing are singled out, as key dimensions of business models that deserve particular attention.

Figure 2.1. **Assessing the strengths and weaknesses of business models**



As discussed in Section 2, "strengths and weaknesses" are relative concepts that need to be assessed against a set of policy objectives. These include:

- *Economic objectives*. The provision of services needs to be effective, efficient, reliable and resilient, and should also contribute to improve the competitiveness of the economy (*e.g.* electricity, transport).
- *Social objectives*. The service provided often has a strong social dimension because it is essential for life and/or has strong positive externalities (*e.g.* clean water, urban public transport).
- *Environmental objectives*. The provision of services creates positive or negative externalities which need to be taken account (*e.g.* road transport, electricity).

As was already noted in Section 2, the different objectives to be pursued may not be consistent with each other. Moreover, the mix of policy objectives may also induce governments to make trade-offs between different types of infrastructures or encourage particular forms of infrastructure. Finally, one needs to keep in mind that policy objectives may vary from country to country, reflecting different cultural and institutional contexts in which the particular models are applied (*e.g.* ideologies and cultural values which have a bearing on the relative importance given to different policy objectives and on the policy formulation process, general attitude towards the role of government in society). Hence, a model that is perceived as "strong" in one country may be viewed as "weak" in another, if different policy evaluation criteria are applied in the two countries.

In what follows, the main factors shaping the design of existing business models and the consequences they may have for the strength and weaknesses of these models are first considered in Section 3.1. This provides the basis, in Section 3.2, for an overall assessment of such models in terms of three main policy concerns. Finally, Section 3.3 highlights in a systematic manner some of the key points that emerge from the discussion for each of the sector under consideration.

3.1. *Main shaping factors*

Nature of the service

From an economic perspective, a key consideration in the design of business models is whether the services to be provided by the infrastructure can be viewed as "private goods" and if not, in what way they differ from the concept of private goods.[3]

Electricity services may be considered to be private goods. In most cases, those who do not pay their electricity bills can be disconnected, while consumption by one consumer prevents consumption by others. However, the provision of electricity is often viewed as an "essential service" from two different public policy perspectives. First, as noted by Morgan, given the economic, social and political importance of "keeping the lights on", policy makers and regulators must develop effective mechanisms for ensuring that an adequate reserve capacity is maintained at all times, that power failures are minimised and that when they occur their consequences are as small as possible. Second, from a social perspective, a minimum level of service needs to be provided to all. This typically implies some degree of subsidy to some users, either by the state or by the utility itself.

As further noted by Morgan, this situation may create conflicts for the state between its responsibilities for maintaining a financially viable electricity industry and protecting taxpayers' interest, on the one hand, and its responsibilities for protecting consumers' interest in the short and long term, on the other hand.

The problem is illustrated by the situation that currently prevails in India, where large subsidies to electricity consumers – notably farmers and households – have caused the state electricity boards to incur huge financial losses. This has undermined the boards' ability to invest, meet growing demand for electricity and maintain reliable supply.

Another difficulty results from the fact that electricity supply suffers from "market failure", since the production and transmission of electricity create negative environmental externalities which are not effectively internalised in existing business models. This state of affairs is unsatisfactory from an environmental policy perspective, and it also has deleterious effects from an economic point of view. The lack of clear environmental policy direction in most countries creates uncertainties for sectoral operators regarding the costs associated with the measures governments are likely to take in the future. This means increased risks for potential investors with detrimental effects on the level of future investment.

Water, like electricity, might also be considered, *a priori*, a private good. However, even more so than for electricity, the provision of clean water and effective wastewater services is considered to be essential for life itself, as well

as for public health and the environment. Hence, as noted by Palaniappan *et al.*, water cannot really be treated as a private good.[4] Protecting public health, as well as ensuring water quality standards and the equitable provision of supply, requires significant public oversight and governance. Thus, business models for the water sector need to factor in the central role that needs to be played by public authorities at the local, regional, national – as well as at the transnational level. The models also need to cover a broad policy front: economic and financial, as well as social, health and environmental.

Freight rail transport is more of a private good and so is more amenable to a strictly business approach, involving essentially economic considerations (*i.e.* how to cope with natural monopoly conditions). One approach adopted in the US in the past to deal with this problem was to foster intermodal competition by favouring the development of alternative means of transport (road and water transport) that offered better scope for intramodal competition. In this regard, Thompson notes that, historically, US policy heavily favoured trucks and barges over rail because of a deeply rooted political perception of railways as "public be damned" monopolists. The private good perception of freight rail was also detrimental from a revenue perspective since it induced the authorities to favour passenger traffic (because of its perceived social benefits) over freight transport. It is only since deregulation that freight rail has been able to operate more or less on a business basis in North America, although US (and Canadian) policy may still favours trucks over rail.

Faced with a similar dilemma, other countries chose to nationalise railways and to create public monoliths – often generating "public failures" at the same time. However, the private good nature of freight rail is increasingly recognised today, as well as the advantages of rail over road transport from a safety and environmental perspectives. Efforts are afoot in a number of countries outside North America to promote a more liberalised model of freight rail services, with the hope that it will lead to improved services with both economic (more efficient transport system) and environmental advantages (a higher share of freight carried by rail).

According to Crozet, the services offered by *urban public transport* networks have strong public good features because of the economic characteristics of their infrastructures (local monopolies that require public action at the design and planning stage, at least); the socio-economic benefits they provide (only reliable means of urban transport for the poor, allows everyone to participate in the economic life of the city);[5] as well as the environmental advantage they offer compared to private car journeys (less adverse effect per passenger-kilometre).[6]

In this context, business models must feature a central role for the government not only in the design and planning stages, but also the financing of the system, as fares collected from users will not cover costs if they are set at

marginal cost (or even below marginal cost if the social and environmental advantages are taken into account) as they should logically be.[7] Today, for most UPT systems, operating costs are not even covered.

Road transport services do not meet the criteria established above for private goods. While they are rivalrous, they are not excludable in the business model that prevails in most countries. Road space is allocated to traffic on a first-come, first-served basis and is free at the point of demand. This model inevitably leads to congestion in densely populated areas (once capacity is reached) and to an inefficient allocation of scarce road space. The mixture of vehicle and fuel taxes that currently exist in most countries is not only inefficient but also unfair for rural users who pay a disproportionately high share of road transport costs.

Given the physical limitations of the extension of the network in already congested areas, the current model is clearly not sustainable. However, introducing a model that is both more efficient from an economic perspective, and at the same time considered "fair" by a large majority of people, is a formidable, if not impossible, task from a political perspective, as noted by Mackie and Smith.

Economies of scale

Technical conditions vary from sector to sector. However, all business model designers face a common problem: the models they build need to be suitable for the production and delivery of *networked* services over a single infrastructure, *i.e.* they need to take into account the fact that monopolistic conditions prevail in at least one segment (the network segment) of the value chain. However, the nature of this monopoly element varies from sector to sector. In the electricity sector, economies of scale prevail at the transmission and distribution stages and only at the regional level. In the water sector, economies of scale vary from stage to stage. For instance, water distribution systems are natural monopolies but may be very small indeed (according to Palaniappan *et al.* there are about 54 000 community drinking water systems and about 16 000 wastewater systems in the US) or very large in the major metropolitan areas. In the rail sector, Thompson notes that there is no particular benefit of system size beyond a few thousand kilometres, but that there are increasing returns to traffic density on a specific line. The same conditions apply in the UPT sector and in road transport.

The key question for business model designers is whether such monopoly conditions call for special public scrutiny and what form such public scrutiny should take. In most cases, the solution that has been adopted is to set up a public monolith for the networked segment (monolith that may or may not be extended to the other segments of the value chain).

This approach has a number of strong but also weak points. A business model that puts responsibility for a network in a ministry gives political decision makers direct control over its management and development. Hence, such a model should ensure that, in principle, the infrastructure is operated in the public interest and is responsive to the policy objectives set out by the government. The problem is that in a number of cases using this model decision making may be "too responsive" to the desires of politicians with short-term policy horizons (the next elections). In this context, important decisions for the future development of the infrastructure may be taken for short-term opportunistic reasons rather than on the basis of long-term sustainability considerations. As noted by Morgan, this is often the case with regard to electricity.

One solution to the problem has been to corporatise the activity so as to foster accountability and to remove it from direct political control by creating an arm's-length regulatory agency for its supervision. However, short-term political interference is still possible in this model, although perhaps more difficult.

Another problem with the public monopoly model – whether regulated or not – is that it can suffer from "public failures", as it offers little incentive to keep costs down. This problem prevails in all sectors and, as noted by Crozet in the case of UPT, is easier to identify than to solve. For instance, in the case of UPT and railways, it is typically reflected in excessive investment in infrastructure and rolling stock, overextension of the network to unprofitable lines and overstaffing, which for rail is hard to trim back under private ownership.[8] Moreover, the monolith typically tends to be relatively insensitive to users' needs to the extent that such users are captive with no alternative sources of supply.

Regulatory oversight can help to a degree. However, regulators may be "captured" over time by the regulated entity, whether it is a public or private corporation.[9] And, even when they remain independent, the regulators are not always well equipped to exercise their mandate. One of the many problems associated with regulating a utility is asymmetry of information skewed in favour of the regulated corporation.

This problem arises, for instance, when a concession has been granted to a company for operating a water system. Concessionaires have first-hand information about expenditures and degree of effort to reduce or control cost and achieve contract deliverables. These elements are largely unobserved by the regulators and are liable to be overblown. The concession agreement (CA hereafter) provides that the Regulatory Office (RO hereafter) approves tariff adjustment petitions by the concessionaires which cover prudent and legitimate costs and to disapprove otherwise. This requires the RO to have some idea of prudent costs and the reasonable toll taken by unforeseen events and *force majeure*. In a complex operation such as a water utility, precious information, while known to concessionaires, is hard to pin down by the RO (Fabella, 2006).

One solution to the problem is to break up the monolith on a geographical basis and introduce some form of *benchmark competition*. This is feasible, for instance, when the monolith operates at the national level, and economies of scales are actually reached at a lower level. This is the case for electricity. Electric utilities already operate *de facto* at the regional level in federal states (*e.g.* US, Canada) or have already been regionalised in some countries (UK). It is also feasible in other sectors, such as the water and UPT sectors, where monopoly conditions exist only at the local level.

As noted by Fabella (2006) in the case of water concessionaires, the idea behind benchmark competition is that a concessionaire may have features similar to those of other concessionaires, as well as features specific to its particular situation. Indeed, the literature (Laffont and Tirole, 1994) distinguishes between two types of features: "systemic features" which are subject to "systemic shock", and "idiosyncratic features" subject to "idiosyncratic shock". The existence of comparators applied to systemic features helps the RO in determining systemic shocks and the reasonable responses thereto (*e.g.* impact of currency fluctuations or of changes in the international price of resources on the costs faced by concessionaires). Assessing the significance of idiosyncratic shocks (*e.g.* impact of a local storm) is more difficult, unless comparators in the same locality and the same domestic and political environments are available (*e.g.* damage to several concessions in the same area hit by the same storm). They can provide valuable knowledge that contributes to reducing the information advantage of the concessionaire over the RO. The usefulness of benchmark competition depends on how systematically similar the concessionaires are and how easily they can collude to minimise being "shown up" by the other. While this does not eliminate the monopoly problem, it does tend to circumscribe it.

In North America, a third model prevails, the "owner-tenant model", where the owning dominant operator remains integrated with the infrastructure, and the minority, tenant operators pay for their access to the infrastructure (Thompson). This model allows railways to take advantage of increasing returns to traffic density on a specific line by sharing the same lines through owner-tenant relationships.

The successful operation of the model depends largely on the ability to set access charges that bear some relationship to marginal cost and that can be shown to relate in an appropriate way to the cost of different types of users. Unfortunately, marginal cost is a more useful concept in theory than in practice and is subject to abuse if the tenant operator is politically powerful (Thompson).

Economies of scope

If significant economies of scope exist in production, several services (which are distinct from a demand perspective) may be provided by the same infrastructure. In such cases, the business model needs to take into account all the actors involved and the relationships that may exist between them, as well as how costs are allocated between the different services. For instance, although the *provision of electricity* may be considered to be a single homogenous service, opportunities for economies of scope may arise in the future as technology evolves (*e.g.* production of electricity from waste treatment, the use of transmission and distribution lines to deliver telecom services). From a business model perspective, the challenge is how to best integrate these different services and ensure that institutional arrangements allow such joint production effectively and efficiently. For instance, if it becomes profitable for waste treatment operators to produce electricity, they should be allowed to do so and to sell their electricity to the distribution network on the same basis as other electricity generators. This means that barriers to entry in the electricity generation industry must have been largely eliminated and that an adequate regulatory oversight has been put in place for maintaining a level competitive playing field.

The same kind of issues arises in the other sectors. In the *water* sector, Palaniappan *et al.* note that economies of scope may be substantial in some cases (storm and sanitary sewers), but not in others (sanitary sewers and wastewater treatment). In the rail sector, the infrastructure can carry both freight and passenger traffic.

By contrast, there are no economies of scope in *urban public transport* systems, as such systems are not currently used for freight, although there are some historical precedents.[10] Freight subways could make a come-back in the future. For instance, Andrew Looney in *The Empty City* describes a "city of the future" where freight subways play a key role, as cars and trucks have been banned from the centre of the city (see Box 2.1). However, even in Looney's vision, the freight and the passenger subways are kept separate.

The lack of economies of scope in mass transit systems means that their economic viability is highly dependent on frequent usage by paying customers if other sources of revenues (*e.g.* public subsidies) are limited. This means that such systems will be highly vulnerable to overextension of the network to areas where population density is too low to generate an adequate level of paying traffic.[11]

However, significant economies of scope exist in road transport since the road network is a ubiquitous multipurpose infrastructure by excellence, which offers unique flexibility and door-to-door service. Moreover, the value of roads

Box 2.1. **Mass transportation and the "City of the Future" according to Andrew Looney**

In the *Empty City*, Andrew Looney describes the transformation of a city under the guidance of a "visionary" mayor, which involves an extensive use of mass transit systems both for commuters and for freight:

"The entire downtown area was, one piece at a time, evacuated, demolished and rebuilt. The small, worn-out old buildings and the tiny, narrow, traffic-clogged streets were all destroyed. In their place sprouted a true City of the Future. Homes, offices, shops, government agencies, mass transportation, and public parks were all combined and intertwined in the new City.

You could take an elevator from your apartment in a towering condominium down to the subway, ride the train across town to your job, work in a sunny office, and return home via the supermarket, all without ever once stepping outside. The towering office and apartment buildings were linked together by a vast underground system of shops and subways. And when you did go outside, you entered a land of beautifully landscaped parks and lush gardens. No roads penetrated the downtown area at all, and in much of the outlying regions, cars were only permitted by special pass. Everyone relied completely on the complicated, comprehensive mass transit system.

Since trucks were not permitted in the downtown sector, an additional network of subways had been built to provide shipping of goods into and out of the centre of the City. These 'freight subways' rumbled back and forth, very deep below the surface of the earth, bringing cargo in from depots on the outskirts of the City that could be reached by truck. Large freight elevators brought the shipments up to the surface from the freight subway stations deep underground.

The freight subways did not overlap with the normal subways at all, and few people other than employees ever saw them. Everyone knew they existed, of course, and those who lived and worked downtown relied on the freight subways for everything-but they never saw them, which was just as well. The freight subways were darker, mustier, and far more utilitarian than the normal subways. The stations didn't even have names, they were simply numbered. However, the people who drove the freight subways did have names for the stations, names like 'The Abyss', 'Hell's Crossover', and 'The Armpit'."

Source: Looney, Andrew (2002), *The Empty City, www.wunderland.com/WTS/Andy/EmptyCity/chapter36.html.*

extends beyond transportation, since the road network also provides space for accommodating lifelines, such as waterworks, sewage systems, gas and electricity.

Vertical co-ordination/integration

A key question in the design of business models is whether substantial needs for co-ordination exist between the various segments of the value chain and how best to achieve that co-ordination.

If co-ordination requirements are indeed strong and transaction costs between segments are high, then vertical integration may indeed be the best option. However, when one segment is subject to large economies of scale (as is the case for all the network services considered here), this means that the monopoly will be extended upstream and downstream.

If the need for vertical co-ordination is not too strong, one may envisage a *structural separation* between the networked monopoly component of the value chain from the other segments that can then be open to competition (if the benefits of doing so in terms of improved efficiency outweigh the burden resulting from higher transaction costs and higher risks for the operators in the competitive segments). Breaking down the monolith on a regional basis, as discussed above, can strengthen the economic viability of the unbundled model.

The need for co-ordination along the value chain has in the past justified the creation of all-inclusive monoliths in a number of sectors, including the electricity supply industry, the railways and urban public transport systems. In the water sector, the case for vertical integration has not been so compelling, although the merit of vertical co-ordination between the various segments of the value chain at the level of the watershed is increasingly recognised (such co-ordination may significantly contribute to improving the quality of service and cut costs). The benefits of vertical co-ordination are illustrated for instance by the New York City example given in Palaniappan *et al*.[12]

In the *freight rail* sector, the "separated model" involves a structural (or at least functional) separation between the infrastructure and freight trains, where the infrastructure remains a regulated monopoly, and freight trains can be privately owned and operated.

This approach has been adopted for instance in the UK where the infrastructure is now privately owned by Network Rail and regulated by the Office of Rail Regulation (ORR) established on 5 July 2004 under the Railways and Transport Safety Act 2003.[13] The role of ORR is to ensure that Network Rail, the owner and operator of the national railway infrastructure (the track and signalling), manages the network efficiently and in a way that meets the needs of its users; to encourage continuous improvement in health and safety performance; to secure compliance with relevant health and safety laws, including taking enforcement action as necessary; to develop policy and enhance relevant railway health and safety legislation. ORR is also responsible for licensing operators of railway assets, setting the terms for access by

operators to the network and other railway facilities, and enforcing competition law in the rail sector. The Department of Transport looks after passenger and train-related matters.

By contrast, in the *road transport* sector, there is a clear separation of infrastructure services from freight transport, coaches and other transport services that use the infrastructure. Unlike rail services, these are rarely or never vertically integrated with the infrastructure and are essentially competitive (or at least contestable). Vertical co-ordination is assured by the formulation and enforcement of standards regarding the kind of vehicle allowed on the roads and the technical requirements they have to meet (size, safety features, etc.) as well as rules that govern the behaviour of users.

Regarding the road infrastructure itself, however, the various elements of the value chain (road planning, building, maintenance and operation) have traditionally been kept under the same public roof. This need not necessarily be the case. First, several public agencies may be involved. Moreover, opportunities may also arise for engaging the private sector through various forms of PPP (public-private partnership), ranging from concessions for running and maintaining the infrastructure (such as motorways in France), to BOT (Build-Operate-Transfer) models. The same argument applies to water systems and UPT systems.

Technology

Technology largely influences the way infrastructure services are provided and how business models are formulated. For instance, it largely determines the existence of economies of scale and scope, the need for co-ordination along the value chain and the way such co-ordination can best be achieved. Business models based on a particular technology may become obsolete if new technologies offer opportunities for doing things differently or provide new services. Moreover, the pace of technical change itself has a bearing on vertical integration. Typically, rapid technological change tends to undermine the advantages of vertical integration, as producers at each stage of the value chain will want to keep their options open so as to be free to choose the best technology available in a timely fashion, whether it is provided or not by the vertically integrated supplier. An interesting historical example in this regard is the vertical disintegration that has taken place in the telecom sector between telecom operators and telecom equipment suppliers, as the pace of change in ICT technologies accelerated in the 1970s with the introduction of digital technology.

In the case of *electricity supply*, the emergence of distributed generation and the development of renewables are having far-reaching consequences for the business models used in this sector. First, they contribute to reducing the

needs for transmission and improving the security of the system. Moreover, they also offer opportunities for more robust competition, contributing to make more viable the "unbundled model" described by Morgan.

In the *water sector*, closed loop systems reduce the need for extensive sanitary sewage systems and offer great opportunities for recycling. In addition, advances in desalination technologies offer new decentralised water collection opportunities, since more than half the world's population lives within 60 km of the sea.[14]

Finally, as already noted, new technology may make the production of electricity from waste more cost effective, offering new opportunities for the design of business models combining electricity generation and waste treatment.

By contrast, technological progress in *freight rail* has been incremental with only minor impact on business models. However, it is in the countries where the liberalised model prevails that the adoption of new technology has been most effective in generating productivity gains. For instance, as noted by Thompson, significant gains in efficiency have been achieved in North America, *inter alia*, as a result of progress in rail metallurgy that allows increases in load, while better traction has reduced energy costs significantly over the last few decades. Gains have also been achieved by the introduction of better operation techniques (block trains, dedicated unit trains), more productive use of human resources and the more effective exploitation of ICT technology (enhanced signalling, scheduling and control).

The business models used in *urban public transport* systems have not been significantly affected by new technology, although the operation of such systems have benefited from some technical advances. For instance, the application of ICT contributes to enhanced signalling, scheduling and control. Automated systems are slowly starting to emerge and could offer opportunities to reduce labour costs (which represent today about 60% of operating costs, according to Crozet).[15]

One factor that explains such relatively slow progress is the fact that most UPT systems have been underfinanced in the past with little resources available to improve the system and little incentive to do so in the public monolith model. Moreover, as the equipment becomes obsolete, it becomes increasingly difficult to retrofit newer equipment. Also, strong unions typically prevail in the UPT sector. They often have the ability to oppose effectively the adoption of new technology that may lead to a drastic job reduction in the sector. This does not mean that the technology will not be implemented eventually, but that the rate of adoption is likely to be slow.

Progress in ICT also has an indirect bearing on urban public transport, to the extent that it offers possible alternatives to urban travel in the form of telework, teleshopping, distant education and telemedicine. However the impact on urban

travel has remained marginal to date. This could change in the future as projects to develop high capacity networks are underway in a growing numbers of cities (Tokyo, Seoul, San Francisco, Philadelphia and Paris, for example).[16]

Technology has had only a minor effect on business models for *road transport* to date. However, things could change drastically in the future. First, research into multifuelled vehicles, fuel cells, biofuels, hydrogen-based fuels, as well as electric batteries, could bear fruit as shortages in more traditional fuels are encountered and bring about drastic reduction in the environmental impact of road transport.[17] Moreover, ICT could be used to regulate road traffic (including road pricing), lane usage and speed and to improve safety, reducing the need for new investment.

Over the next few decades, the development of intelligent infrastructure systems (IIS) could indeed have far reaching implications, not only for the economy but also for society at large and the environment. (See Chapter 1, Box 1.21 on the Foresight Project on Intelligent Infrastructure Systems in the UK.)

Clearly, IIS have great potential over the longer term to help address some of the challenges that will be raised by the further development of the transport network. However, their deployment faces a number of serious challenges, as noted in the UK Office of Science and Technology Foresight Directorate's *Intelligent Infrastructure Futures Project Overview* (2006).

First, new technology will need to be accepted as safe by the population at large, both in terms of security of any information surrendered to the system and physical safety. There will also be questions of who owns any data collected by the system and where liability rests if the system fails, as it will do from time to time.

Second, the success of the system will largely depend on the ability to model realistically complex processes in transport and other related activities. Although our ability to do so will increase, we will need to establish a means of quality assurance for those simulations. This will be a challenge, especially as more and more software programs work out for themselves how to meet their objectives, but the programmer will not necessarily have complete knowledge of how it works.

Third, widespread use of agent-based software approaches to support decision making could create social division between those who can and those who cannot afford the best software agents. Also, what will the effect be of the use of agents on the psychology of the user if people become dependent on and, in some cases, emotionally attached to an agent or avatar?

A further question concerns the ability to connect different computerised systems to provide seamless IIS. Integration could fail for a number of reasons. To begin with, the cost could be prohibitive. Systems running on different

standards might not be able to talk to one another. Unexpected emergent behaviour could also prevent effective co-operation between systems. These obstacles could drive us more towards a situation where there are many systems, only some of which are integrated.

More fundamentally, policy making in this area faces two major uncertainties: will society embrace a world where we track, and perhaps control, the movement of all goods and people? The second is whether or not we develop an alternative source of energy for transport that has minimal impact on the climate. If we do have this energy source, we would want to use IIS to support as much movement of goods and people as possible. If we do not have such an energy source, we would want to use IIS to minimise the movement of goods and people, while still supporting economic growth.

Institutions

The constitutional arrangements that prevail in a given country play a major role in determining which actors will be involved in a particular business model and how they will interact. For instance, in unitary states, *electricity services* typically tend to be provided by national monoliths. By contrast, in federal states, the main responsibility for electricity provision generally falls under regional (provincial or state) jurisdiction. In Canada, the federal government has jurisdiction over electricity exports, as well as international and designated interprovincial power lines; the provinces and territories have jurisdiction over generation, transmission and distribution of electricity within their boundaries, including restructuring initiatives and electricity prices.[18]

This regional arrangement offers perhaps more opportunities to experiment with different business models than is possible in a unitary state where the public monolith has a vested interest in maintaining the *status quo*. For instance, in the Canadian context, both industry structure and policies vary considerably across provinces. While most provinces have adopted the monolith model, two major provinces, Alberta and Ontario, have established markets characterised by wholesale and retail unbundling, although their specific market designs differ. In the two provinces, an independent system operator (ISO) sets and administers policies for grid interconnection, transmission planning and spot market operation.[19]

Canada also provides an interesting example of what the impact of liberalisation in one country (the US) may have on another (Canada). In most cases, Canadian provinces are moving to the *unbundled* model, that is, separated business units (generation, transmission and distribution) to comply with orders from the US Federal Energy Regulatory Commission (FERC) related to competition, allowing them to export into the US market.[20]

In the *water* sector, institutional arrangements vary from country to country, although the main responsibility for the provision of water typically rests at the local level in all countries. However, a growing recognition of the multidimensional nature of the issues at stake is gradually forcing the adoption of a more holistic approach to the management of water resources everywhere.

For instance, the fact that consumption of water by one consumer upstream affects the quality of the water available to other consumers downstream means that water should logically be managed at the water basin level, irrespective of administrative boundaries. In some cases, a transnational approach needs to be adopted when the water basin straddles the territories of several countries. This water basin approach has been adopted in many countries already and has been advocated by the European Council (EC) in its Water Framework Directive.

A complex web of institutional relationships needs to be established across agencies at different levels of government. The national government has an important role to play not only in setting and enforcing standards, but also in funnelling the necessary resources to operational agencies at the local level for the effective implementation of such standards.[21] For instance, in France responsibilities for water management shared between the state and other levels of government. (See Chapter 1, Box 1.11 on the management of water systems in France.)

The formulation of water standards may also be formulated at the transnational level. For example, over the years, the EC has issued a number of water directives after extensive consultation throughout the EU. These directives are gradually reflected in national laws and implemented in member states. On balance, these efforts have had positive effects on the quality of water in Europe. For instance, the quality of bathing water has improved in the UK over the last ten years or so as a result of the application of the 1976 Bathing Water Directive (see Box 2.2).[22]

In the *freight rail* sector, national institutional arrangements do not seem to influence much the business models adopted in the various countries. For instance, the monolith model can be found in unitary states, such as France, as well as federal states, such as Germany. Liberalised models prevail in federal states (US, Canada), as well as unitary states (UK). However, as noted by Thompson, the institutional framework may have an impact on the way some major projects are carried out. In this regard, he points to the complex arrangements that were needed for the construction of major new terminals in California and the Chicago area, and the lack of involvement of the federal government in such projects, despite their importance at the national level for the US economy.

Box 2.2. **Application of the EC Bathing Water Directive in the UK**

Since 1995, water companies in England and Wales have invested over GBP 1 billion to upgrade sewerage infrastructure. This has resulted in a steady improvement of bathing water quality.

Compliance with mandatory standards in England has improved from 88.9% in 1995 to 98.8% in 2005, and the proportion of sites meeting all bacterial guideline standards has shown a marked increase from 41.1% to 73.7% between 1995 and 2005. Further improvements are planned at sewage treatment works and overflows at an additional 99 sites in England and Wales over the next five years (up until 2010), bringing additional benefits to bathing water.

However, despite significant improvements to the surrounding sewerage infrastructure, several bathing water sites continue to be affected by diffuse water pollution, *i.e.* fecal pollution from agricultural and/or urban runoff after heavy rain. Diffuse water pollution, particularly from agricultural sources, contributed to the "failure" of at least two of the five English bathing water sites which did not meet the mandatory microbiological standards of the directive in 2005.

Tackling sources of diffuse water pollution is the next big challenge if we are to see further significant improvements in bathing water quality. This will be delivered through initiatives such as the Catchment-Sensitive Farming Project, with the UK Department of Environment Food and Rural Affairs (Defra) working closely with farmers and other stakeholders to improve farming practices.

Source: www.defra.gov.uk/environment/water/quality/bathing/default.htm.

Institutional arrangements at the transnational level can also play a key role. For instance, EU institutions are major actors actively promoting the adoption of a *more liberalised rail* business model in Europe where railway systems and the rail markets largely still consist of a patchwork of badly interconnected national systems. Without the EU, progress would probably have been much slower than it is.

The Treaty of Rome and the Common Transport Policy have provided the basis for the formulation of pertinent legislative measures. Several regulations and directives have been adopted by the EC which contain detailed provisions on the opening of markets for rail transport of freight and passengers; on the interoperability of high-speed and conventional rail systems; on the conditions under which state aids can be granted and public service obligations and contracts can be concluded; on the access to the networks; and so on.[23]

UPT systems are typically developed and operated at the municipal level. However, since the fares generally cover only a fraction of operating expenses,

public coffers need to be tapped one way or another for their financing. This may include revenues from a municipal tax as well as subsidies from the regional or national authorities. Moreover, whenever a metropolitan area extends over several municipalities, special institutional arrangements need to be made for managing the UPT system at the metropolitan level.

In some cases, considerable autonomy has been granted to local authorities. In the UK, the mayor of London is the key figure in urban public transport for the capital city since the devolution of power to the local level, enacted by the Greater London Authority (GLA) Act in 1999, which created the GLA as a corporation and defines the roles and responsibilities of the mayor and the authority's assembly. Having made transport a priority, the current mayor, Ken Livingstone (re-elected in June 2004 for a four-year term), has chosen to chair Transport of London (TfL), the main transport authority, which has been responsible for most transport in London since July 2000. This includes buses, major roads, river transport, cycling, taxis and private hire (the Public Carriage Office), and trams. Since July 2003, it has also been responsible for the "Tube" (the London Underground).

As chairman of the board of TfL, the mayor:

- Sets the budget, appoints the board and can direct the actions of TfL.
- Sets the fares for the Tube, buses, Docklands Light Railway, Croydon Tramlink and taxis.

From a legal perspective, TfL is a corporation treated as a local authority for accounting purposes. It is allowed to borrow without prior approval from the Department of Transport (DfT).

The autonomy given to the mayor of London and the resources put at his disposal reflect the high priority given by the UK government to the upgrading of the London transport system. Recognition is thus given to the key role played by capital cities in international competitiveness, and in this context, the crucial importance of urban transport for the economic development of the megalopolis (mobility of the workforce, efficiency of the communications network, quality of life for residents, etc.). This also underscores the many challenges of London in comparison with other large capital cities (New York, Paris and Tokyo) and the need for a major upgrading of its facilities. The success of London's Olympic bid in July 2005 has underlined the commitment of central government to support the upgrade of the capital city's transport network.

It is interesting to note, however, that the autonomy given to the mayor has been severely constrained by the setting up of a PPP for the upgrading of the Tube prior to its transfer to the local authority and despite strong opposition by the mayor and TfL. The PPP, aimed at providing a GBP 16 billion upgrade and maintenance programme for the Tube, was decided upon and organised by the government, leading to a political and judicial dispute with the mayor and TfL.

Different levels of government are typically given responsibility for the development and management of different types of *roads* (national, regional, local). In some cases, national governments may delegate their responsibility for the maintenance of national roads to regional authorities (as in France). This layered approach provides opportunities for experimenting with different types of business models. This may include, for instance, concessions at the national level for the operation of major motorways in some countries, or PPPs involving several levels of government for major new facilities. (See Chapter 1, Box 1.3 on the creative financing and funding of the Confederation Bridge, Canada) or concessions at the local level for the upgrading of roads at the municipal level.[24]

Public and private roles

It was noted earlier that in all five infrastructure sectors in this project the nature of the service as well as the monopoly conditions that prevail in its provision call for public scrutiny in at least some stages of the value chain. However, this leaves an important role to play for the private sector. Indeed, in all sectors one can find examples of private operation and private ownership.

As Mackie and Smith note in the case of *road transport*, the major challenge for business model designers is to find the best way to harness the expertise and resources that the private sector can bring to the development and maintenance of infrastructure. This challenge, which applies to other sectors as well, is no easy task.

Logically, the closer the service is to a purely private good, the greater the participation of the private sector should be. Thus, one would expect to find significant private ownership in the electricity and the freight rail sectors. Yet, this is clearly not the case in most countries. One reason is that the creation of a public monolith addresses, in principle at least, the market failure related to monopoly provision. Another one is that non-economic considerations have historically played a key role in business model choice in both sectors.

A key question is whether the alleged benefits of these non-economic considerations are worth their costs. For instance, *railways* were long viewed as strategic assets for the industrial and economic development of European nations and played a crucial role in the conflicts that split Europe for so many years. Railways were almost considered as being part of the state itself. This state involvement, however, had, and still has, its price for the taxpayers. State aids and other public contributions to the sector accounted for almost EUR 40 billion in 2001 in the EU.[25]

In addition, in the *electricity* sector, the choice of business model often hinges on the trade-offs to be made between economic and non-economic considerations. For instance, at the European level, there is on the one hand a long-standing project for lower prices led by the EC designed to liberalise the market and to enable producers and distributors to compete freely within and

across national borders. On the other hand, there is a camp that argues with growing confidence against further freeing the market. In its view, long-term security and stable prices can best be preserved in managed national markets that are dominated by strong quasi-monopolistic companies that can withstand bullying input fuel suppliers (such as, gas from Russia) and sudden shifts in demand and supply.[26]

In the other three sectors (*water, UPT, road transport*), the role of public actors remains dominant at the design planning and ownership stage, while private operation is becoming more common. In some cases, the separation between ownership and operation may involve two public entities. There are some exceptions of course to this general rule. For instance in the water sector, the development of closed loop systems offer more scope for private ownership. In addition, Mackie and Smith give examples of purely privately owned and privately operated roads.

A potential advantage of separating ownership and operation is that it allows injecting some degree of competition in the process. Although competition *in* the market may not be possible, competition *for* the market might be feasible. However, successful co-operation between public and private actors is difficult to achieve in practice for a number of reasons. First, it must be feasible to delegate responsibility for the operation to a third party. This means that the public agency should be able to clearly define in advance the tasks to be performed by the concessionaire and how responsibilities and risks are shared between the different parties to the agreement. The contract should also define the conditions under which changes in circumstances may justify a revision of the contract, as well as the procedures (*e.g.* arbitration) to be applied in case of disagreement between the parties.

These last two elements are particularly important because of the long duration of most infrastructure contracts. Indeed, such contracts are particularly vulnerable to bounded rationality and lack of perfect foresight by the parties to the agreement. For instance, events unforeseen when the contract was signed, may nevertheless drastically affect its execution. The fact that one of the parties to the agreement is a public agency further complicates the situation for the concessionaire since such an agency may not be bound by contract law in the same way as a private company would be.

The experience of the London Underground with PPP (see Box 2.3) is an interesting case in point from all these perspectives.

Even when contracts can be drawn up effectively, the bidding process will be ineffective if bidders collude. This may occur for instance when there is only a small number of bidders. The problem may arise in all sectors, including the UPT sector as illustrated by Crozet.[27]

Box 2.3. **The London Underground PPP gamble**

The problems associated with attempts to harness private sector resources and expertise in a major infrastructure project are well illustrated by the 30-year PPP signed in March 2003 by the UK Department for Transport with two infrastructure companies (Infracos), Metronet and Tube Lines, for the maintenance and renewal of London Underground trains, stations, track and signalling. This followed a five-year procurement process costing some GBP 455 million. The PPP provides for spending an estimated GBP 15.7 billion over 30 years at present values, of which GBP 9.7 billion in the first seven and a half years.

The PPP split the Underground business in a new, complex way. London Underground retains responsibility for operations and safety, while Infracos maintains and renews the infrastructure over 30 years. London Underground pays Infracos largely on the basis of delivery of specified outputs, such as asset availability, rather than on the cost of the work. There is a built-in periodic review mechanism, untried in any other PPP arrangement, which enables the parties to respecify requirements within the PPP scope and reprice the deals at least every seven and a half years.

Independently of the political aspects, the disagreements that have emerged between the major public parties involved and the choice of Infracos, one may wonder if the expected benefits of this approach are worth the costs.

The government saw the PPP as the best way of ensuring stability of funding for the maintenance and renewal of the Tube, continued public sector management of operations, and the benefits of private sector management of a major infrastructure programme.

Critics point out that an alternative option – public sector management of maintenance and renewal financed by bonds raised by Transport of London (TfL) – would have allowed a simpler structure. They further point out that bond financing would have been cheaper than the PPP financing costs.

The crux of the matter seems to be the incentive scheme resulting from the allocation of risks. In the PPP approach, some of the risks are assumed by the private actors who are also responsible for the management of the infrastructure project. By contrast, in the public approach, the risks of non-performance fall directly on the public sector. Hence, the key question here is whether the gains to be achieved by the incentive structure and the greater scope for private initiative created by the PPP are worth the additional costs of the PPP (time and cost of negotiation, complexity of the structure, risk of conflicts, and so on).

So far the performance of Infracos has not lived up to expectation. However, this is only the beginning, and users do not seem unduly concerned. Up to almost four out of five Tube users appear to be reasonably satisfied with the operation of the infrastructure, despite the construction work. Only time will tell whether the results achieved are worth the PPP gamble.

Source: UK House of Commons Committee on Public Accounts (2005), *London Underground Public-Private Partnership*, Seventeenth Report of Session, 2004-05.

It is also common in the *water* sector where only very few companies operate at the global level. Three French companies (Suez, Veolia Water and Saur/Bouygues) account for 70% of the market world wide, and in most cases contracts have been awarded without genuine competition between bidders. Indeed, the largest companies in the sector (Suez and Veolia Water) sometimes submit joint bids. Abuses of dominant position have been found in France for instance.[28]

Competition is further restricted by the fact that construction and other contracts are frequently awarded to other subsidiaries of the company which holds the concession, without public tendering. This allows inflated charges to be imposed.

Even when there are enough bidders, the bidding process may be biased when some bidders "are more equal than others", that is, they have particular advantages over others because of access to information other bidders may not have or can take advantage of a monopoly position in one market to cross-subsidise their bid in another market. This situation which is not unusual in the *UPT* sector has induced the EC to issue the Public Service Obligation (PSO) directive which addresses the problem. The directive stipulates that no enterprise, notably if under state control, can reply to a call for tender if, in its area of origin, it benefits from a delegation of public service without any competitive process. The idea is to put an end to suspicions of "incompatible" aid while preserving recourse to an internal operator and margins of flexibility in the tendering process.

Financing

Financing is a major issue in the design of business models because all infrastructures require large investments over long periods of time. And increasing claims on the public purse not related to infrastructure development (such as health expenditures) mean that public funding (which was the major source of funds up to now) may be less readily available in the future. This is leading to a search for the formulation of models featuring private sector involvement, not only for the operation, but also for the financing of the infrastructure in all sectors. (See Chapter 1 for policy recomendations.)

As noted by Mackie and Smith, this search is somewhat illusory to the extent that whether financing is provided by public or private actors, "it comes from the same bank" anyway. Indeed, public agencies may get a better deal from the bank when borrowing money than private actors who may be perceived as more risky by financial institutions.

More important than the source of funding is whether the arrangement is financially sound, that is whether the lender has a good chance to recoup the money.[29]

In the *electricity* sector, financing depends largely on the revenues generated by providing the service. It follows that investment will be very much affected by the way electricity rates are set and what social obligations, if any, are imposed on operators. As already noted, the long-term soundness of the infrastructure may be undermined by price caps or requirements to subsidise particular categories of clients.

Changes in business models that affect risk allocation may also have a bearing on financial conditions and the outcome of projects involving public and private actors. Typically, liberalisation means in most cases that individual decision makers assume a greater level of risk, *i.e.* greater freedom of action implies more risk taking. For instance, a private actor will accept to manage a risky project and take responsibility for achieving specific objectives only if given sufficient leeway in the way the project is carried out. Successful business models will be those that provide an effective balance between the two: too much risk and not enough freedom of action can be a recipe for disaster for private actors. Conversely, low risk and high degree of freedom may allow the private actor to earn rents at the expense of the taxpayer.

An interesting case in point is the move to the unbundled model in the electricity supply sector, which is *shifting the business risk* from users and taxpayers to the different actors along the value chain (electricity generators, transmission and distribution networks operators, wholesalers and retailers). These actors, notably electricity generators, may be unwilling to make the investment necessary to meet increasing demand if they perceive the business risks resulting from higher price volatility and uncertainties about input supply to be too high.

In principle, this process should be self-correcting over time to the extent that reduced investments today should lead to higher electricity prices tomorrow which, in turn, should boost the perceived profitability of future investment, encouraging further investment. However, the process could generate serious price instability over time, if investors overreact to price signals and investment is subject to substantial bunching (an argument advanced by those who oppose the liberalisation of electricity markets in Europe). This can be corrected, in part at least, by appropriate mechanisms such as the formulation of long-term supply contracts and the development of more sophisticated futures markets for electricity.

In the *water* sector the bulk of the financing of capital expenditures come from the public sector, largely at the local level. In most countries, the sector has suffered for years from chronic underfinancing, as public authorities have not been able to provide the proper level of funding, while user charges often do not cover operating and maintenance costs. Private financing by large multinational enterprises (MNEs) have taken place in the past. However, the experience has not been very successful when water prices have been set too

low to cover costs or when attempts to raise prices have met with strong political opposition. This has been the case in emerging markets, forcing most such companies to abandon their forays outside their traditional markets.

In *the rail freight* sector, the financing of investment depends largely on revenues generated by the operation of freight trains. However, such financing is often undermined by obligations to cross-subsidise passenger traffic and/or public policies that favour other modes of transport over rail. Thompson notes that where rail freight is provided privately or, at least fully commercially, and where governments do not unduly support highway or water competition, there is reason to believe that the wholly market-driven needs for freight infrastructure and operating investment will be met (one way or the other). The rail infrastructure challenge lies more in the willingness of governments to identify social benefits and costs transparently, and to fund them.

Thompson also notes that an important question arises with regard to the role that should be assumed by national governments for the financing of major infrastructure projects, such as the construction of intermodal terminals. In a globalising world, such terminals are likely to become increasingly important for international competitiveness, notably those involving maritime to rail transfers, as maritime to road transport terminals become increasingly saturated. This could justify public support at the national level for such facilities on economic as well as on environmental grounds. This is the approach adopted in Canada by the federal government in its decision to contribute to the financing of the major box container terminal of Prince Rupert, British Columbia, which is viewed as a strategic investment for the country as a whole. The Canadian policy contrasts with the hands-off approach of the US government noted by Thompson.

In Europe, progress in *intermodal* maritime/rail traffic is very much linked to the adoption of a more liberal business model for rail. This will give maritime companies additional freedom for integrating more effectively the maritime and terrestrial legs of their operation, so as to offer door-to-door service to their clients.[30]

In the *urban public transport* sector, outside sources of financing need to be found since revenues generated from passenger fares typically do not even cover operating costs. Even in London, where Tube tickets are among the most expensive in the world, fare revenues still represent a smaller share of revenues (41%) than grants (45%) for TfL.[31] In some countries, additional funding may come from those who benefit indirectly from the UPT system, including employers (such as, in France) and landlords.[32]

Another way to fund UPT systems that has been used in London is to impose a congestion charge on private cars entering the central area and to use the proceeds to improve the UPT. However, success has been mixed. While the scheme has been very effective in reducing private car traffic (down 30%)

and in encouraging the use of buses, it has generated less revenue than originally anticipated.[33]

In the *road transport* sector, financing depends on the business model: from the public purse in most cases; from private sources if the BOT approach is adopted. Regarding public financing, Mackie and Smith note that several approaches have been developed when more than one level of government is involved, including new two-tier models of public sector funding. In this respect, an interesting model quoted by Mackie and Smith is the Grant Anticipation Revenue Vehicle (GARVEE) programme and the Transportation Infrastructure Finance and Innovation Act (TIFIA) adopted in the US.[34]

Several approaches have also been used to take advantage of private sector resources and expertise. For instance, Mackie and Smith note that in the UK road infrastructure projects have been procured using the Design-Build-Finance-Operate (DBFO) model. This model is based on "shadow tolls", that is payments made to the private sector concession holder in regular instalments by the public sector, usually based on traffic usage, availability and service quality indices.

In France, the use of concessions for developing the highway system is well established since the first such concession for toll roads was signed in 1956. In 2004, the French highway system was more than 10 000 km long. About 75% was managed by concessions.

In Canada, the federal government also participates in the financing of roads, although road transport is largely a provincial responsibility. The Canadian experience with PPP has been limited to date, and the results have been mixed.

3.2. Overall assessment

The strengths and weaknesses of a particular business model can be measured in terms of its ability to provide solutions to problems raised in the pursuit of policy objectives. In assessing the merit of various business models, one can therefore examine how effectively the solutions they offer – in particular the way that public oversight is exercised – deals with the problems at hand.

Three evaluation criteria can be established on this basis:

- ***How effectively does the model deal with private and public failures?*** The need to correct for market failures often justifies government intervention. However, such public action may introduce some forms of "public failure". Hence, when assessing a business model, it is important to determine how it copes with both types of failures, and if the "solutions" are not worse than the problems to be solved.

- ***How well does the model take into account public obligations?*** Public action is often taken to meet social needs that would not otherwise be fulfilled by the market. Thus, business models can be assessed in terms of their ability to offer solutions to public obligations, without undermining the long-term viability of the infrastructure.
- ***How effectively does the model deal with environmental concerns?*** The provision of infrastructure services generates externalities that are ignored by traditional market mechanisms. Business models can be assessed on their ability to find appropriate solutions.

Dealing with private and public failures

It follows from the above discussion that two polar models typically tend to prevail in the five sectors under consideration:

- The *monolith model*. All segments of the value chain are vertically integrated. The monolith can be public (ministry, public corporation) or private under some form of public scrutiny (*e.g.* rate of return regulation).
- The *unbundled or separated model*. Only those segments (the network) of the value chain that are monopolistic are run as public or regulated private monopoly. Other segments are open to competition.

As discussed at length in the sectoral chapters, the monolith model is widely used in a number of sectors including electricity supply, water and water treatment, freight rail, UPT, and road transport. The separated or unbundled model is found in road transport and is gradually being introduced in rail transport and the electricity supply sector.

Each model has its strengths and weaknesses. The *monolith model* typically offers greater scope for vertical co-ordination and long-term planning, when appropriate financing mechanisms are put in place. Monoliths may also be in a stronger position to resist monopsonistic tactics of input suppliers (*e.g.* supplier of natural gas to electricity generators).

Conversely, the monolith model is more vulnerable to public or regulatory failures reflected in inefficient operation, lack of responsiveness to user needs, overextension of the infrastructure, capture of the regulator by the utility, high rents received by workers in the sector, lack of accountability, and vulnerability to political short-termism, leading to unsustainable levels of investment and poor maintenance of existing assets.

The weaknesses outlined above are particularly glaring in the water sector (notably short-termism and inefficiency), the rail and UPT sectors in OECD and non-OECD countries alike, as well as in the electricity sector in developing countries.

The *unbundled or separated model* is less vulnerable to public failures. It offers greater scope for efficiency and for responsiveness to users needs. It may also be less sensitive to political short-termism. However, the co-ordination of activities over the value chain may be more difficult to achieve in some sectors, resulting in increased uncertainty for key actors. This may lead to lower levels of investment than those that may be deemed desirable from an overall social perspective.

In practice, introducing the unbundled or separated model in sectors dominated by monoliths has proved difficult. For instance, in the electricity supply sector, effective reform has been more complex to achieve than originally anticipated. In the freight rail sector, the benefit of introducing some degree of competition whether following the US or UK/EU model is more clear-cut, but faces very strong opposition in Europe by legacy actors.

Dealing with social obligations

As already noted, social obligations are largely determined by the nature of the service provided by the infrastructure. Such obligations are relatively limited when the service is considered to be essentially a private good (freight rail, electricity). They are more extensive when the service is perceived to have a strong social dimension, either because the service is essential for life (water) or because it is viewed as important for fostering social cohesion (water, UPT, road transport).

In most existing models, social obligations are met by pricing the service below cost. For instance, in most countries, the price of water is very low and the main users (farmers) pay only a fraction of the cost, if at all. In addition, in the vast majority of public transport systems in the world, fares do not cover operating costs and do not rise in line with inflation (as an example, in the New York City subway, the "nickel fare syndrome" existed, where the fare remained set at a nickel, that is five cents, for more than forty years). In the rail sector, passenger rail fares typically do not cover costs, and passenger rail service is cross-subsidised by freight rail. Road transport provides free access at point of demand. Electricity is offered at highly subsidised prices in many developing countries (such as in India).

Putting the burden of social obligations on the infrastructure itself through below-cost pricing in such a way is inefficient and leads to the wastage of scarce resources (such as water). Moreover, it may have perverse distributional impacts (*e.g.* in a number of developing countries, the rich benefit from subsidised water rates, while the poor who are not connected to the network have to pay much higher prices to street water merchants). It is also clearly detrimental to the long-term sustainability of infrastructure and largely explains the chronic "infrastructure investment gap" that currently prevails in most countries.

The low priority attached to infrastructure development and maintenance at the political level arises in democratic societies from an "agency problem", that is from the fact that elected representatives only have a short-term political horizon (the next elections) and that future generations are not represented in the political process. Even when infrastructure-related issues attract political attention, such attention is more likely to focus on the development of new infrastructures rather than on the maintenance of existing ones.

This agency problem could be corrected in part at least by a greater emphasis on participatory democracy. Indeed, encouraging individual citizens directly concerned by a particular infrastructure – and who typically have a longer time horizon than the next election – to participate effectively in the decision-making process related to its development and management, could correct, at least in part, for the short-termism of elected representatives. Unfortunately, this is not the case in most instances. As a result, the need to ensure the long-term sustainability of the infrastructure is not fully taken into account in public decisions, leading to serious underinvestment.

Dealing with externalities

In most cases, the provision of infrastructure services does not reflect the externalities such provision generates. For instance, in the case of *electricity*, the pricing of services does not take into account the greenhouse gases (GHG) produced by the use of fossil fuels for electricity generation (coal-fired generators alone are responsible for 25% of the CO_2 released each year in the atmosphere). In addition, most users of *water*, notably farmers do not pay for the pollution they generate. In the *rail and UPT* sectors, the overextension of networks for political reasons under the monolith model results in wasteful energy use. In road transport, there is no incentive to pollute less because of the free access model.

Not only are the costs of externalities not reflected in the price of the infrastructure service, but less polluting infrastructure are not given preference over more polluting infrastructure. For instance, in the US, public policy typically tends to favour road transport over rail. In Europe, although the official policy is to promote rail transport, the patchwork organisation of railways prevents rail operators to compete on equal terms with trucks, in practice.

3.3. Sectoral perspective

The overall conclusion one may draw from the broad analysis in Section 3.2 above is rather pessimistic. Indeed, existing business models suffer from a number of weaknesses: 1) market and public failures prevail in many sectors, causing inefficiencies and lack of effectiveness; 2) the use of pricing for meeting social obligations contributes significantly to such inefficiency and results in

unsustainable levels of investment; 3) the environmental consequences of providing infrastructure services are still largely ignored.

It is interesting to see how these general conclusions are reflected at the sectoral level. This is the purpose of the summary assessment presented below. It draws on the analysis above and attempts to put the findings in perspective, by highlighting some of the key points that emerge from the discussion for each of the sectors.

For each of the five sectors, the nature of the service provided by the infrastructure, as well as the main business models, are identified succinctly. This is followed by a quick overview of strengths and weaknesses from the three main policy perspectives considered here, that is, economic, social and environmental.

Electricity

Nature of the service and main business models. *Nature of the service.* Electricity is generally viewed a private good. However, it is considered to be an essential service from a security and social perspective. Moreover, electricity generation and distribution create negative externalities from an environmental point of view.

Main business models. Although a broad range of models exist, two polar models tend to dominate: the monolith and the unbundled models.

Strengths and weaknesses of existing models. From an *economic perspective*, the monolith model is strong for vertical co-ordination and long-term investment planning and implementation, provided the level of revenue generated is adequate and interference for short-term political gains is kept to a minimum. However, it tends to be inefficient and not very responsive to user needs. The unbundled model is more efficient, more responsive, but vertical co-ordination can be a problem. Moreover, systemic long-run planning is more difficult, as risk is born by individual private decision makers in a competitive context, rather than by captive users and taxpayers. This raises questions about future supply conditions with regard to reserve capacity. Conversely, the unbundled model offers greater opportunities for network interconnection across regions and across countries, which should reduce some of the risks of supply disruption and should allow a more efficient handling of peak demand across the different markets. It is nevertheless interesting to note that, in practice, the interconnection of networks may increase the risk of failure or at least the adverse consequences of failure as illustrated by the black out of 2003 in the north-eastern part of North America that affected close to 50 million people.[35] Although the outlook for deregulation was rather upbeat a few years ago, the impact of deregulation today is generally viewed as mixed,

underscoring the difficulty of introducing effective market reforms in this sector. (See Annex 2.A1 for more details on this point.)

From a *social perspective*, the monolith model offers more scope for political interference. While interference is still possible with the unbundled model, its adoption encourages a more sound approach to meeting social objectives, by inducing governments to avoid actions that could undermine the sustainability of the infrastructure and the ability of the utility to undertake the necessary investment. However, concerns have been raised regarding the social implications of unbundling on the price of electricity charged to domestic users, to the extent that market conditions are likely to induce suppliers to adopt a Ramsay pricing approach to maximise revenues, *i.e.* discriminate in favour of large (industrial) users who have more options for meeting their demand for electricity than domestic users who typically have a more inelastic demand.[36]

From an *environmental perspective*, both models have failed so far to take into account the externalities generated by the industry, although the unbundled model may be more environmentally friendly to the extent that greater concern for efficiency results in reduced use of costly inputs and greater efforts to minimise transmission losses.

The design of an effective business model from an environmental point of view is a major challenge. The creation of a market for emission rights is a promising step in this direction as well as efforts to develop renewable energy sources. However, there is a danger that technology-specific incentives may be counterproductive. Moreover, uncertainty regarding the measures that will eventually be put in place by governments is creating uncertainty for the industry and may delay investment, notably in the unbundled model.

Water

Nature of the service and main business models. *Nature of the service.* Although water may seem to be a private good, it has strong public good characteristics (social, health, environmental). This justifies extensive public scrutiny, not only at the local level, but also at the regional, national and even the transnational level.

Another major consideration is the fact that urban use of water is only a relatively minor use of water.[37] Urban dwellers must therefore compete with other users for access to water supplies and also must bear the cost of the pollution generated by these users. This contributes to making the management of urban water systems particularly difficult. Indeed, urban water systems will not be able to satisfy surging urban demand unless rural supplies of water are also properly managed.[38]

Main business models. The public monolith model organised at the local level largely dominates in the world, although private concession models play an important role in some countries (for instance, in France).

Strengths and weaknesses of existing models. From an *economic perspective*, water systems under public monolith regimes have typically suffered from underinvestment over prolonged periods of time. This has lead to a serious deterioration of the infrastructure in most countries, resulting in significant inefficiencies while in emerging markets water systems remain largely underdeveloped.[39]

The seriousness of the problem faced by BRIC countries is well illustrated by the situation that currently prevails in Delhi where the city's water board, the Delhi Jal Board (DJB), is only able to meet a small fraction of actual demand for water (while 40% is lost to leakage) and receives revenues that cover only 60% of its operating costs.[40]

Growing pressures from financially hard-pressed governments and threats of privatisation have put pressures on public systems to improve performance via a "re-engineering" of existing systems. Corporatisation has also contributed to improved accountability.

Models involving strong private sector participation have met with mixed results outside the traditional markets of the private players. This has induced a number of players to be more selective and concentrate on contracts involving only limited risk. However, it is interesting to note that in France, where public oversight is strong and there is a clear policy that the management of water should be financially balanced ("l'eau doit payer pour l'eau", that is "water must pay for water"), private companies have been very effective in running water and water treatment systems. This suggests that these two conditions (strong public oversight and clear policy to set water prices at cost recovery levels) may be two important prerequisites for the effective participation of private actors in water management elsewhere.

From a social perspective. Concerns about meeting the needs of low-income users have kept user charges low, undermining the economic viability of many systems. However, models have often failed to pay sufficient attention to the key role public involvement and transparency play in the success and sustainability of water sector projects.

From an environmental perspective, existing models have not proved very successful. Water pollution and water stress is on the rise in a growing number of countries. Most of the problem, however, results from the wasteful use of water and water pollution in agriculture.

In the developing world, increasing industrialisation, population growth and lack of effective wastewater treatment are polluting future sources of water supply.

Developing country governments are typically more focused on providing water than with treating of wastewater. Continuing in this vein will certainly drive up costs for water provision as future sources of water supply become increasingly difficult to find, transport and treat to standards.

In OECD countries, the public awareness of problems is increasing, and a number of corrective actions have been implemented in recent years, including at the transnational level (for example, the water directives in Europe).

Hence, one may wonder whether current business models are up to the challenges they face. Are they able to channel the massive flows of additional finance needed to further extend infrastructure (to reach new segments of population, or to achieve more stringent health and environment standards) and to enhance maintenance of existing assets, in both OECD member and non-member countries? Alternative technologies may generate innovative approaches, harnessing such newcomers as the financial community (carriers of long-term savings), domestic operators and property developers.

Freight rail

Nature of the service and main business models. *Nature of the service.* Perhaps more than the other four infrastructure services covered in this book, freight rail may be viewed as a private good. This means that, in principle at least, economic considerations should dominate the policy agenda. However, the environmental advantage of rail over road transport should also be taken into account.

Main business models. Three main models seem to dominate the sector: the public monolith model which is still the dominant model world wide, the separated model (first introduced in the UK and which should be extended gradually to the rest of Europe in the coming years) and the owner-tenant model that prevails in North America.

Strengths and weaknesses of existing models. *From an economic perspective*, the monolith model offers some advantage in terms of co-ordination between infrastructure development and operation of rolling stock. However, it is vulnerable to political interference, and there is no strong incentive for efficiency while the service is not very responsive to user needs. The monolith model is also not conducive to long-term investment, when such investment requires substantial subsidies from the government (*e.g.* BR before privatisation in the UK, and the SNCF today in France).

The separated model should in principle allow for more efficient operation and greater responsiveness to user needs. In Europe, the EC has high hopes that this could eventually lead to a reversal of the gradual decline of freight rail, in competition with road and water transport. However, many obstacles remain to be overcome, including the strong resistance of legacy monoliths in a number of countries.

In the aftermath of the Stagger Act of 1980, the North American model has proved very successful, allowing freight railways to improve significantly the efficiency of their operation and increase their market share of the freight market, despite a bias by the US federal government in favour of road and water transport.

From a social perspective, both the monolith model and the North American models were vulnerable in the past to public policy aimed at cross-subsidising passenger service by freight. The problem has been largely resolved in North America by the creation of AMTRAK and VIA Rail which are funded directly by the government.[41] It remains very serious in other parts of the world. This includes Europe where investment plans clearly favour passenger traffic over freight traffic.

From an environmental perspective, freight rail is receiving growing attention from policy makers. This could have beneficial effects for rail across all models if it results in efforts to divert part of the growth in road transport to rail and to promote multimodal transport. In North America, such diversion is likely to be modest given the high share of freight already carried by rail. The potential is much larger in Europe where rail accounts for only 8% of the freight traffic. Doubling this share is doable according to the experts, but it would require more forceful efforts to move to a more liberalised (separated) business model, allowing private freight trains to move freely over a truly pan-European railway network and beyond.

Urban public transport (UPT) systems

Nature of the service and main business models. *Nature of the service.* Urban public transport systems are natural local monopolies and the services they offer have a strong "public good" dimension.

Main business models. Although a number of UPT systems were historically developed by private investors (notably the London and the New York City subway systems), today most are run as public monopolies. However, private sector participation occurs in some cases, either for the operation of the systems, or for the maintenance and upgrading of the infrastructure.

Strengths and weaknesses of existing models. *From an economic perspective*, as noted by Crozet, the public monolith model is vulnerable to political interference that can lead to significant inefficiencies. In most instances, UPT systems do not cover operating costs.[42]

Introducing competition for the market can help, but the tendering process is vulnerable to collusion among the bidders; and setting up a level playing field is not easy when incumbents of existing systems that have not had to go through a tendering process are allowed to bid on new contracts.

The use of PPP for maintenance and upgrading of the infrastructure is more controversial (see the London Underground example in Box 2.3).

From a social perspective, UPT systems fulfil an important social role by providing access to all within the city. However, setting fares too low and preventing such fares to rise in line with costs undermines the ability of the system to maintain and upgrade facilities with adverse consequences for all users.

From an environmental perspective, UPT systems offer an effective alternative to private cars in densely populated areas, and it is indeed the main reason often given in recent years for their implementation. However, overextension of the network to less densely populated areas – which may very well occur in the public monolith model – is questionable, both from an economic and environmental perspective. Moreover, the development of cleaner cars (such as, "plug in" electric cars), combined with effective road pricing and greater reliance on ICT (for telework, teleshopping, telemedicine, and distant education) may weaken the environmental advantage of UPT systems in the future.

From a planning perspective, it is becoming increasingly necessary to approach the planning process from a metropolitan-regional point of view, so as to ensure that all relevant institutional actors (national government, regions, municipalities, etc.) are involved. The same applies for certain other infrastructure sectors.

Road transport

Nature of the service and main business models. *Nature of the service.* Road services do not meet the criteria established for private goods: while they are rivalrous, they are not excludable in the business model that prevails in most countries. Road space is allocated to traffic on a first-come, first-served basis, and is free at the point of demand

Main business models. The large majority of roads in the world are owned and operated by the state and different levels of government. However, there is scope for private sector participation as concessionaires of motorways or, in some cases, as owners and operators of private roads.

Strengths and weaknesses of existing models. *From an economic perspective*, the model of free access at the point of demand inevitably leads to costly congestion in densely populated areas, once capacity is reached, resulting in an inefficient allocation of scarce road space. However, introducing a system that is both more efficient (*e.g.* road pricing) and viewed as fair by the majority of users is a politically formidable task. Nevertheless, as demonstrated by the London experiment with cordon charges, the imposition of such charges over a limited geographical region can be quite successful in reducing congestion and in encouraging greater use of public transport, even if the scheme is costly to implement and does not generate as much revenue as originally anticipated.

From a social perspective, the current regime may be considered unfair to rural dwellers who have to pay a disproportionately high share of the cost of the network, through the mixture of vehicle and fuel taxes that prevail in most countries.

On balance, the distributional impact of cordon charges may be positive. On the face of it, such charges seems to favour the rich, since they are better able to shoulder the extra burden of the charge, while they can take advantage of reduced congestion to move more quickly than previously in the city centre, saving economically valuable time. However, low-income commuters who were taking the bus before also benefit from a better service too, without having to pay for the charge. Those who might be most negatively affected are the middle-class users who are forced to abandon their private vehicle for public transport. However, their overall cost of commuting may be reduced, and they benefit too from reduced congestion in the central area.

From an environmental perspective, the current model of free access at the point of demand is inefficient since it encourages overuse of the facilities by vehicles that create negative environmental externalities.

4. Future prospects

This section examines how the assessment conducted in Section 3 above may be modified in the coming decades under the influence of major drivers of change, taking into account the impact that such drivers may have, not only on the future viability of existing business models, but also on the balance of objectives that policy makers are likely to pursue (*i.e.* some objectives are likely to become more/less important; the balancing of a new configuration of multiple policy objectives in the future may raise new issues).

The analysis above suggests that, on the basis of the current state of play alone, substantial changes should be made to existing business models. But given the long term nature of infrastructure development and management, considering the current situation is not enough for effective policy making. Ideally, one should also look into the future in order to take into account – to

the extent possible – the future prospects of existing models, *i.e.* how such models may fare in the future in the light of changing circumstances, as well as likely changes in the public policy agenda.

This is a highly speculative undertaking since it is impossible to predict the future. However, the future is not completely open. Indeed, the set of possible futures is largely determined by a number of drivers of change. While it is not possible to determine in advance how such drivers will play out in the end, one can nevertheless speculate on the way each one may influence the future of our economy and society at large and on the consequences this may have for infrastructure development.[43]

Some of these trends may directly affect the strengths and weaknesses of the business models (*e.g.* a new technology may render an existing model obsolete); others may have indirect impacts, by changing the relative weight that may be assigned to various policy objectives (*e.g.* growing concerns about the environment may induce decision makers in the future to favour models that deal more effectively with externalities).

On the basis of work conducted in earlier phases of this project, several drivers of change have been identified as having a particularly important bearing for infrastructure development in the future.[44] The drivers which are considered below include the changing geopolitical environment; the growing importance of security considerations; the challenges raised by future economic growth, globalisation and expected changes in the structure of economic activities; key demographic trends (population growth, population ageing and urbanisation); new opportunities that may be offered by technological change; and the consequences of growing concerns for the environment. Attention is also given in this section to the increasing demands that are likely to be put on the public purse, the changing role of private actors and the general trend observed in OECD countries and beyond towards a more participatory form of democracy. These trends may also have important consequences for the formulation of public policy and the conditions under which infrastructure services will be provided.

4.1. *Geopolitics*

Growing interdependence in the coming decades will create an environment where geopolitical relations will be more complex and involve a larger set of actors beyond nation-states. This will have important implications for infrastructure development.

First, because of growing international interdependence, individual countries will become more vulnerable to the actions of other actors. This is the case for electricity generation and distribution, where concerns about security of supply of input fuel will become increasingly important.

Second, the management of common resources will require increasing co-ordination across countries and may lead to the formulation of transnational regulation and the establishment of transnational standards (*e.g.* water, road and rail transport).

Third, geopolitical considerations will significantly influence the development of some infrastructure. This applies, for instance, to the proposed extension of railways beyond Europe to the Middle East and Asia.

These developments will have important implications for *business models*. For instance, in the case of the *electricity* supply industry, as supply chains become increasingly globalised, the volatility of input fuel prices will be felt more quickly everywhere, increasing risk for investors. This could have a detrimental effect on investment and call for the adoption of risk mitigation measures, such as the storage of larger input fuel reserves and the development of more effective fuel switching capabilities.

The need for managing common resources more effectively across jurisdictions will call for a greater role for transnational governance. For instance, although the day-to-day management of *water* systems will remain largely local, transnational actors will play a growing role in shaping infrastructure development. This role will need to be reflected in business models both at the local and national levels. Standards established at the transnational level will increasingly influence the level and nature of infrastructure investment that will need to be carried at the local and regional levels (*e.g.* EC water directive). Moreover, as water becomes scarcer, co-ordination across countries sharing the same water basin will become increasingly critical, as access to water could become a growing source of conflict.

Finally, favourable geopolitical conditions will increase the potential for international exchanges, as well as the economic benefits that can be derived from such exchanges, resulting in an increased demand for the development of effective and efficient transnational *transportation* links (including multimodal terminals). These benefits will be better achieved with models that foster carriage competition than in monolith models.

The *implications for policy* will also be substantial. First, international relations will become increasingly important, and the distinction between "international" and "domestic" policy will become more blurred. In this context, national governments will increasingly have to negotiate international agreements with their neighbours and assist local authorities in the implementation of such agreements, including financially. The role of international organisations is also likely to grow, particularly in areas where specialised expertise is required.

The *electricity* supply industry is an interesting case in point in this regard. Governments in fuel-importing countries will have to pay particular attention to their relationship with input fuel supplying countries and will have to

co-ordinate their position with other fuel-importing countries more effectively.[45] Efforts will also have to be made to strengthen links across electricity markets so as to be better able to cope with disruptions of supply. In addition, measures designed to foster the responsiveness of electricity demand to fluctuating electricity prices should help. This could be encouraged, *inter alia*, by the widespread adoption of smart metering so as to allow users to respond to price changes in real time.

When making policies affecting input fuel choices, governments will have to make difficult trade-offs between conflicting policy objectives. For instance, security of supply considerations may favour the use of coal as input fuel; whereas relying on gas supplies from abroad, although more risky, might be preferable from an environmental perspective. Such choices, however, will be increasingly constrained by international commitments (such as those under the Kyoto Protocol) unless new technological advances modify the balance of power between users and suppliers.[46]

Geopolitical factors will also be important in other sectors. For instance, beyond purely economic or social considerations, *transportation and communications networks* will continue to be given high priority by government as a tool for nation-building (or regional integration) and for forging links with other countries (*e.g.* TEN-T in Europe and plans to expand it to 26 neighbouring countries).

4.2. Security

As was noted in Andrieu (2005), in the future security will encompass a broad range of concerns beyond purely military ones. Such concerns will focus on a multiplicity of systemic risks (both natural and man-made) that could cause major devastation in terms both of loss of lives and loss of property. The increasingly sophisticated and ubiquitous infrastructures that we depend upon more and more could be particularly vulnerable in this regard.

For instance, in the case of the *electricity* supply industry – and in addition to the geopolitical threats outlined above – major disruptions at key choke points in the energy supply chain resulting from accidents, natural phenomena or terrorist attacks could have devastating effects throughout the world on input fuel supply. In this context, models featuring high dependence on the import of gas and a highly centralised network with limited interconnection to other networks are likely to be increasingly vulnerable. Moreover, such disruption could have far-reaching domino effects on other infrastructures that depend heavily on electricity, such as water treatment systems, road and rail transport and electronic financial networks.

Increased security threats will also have an adverse effect on investment in all models. In the case of public models, increased attention by government to security will put further constraints on the public purse, reducing the ability of

government to devote resources to infrastructure development and maintenance. In addition, in the face of higher security risks, private sector actors will be more reluctant to invest in infrastructure. In both cases, this could have a vicious circle effect to the extent that underinvestment undermines the robustness of the network and makes it more vulnerable to future disruptions.

Security concerns may also open a debate on whether centralised or decentralised models should be adopted. For instance, in the case of *water*, security consideration may favour the adoption of more centralised governance and may make the use of private actors less attractive. Plus, in the case of *freight rail*, security risks may induce governments to favour public ownership and centralised systems that can more easily be monitored and controlled. A similar argument in favour of centralisation has been made regarding *electricity* supply in Europe, as already noted above.

Functionally, however, decentralised systems may be less vulnerable to some risks. For instance, in the case of *electricity*, distributed generation and interconnection across networks are thought to reduce vulnerability to disruption and to alleviate the need for capacity reserve. The risk of massive disruption is also reduced in decentralised water systems, while increased interoperability in the case of *rail* increases the robustness of the network.

In all cases, there is a clear message that security concerns will increase the need to monitor effectively the state of the network so as to be in a better position to take appropriate action in a timely manner. For instance, in the case of *water*, Palaniappan *et al.* note that security factors also make water quality monitoring more important: it should be well informed, well funded, publicly controlled and nationwide. This could put greater emphasis on the development of ICT-based monitoring technology and more investment in instrumentation for water systems.

In some cases, security concerns may affect the choice of infrastructure. For instance, terrorist attacks on *public transport* systems might induce commuters to favour the use of private cars. However, other security considerations could induce government to favour rail over road transport. *Rail transport* is not only safer, but it is also less vulnerable to fluctuation in the price and availability of oil than road transport.

Security concerns will also result in the development and stricter enforcement of security standards. For instance, in the case of *electricity*, more attention will be given to the development and enforcement of mandatory standards, including close monitoring of the condition of transmission lines.[47]

4.3. Economic growth and structure

Economic growth is generally viewed as the major driver of the demand for infrastructure services. However, changes in the composition of output

also have a bearing (*e.g.* growing share of services in overall consumption) on infrastructure use, as well as the growing globalisation of economic activities.

In the case of most infrastructures, economic growth will fuel an increased demand for infrastructure services, creating pressures for increased production. Doing so can be achieved either by more efficient use of the existing infrastructure and/or an increase in its physical capacity.

Serious questions have been raised however, regarding the ability of existing business models to deliver the necessary investment. For instance, Morgan notes that there is no certainty that with existing business models all of the investment needed will, in fact, be forthcoming. If actual investment falls short of that required or is delayed, some part of demand might go unmet, leading to temporary or persistent power shortages. The main uncertainties surrounding the adequacy of electricity investment world wide relate in part to the impact of liberalisation and market reforms and the adoption of the unbundled model which will affect incentives to invest and access to capital (see Annex 2.A1). However, the monolith model could also be under strain, notably in countries where the revenue generating capacity of the model is insufficient, as already noted for instance in the case of India.

In the case of *water*, Palaniappan *et al*. note that underinvestment has been a serious problem for decades under largely public business models, as there is a failure of public governance to take the necessary action in a sustainable long-term manner. Underinvestment is also a serious problem for the *rail network* and *road transport* under the public monolith model.

In this context, the key issue for governments will be the adoption of business models that are *responsive to growing demand*, that is, models where prices better reflect the cost of providing the service and which take into account the need to adopt a long-term approach to infrastructure development in a sustainable manner. In many cases, this will call for regulatory reform so as to provide a more supportive environment to infrastructure development. An interesting case in point in this regard is Brazil where government must rely on the private sector, including foreign investors, for infrastructure development. This is forcing the adoption of more business-friendly policies by the authorities, as well as efforts to put in place more effective regulations.

Globalisation will also have an impact on business models and related public policy. As the volume and scope of international exchanges increase in the future, greater attention will need to be given at the national level to business models that effectively support the development of efficient transport and communication systems. This will create growing pressures for the adoption of more liberalised business models in these sectors (*e.g.* freight rail). Growing attention will also be given to urban development, as cities will likely be the major

engines of growth in the future. Their effectiveness in this regard will depend in part on the availability of an efficient *urban transport* system that allows city dwellers to fully exploit agglomerations' economies.

Economic growth, however, will also have adverse consequences that will increasingly need to be taken into account. In some cases, expanding the capacity of the existing infrastructure will not be feasible. This will raise three key questions for policy makers: 1) how the existing capacity should be rationed, taking into account social and political objectives; 2) to what extent it is possible to induce infrastructure users to switch to other types of infrastructure services that are considered more desirable from an overall public policy perspective; and 3) how the use of the existing infrastructure can be improved.

In other cases, greater attention will be given to the externalities generated by the operation of the infrastructure. This will call for far-reaching changes on the supply and on the demand sides that will need to be reflected in the business models (*e.g.* for reducing environmental effects of electricity generation or road transport).

4.4. *Financing*

Given the growing constraints on the public purse, not least those stemming from ageing populations and the prospect of a possibly shrinking tax base, alternative sources of funding will have to be tapped to reach the necessary levels of investment.

In *monolith business models*, the key questions will be whether users are solvable or not and whether there is a political will to charge users a price that reflects costs. In traditional OECD *electricity* markets for instance, where the risk is largely borne by users, this should not be a problem. However, the situation is quite different when users are not solvable. This is the case for electricity distribution in countries such as India where the rates charged to users are deliberately kept low for political reasons. In addition, this applies to monolith models used in the *water* sector, in *UPT*, as well as *in rail transport* where passenger services may be cross-subsidised by a shrinking freight rail service (*e.g.* experiences of BR in the UK, and of SNCF in France where non-TGV infrastructure has suffered from underfunding as reported by Thompson). The situation is even worse in models where the service is provided free of charge (road transport), unless the fuel tax and tax on vehicles can be tapped for road network upgrading, as is the case in the US.

In *liberalised models*, the situation may be quite different to the extent that risks are borne by those who make the investment decision, rather than by captive final users. Investment will be forthcoming if the revenue stream received by the investor provides a rate of return in line with market rates, taking into account the specific risks facing investors in that sector.

The *electricity* sector seems to be where such conditions are most likely to be met in the future, provided that adequate instruments can be developed to mitigate risks and encourage investment.

In the *freight rail* sector, even in liberalised markets such as the US, private operators may not always have the resources necessary to expand capacity. Rail operators are typically very cautious when making investment decisions because of the long duration of rail assets and the long depreciation periods that apply from a fiscal point of view (such as, 30 years in Canada). Moreover, when investment involves the construction of major intermodal terminals of national interest, the question arises regarding the role that should be played by the state in such investment.

In the *water* sector, there are reasons to believe that the contribution of users could be strengthened; new technologies allow the development of on-site and closed-cycle systems that can be provided on a commercial basis. However, when considered from an overall policy perspective, all models should provide a minimum service to the poor. This should not be a problem in OECD countries, but this could undermine the financial viability of business models in the future in many developing countries, unless multilateral sources of funding can be tapped effectively.

In the *UPT* sector, public funding is essential. Regional and national authorities can be expected to continue to play an active role in this regard, because of the growing recognition of the regional and national significance of well-functioning cities in the overall economy and society. However, users may assume a larger share of the burden as such systems expand. Moreover, indirect beneficiaries of the systems (landowners, employers, private car commuters) could also be called upon to contribute more financially.

In *road transport*, public funding is likely to remain dominant, except in very specific cases. However, private finance initiative (PFI) models for rehabilitation schemes could be envisaged (the Portsmouth model in the UK as described by Mackie and Smith). Toll highways may also be progressively introduced in countries where they remain the exception today. This is likely to start first in situations where a "free" (but congested) alternative exist. However, strong public resistance may delay the implementation of this model, as illustrated by the Canadian experience in this regard (Highway 407, Fredericton-Moncton Highway).

4.5. *Demography*

When considering the impact of demographic development on infrastructure, several dimensions of such evolution need to be taken into account, beyond the mere increase in number. This includes for instance population ageing, urbanisation and international migration.

Growth in population by itself will put growing strain on existing infrastructures and create pressure for increases in capacity. The strain will be particularly severe in sectors where the available resources are limited (*e.g.* water services) or where there are physical limits to the extension of the network (*e.g.* roads). This will put existing business models under jeopardy, notably those that are not on a sound financial footing today. This problem is a major one for developing countries, since it is there that population growth of the poorest is expected to be the fastest.

Perhaps, it is in the case of the *water* sector that such problems are most severe. As noted by Palaniappan *et al.*, growing populations will contribute to rising demand for water in the future while, at the same time, the increased pollution generated by such populations will reduce readily available supplies of fresh water. Population is growing fast in areas that are already water-stressed. By 2025, two-thirds of the people in the world could live in water-stressed areas. In these regions, water systems already suffer from severe underinvestment and are clearly not on a sound financial footing. This implies that water-related issues will become increasingly prominent in the future, including the search for business models that can deal effectively with the problem. Particular attention will need to be given to wastewater treatment and recycling, an area that currently is not given much attention in developing countries. A key question will be the role that can be played by the private sector, including large multinationals specialising in this field, but also domestic operators and the financial community, *i.e.* how to develop "win-win" partnerships where the expertise of these companies are fully exploited for the benefit of all users, including the poor who do not currently have access to potable water.[48]

Growing populations will also have an adverse effect in other sectors. In the *electricity* sector, this will contribute to increased strains on energy resources. In the *road* sector, it will exacerbate road congestion. Larger populations will also have an impact on *freight rail*, not only on the demand side (because of the increased volume of goods that will need to be transported), but also on the supply side, as noted by Thompson, because of the increase in passenger train traffic it will generate. This could undermine the economic viability of existing rail freight business models to the extent that heavier passenger traffic may result in a higher burden on rail freight operators (more cross-subsidies from rail to passenger traffic), while priority given to passenger rail traffic means more disruption of freight rail traffic. This may lead to renewed efforts to more clearly separate passenger rail and freight rail traffic, *inter alia*, by developing freight corridors.

Population ageing will also have an impact on infrastructure development and business models. First and foremost, business models relying heavily on public funding will be under stress as population ageing will put increasing pressure on the public purse, reducing the ability of the central governments

to finance infrastructure. This will encourage government to favour full cost pricing business models and to push financing to the local level whenever it is feasible to do so.

Population ageing will also be reflected in lower population growth in the OECD area and beyond, or even population decline in some cases. This means that particular attention should be given in these countries to business models that provide for effective maintenance of existing capacity. This is no easy task in light of the short-termism that prevails in democratic societies.

However, population ageing could have some *favourable* consequences for some infrastructures. Although this question is not addressed by either Crozet or Mackie and Smith, it would seem that, *ceteris paribus*, as population gets older, UPT could become more viable and the stress on the road network could be reduced, to the extent that older people are likely to prefer public transport over private cars in congested areas where the supply of public transport is adequate to meet their needs. Moreover, older people typically have the choice of travelling during off-peak periods. Finally, the elderly tend to move away from large cities, thereby contributing to reducing population density in large metropolitan areas.

Urbanisation is a major trend that will be particularly important in developing countries. It will strongly influence infrastructure development and the business models that will be used for this purpose. This will be the case notably for *water* infrastructure. Palaniappan *et al.* note that rapid urbanisation will call for significant investment in the development of centralised systems that may be the cheapest option to serve large population concentrations. Financing the development of such systems will be a major challenge given that a large share of the populations to be served will be poor. Business models involving financing in part by multilateral institutions such as the World Bank may be the most promising option for this purpose. Bringing in the private sector is unlikely to be successful except at the technical level.

It is clear that urbanisation will significantly increase the strain on *transport* systems, notably on the public transport systems in the large cities of the developing world, since most of the growth in population over the next few decades will be in urban areas in these countries. In this regard, one may wonder whether the countries involved will try to adopt the centralised segregated public transport model advocated by Crozet, given the heavy level of funding involved and the serious danger of public failures that such systems involve. Instead, they may attempt to build on the relatively successful informal private models found in many cities of Africa and Latin America that rely largely on the management of minibuses. Crozet notes that such a private transport offer is often least costly and of better quality than the public one and points out that this private model may offer an interesting example for developed countries, including notably the development of "car sharing" and "car pooling".

4.6. Technology

In all the infrastructure sectors, advances in technology are expected to have important consequences for existing business models and may allow the emergence of new ones. Overall, technology is not "business model-neutral". By multiplying options and opportunities, advances in technology tend typically to undermine "monolith-type models" and to favour a more distributed and diversified approach to infrastructure service provision.[49]

In the case of *electricity*, Morgan notes, for instance, that technology has significantly contributed to the adoption of the unbundled model in a number of countries. He notes further that the growth of small-scale renewables-based generation technologies, as well as other forms of distributed generation, such as small-scale fossil-based co-generation plants and fuel cells, could radically alter the structure of the electricity industry.

Policy makers in many countries are actively encouraging the development and deployment of *distributed generation* because of the economic, environmental and energy security benefits they can bring. On-site power production by fossil fuels generates waste heat that can be used by the customer, reducing overall primary energy needs. Distributed generation may also be better positioned to use inexpensive fuels that would otherwise go to waste, such as landfill gas. Distributed generation facilities located at an end-user's site or at a local distribution utility, and supplying power directly to the local distribution network, can also reduce the need to invest in long-distance high-tension transmission lines. Increased use of distributed generation technologies could avoid around USD 130 billion (in year-2000 dollars) of global investment in transmission networks between 2001 and 2030 – equal to 8% of total transmission investment (IEA, 2003). The reliability of electric power systems can be enhanced by distributed generation, as the system is less dependent on centralised facilities. The use of distributed generators at selected locations can also help distributors overcome local bottlenecks.

The widespread deployment of distributed generation would require profound changes in the way the electricity networks are organised, constructed and operated. Networks would operate in a much more decentralised manner. This could expand opportunities for small generators. More power would be generated and managed by the system operator at low voltages. In such a system, the high-voltage network would need to provide back up for the local decentralised systems.

In the case of the *water* sector, Palaniappan *et al.* notes that new technology will contribute to reducing the cost of water development and to increasing the quality of water as well as the security of water systems. It can also bring about the emergence of new business models, as such new technology makes smaller scale, decentralised systems cost-competitive.

On-site systems developed and managed *locally* will increasingly allow peri-urban, rural and greenfields to opt out of conventional large-scale centralised water and wastewater systems. Such a move should result in considerable savings, compared to extending the centralised system far afield, and will shift the burden of investment from the centralised system to property owners.

Desalination technology could provide a useful option in water-stressed regions. Advances in the technology have already brought the price of such units to levels not too far removed from more traditional source of waters (*e.g.* water pumped from rivers). Private entrepreneurs may apply this solution in a growing number of water-stressed areas in a decentralised manner, since more than half the world population lives within 60 kilometres of the sea.

The ability to generate energy from waste through *biotechnology* could considerably alter the business models of wastewater treatment. Up to now, the anaerobic digestion that creates biogas has been a niche technology. If energy can be generated profitably, such as through the development of microbial fuel cells, the cost of waste treatment could decline drastically and become more attractive for the private sector.

The development of "low impact technologies" could considerably reduce runoff water quality problems. But these decentralised solutions may be difficult to implement in a centralised water system context.

However, some technological development may favour centralised systems. *ICT and GPS-based technologies* will allow a closer remote real-time monitoring of water systems, improving the ability of managers to make decisions related to water sourcing and water pollution on a large scale (*e.g.* watershed level) and will provide for greater system robustness. ICT technologies will also allow systems to be effectively managed at larger scale.

New technology will also raise important *policy issues*. Governments will need to pay particular attention to the obstacles that may exist in business models regarding the application of new technologies. This includes rules and regulation and standards that are technology biased (*e.g.* a requirement that the new development be connected to a centralised system may discourage the adoption of on-site and closed water cycle solutions). Moreover, new technology that makes fresh water available where it was not previously will raise water rights issues. It will change the nature of who owns the water.

In the case of *rail freight* transport, technological progress is expected to have only a moderate impact on business models, although new technology is more likely to be adopted quickly in "separated models" where competitive pressures on operators will be the greatest than in monolith models. Progress is expected to be gradual, including increased freight wagon cargo capacity; increasing freight train loading; increasing maximum axle load; enhanced signalling, including the possible adoption of "moving block" signalling;

improved traction of locomotives and reduced energy consumption; improved operating techniques (including the use of block trains and dedicated unit trains). However, public monoliths may be in a stronger position to introduce breakthrough technologies (*e.g.* TGV) since all the risks are borne by users or taxpayers, while the public authority has the necessary clout to remove regulatory and institutional obstacles, if the political will is strong enough.

Governments keen to shift traffic from road to rail are likely to pay particular attention to the development of technologies that could contribute to giving rail an edge over road, hence to improve the efficiency, security and reliability of rail freight services.

However, as noted by Thompson, it seems quite possible that the single most important advance in technology aiding the growth of railway freight traffic will be in highway tolling, which should contribute to create a more level competitive playing field for rail freight carriers. However, the impact of highway tolling will very much depend on the business model used in the rail freight sector. In Europe, it will benefit EU freight rail traffic only if the management model for rail freight is changed to promote private ownership and operation of rail freight carriers at the European level, and if border barriers are considerably reduced.

Although Crozet does not address technology specifically, it is clear that it will have an important bearing on the business models used in *urban public transport*. First, technological advances could foster the efficiency and effectiveness of UPT systems by improving their carrying capacity through improved signalling, control and more widespread adoption of automation, reducing labour costs that currently represent 60% of operating costs, as noted by Crozet.

But technology could also improve the effectiveness of more decentralised models. ICT will contribute to improved road traffic management and should facilitate the introduction of demand management scheme (road pricing). It may also make decentralised solutions such as car pooling, car sharing or private minibus services more viable.

The development of ICT could help reduce the need for physical mobility within cities (telework, teleshopping, tele-education, telemedicine). In this regard, efforts in a number of cities to offer city-wide very high capacity Internet connections are interesting developments. But ICT may undermine the very *raison d'être* of cities by reducing the significance of agglomerations' economies, and by promoting the development of Internet-based communities outside large cities. However, the evidence on this score is not clear. Indeed, ICT seems to have favoured increased physical concentration up to now.

Finally, the enthusiasm for UPT, which has been largely motivated, as noted by Crozet, by environmental considerations, may be dampened by the development of emission-free vehicles, such as electric cars.

From a public policy perspective, technology raises a number of issues in an urban transport context. To what extent should the deployment of ICT technologies be encouraged (*e.g.* development of Wi-Fi in cities)? What changes should be made to regulations so as to encourage the development of new innovative business models (*e.g.* elimination of quotas on taxi licences that currently limit the offer in a number of cities and prevent the development of private minibus initiatives)? What policies should be adopted to encourage telework, e-commerce, tele-education, telemedicine?

Many of the remarks made regarding urban road transport are also pertinent for *road transport* in general, particularly those that apply to the application of ICT, and the role it could play for demand management and the introduction of business models based *on road pricing schemes*. The development of new fuel technologies could also contribute to reducing dependence on foreign oil as well as the adverse environmental effects of road transport. Research into multifuelled vehicles, fuel cells, biofuels and hydrogen-based fuels is promising and likely to be stepped up as shortages in more traditional fuels are encountered. This could help induce policy makers to consider further expansion of the network more favourably, especially if congestion becomes so widespread that the economic and social costs of reduced mobility become unbearable.

As noted by Mackie and Smith, the challenge in introducing road pricing schemes is not technical feasibility but cost effectiveness and political/social acceptability. They point out that it would be essential to think in terms of tariff reform, with road user charging for congestion and environmental reasons associated with reforms to fuel taxation and vehicle ownership taxes, so as to ensure that a strong coalition of road users would be willing to accept the package. In the UK (and probably in other countries as well), there is acute political sensitivity in the treasury to such a concept. The other point is that it appears that implementation would be hugely expensive.

The introduction of *tolls* in exchange for a reduction in fuel tax raises significant fiscal policy issues because of the weight of fuel taxes in public budget (these taxes are used for other areas and not only road transport). With a toll system, users will logically expect a closer link between the toll charged and the road service provided. Hence, the introduction of tolls could induce a sea change in the way the road network is managed, with greater emphasis on maintaining a sustainable level of quality of service over time.

4.7. Environment

The future evolution of the environment (in particular, climate change) and the growing concerns engendered will have a profound impact on infrastructure development and may bring about significant changes that could affect the viability of existing business models and induce governments to reassess their overall approach to infrastructure development and maintenance. In this regard, the *Stern Review on the Economics of Climate Change* (United Kingdom, 2006a), may be as J.F.O. McAllister of *Time* magazine puts it "a tipping point, one of those moments when a lot of trends converge to make old obstacles look punier".[50] For policy makers, the merit of the Stern report is that it considers climate change mitigation policies in a benefit/cost context, that is, to what extent the future benefits of mitigation are worth the costs they will impose on society today.

With regard to the consequences of climate change, the general conclusion reached in the report is that the scientific evidence points to increasing risks of serious, irreversible impacts from climate change associated with business-as-usual (BAU) paths for emissions. Climate change threatens the basic elements of life for people around the world: access to water, food production, health, and use of land and the environment.

The authors of the Stern report further point out that the damages from climate change will accelerate as the world gets warmer. Higher temperatures will increase the chance of triggering abrupt and large-scale changes. The impacts of climate change are not evenly distributed; the poorest countries and people will suffer earliest and most. And if and when the damages appear, it will be too late to reverse the process.

Of course, infrastructures will not escape unscathed. The findings of the Stern report most relevant in this regard focus on four consequences of climate change: greater weather variability, more extreme weather events (storms), permafrost melting and rising sea levels.

Greater weather variability. The impact of climate change will be particularly severe in the *water* sector. Greater weather variability will mean that rain precipitation will become more uneven and less predictable, increasing the occurrence of runoff, the amount of water that flows over the land surface. This will not only mean potential changes in water availability to people, but also will amplify the need to invest in infrastructure to help manage patterns of water supply. More frequent water shortages will raise the investment required in infrastructure, reduce agricultural output and exacerbate infrastructure damage from subsidence.

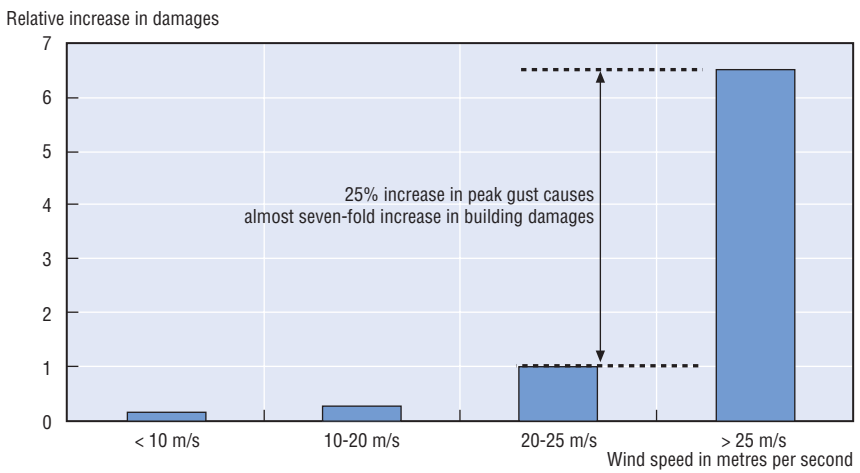
Water-related issues will be particularly challenging in developing countries which are highly dependent on water – the most climate-sensitive economic resource – for their development. Indeed, many developing countries do not have enough water storage to manage annual water demand based on the current

average seasonal rainfall cycle. This will become an even greater bind with a future, less predictable cycle.

More extreme weather events. Critical infrastructure, which is often concentrated around coastlines, including oil refineries, nuclear power stations, port and industrial facilities will be increasingly vulnerable to violent storms.

Infrastructure damage will rise sharply in a warmer world because of the combined effects of increasing potency of storms from warmer ocean waters and the increasing vulnerability of infrastructure to rising wind speeds. Indeed, such damage will increase substantially from even small rises in sea temperatures because: 1) peak wind speeds of tropical storms are a strongly exponential function of temperature, increasing by about 15-20% for a 3 °C increase in tropical sea surface temperatures; and 2) damage costs typically scale as the cube of wind-speed or more (see Figure 2.2). Storms and associated flooding are already the most costly natural disaster today, making up almost 90% of the total losses from natural catastrophes in 2005 (USD 184 billion from windstorms alone, particularly hurricanes and typhoons).[51]

Figure 2.2. **Relationship between building damage cost and peak wind speed**



Source: United Kingdom (2006a), *Stern Review: The Economics of Climate Change*, HM Treasury, London.

Melting permafrost. Climate change will also have a detrimental effect on infrastructure in colder regions. High latitude regions are already experiencing the effects of warming on previously frozen soil. Thawing weakens soil conditions and causes subsidence of buildings and infrastructure. Climate change is likely to lead to significant damage to buildings and roads in settlements in Canada and parts of Russia currently built on permafrost.

Melting permafrost risks damaging high latitude oil and gas installations, pipelines and other infrastructure, including railways, such as the Russian Federation's Baikal-Amur railway, and will also require expensive remedial investment. Stormier seas could raise the attraction of land routes from Asia to Europe, including the planned new Eurasian railway across Kazakhstan.

Rising sea levels. This will increase the risk of damages to coastal infrastructure and accelerate capital depreciation. Costs of flood defences on the coast will rise, along with insurance premiums. A government study calculated that in the UK the average annual costs of flood damage to homes, businesses and infrastructure could increase from around 0.1% of GDP currently to 0.2-0.4% of GDP if global temperatures rise by 3 to 4 °C. Greater investment in flood protection is likely to keep damages in check. Similarly, preliminary estimates suggest that annual flood losses in Europe could rise from USD 10 billion today to USD 120-150 billion (EUR 100-120 billion) by the end of the century. If flood management is strengthened in line with the rising risk, the costs may only increase two-fold. According to one recent report, storm surge heights all along Australia's East Coast from Victoria to Cairns could rise by 25-30% with only a 2 °C increase in global temperatures.

From a policy perspective, the main message of the Stern report is that while climate change is real, dangerous and costly, it is much cheaper to solve – equivalent to just a 1% tax on everything we buy – if we act now rather than later. Indeed, it may be impossible to correct the situation as many of the damages will become irreversible.

Even though, in principle, climate change mitigation measures are highly desirable from a longer-term environmental perspective, they can be expected to undermine the economic viability of existing business models. Moreover, in practice, some measures may prove to be misguided and result in a waste of resources without clear environmental benefits (*e.g.* technology-dependent subsidies).

Environmental regulations will typically impose higher costs on existing infrastructure operators and developers by forcing them to modify their *modus operandi*. Such regulations may also reduce their ability to generate revenues by imposing heavier constraints on the use of the services they produce. The impact can be expected to be greater in liberalised models – where decisions tend to reflect market conditions – than in monolith models which are relatively immune to market changes and are better able to weather the imposition of new constraints which are ultimately born in any case by captive users or by taxpayers.

In the *electricity* sector, the application of environmental policies is clearly a necessary but also highly complex matter. Uncertainties about the measures that will actually be put in place in the coming years and their financial implications

for investors are increasing the business risk faced by entrepreneurs in the unbundled model, which may delay needed investment. As noted by Morgan, some environmental policies may cause market distortions and inefficiencies, particularly where cross-border trade is possible. Subsidies for particular technologies, or non-transparent barriers that impede the development of others, may not lead to the optimal fuel mix or choice of technology in the long term given the unpredictability of technological development and imperfect information. The challenge, here, is to establish a legal and market framework that ensures that environmental objectives are met flexibly and at least cost, encouraging innovation without distorting business incentives and competitive conditions unduly. One such approach which is likely to receive growing policy attention is to cap and trade emission allowances.[52] The United States was one of the first countries to introduce such a system for sulphur dioxide emissions from power plants and large industrial facilities under the 1990 Clean Air Act Amendments. In January 2005, the European Union launched an Emission Trading Scheme for carbon dioxide, the largest multicountry, multisector greenhouse-gas emission-trading scheme in the world.

In monolith models, uncertainties regarding environmental policies can be very costly, too. In Europe, political uncertainty regarding the future of nuclear energy for the generation of electricity has had adverse effects in a number of countries. This includes the controversy raised by the Superphénix programme in France, and the political uncertainties that prevail regarding the future of the European Pressurised Water Reactor (EPR).

As already noted, in the *electricity* supply sector, governments may favour the unbundled model (assuming that an appropriate regulatory framework can be established), despite increased sensitivities to environmentally related uncertainties. This may encourage the development and deployment of distributed generation because of the economic, environmental and energy-security benefits they can bring.

In the *water* sector, with large potential increases in costs from climate change, water pollution, and more stringent regulations, environmental drivers will make it more difficult for utilities to recover all costs from user fees. This will mean that tax revenues or government support will most likely continue to be needed to finance major projects that address climate change impacts. Full cost pricing does not account for the external costs of climate change or water pollution that will affect the water system's sustainability.

Environmental concerns will contribute to shifting the level of governance to the regional and national levels, so as to ensure a better overall abstraction and discharge policy, as well as the more effective formulation and enforcement of water quality standards. At the same time, the management of water and water treatment systems will become more challenging technically, forcing

greater reliance on outside expertise. As the claims on scarce water resources increase, greater efforts will also be required for ensuring that the needs of the poor are properly met in an environmentally sound manner.

In contrast to the two previous sectors, environmental concerns could have a positive impact on the *rail freight* sector. Indeed, concerns over the environment will give rail freight transport an edge over road transport as measures designed to reflect the environmental cost of transport services are put in place. In such a case, business models leaving a large place to competitive private actors are likely to be more successful in taking advantage of the situation, to the extent that private operators are closer to the market and their customers, hence better able to compete successfully with truck and water operators that have always be private than monoliths. In this context, the regulation of rail freight tariffs will be largely eliminated, replaced by enhanced intermodal competition or in some cases, with intramodal competition.

Shifting traffic from road to rail for a broad range of reasons including environmental ones (reduced pollution and reduced emission of GHG) has become a priority in a number of countries. For instance, in Europe, many countries, as well as the EC, have an explicit policy to shift freight and passenger traffic from highway to rail in order to reduce highway congestion and to achieve a number of desired social benefits (reduced pollution and CO_2 emissions, improved safety, changes in urban design, etc.). In fact, the EC has set an explicit goal of raising the rail market share in freight from 8% ton-km to 15% ton-km. The tools for doing so in the rail sector appear to be: 1) to encourage rail access charges to be set at incremental cost;[53] 2) to foster adequate investment and maintenance of the EU rail infrastructure; and 3) to separate the accounts of freight and passenger operators in order to ensure that freight operators are not asked to cross-subsidise passenger losses from freight profits (a policy that is clearly in operation in most of the eastern European railways, and the Russian Federation).

In other countries, the *opposite trend* may be observed and may continue to prevail in the coming years, reflecting their move to a market economy, as well as the changing composition of output. For instance, in China, current policies favouring rapid construction of highways may have the effect of shifting the modal balance toward highways. But given the trends in the Chinese economy towards higher valued products, especially for export, some shift away from overdependence on rail may well be rational from an economic point of view, although it may not be so from an environmental one. Indeed, the rail freight market share in China has been falling for many years from 72.3% in 1971 to 47% in 1981 to 39.2% in 1991 to 30.6% in 2001 (ton-km share).

Although Crozet does not address environmental issues *per se*, he does recognise that environmental concerns have been a major driver behind the renewed interest in *urban public transport systems* in recent years. This is likely to be even more so in the future.

Critics of UPT systems are not convinced. They point first to the high costs involved in the development of such systems and the long time it takes to build them. Moreover, the development and widespread adoption of emission-free cars could undermine the environmental arguments in favour of UPT. For mass transit critics, the UPT solution also contradicts the prevailing worldwide trend toward more personal transportation, in which people maintain control over their starting point, destination, route and time of travel. Hence, in this view, UPT systems will work in the future only if they integrate well with a flexible and mobile society, that is, when they run frequently, run to outlying stations with plentiful and inexpensive parking and connect easily to airports and each other.

Technology can help. In particular, the development of automatic transport systems such as driverless taxis could help alleviate traffic in congested areas.[54] However, technology is likely to provide only a partial solution to the gridlock problem to the extent that installing a big new transportation infrastructure in an established city will be extremely difficult.[55] In this context, non-technology approaches such as the application of the polluter pays principle is likely to be increasingly adopted and the development of car-free areas, as well as attention to the development of "environmental infrastructure" will become a more prominent on the public policy agenda. Greater attention may also be given to road-based approaches to urban transport such as the minibus solutions used for example in Latin America, as well as to improving the governance of taxis in urban areas.

Nevertheless, given the high costs that gridlocks impose on society from economic, social and environmental perspectives, some solution is "inevitable", as Peter Schwartz puts it, although it is not clear when and where it will occur first. Cities with well-designed transit and traffic infrastructure will thrive, if only because the best and the brightest will want to move there (Schwartz, 2003, pp. 86-88).

Regarding *road transport*, growing concern about the environment will induce governments to use price mechanisms to internalise the external cost of road transport and to use price as a tool for demand management. Moreover, greater efforts to shift traffic from roads to rail are likely.

4.8. Private and professional actors

The construction of models – whether they are business models or not – inevitably involves a simplification of reality. Modelling is clearly a useful analytical tool. However, there is always a danger of misspecification and

oversimplification if important relationships are omitted from the analysis or if major players are not properly represented in their proper cultural and institutional context.[56]

The previous section indicated that it is not enough to refer only to "public actors". Depending on institutional arrangements and cultural values, several different types of public actor may play a key role in infrastructure development at the local, regional, national and transnational levels. The relationships that exist between these various actors may also vary from country to country. For instance, Thompson notes in the case of *railways* how national cultures influence the policy approaches adopted in North America and Europe.

Cultural and institutional factors are also important regarding the role played by non-public actors. Two categories of actors can be considered in this context: "expert" private and professional actors (discussed here) and "non-expert" civil society (discussed in the next section).

Private and professional actors include private firms involved in the development and maintenance of infrastructure and financial institutions, as well as professional and trade associations (*e.g.* for the engineering, urban planning and construction sectors) that contribute to the development of the necessary expertise, the formulation of standards and shape public policies.

Typically, such actors are large corporations that have developed specialised expertise and operate at the global level. For instance, as noted by Palaniappan *et al.*, the *water* sector is dominated by three or four large MNEs (Suez, Veolia Water, RWE and Bouygues/Saur) which have played a major role in their home market but have had mixed experience elsewhere.

A few large private actors also prevail in other sectors such as the *UPT* and *road transport* sectors. They typically form consortia with other firms when bidding for particular projects.[57] Because so few companies operate in these sectors and because they often submit joint bids, the bidding process may be ineffective or undermined by collusion among the bidders. Another danger is conflict of interest when experts participate in consortia in some instances, while in other cases governments retain them to assess bids.[58]

A few major private actors play a key role in the financing of infrastructure projects, although most investors have been wary of such ventures in the past because of the potentially large risks. In OECD countries, there is always a danger that *citizen protests* over high tolls or changes in political priorities may undermine the economic viability of expensive projects. In the developing world, the risks are even greater, as war, famine, political unrest and corruption all threaten investments. When financing large projects in a foreign society, the key question for investors is often how to tie the hands of the government so as to guarantee that it is not going to seize the property illegally, fail to abide by

important terms of the contract or take actions that adversely affect the investment.

In the optimistic atmosphere that prevailed in the first half of the 1990s, large private investors became involved in infrastructure development throughout the world. But in the wake of large economic crises at the end of the 1990s, many projects became distressed or failed, and some governments, including those of Argentina and Indonesia, repossessed the infrastructure that foreign investors had helped to build.

After this painful episode, the situation is still uncertain today. On the one hand, investment risks may be lower than in the past to the extent that recent international laws have made it possible for investors to hold foreign governments responsible for the assets they seize and to arbitrate disputes in a neutral court.[59] On the other hand, the trend toward privatisation of infrastructure has been fiercely opposed in some quarters on the grounds that profit-hungry investors could cut corners, potentially endangering citizens with poorly designed or poorly maintained roads, bridges and airports.

Despite such concerns, it is clear that the "infrastructure gap" which currently exists throughout the world will not be met in the future without increased private sector participation. If political risks could be kept to a minimum, infrastructure investment could indeed be an attractive proposition for investors. For instance, according to Macquarie Bank, a major actor in the sector, the main reason for such infrastructure investment is that its defining characteristics offer long-term stable returns with the opportunity for capital growth:[60]

- ***Long life.*** This is created through the security of long-term concessions or agreements, government regulations or licenses.
- ***Sustainable competitive advantages and barriers to entry by competitors.*** These barriers can be exclusive concession periods or licences provided by legislation or regulation, natural barriers such as planning restrictions or availability of land, the high cost of new development, or long-term contracts for a significant portion of demand.
- ***Low variable cost base.*** Highly predictable operating costs create greater certainty in cash flows and returns to investors.
- ***Low demand variability.*** Demand for products or services provided by infrastructure assets is generally stable and often grows with underlying economic or demographic growth. This creates stable operating cash flows and reduced volatility in returns to investors.

Indeed, Macquarie Bank has demonstrated by its own actions that infrastructure can be profitable, earning an average return of 19% on its infrastructure investments over 11 years.[61]

Although infrastructure projects may be attractive for private investors, one clearly needs to be selective. Even without major crises looming on the horizon, some sales of public assets to private actors are likely to generate growing public discontent, hence fuel hostility towards privatisation, depending on the particular motivation for the sale and the intrinsic nature of the project. For instance, when a publicly owned asset, say a bridge, is sold to a private actor and the proceeds of the sale are used to fund public operating budgets rather than improving the road network, the users of the bridge are likely to be irritated since they have now to pay a toll for an access which was previously free. They are bound to become even more irritated over time if the toll increases without noticeable improvement in service. Moreover, selling the asset may undermine the ability of the public authorities to manage the regional transportation network in a co-ordinated manner, adding to the frustration of motorists. For instance, higher tolls on the asset will increase the congestion on neighbouring roads, with adverse consequences on citizens living near the privatised asset. Opposition to privatisation may therefore increase over time leading to growing pressures on the authorities to reclaim the asset.

Private investors need to be particularly careful to avoid this kind of situation that can only backfire on them in the medium to longer term and that involves "the outsourcing of political will", as John Foote (a senior fellow in the Kennedy School of government at Harvard) puts it in a recent testimony to Congress.[62] The private actor becomes in effect a scapegoat for politicians who are not able to muster the political will to confront voters with the reality regarding the cost of providing services to the public.

John Foote concludes his testimony by pointing out the three tests in his view that the sale of existing roads should meet:

- First, a significant portion of the proceeds of the sale should be reinvested in improving and enlarging the particular region's transportation infrastructure.
- Second, the private owner should be held accountable for the externalities – the non-cash costs – of operating the road.
- Third, if the road is part of a regional network, the toll regulation needs to accommodate regional solutions.

Applying these tests may reduce the amount of money that can be raised by state and local governments through these sales, but maximising the dollars should not be the sole objective. Improving the mobility of our citizens should be the overriding goal.

4.9. *Civil society*

"Civil society"[63] includes universities, non-governmental organisations, environmental movements, indigenous peoples' associations, organised local

communities and trade unions. Their participation is essential for ensuring the success of infrastructure projects, as civil society actors help define what is the "public interest" or common well-being in infrastructure development.

Public administrations were reluctant in the past to engage a dialogue with civil society actors on the grounds that they were non-experts, hence not in a position to make a useful contribution in the decision-making process or that they would offer a view coloured by their narrow personal interest.

However, the faith in experts and in the ability of public administrations to deliver on the services that citizens want has been undermined over the years. In this context, a growing interest has been expressed in the institution of a "deliberative form of democracy" where "non-experts" can air their views and participate actively in the decision-making process.[64]

For advocates of deliberative democracy, deliberation is primarily a discursive approach to decision making in which citizens come together in a non-coercive environment to solve public problems. *Citizen engagement* is not about replacing representative government, but rather about making the current system more participatory by strengthening the deliberative input of the represented within a culture of democratic governance. Citizen engagement is a process of interaction between government and citizens. It is about creating the opportunity for effective dialogue and deliberation among and between citizens and elected representatives, so that the views and concerns of citizens are taken into account in the policy and decision-making processes.

Several arguments have been advanced for fostering citizen participation. First, such participation in policy formulation and decision making can reduce conflict. Experience suggests that by involving all the perspectives of community members who will be impacted by the policy outcome – and the competing interests – in governance processes, consensus develops around politically reasonable outcomes and lays the groundwork for successful implementation.

Second, citizen participation can lead to better, longer lasting, and wiser policy choices with better outcomes. This argument makes the case that the privately held knowledge of citizens – grounded largely in local experience – is "uncovered" through deliberation and can contribute valuable information to the policy process and outcome that would otherwise be overlooked. Citizens have a good sense of their needs; involving them may yield a different set of proposals.

Third, citizen participation builds citizen competence. It also gives citizens control of their lives, the opportunity to problem solve and, ultimately, better their lives through mechanisms that impact outcomes.

Fourth, citizen participation cultivates mutual understanding, builds bonds of trust among citizens, decision makers and governing institutions, and can effect changes in political attitudes and behaviour.

In summary, for citizen participation advocates, mechanisms of participation serve three important democratic values: they can make public decisions and actions more legitimate, more just, and more effective.

Citizen participation is thought to be particularly important in the case of infrastructure development. Indeed, infrastructure projects should be viewed as a collaborative effort, whereby citizens act as "partners" in the process of priority setting, planning and implementation (Perlman, 2000). Ideally, it should be seen as an ongoing process. "While one-shot deliberative efforts can be powerful catalysts for community change, citizen participation ultimately needs to be connected to processes that monitor and evaluate implementation. Without an enforcement mechanism, such efforts at community involvement will do little if economic development steers off course, or partners back out of their commitments. Thus, mechanisms for ongoing involvement in a self-correcting process of community development must be set up to ensure that the vision, motivation, and ends of citizen participation are not lost" (Lukensmeyer and Torres, 2003, p. 13). Ongoing engagement will help insure accountability.

However, it is important to ensure that greater citizen participation in the decision-making process does not result in more red tape at the planning stage and that the exploitation of the review process by special interest groups does not cause economic harm by unduly delaying the development of infrastructure projects which are important from an overall public interest perspective.[65]

5. Lessons learned for the future design of business models and public policy

This section outlines some of the lessons from the analysis in Sections 3 and 4 for the future design of business models and related supportive measures.

These "lessons learned" are presented here in terms of four main policy thrusts:

1. Improving economic performance.
2. Improving social performance.
3. Improving environmental performance.
4. Ensuring more sustainable financing of infrastructure development.

5.1. *Improving economic performance*

In all sectors, it has been clearly established that the public monolith model suffers from public failures, which adversely affect its economic performance. It follows that governments should explore the possibility of

adopting business models that offer greater scope for introducing some degree of competition and private sector participation.

This can be achieved first by promoting competition *in* the market whenever potentially competitive components of the value chain can be unbundled. When this approach is not feasible, it might still be possible to promote competition *for* the market. In any case, whatever approach is adopted, models that contribute to align prices more closely with costs are highly desirable from an economic perspective as they bring about a more efficient use of scarce resources.

Promoting competition in *the market*

Enhanced competition should contribute to reducing both market and public failures. This calls whenever possible – and notably when the service is close to an economic good (electricity, freight rail) – to the adoption of models featuring a structural separation between the monopoly components of the value chain (typically the network component) from those components that can be open to competition. However, such structural reform is not always easy to achieve in practice and may take a long time to implement fully and effectively.

In the case of *electricity*, adoption of the unbundled model requires "deregulation", market reforms or "market restructure" that involves the implementation of a market design that transforms an electricity sector dominated by regulated integrated utilities into one that relies on competition to deliver generation and retail services. In this model, customers can choose to buy electricity directly from wholesale generation markets (which are the pool and the bilateral market), or through load-serving entities (LSE), such as distribution companies and retailers that procure from wholesale generation markets to meet their load obligations. Buyers and sellers may manage electricity spot price risk using hedge instruments (*e.g.* forward contracts) traded in a financial market. Moreover, a transmission company operates the grid and offers open and comparable access to all market participants (such as, in the UK). Alternatively, an independent system operator (ISO) leases transmission facilities from transmission owners to perform the same functions (*e.g.* California, New England, New York, PJM, Texas, Alberta, and Ontario).

Experience with this type of reform has been rather mixed to date. First, market reform has proved to be costly; the cost of setting up and operating an ISO is substantial. Second, deregulation has lead to the creation of complicated market design which invites gaming by traders and retailers. Third, because electricity cannot be stored, electricity spot prices are very volatile. This has resulted in considerable price uncertainty and offered ample opportunities for the exercise of market power in generation markets. Fourth, because of increased uncertainty, generation and transmission investment has been inefficient and

the service has become less reliable as capacity reserves have declined. This has forced regulators to impose capacity obligations on LSEs. Fifth, efficiency gains have not always been achieved in generation because lower operation costs have been at least partially offset by higher capital cost in a more volatile environment. Moreover, higher transaction costs have contributed to dissipate the potential benefit of deregulation. Finally, even when deregulation has resulted in net benefits, such benefits have often been captured by electricity producers rather than by households and business customers.[66]

The obstacles to successful deregulations that have been encountered in a number of countries (see Annex 2.A1) clearly point to the need for a more careful approach to market reform. Particular attention needs to be given to the design of the model in the way risks are handled and to the responsiveness of supply and demand to price signals, notably when the price of input fuels are subject to severe fluctuations.

On the supply side, this requires first of all that all the barriers to electricity generation activities be removed as well as any restraint to transmission capacity. In this latter regard, appropriate incentive schemes should be put in place to stimulate construction to remove bottlenecks (*e.g.* node pricing).

To reduce risks, utilities should be allowed to enter into longer-term contracts at fixed price and to hedge through the futures market. Greater price stability could also be achieved by building a large reserve capacity. However, this is an expensive way to do so. Indeed, one of the reasons to move to a competitive market structure is to help reduce electricity prices by lowering the costs of the utilities' reserve capacity. In a competitive market, producers' investment in reserve capacity should be consistent with the amount of price stability (or, equivalently, supply security) that consumers are willing to pay for in the form of long-term supply contracts. The model must also allow the forging of alliances that can generate synergies (*e.g.* between the electricity and gas networks). This may involve some degree of re-integration of activities that were unbundled.

The ability of the unbundled model to withstand shocks can also be improved if greater flexibility is achieved on the demand side. First, consumers need to face the *real cost* of electricity. Exposing consumers to price changes will induce them to increase their use of power when prices fall and curtail it when prices rise. When prices do not change along with costs, and when the amount of power demanded cannot respond to prices in that way, a greater adjustment must be made on the supply side of the market.

Second, price signals should encourage consumers not only to buy more or less power now but also to invest in the ability to adjust their future power use. Some of the same demand responsiveness that results from having consumers pay market prices may also be achieved if utilities either compensate customers

for reducing their consumption at peak demand time or allow customers to resell power to others (in which case, a third party is paying them to reduce their use).

In addition, electricity consumers should be encouraged to acquire devices that allow them to reduce use on short-term notice. For example, several approaches can make real-time pricing easier, such as technologies that monitor electricity use and prices, and contracting arrangements with electricity suppliers that permit the customer (or a designated agent) to interrupt the service when the price rises. In many cases, large industrial customers already have the capacity to monitor and adjust their demand in the face of rising prices and, in fact, do so. Successful restructuring may necessitate that residential and commercial customers acquire many of the same demand-management capabilities that industrial consumers have.

In the case of *rail freight*, the advantage of the deregulated model over the monolith model is clearly illustrated by the contrasting performance of railways in North America and Europe. While North American railways have been able to maintain or even increase their market share, despite stiff competition from trucks, the volume of freight carried by European railways under the monolith model has been steadily declining, both in relative and absolute terms. The decline experienced by European railways is largely linked to the business model that prevails on the old continent.

As noted by the European Commission, a careful analysis of the reasons for this decline, points at the organisation and structure of rail transport in the member states.[67] Historically, both passenger and freight transport have been organised along national lines. Rail transport was carried out by national railway undertakings, which were also responsible for the construction and maintenance of the rail infrastructure, railway safety and the rolling stock. Rail transport between member states was, and still is, organised as co-operation between national railway undertakings, which prevented railway undertakings from starting operations in other member states. International rail transport suffered from this structure as national rail networks were hardly interoperable. For example, locomotives had to be changed at the border as they were unable to run on the network of another member state due to different signalling systems, electrification systems or even gauge widths. Train staff very often could only operate in one member state, and had to be replaced at the border as well. Administrative and technical formalities to be complied with at the border added to long waiting times at the border which made rail transport less and less attractive, compared to other modes of transport, such as road or inland waterways. The organisation according to national lines prevented, and still prevents, railway undertakings from realising economies of scale and optimisation of market segments, such as rail freight.

Promoting competition for the market

When competition *in* the market is not possible, promoting competition *for* the market through the use of PPPs and the development of appropriate tender mechanisms could be a good way to foster the efficiency of infrastructure services. This approach can be applied for instance to the *water and water treatment* systems, as well as to *UPT* systems and the *road network*. However, as illustrated by the French experience, it requires strong public oversight, calling for the development of the necessary expertise and mindset in the public sector.

For advocates of this approach, the advantages for government and the economy at large are substantial. It allows the state to focus more effectively on its core role as regulator and task master. It brings about a reduction in the cost of construction and enables faster development of the infrastructure. It also offers opportunities for lower operating costs, reduced public funding needs, as well as lower risks for the state.

Let us examine these claims in greater detail:

More focus on core competence. The main function of the state is to conceive the development of infrastructure services and to ensure that they are effectively and efficiently provided to users. However, this does mean that government should develop the infrastructure and produce the service. In a democratic society, the state is the only entity with the legitimacy to make trade-offs between various policy objectives and to define the policy and regulatory environment for the provision of the service. The role of governments is to make decisions, to make trade-offs, to protect social justice and to keep the decision-making process transparent. In this context, greater private sector participation in the development and operation of infrastructure is not a retreat of the state but rather a redefinition of its role.

Reduction of construction costs. Contract clauses in PPPs that provide maximal cost for construction allow for a stricter control of budgets than the traditional construction approach. According to the UK auditor general, 73% of projects done in the conventional way have cost overruns compared to only 22% for PPPs.

Faster delivery of the infrastructure. PPPs allow for faster delivery because the returns to the private partners are linked to the availability of the infrastructure and penalty clauses in case of delays are often included in contracts. As a result, infrastructures are more often delivered on time than in conventional technique (76% compared to 22% in the public service). They are even sometimes completed ahead of schedule. Moreover, if the concession extends over a substantial number of years, the concessionaire is more likely to pay particular attention to the quality of the construction up front, so as to reduce maintenance costs over the life of the concession to a minimum.

Reduced operating costs. By using PPPs, the state is able to take advantage of expertise it does not have. For instance, in *water treatment*, savings of more than 30% in operating cost have been observed in some major US cities, such as Indianapolis, Seattle and Milwaukee. In Alberta, savings of more than 25% have been realised in the maintenance of *roads*.

If the advantages of PPPs are so great, then why are they not used more often? Four main reasons are usually given:

PPPs are most suitable for infrastructures where access can be controlled. As noted by Mackie and Smith, suitable *highways for toll* represent roughly 1% of the road network, although they probably carry a much larger share of the traffic. In other sectors, the scope for PPPs is greater. For example, in France, as already noted, 75% of *water* systems are run by concessions. Concessions are also widely used in *UPT*.

Contractual complexity. Second, one of the major obstacles to the use of PPPs is the need to negotiate the agreement. By definition, a PPP implies a long-term commitment by the private partner, as well as a large investment. An effective sharing of risks, gains and responsibilities must be done to the satisfaction of all parties to the agreement, a very complex task.

This task is not only complex but may be fraught with dangers if the public partner does not have the in-house expertise needed to properly assess all pertinent aspects of the project and to negotiate effectively with the potential concessionaires. This danger is higher in early experience with PPPs, *i.e.* when the attitude of the state has not yet fully evolved from a "doer" to a regulator and task master. In this regard, it has been noted that it is often difficult to find unbiased expertise both inside and outside the government and that in some cases the potential for conflicts of interest or corruption of public officials is real. Moreover, in practice, the number of potential bidders on large projects is limited, not only in the *water* sector but also in the *UPT* and *road* construction sectors.

In contract negotiations, particular attention also needs to be given to penalty clauses to ensure that they can be effectively enforced, if and when the need arise.

Political risk. Third, another major hurdle is linked to the political risk: the irreversible nature of the commitment and its length generate a high political risk. For instance, both in the case of Highway 407 and the Fredericton-Moncton Highway in Canada, new governments attempted to renegotiate the agreement signed by the previous government. In the case of Highway 407, it even went to court. This sends a negative signal to all companies interested in PPPs.

Political opposition to PPPs is often fuelled by various lobby groups (*e.g.* local construction firms) that benefit from the cosy relationship they have been able to establish with government officials over the years. Unions that have taken advantage of their strong bargaining position to earn economic

rents are also likely to be hostile to PPPs that may undermine their position. In addition, there is a danger that the selection of the concessionaire could be influenced by job creation or job protection considerations. In such a case, the choice of concessionaire may not necessarily be in the best interest of users of the infrastructure or taxpayers.

Public perception. A fourth stumbling block is the perception of the population that the provision of public services should not be for profit. There is also a persistent view that public services should be free. Hence, efforts to inform the population, seek their views and ensure that the bidding process is fully transparent play a critical role in the success of PPPs.

Promoting cost pricing

Whatever the model adopted, in order to ensure a proper balance between the demand and the supply of infrastructure services, the price of services should be set as close as possible to cost recovery levels (taking into account externalities caused by the production and consumption of the service), and cross-subsidies that distort competition (*e.g.* in rail transport) should be eliminated.

Regarding *electricity*, Morgan notes the predicament of the Indian Electricity Board which is unable to generate sufficient revenues for maintaining the network because it is forced to provide electricity at tariffs that are too low and no alternative source of funding is available.

Chronic underinvestment prevails in the *water* sector because rates have been kept too low for too long as noted by Palaniappan *et al*. More generally, water management is grossly inefficient. First, some activities (*e.g.* agriculture) consume far too much water when compared to their contribution to GDP. Moreover, in urban areas a large share of available water is wasted because of leaky pipes or is stolen. Furthermore, at the watershed level, water is often polluted upstream with little regard for the need of users downstream.[68] Finally, the price of water varies considerably across users, suggesting gross misallocations of resources. For instance, in Australia, the driest continent in the world, Australian households pay on average about AUD 1.30 a kilolitre, compared to only a few cents per kilolitre paid by irrigators (farmers).

As the demand for water continues to increase in the future and as water resources become increasingly valuable, a major effort to improve the management of water is inevitable. Governments will have to implement effective business models for getting such water to high value users, despite the tensions between the historical and the new users this will create.

As illustrated by Crozet, the same problem exists regarding *UPT* systems. Typically, the fare charged to users does not cover operational costs. Moreover, as mentioned previously, fares tend to be subject to the "nickel syndrome", *i.e.* they are not allowed to rise over time in line with rising costs. Over time,

the system becomes increasingly run down as maintenance is increasingly neglected, causing declines in ridership that, in turn, further reduce the ability of the operator to finance maintenance.

In the case of *rail freight*, cross-subsidy obligations have been a heavy burden on operators throughout the world and have significantly affected their economic viability. The problem has been largely solved in North America since deregulation and the creation of AMTRAK in the US and VIA Rail in Canada, although freight rail operators still complain about the low access charge they have been forced to grant the passenger rail operators.[69]

In Europe, the situation is much less favourable for freight operators. Cross-subsidies have contributed to the steady decline of rail freight in that region. Time will tell whether the efforts of the European Commission to remedy the situation will bear fruit in the coming years. One solution that is increasingly popular is to develop rail freight corridors, so as to separate passenger and freight traffic on some routes.

In *road transport*, free access at the point of demand leads to congestion. While this can be accommodated for a while by an expansion of the road network, there comes a time when such physical expansion is no longer feasible or is increasingly resisted because of the adverse side effects it creates. This is a situation that largely prevails today in north-western Europe, as noted by Mackie and Smith. Daily traffic over time remains paralysed for increasing hours, resulting in growing economic and environmental costs. This is clearly an unsustainable situation that can only be solved in the short term by introducing a form of demand management which rations scarce road space more efficiently. In the longer term, changes in land use patterns or the delocalisation of major activities to less populated regions may be the only viable option.

5.2. Improving social performance

Dealing more effectively with social obligations

In affluent countries there is no reason why infrastructure services should be subsidised for the vast majority of the population. Given the distortionary effect of taxes, it is more effective to pay directly for service rather than through increased taxation. Special targeted relief mechanisms can be devised for the poor, although broader income distribution schemes are likely to be the most effective way of dealing with the problem.

For instance, in the case of *water*, there is no good reason why the vast majority of (middle-class) users in OECD countries should not pay the true cost of water. Maintaining water prices artificially low can only by achieved by subsidies that middle-class users will have to pay anyway in the form of higher taxes. The alternative is to accept a deterioration of the service over

time. Moreover, low water prices only encourage an economically wasteful and ecologically harmful use of water resources.[70]

Social obligation to the needy should be met directly either in the form of an income subsidy, or a more targeted subsidy, for instance through the use of "water stamps" for whatever minimum amount of water is deemed necessary to maintain a reasonably healthy life.[71] Alternatively, a price schedule involving rising price with usage could be implemented. This requires, however, effective metering of the water actually used.[72]

The same argument applies to electricity and passenger rail traffic. However, the situation may be somewhat different for *UPT* systems because of the social advantages that such systems offer. The cost balance should nevertheless largely be made up by those who benefit indirectly from the system (employers, landowners, landlords, private car commuters).

In some cases, efforts to foster efficiency involve a reallocation of resources from one category of users to another. While beneficial from an economic perspective, such reallocation may be detrimental from a social perspective if the "losers" are not adequately compensated. One possible solution to this problem may be to introduce a market for *tradable entitlements*. This solution, in particular the introduction of water markets, has been used, in Australia to promote a more efficient use of *water* resources without penalising the poor. (See Box 2.4 for more details on the use of water markets for the management of water resources in Australia.)

Water markets are more flexible than command-and-control instruments in moving water to higher-valued uses in a manner agreeable to all parties, thus promoting economic growth and diminishing social tension from competition for scarce water resources. The adoption of the user pays principle is more difficult in developing countries since the large majority of users is typically poor, hence cannot be expected to pay much for services. This means that new innovative solutions will need to be found with the support of multilateral funding institutions.

Encouraging participatory democracy

Greater attention should be given to fostering participatory democracy. Citizens affected by a particular infrastructure should be consulted and given a chance to participate in the decision-making process. Although this may at first be viewed as a cumbersome process that may delay implementation, it should contribute to ensuring that the infrastructure better meets the need of users in the longer run and may induce such users to be more inclined to pay directly for the full cost of the service they receive.

According to Palaniappan *et al.*, experience supports the views expressed by citizen participation advocates as outlined above. *Water* users are often

willing to pay for improvements in service when such improvements are designed with their participation and when improvements are actually delivered. Broad participation by affected parties ensures that diverse values and varying viewpoints are articulated and incorporated into water-sector decision making. It also provides a sense of ownership and stewardship over the process and resulting decisions. Water is a resource that is essential for life and health and plays vital social, economic, and environmental roles. Water management is linked to issues of poverty alleviation, public health, social equity, and the sustainability of ecosystems. The best way to balance the multiple roles of water is to ensure that water-resource decisions involve multiple stakeholders and the public at large in needs assessment, planning, and implementation of any potential project. Governments must ensure that the public is aware of and educated on water sector decisions. They should also provide access to information, and include public input into all decisions and plans made about water resources.

Public involvement is important for both private and public actors. Increased transparency and public involvement may improve public trust in the private sector and increase the ability of the private sector to float private bonds. Increasing transparency and public communication will also allow public sector providers and governments to float bonds and successfully advocate for more public financing.

Palaniappan *et al.* also note that the importance of public involvement varies depending on the nature of the project. It is particularly important for large projects involving private actors. Small-scale private operations tend to be far enough from the public eye that it may continue unimpeded. For example, private operation of a particular wastewater treatment facility, private management of billing operations, and other specific functions tend to be under the purview of the water utility, and are rarely subject to public protest.

Public involvement is likely to greatly influence the future development of water systems. First, public pressure will probably keep large built system assets in public hands. Moreover, the public will be profoundly affected and undoubtedly involved in any changes to water rights regimes and accompanying legislation. Furthermore, international and local NGOs and public employees have always voiced the concern that the profit motive is ill-suited to the successful provision of water. Finally, the public and international and local NGOs will continue to be suspicious of private sector involvement in the water sector, primarily because of its impacts on the poor.

Despite its potential benefits, public involvement faces a number of political obstacles. For instance, it is noted in the case of the US that without federal mandates tied to federal programmes, it is unlikely that most municipal governments would voluntarily seek to share power with neighbourhood-based organisations.[73]

Although the issue is not addressed specifically in the other sectoral chapters, it is clear that citizen participation can play a key role in the other sectors under review. For instance in the *electricity* sector, many projects currently face widespread difficulty associated with facilities siting. This rising difficulty is due to a variety of causes, including public opposition and not-in-my-backyard (NIMBY) protests. Efforts to mitigate public opposition have focused on improving citizen participation, but many participatory programmes have still resulted in opposition and project delays. Taken as a whole, there is a growing need for: 1) better characterisations of siting difficulty and the relative role of public opposition; and 2) new strategies for facilitating timely, inclusive, and effective public participation (Vajjhala, 2005). Similar problems arise in the road transport network. For instance Mackie and Smith note the growing local opposition to the creation of new roads or highway in north-western Europe.

Dealing more effectively with labour relations issues

Infrastructures may also raise social issues from a labour relations' perspective. Because they are ubiquitous and vital in our daily life, they are highly vulnerable to crippling strikes.

In the case of *UPT* systems, transport workers' unions have acquired considerable clout, which they have been able to exercise successfully to obtain wage increases above those granted to workers of equivalent qualification, as noted by Crozet. This raises the question of whether urban public transport workers' right to strike should be reduced or abolished.

Some countries have indeed limited the right to strike by imposing minimum service obligations (*e.g.* Italy, Portugal). In a number of jurisdictions, what constitutes an "essential service" has been defined by law (for instance in Quebec labour law, a public service is deemed to be "essential" when withholding it would threaten the health or the security of the population) and a precise list of essential services has been drawn up, as well as rules for establishing a minimum service.

In other jurisdictions, subway strikes are forbidden by law. This is the case for instance in New York City with the Taylor Law, which was put into affect in 1967. One of the most controversial parts of the Taylor Law is Section 210, which prohibits New York state public employees from striking, compelling binding PERB (Public Employment Relations Board) arbitration in the event of an impasse in negotiations.[74] The fine for striking is twice the employee's salary for each day the strike lasts. Since its declaration, the law has been cited in averting several potential transit strikes, but did not prevent the 1980 and 2005 strikes. In both cases, the fine was applied.

5.3. *Improving environmental performance*

From a public policy perspective, environmental considerations play an important role for each of the infrastructure sectors under review. In some cases, it is because of their adverse effects. For instance, the generation and transmission of *electricity* generate negative externalities; the overexploitation of *water* resources represents a threat for ecosystems; *road transport* is a major source of pollution and the main source of GHG.

In other cases, public interest results from the fact that the use of the particular infrastructure is considered to be more desirable from an environmental perspective than alternative options. For instance, *UPT* commuting is less environmentally damaging than private car commuting (assuming the UPT network is not overextended to low population density areas); rail freight is more environmentally friendly than road transport.

In this context, the main challenge from an environmental public policy perspective is the adoption of measures that more strictly enforce the polluter pays principle and encourage greater use of more environmentally friendly infrastructures. Moreover, governments have an important role to play in fostering basic research on environmentally friendly technologies, not only at the national level, but perhaps more importantly at the international level.

Enforcing the polluter pays principle

Enforcing the polluter pays principle is highly desirable, but no easy task in practice. First, it needs to be applied gradually over a significant period of time because of the serious disruptions it may cause to important segments of the economy (*e.g.* heavy industry, agriculture). Second, its application often faces strong political opposition because of the adverse income distribution effects it may have. Third, to be effective and avoid damaging distortions of competition in an open international economic environment, the principle needs to be applied in a consistent manner over broad enough geographical areas, if not at the global level.

There are no easy solutions to this challenge, but a few approaches may be promising:

Emissions trading schemes. Capping emissions and creating a market for the trading of emission rights could be an interesting option for curbing GHG, notably those generated by industry and the electricity supply sector. As already noted, efforts in this direction have already been initiated in Europe.[75]

Although the scheme faces a number of problems, as might be expected, the market is growing fast. In the first half of 2006, carbon to the value of EUR 12 billion (USD 15 billion) was traded, five times more than in the same period in 2005. It has made some headway in reducing GHG. Last year it got

rich-world consumers to invest USD 2.7 billion to cut developing-country greenhouse-gas emissions by around 374 million tons of CO_2 equivalent. That is only about half of Texas's annual emissions – but it's a start.[76]

Water markets. In addition to stricter enforcement of water quality and water treatment requirements, a water market approach might offer opportunities for more effective management of water resources and ecosystems, as illustrated by the Australian example in Box 2.4.

The greatest impact of water trading schemes is that they disconnect water rights from land property rights. This means that water access entitlements are commodities that can be traded.

The water trading schemes set a cap on current water use and allow trading of current allocation licenses to enable new users to obtain water supply and current licence holders who do not use their full allocation ("sleepers" and "dozers") to sell excess water entitlements for economic benefit.

In addition to providing a cap on water use, water trading schemes regulate different types of water use (ranging from agriculture to service provision) through the establishment of different water access licence types.

Water licences have been allocated a priority rating, so that in times of scarcity those with less "secure" licences will be the first to lose entitlements while "permanent security" licence holders such as drinking water providers and year-round irrigators (such as rice farmers) will be protected. In NSW for example, rights are organised on a priority basis and increases in scarcity result in reduction in licence rights of access entitlements beginning with the lowest priority licence holders.

A justification for water trading has been the capacity for water to be purchased for environmental flows. For example, the Australian federal government (under COAG) has allocated AUD 500 million to purchase water for the environment in the Murray-Darling Basin. An interest in environmental flows has resulted from increasing awareness of ecological degradation in Australia's river basins. Salinity has been particularly bad and has affected agriculture and altered flows in the Murray-Darling river system. Trading is represented as a means by which to improve water quality and quantity in rivers while providing current water with the appropriate market value in compensation. However, "the environment" still has to compete for its water needs with other users operating within the water market and is less represented at the political decision-making level. Furthermore, there is much debate concerning how much water is needed to maintain a healthy river system; the extent to which the environment can compete within the water market to obtain environmental flows in accordance with changing knowledge of ecosystem requirements remains to be seen.

Box 2.4. **The management of water resources in Australia**

As the driest continent in the world, Australia represents an interesting case in point regarding water management. The solutions adopted there could be a harbinger of things to come elsewhere.

The majority of water consumption in Australia is due to irrigation n (75%). Water use has increased by 65% since 1985. This is primarily due to irrigated agriculture, while only small increases or decreases have occurred in urban water consumption.

Prior to the introduction of the current regime of water trading, the country was faced with inefficient use of scarce water resources. Water was fully allocated and poorly used for irrigation purposes. Much irrigated land was unsuitable for irrigation; and many irrigators were low-value producers.

Water trading reform. In response to this situation, the government decided to introduce water trading as a way to gradually reallocate water from existing users and land.

This regime is largely determined by Australian constitutional arrangements. Under the Australian system of co-operative federalism, constitutional power for water management is vested in state and territorial governments. In most states, a licensing system regulates water access and distribution. These licences are often equated with water "ownership"; however, water in Australia remains a public good in legal terms. Licences do not equate with water ownership, but give the licence holder the right to use an amount of water at a particular time and place. Governments can withdraw or alter water rights without any statutory guarantee in most cases. Whether there exists a common law right to compensation for the removal of water rights has not yet been established.

Following a Council of Australian Governments (COAG) agreement in 2004 to establish a new national market to trade water rights, water trading has now become mandatory under the National Competition Policy. Although water markets are under state legislation, and although the rules vary considerably from state to state, two distinct markets exist: 1) Informal markets transfer the right to use a given volume of water for a given period of time; and 2) formal markets transfer the long term right of access to water.

Expectations. Regarding the *formal market*, the expectation was that it would move water resources to higher value and more efficient users and that water would be used in more suitable location and better soil. It was expected that such action would result in more economic activity per unit of water and a reduction in environmental damage.

Box 2.4. **The management of water resources in Australia** *(cont.)*

Regarding the *informal market*, it was expected that it would facilitate the adjustment of water use between seasons and within seasons in response to fluctuation in supply and in commodity prices. In addition, it was thought that it would allow retiring or unviable farmers to stay in the community and permit unviable farmer assets to be split and used in the most beneficial way.

Outcomes. In practice, informal markets have worked as expected. They are popular because they alleviate communities fear about change in long-term ownership. Water exchanges have emerged that are easy, quick, cheap, safe and predictable.

Formal markets have resulted in higher value use of water. But they remain limited (only 1% of entitlement per year; 60% of the water was previously unused). Farmers only sell if under strain or ill-informed. The reasons why it is not more widely used include: policy uncertainty, policy decisions regarding unused water; irrigator perception; community concern; a cumbersome and expensive procedure compared to the informal market. Moreover, many farmers cannot afford to buy water on the formal market.

The combined impact of water trading has been significant: 20% of the farmers have been involved in both the formal and informal markets and such markets have substantially assisted irrigators in managing the increased risk associated with water supply uncertainty.

Source: Bjornlund, Henning (2005), various papers on water trading in Australia, University of South Australia, School of Commerce, Division of Business. For more information, see *www.unisanet.unisa.edu.au/staff/homepage.asp?Name=Henning.Bjornlund.*

In the long run more sophisticated water markets may emerge. This may include for instance, the *water resource observations network* developed by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency. According to CSIRO, the network, which is about ten years from completion, will allow instant trading of water entitlements, adjustment for seasonal and natural flows, and the creation and trading of derivatives, such as water futures, options and hedges. It will be better able to allocate optimal environmental flows, remove uncertainty from the market process, optimise prices, find the most willing buyers and sellers, and signal scarcity.

Road transport. The cost of pollution could be better reflected in the price of gasoline, car ownership taxes and environmental fees imposed on trucks for instance. However, there is some degree of controversy regarding whether cars and trucks currently pay their "fair share". For instance, research by David Newbery, a professor of economics at Cambridge University, suggests that the

cost to society imposed by the various pollutants, including carbon, produced from car engines works out to around 42p per litre of petrol burned and 47p for diesel in the UK. With fuel taxed at 47.1p per litre, this implies that road transport is, if anything, paying too much. By contrast, housing is getting off lightly, according to Newbery. Heating fuel, for example, receives substantial tax breaks. But at a time of soaring utility bills, ending these concessions would be as politically unpalatable as squeezing motorists.[77] This suggests that there is a clear need to establish a better factual and conceptual basis for the formulation of policy in this area.

Encouraging the development and greater use of environmentally friendly infrastructures

In the case of *rail freight*, this includes the removal of the obstacles to its development in Europe and perhaps a reduced bias against rail in North America, including tax law reform and greater public support to major intermodal rail to ship terminals. Efforts to foster the development of rail freight corridors in developing countries are also desirable. An interesting example in this regard is the Golden Quadrilateral freight corridor project in India which should link the largest Indian cities (Delhi, Mumbai, Madras and Calcutta) with financial support from the Japanese ODA agency.

Policies to encourage greater use of *UPT* include not only initiatives to improve the quality of service but also measures to provide a more effective demand management of traffic; and from a long-run perspective, changes in land use pattern to promote a more mixed land use pattern.

First of all, efforts to promote the adoption of sustainable transportation practices may involve for instance measures to encourage people to take fewer and shorter vehicle trips (*e.g.* ridesharing, telecommuting and parking management); balancing more carefully the traffic needs of new developments with the broader social and environmental objectives for the city as a whole; exploiting new technologies that improve urban travel conditions and help protect the environment.

But such measures need to be complemented by supportive land use planning initiatives. The development of an effective urban transport system requires that land use and transportation planning policies be closely linked to create an effective strategy for accommodating future trip growth in a way that reduces auto-dependency by making transit, cycling and walking more attractive alternatives. Such measures could include the *promotion of mixed use development* to increase opportunities for living close to work and to encourage walking and cycling for local trips. Moreover, in the targeted growth areas with good transit service, consideration should be given to: minimum development density requirements; lower parking standards; enhanced pedestrian facilities.

Security considerations play also a key role. For instance in the US, it is probably the most important single factor for revitalising city centres and inducing those who have fled the city for the suburbs in the past to come back. As already noted, demographic factors should favour such a move in coming decades. Finally, urban sprawl could be slowed perhaps by reducing the disparity in taxation between downtown and suburban residence.

Encouraging the development of environmentally friendly technologies

Governments also have a key role to play in encouraging the development of environmentally friendly technologies. In the case of *electricity* this includes efforts to foster renewable energies and perhaps having a second look at the nuclear option. An interesting programme in this regard is the GIF (Generation IV International Forum) which was set up in 2000 to foster international co-operation for the development of future nuclear reactors. The 13 participating countries (now including the Russian Federation and China) intend to spend USD 6 billion over 15 years to develop the fourth generation of reactors that should come on stream by 2030.[78]

As already noted, further research leading to the development and widespread adoption of clean coal technologies could also have far-reaching implications for the electricity supply industry, including from a geopolitical perspective. Moreover, it is expected to play a critical role in the mitigation effort until 2100.[79]

Public support to research efforts is clearly desirable in the early stage of development of these technologies. Current initiatives include a subsidised scheme unveiled in 2003 by the Bush administration to build a zero-emissions "integrated gasification combined cycle" (IGCC) plant called "FutureGen" by 2013. Such technology is promising because IGCC plants, aside from their carbon-capture potential, produce fewer traditional pollutants and also generate hydrogen, which can either be put to industrial uses or burnt. Research efforts are also under way in Europe on IGCC plants and other carbon capture technologies. Altogether it is estimated that the extra energy required to capture carbon would reduce a state-of-the-art supercritical plant's overall efficiency by about 10%.[80]

Electricity infrastructure services and their management would also change fundamentally with the emergence of small-scale decentralised generation and CHP (combined heat and power), and with hydrogen as an energy-carrying and storage medium for the transport and heat markets. There will also be new opportunities for demand management through new metering and information and control technologies.

In the case of *water*, new water treatment technologies are very promising, as already noted. Desalination may also become an attractive option for water-

starved cities close to the sea. Indeed, desalination is becoming increasingly efficient. Despite controversy about its high energy use, new technologies have driven efficiencies up and costs down to nearly half the price for urban water. One major advantage of desalination is that it is not climate-dependent. The water is available continuously and just in time: it does not need to be stored and does not evaporate while waiting to be used.

Road transport is still likely to remain oil-based for several decades, and efficiency gains will be important for keeping emissions down. Incremental energy efficiency improvements are expected to continue in the transport sector. These will be stimulated both by fuel savings and, as they have been in the past, by government regulation. Increasing use of biofuels will also be important. In the long term, decarbonising transport will also depend on progress in decarbonising electricity generation and on developments in hydrogen production. The main technological options currently being considered for decarbonising transport (other than the contributions of biofuels and efficiency) are hydrogen and battery-electric vehicles. Both the hybrid car, and later, the fuel cell vehicle, will be capable of doubling the fuel efficiency of road vehicles. Much will depend on transport systems too, including road pricing, intelligent infrastructure, public transport and urban design (United Kingdom, 2006a).

As noted in the Stern review, it is critically important that the long-term investments over the next two decades *not* be made in high-carbon infrastructure. In this regard, the credibility of policies is key. This is particularly important in the *electricity* supply sector which is largely geared to the use of fossil fuels and where new low-carbon technologies do not easily fit.[81] Policy uncertainty not only undermines climate change policy, it can also undermine security of supply, by creating an incentive to delay investment decisions.[82]

5.4. *Ensuring more sustainable financing of infrastructure development*

As financial pressures on the government increase, notably to meet health and social obligations, fewer public resources will be available for infrastructure development. It follows that new ways of financing infrastructure will need to be developed.

Some of the measures already discussed in this section should help. Moving closer to *cost pricing* by expanding the scope of user charges should not only be beneficial from an economic point of view, but it should also provide utilities with a more stable and reliable source of funds than public grants that are often vulnerable to short-term political considerations. As already noted, the impact of short-termism can also be reduced by the corporatisation of utilities, which provides for greater accountability of their activities, the adoption of arm's-length regulatory schemes, so as to remove the decision-making process from the short-

term political arena and by putting a greater emphasis on participatory democracy so as to give a greater voice to users, hence ensuring that the services provided are more responsive to their expectations, including their sustainability over time.

Another complementary approach is to seek greater private sector participation to the operation and development of infrastructure and to look for new financial partners with complementary interests. Finally, it is also important to ensure that resource for infrastructure development and management be effectively allocated between the various levels of government.

Encouraging greater private sector participation to the financing of infrastructure

It has already been discussed that greater private sector participation should contribute to fostering efficiency in the development and management of infrastructure. In addition to the benefits of greater focus on core competence, reduced construction and operating costs and faster delivery of the infrastructure than under traditional contractual arrangements, PPPs offer opportunities for reduced public funding and contribute to reducing the project-related financial risks incurred by the state.

The concept of PPP is based on the transfer of risk from the state to the private sector. This results in a greater control of costs by the state and higher incentives for private actors because their profits are linked to performance. This is reflected in reduced construction and operation costs and a faster implementation.

Success stories. The merits of PPPs are clearly demonstrated by a number of success stories, such as the Confederation Bridge in Canada (see Chapter 1, Box 1.3) or the Millau Viaduct in France, the tallest bridge in the world, that offers the fastest and cheapest link from Paris to the Mediterranean. In this latter case, for instance, all the risks (construction, financing, operation, maintenance, ownership over the period of the concession) except for the conception of the work were assumed by the private partner (Eiffage).[83]

The full cost of construction (EUR 320 millions) was born by Eiffage. The concession is over a 78-year period. After that, the overpass will be turned over to the state. The concessionaire guarantees that the overpass will remain fully operational for at least 120 years. The toll should not increase faster than inflation. It has been set at a rate that is well accepted by the population although no alternative "free road" is available.

The PPP is clearly a win-win solution. For the "concédant" (the state) the advantages are substantial:

- It allows the construction of a major infrastructure without public funding.
- Most of the risks are transferred to the private sector.

- The state will recuperate the infrastructure at the end of the contract.

There are also tangible benefits for the concessionaire: although Eiffage assumes most of the risk, the expectations of profits are substantial. The expected internal rate of return calculated by the École Nationale des Ponts et Chaussées ranges from 9.2% to 17.3%.

The cost of capital. From a financial perspective, one of the main arguments often raised against PPP is that the cost of capital for private actors is higher than for the state, hence that the infrastructure ends up costing more than it would have if the traditional public contract route had been used.

This is a somewhat simplistic analysis of the situation. First of all, the cost of capital is only one of the costs of the project. If indeed it is higher for the private actor than for the state, this may be more than compensated by the fact that the project is likely to be cheaper and has a better chance of being completed within budget and on time as noted above. Moreover, the extra cost of capital can be viewed as an "insurance policy" to the extent that most of the risks are transferred to the private partner. Furthermore, one needs to take into account the down sides of the alternative option: if instead of the PPP, the government chooses to issue more debt, this could reduce its freedom of action and may even lead to a reduction in the rating of government bonds, increasing the cost of capital for the whole debt. Finally, the lower cost of capital of governments is predicated on their ability to raise taxes to reimburse their debt. However, this is becoming increasingly difficult politically and unwise economically.

Hence, on balance, if appropriate governance mechanisms are put in place with a clear focus on users and taxpayers interests, the PPP route is an attractive option for the development and operation of infrastructures, not only because they can potentially provide best value for money but also because they can contribute effectively to the financing of infrastructure. For instance, in France, 75% of the highways built in the post-World War II period have been in the context of concessions (the first one dates to 1956). Thanks to concessions, the highway network was developed with minimum financial participation by the state. This has allowed the general population to take advantage of the network faster than if it had to be financed publicly. Moreover, the concession is temporary; the infrastructure returns to the state after the concession.

So far, the discussion has focussed largely on PPPs involving the private ownership of assets (including cases where the assets return eventually to the state, such as in the Millau Viaduct example). This is not the only way public sector actors can tap the expertise and resources of the private sector. Indeed, a Private Finance Initiative (PFI), another form of PPP, has been gaining growing attention in recent years (notably in the UK) and may become more prevalent in the future in the OECD area and beyond.

In PFI, the public sector contracts to purchase quality services on a long-term basis so as to take advantage of private sector management skills incentivised by having private finance at risk. This includes concessions and franchises, where a private sector partner takes on the responsibility for providing a public service, including maintaining, enhancing or constructing the necessary infrastructure (United Kingdom, 2003).

To be effective, PFI needs to be managed as a mature relationship between the public and private sectors that recognises their mutual responsibilities. PFI ensures that contractors are bound into long-term maintenance contracts and shoulder the responsibility for the quality of the work they do. With PFI, the public sector defines what is required to meet public needs and remains the client throughout the life of the contract. The public sector also ensures, by contract, delivery of the outputs it sets and has rights under those contracts to change the output required from time to time. Consequently, with PFI the public sector can harness the private sector to deliver investment in better quality public services while maintaining frontline services in the public sector.

The key to the success of PFI is to ensure that the sharing of risks between the public and private partners is done appropriately and effectively. The benefits PFI can offer, in terms of on time and on budget delivery and whole-of-life costing, all flow from ensuring that the many different types of risks inherent in a major investment programme – for example construction risk or the risk associated with the design of a building – are borne by the party who is best placed to manage them. In this way, the private sector is incentivised by having its capital at risk to perform well, and takes responsibility for the work it undertakes.[84]

While the private sector takes on the major project performance risks, such as cost overruns and delay, key risks in an investment project are retained by the public sector in both conventional procurement and in a PFI scheme. These include the need to make alterations in the delivery of services necessary to reflect changing needs of the public sector in the future. The government also needs to protect the ongoing delivery of public services. For those services provided through PFI, the contract entered into with the private sector builds in major protections for the public sector to safeguard the standards of delivery by PFI schemes in public services, and their flexibility in future.[85]

For further details regarding the British experience with PFI, see Chapter 1, Box 1.2. Experience in the UK has been largely positive to date, although PFIs are thought to be a suitable form of procurement for only 10-15% of total investment in public services.

Encouraging more funding of infrastructure by pension funds

As noted in the previous section, infrastructure investment offers long-term stable returns with the opportunity for capital growth. Such features could be

particularly attractive to pension funds managers if political risks can be kept to a minimum. Indeed, pension funds are following a global trend by moving away from volatile stock markets into infrastructures that provide stable returns needed to pay future pension payments. The fact that traditional real estate has become too pricey in almost every market has prompted them to seek out alternate investments, including a broad scope of infrastructure projects like shipping ports, airports, communications, utilities, natural gas networks, health care, educational facilities and forestry. One of the attractive by-products of this strategy from the pension funds perspective is increased diversification, leading to lower portfolio risk since infrastructure has a low correlation to other asset classes. Some pension fund managers see infrastructure investment as somewhat between equities and bonds: some growth prospects and a very good running yield.[86]

An interesting case in point in this regard is the recent proposal (April 2006) by Treasurer Angelides that California's pension funds – the California Public Employees' Retirement System (CalPERS) and the California State Teachers' Retirement System (CalSTRS) – invest USD 15 billion in urban, smart growth infrastructure projects in California. This is in order to finance the projects that California needs, create jobs and earn a return for the pension funds and taxpayers. The Treasurer's Cal-Build initiative would provide a new source of capital for state and local infrastructure projects, supplementing the financing available from tax-exempt municipal bonds. And it would create a secure new investment for the pension funds to help them meet their need for solid, long-term financial returns.[87]

Proponents view investing pension funds in infrastructure as a way to kill two birds with one stone, *i.e.* meeting the needs of future pensioners while at the same time reducing the infrastructure investment gap. As Ryan Orr, executive director of the Collaboratory for Research on Global Projects (CRGP) at Stanford University puts it:

> *The (pension fund) money belongs to the school teachers and public employees. Why not invest it back into the roads and the infrastructure that they all use every day? Why not have the pension funds both earning their returns and improving the lifestyle for all?*

Canadian pension funds are also investing in infrastructure. For instance, two major funds, the Canada Pension Plan Investment Board and Ontario Municipal Employees Retirement System recently struck billion-dollar deals to acquire stakes in a British water company, AWG PLC, several Fairmont luxury hotels and MDS Diagnostic Services, Canada's largest laboratory operator.

Time will tell whether this interest of pension funds in infrastructure projects is a major new trend in OECD countries that may eventually extend to the developing world.

Indeed, the current enthusiasm for infrastructure investment is causing concern in some quarters that we may experience an asset bubble over the next few years.[88]

Moreover, even in the OECD area, infrastructure investment is not without risks. First, although regulatory regimes are clear and predictable, risks and rewards of investing in utilities can be skewed: high returns in one period cause the regulator to adjust his calculations for the next, so that the upside is capped whereas the downside is not. Second, it is clear that some infrastructure investments have proved disastrous for some investors, such as the tolled Cross City Tunnel in Sydney, which has just gone bankrupt, or Eurotunnel.

However, it is likely that in the longer run, the current surge of investor demand will be counteracted by a wave of supply from governments in light of the growing constrains on the public purse. The idea of privatising is probably most deeply embedded in Britain and Australia. The growing acceptance of the concept in the US is opening a huge new market. Success will critically depend on the putting in place appropriate institutions for managing risk as well as ensuring that risks are taken by those most able to assume it.

Pension funds in the OECD area have grown sharply over the last decade, from USD 5.9 trillion in 1994 to USD 15.6 trillion by 2004, representing a compound growth rate of 10.2% per annum.

According to the third edition of OECD's new bulletin, *Pension Markets in Focus*, the ratio of total OECD pension fund assets to GDP increased from 84.1% in 2004 to 87.6% in 2005. Some countries recorded fast growth, albeit from a low base. Total pension fund assets amounted to USD 17.9 trillion in 2005, up from USD 13 trillion in 2001. (See Chapter 1, Figures 1.5 and 1.6.)

Even if only 1-5% of these funds were devoted to infrastructure projects, as suggested for instance in Vives (1999), this would translate into a total infrastructure investment of USD 179-895 billion. The same logic could be applied in developing countries where pension funds have been expanding as a result of pension fund reform, building up a pool of financial resources in search of attractive investment opportunities that the local market can supply (*e.g.* Latin America).[89]

Promoting a more effective allocation of public resources across the various levels of government

Two main approaches have been discussed above to putting the financing of infrastructure on a more sound footing: greater reliance on user fees; and greater private sector participation in the development, operation and financing of infrastructure. It is also important to ensure that public resources are properly allocated between the various infrastructures (taking into account their specific features but also their complementarities) and between the

various levels of government on the basis of their responsibilities and existing institutional arrangements.

For instance, *municipalities* often bear the greatest share of the cost of infrastructure development, in particular because of their responsibilities regarding *water and water treatment* systems. However, they do not always have the tax base necessary to carry out this responsibility. Hence, it is critical that appropriate mechanisms be put in place to ensure that adequate funding is made available to meet their needs, notably when they face added costs resulting from the imposition of stricter standards by national or transnational authorities. In addition, it is legitimate to expect higher levels of government to be involved in the financing of infrastructure that can be considered as strategic from a national perspective, such as *major intermodal terminals* or the development of *UPT* systems in large cities. Such issues arise in particular in federal states where co-operation between various levels of governments is essential whatever the jurisdictional distribution of responsibilities. For such co-operation to happen, a strong impulse is required from *higher* levels of government.

In the case of infrastructures financed essentially by *user fees*, it may be desirable to give municipalities a greater ability to issue bonds. The use of tax-free bonds appears an attractive way to give municipalities more freedom of action while at the same time providing for a transfer of resources from the state (forgone tax revenues). To encourage the greater use of user fees, federal grants can be made conditional on their adoption at the local level. For instance in Canada, one condition imposed on municipalities for receiving financial funding for a municipal water project under the Canadian Strategic Infrastructure Fund (CSIF) is that the issue of water metering and pricing be addressed in the project.[90]

6. Concluding remarks

Infrastructures are key determinants of the way our society is organised, and they affect all aspects of our daily lives. In the future, we will become more and more dependent on their effective, efficient and ubiquitous operation. In this context, the concept of "business model" offers a useful analytical tool for assessing the effectiveness and efficiency of existing arrangements from a policy perspective. It puts the emphasis on the need "to create value for money": how effective and efficient are our infrastructures and what can we do to make them more so in the face of changing conditions, both on the supply and on the demand side?

When considering the present situation, it is clear that we are confronted by a legacy of business models rooted in history, many of which are becoming increasingly inadequate in our rapidly changing world. Such inadequacy, which has lead to serious market and public failures, goes a long way in explaining the

"infrastructure investment gap" that currently prevails throughout the world. Obsolete models no longer produce enough value for satisfying either the requirements of investors, the needs of users or for meeting the objectives set by policy makers.

A Darwinian selection process fuelled by globalisation is under way to eliminate the weakest models. Indeed, as a growing range of activities are globalised, underperformance becomes ever more visible, not only in the eyes of experts but also of individual citizens that have to bear the cost of obsolete infrastructures, both as users and taxpayers. However, this process is painfully slow, as it is often opposed by powerful legacy players. Moreover, the direction and the pace of reform are not always clear. And to be successful such reforms generally require the implementation of far-reaching innovative measures that need to be carried out with undaunted determination over extended periods of time – a formidable task for politicians with only a short policy horizon. Finally, because of cultural and institutional differences, the advances achieved in one country cannot be easily transposed to another, slowing down the adjustment process.

As business models slowly adjust to changing conditions in the coming years, they will be confronted by new challenges. First of all, they will need to take into account an increasing range of actors as *interdependence* between nations increases at the international level. They will also need to be more responsive to the needs of individual citizens at the local level, as the concept of participatory democracy is likely to be increasingly embraced, leading to a more proactive and ongoing participation of individual citizens regarding decisions that affect the key infrastructures that shape their daily life.

Greater attention should be given in the future design of business models to the need to ensure the *longer term financial viability* of the infrastructure in the face of *shrinking public budgets*. This will include efforts to reduce the scope for inappropriate interventions by opportunistic politicians, as well as efforts to make infrastructures more self financing by appropriate increases in the fees charged for the use of the infrastructure. Particularly important in this context will be ensuring that social obligations are effectively met but do not bear unduly on the financial viability of the infrastructure.

New technology will offer opportunities to provide service more effectively and efficiently and to reduce the burden on the public purse. In this regard, business models will need to be flexible enough so as to ensure that new technology, even when it is disruptive for legacy players, can be adopted rapidly for the benefit of all users and taxpayers alike.

This will call in particular for the more widespread adoption of ICT in order to develop intelligent infrastructure systems capable of responding in real time to changing conditions and providing incentives for effective modifications in

the behaviour of users. In addition, this will contribute to greater flexibility and resilience when coping with security risk.

Business models will also need to allow key actors to be able to take into account new constraints, such as those related to the *environment*. This may call for the introduction of new market mechanisms to allocate resources more effectively and *internalise externalities* and the adoption of technology-neutral incentive schemes.

Notes

1. It is interesting to note that "customers" and "users" are not necessarily the same in all models. For instance, in the Google model, the sponsors (advertisers) are the customers, while usage of the service is free. But to be valuable for the customer, the service needs also to be valuable to the user. In a way, the Google model is very similar to the model used by private broadcasters or "free" newspapers. The main difference is that Google offers a superior ability to target the advertising message to users.
2. As noted above, "customers" and "users" are not necessarily the same. In the Google model or a private broadcaster type model, customers (advertisers) are prepared to pay for what users want, only if it is profitable for them to do so.
3. Private goods (or services) are defined here as goods that are *excludable* (*i.e.* it is reasonably possible to prevent a class of consumers – those who have not paid for it – from consuming the service) and *rivalrous* (*i.e.* consumption by one consumer prevents simultaneous consumption by other consumers).
4. One needs to be careful not to extend unduly the concept of "good essential for life" as a justification for strong public oversight. For instance, food is essential for life, but it does not follow that it cannot be provided under normal business conditions. Indeed, this is what markets are for. What is important for the state from a social perspective is to guarantee minimum access to all and to control the quality of the service provided. Provision can be left to the private sector, as long as environmental rules are fully respected.
5. It is worth noting though that, historically, subway systems were originally developed by the private sector in large cities, such as London and New York.
6. This argument holds only as long as the UPT networks are not overextended to low density areas and that such networks are properly maintained and upgraded.
7. It is interesting to note though that considerable price discrimination prevails in the setting of UPT systems' fares. However, such discrimination reflects social concerns rather than attempts to maximise revenues, as would be the case if a form of Ramsay pricing was adopted.
8. For instance, in the UK, rural rail services receive 60% of the subsidies but account only for 16% of the passenger kilometres travelled. (*Source: The Economist,* 2006a, "Cattle Class", 6 June, London.)
9. George Stigler, winner of the 1982 Nobel Prize in economics, has argued that interest groups will spend resources in an attempt to gain access to the rents created by regulations, *i.e.* that interest groups will spend resources in an attempt to increase the probability that they will be given a large rent. The probability of

receiving a rent can be increased by lobbying regulators in order to get sympathetic regulators elected or appointed, or, more directly, to influence regulators with monetary bribes.

10. An interesting historical example of a freight subway is the Chicago Freight Subway that was in operation from 1906 to 1956 and which was used largely to deliver coal to heat buildings in the city. (*Source: www.reference.com/browse/wiki/Chicago_Freight_Subway*.)

11. Economies of scope exist when taking into account other infrastructures. Subways offer a conduit for other infrastructures, such as communications, electricity or water.

12. In order to meet a new more stringent federal requirement for water filtration, New York City faced the prospect of having to build a new filtration facility at considerable cost (USD 6 billion). It chose instead to meet the new requirement by working with local residents in the upstate watershed to reduce contamination from local septic and sewer systems, to protect land from inappropriate uses that contributed to water contamination, and to locally manage storm water runoff. By implementing a wide range of watershed management tools, the City was able to meet its water quality obligations for about a third of the cost of a new centralised filtration infrastructure. This is a clear application of Coase theorem which suggests that in the absence of transaction costs, all government allocations of property rights are equally efficient, because interested parties will bargain privately to correct any externality. In this case, the upstream externalities have been internalised through bargaining between the City of New York and residents in the upstate watershed. This can work only when transaction costs are modest, as seems to be the case here. Alternatively, it might have been more efficient from a public policy perspective to impose more stringent requirements on upstate residents, *i.e.* more forcefully apply the polluter pays principle.

13. Network Rail took over the UK rail network (former British Rail) by the acquisition of Railtrack plc in October 2002 for GBP 500 million. Railtrack was managing the network since privatisation and was close to bankruptcy. Although Network Rail is a private company, it has a special and rather ambiguous status: it is a not-for-profit company. The shareholders do not receive dividends; profits being invested in the maintenance and upgrading of the network. Their position is similar to the managers of a public enterprise.

14. According to industry experts, the cost of producing drinking water from seawater is now 0.8 to 1.1 EUR/m^3 compared to 0.6 to 0.8 EUR/m^3 for water drawn from rivers and 0.4 EUR/m^3 for water pumped from aquifers. (*Source: Le Monde*, 24 July 2006, p. 7.) Desalination is becoming increasingly popular in some parts of Asia. For instance, the development of Binhai, a high priority area for the Chinese authorities, will depend on water diverted from the Yangtze river, but also from desalinated seawater. (*Source: The Economist*, 22 June 2006, London.)

15. Automated trains are by no means new. In San Francisco, Bay Area Rapid Transit (BART) trains have been completely automated since the 1970s. And New York City had a fully automated train between Grand Central and Times Square for two years in the early 1960s. More recently, driverless, computer-controlled train lines have emerged in Paris, London, Vancouver, Kuala Lumpur, Singapore and elsewhere.

16. In Paris, it is envisaged that 80% of Parisians will have access to very high transmission capacity (100 Mb), with 10 000 km of new optic fibre installed by 2010, as well as free Wi-Fi access in several municipal locations. (*Source: Le Monde*, 6 July 2006, Paris, p. 14.)

17. For instance, General Motors has recently unveiled a "plug-in" hybrid which can be recharged by plugging it into the mains. The principal drawback so far is the cost of the battery pack. However, as batteries improve in the future, all electric vehicles will become more feasible. (*Source: The Economist*, "Plugging In", 6 January 2007, London, p. 53.)

18. Comments from Infrastructure Canada in 2006 to the OECD IFP Project Team.

19. *Ibid*.

20. *Ibid*.

21. Institutional arrangements also have a bearing on the ability of the national government to issue standards. For instance, in Canada there is no standard set at the federal level for the quality of water.

22. A new EC Bathing Water Directive was adopted on 15 February 2006 to tighten but simplify the health standards for bathing water; to improve the management of bathing sites and the provision of public information about them; and to streamline water quality monitoring programmes.

23. European Commission, Rail Transport and Interoperability, *http://ec.europa.eu/transport/rail/overview/fascinating_en.htm*.

24. See for instance the Portsmouth example given by Mackie and Smith (2007). The project, which was signed in July 2004 by the Portsmouth City Council, will put the management and maintenance of all 414 kilometres of Portsmouth roads in the hands of a private company for 25 years. In addition to management and maintenance the contract also includes road cleansing, pot-holes, bringing street lights up to modern standards bridges, structures, street lighting, maintenance of traffic management equipment, highways-related tree and grounds maintenance, winter maintenance and street cleansing and managing the highways with regards to licences and inspections.

25. *Source:* EC, Rail Transport and Interoperability, *http://ec.europa.eu/transport/rail/overview/fascinating_en.htm*.

26. *Source: The Economist* (2006b), "The Politics of Power", 9 February, London.

27. See Crozet (2007) for a French example.

28. On 11 July 2002, the French competition council ("Conseil de la concurrence") ruled that Suez (Lyonnaise des Eaux, SLDE) and Vivendi (Générale des Eaux, CGE) had been abusing their market dominance in France, where they control 85% of private water. The two companies have created joint subsidiaries in a number of towns and regions, so that they are sharing the profits of a water concession instead of competing against each other. Twelve joint ventures in France were listed, including cities such as Marseille and Lille – two involving SAUR as well. The council also said that since June 1997 more than 40 tenders had been made uncompetitive by the groups' behaviour ("le Conseil a constaté à l'occasion de plusieurs appels d'offres publics que le jeu de la concurrence a été 'faussé' dans plus de quarante marchés à partir de juin 1997"). CGE failed to bid on 37 occasions, and SLDE on 33 occasions. (*Source: La Tribune*, 2002, "Vivendi et Suez accusés de fausser le jeu de la concurrence", 18 July.)

29. Recourse to the private sector to finance large infrastructure projects also raises ethical questions when inexperienced investors are lulled into investing in a project on the basis of incomplete or misleading information, as illustrated by the Panama Canal scandal in France in the 1890s and the more recent ordeal of small shareholders of Eurotunnel.

30. Gouvernal, Élisabeth (2003), "Les lignes maritimes et le transport terrestre : quels enseignements peut-on tirer du cas 'Rail Link'?", *Les Cahiers scientifiques du transport*, No. 44, pp. 95-113.

31. Fares are an important source of income for the TfL budget (41% of revenue in 2005), and represent a growing and much higher proportion than in many European transport systems (28% in Greater Paris). Annual Tube travelcards for zones 1 to 4 cost approximately 6% of the average wage of a London worker, which is much higher than the equivalent for Paris and Berlin (2% of the average wage). Single Tube tickets are among the most expensive in the world: GBP 1.52 (approx. EUR 2.2) for a single trip in zone 1 when paid via the new Oyster fare system; GBP 3 (approx EUR 4.4) when paid with cash (*i.e.* more than three times the price paid in Paris). The fare structure is, however, highly sophisticated, with pricing innovation (off-peak prices, family discounts, etc.), and is much more market-orientated than in other cities. (*Source:* FitchRating – Transport for London [TfL], International Public Finance, United Kingdom Credit Analysis, 10 March 2006.)

32. For instance, in Toronto property taxpayers pay 95% of transit costs according to Juri Pill, chairman of the Toronto Office Coalition. (*Source: National Post*, 17 October 2006, p. 1.)

33. On 17 February 2003, TfL launched the congestion charge, which aims to reduce the number of private cars entering the most congested central area. The congestion charge system is operated by a private contractor. Although it has been extremely successful as far as the restriction of car traffic (minus 30%) and the increase in bus patronage are concerned, the congestion charge is generating less revenue than initially expected. The congestion charge was raised from GBP 5 to GBP 8 as of 4 July 2005. In September 2005, the mayor approved the extension of the congestion charging zone to include the western portion of central London as of 19 February 2007. However, the revenues yielded by the extension are expected to be largely offset by the costs of administering this area. (*Source:* FitchRating – Transport for London [TfL], International Public Finance, United Kingdom Credit Analysis, 10 March 2006.)

34. Both programmes use leveraged federal assistance and access to capital markets. The GARVEE programme enables states and other public authorities to issue debt-financing instruments, such as bonds, to pay for current expenditures on transportation construction projects and repay the debt using future federal apportionments. However, reimbursement of construction costs occurs only when debt service is due. The main benefit is that upfront capital is generated to keep projects moving forward at tax-exempt rates, and the cost of the infrastructure is spread over its useful life rather than just over the construction period.

35. The Northeast Blackout of 2003 was a massive power outage that occurred throughout parts of the north-eastern United States and eastern Canada on Thursday, 14 August 2003. Although not affecting as many people as the later 2003 Italy blackout, it was the largest blackout in North American history. It affected an estimated 10 million people in the Canadian province of Ontario (about one-third of the population of Canada), and 40 million people in eight US states (about one-seventh of the population of the US). Outage-related financial losses were estimated at USD 6 billion. (*Source: http://en.wikipedia.org/wiki/2003_North_America_blackout.*)

36. In order to maximise revenues, suppliers of electricity are tempted in effect to apply the pricing strategy used by airlines: *i.e.* price discriminate on the basis of demand elasticity. In the case of airlines this pricing strategy results in outcomes that are generally considered to be "socially acceptable" to the extent that the discrimination is in favour of individual consumers and leisure travellers (and at

the expense of business travellers). In the electricity market, on the other hand, the burden of the discrimination would be born by households, if this pricing model was to be used.

37. It has been noted by a commentator that in a number of developing countries, such as Egypt, the management of rural water is even more challenging than urban water because capital costs per unit of water sold are much higher than in urban areas and the ability to pay of rural households is usually lower than that of city dwellers.

38. For instance in California, well-connected farmers grow rice in the desert, even as Los Angeles begs for water. Altogether, the Californian agriculture sector accounts for 80% of water use in the state although it contributes only 2% to California GDP.

39. In this regard, *The Economist* noted in 2000 that most governments have so mismanaged supplies that much of the world's fresh water is wasted. That is the main reason nearly one in five of the world's people lacks access to safe, reliable water. This is most visible in the sprawling cities of the developing world. With the encouragement of international donors, governments have invested in urban water infrastructure, and they provide water at rates well below the cost of provision. Unfortunately, this strategy born of good intentions has in practice created a morass of bureaucracy and corruption. Though governments spend a fortune on urban water utilities, the main benefits flow to the middle and upper classes. The poor rarely have access to sewerage or piped water. Out of desperation, they endure open sewers and have to buy water, often of dubious quality, from private vendors from the backs of lorries. Even in Haiti, the poorest place in the Americas, slum dwellers pay 100 times what the "morally repugnant elites" (as they take perverse pride in calling themselves) pay for water piped to the hillside mansions that rise above Port-au-Prince. (*Source: The Economist*, 23 March 2000, London.)

40. The DJB says it supplies some 2.9 billion litres (650 million gallons) of water a day, against demand of 4.2 billion litres. But that understates the gap. It estimates demand only from those with water connections, variously estimated at 60% and 80% of Delhi's 16 million people. As for supply, some 15% is stolen and 40% lost to leakage. Many people queue at tankers, standpipes and boreholes fitted with handpipes. (*Source: The Economist*, 11 August 2005, London.)

41. While the elimination of the cross-subsidy has been beneficial for the freight rail operators, the passenger rail operators have suffered; For instance in the US, AMTRAK has been caught in a double bind where, on the one hand, Congress requests that the company breaks even, while on the other hand politicians, including senators, individually urge AMTRAK to extend its service to clearly unprofitable services for political reasons. The net result is that despite repeated injunctions made by Congress for the company to break even, AMTRAK is still losing money. Altogether it has cost the taxpayer USD 31 billion in 25 years of operation and serves only a tiny portion of the population.

42. In the Paris area, in 2005, the largest share of operating costs of all public transport systems in the area (*i.e.* EUR 3.7 billion) were covered by public funding, including a special tax on firms employing more than 9 employees. Fare revenues amounted only to EUR 2.63 billion over the same period. (*Source: www.stif-idf.fr/IMG/pdf/presentation_stif-2.pdf*.)

43. In this regard, Peter Schwartz, a well-known futurist in the business community, notes that there are many "surprises" that we can anticipate, and we can make fairly good assumptions on how most of them will play out. Even the most devastating surprises – like terrorist attacks and economic collapses – are often predictable

because they have their roots in the driving forces at work today. In short, we know many of the surprises to come, although we can only speculate in advance on their consequences or how they will affect us. (*Source:* Schwartz, 2003, p. 3.)

44. See Andrieu (2005).

45. In this context, pipeline projects are very revealing regarding the long-term energy strategies adopted by key players.

46. It is worth noting though that improvement in the design of coal-fired power stations and the possibility of substituting biomass for some of the coal burned could reduce the emissions of carbon dioxide to the same level as those stations using natural gas. Given the abundance of and easy access to coal reserves, such a technological advance by itself (without even considering carbon dioxide capture technologies) could significantly modify the geopolitics of input fuel supply over the coming years. (*Source: The Economist,* 2006, "Can Coal be Clean?", 30 November, London.)

47. *E.g.* the North American Electric Reliability Council. (*Source: The Economist*, 29 July 2006, London, p. 46.)

48. A recent conference co-organised by the OECD, the World Bank and the Agence française de développement has scrutinised the emergence of domestic operators in non-member countries. This dynamic is seen as an opportunity to serve new communities (including the poor) and to develop expertise via innovative partnerships between large international and local players. (*Source:* OECD Global Forum on Sustainable Development "Public-Private Partnerships in Water Supply and Sanitation – Recent Trends and New Opportunities", 29-30 November 2006, Paris.)

49. This is not always the case, though. In the telecom sector, fibre optics – because of its huge capacity – clearly favours monopoly provision for trunk traffic.

50. McAllister, J.F.O. (2006), "Warming to a Global Theme", *Time*, 13 November.

51. Storms are currently the costliest weather catastrophes in the developed world, and they are likely to become more powerful in the future as the oceans warm and provide more energy to fuel storms. Many of the world's largest cities are at risk from severe windstorms. Miami alone has USD 900 billion worth of total capital stock at risk. Two recent studies have found that just a 5-10% rise in the intensity of major storms with a 3°C increase in global temperatures could approximately double the damage costs, resulting in total losses of 0.13% of GDP in the US each year on average or insured losses of USD 100-150 billion in an extreme year (2004 prices). If temperatures increase by 4 or 5 °C, the losses are likely to be substantially greater, because any further increase in storm intensity has an even larger impact on damage costs. This effect will be magnified for the costs of extreme storms, which are expected to increase disproportionately more than the costs of an average storm. (*Source:* United Kingdom, 2006a, The Stern Review.)

52. Although technologies for eliminating carbon dioxide emissions from coal-fired plants already exist, such technologies will not be adopted without strong regulatory incentives from governments, such as long time caps or taxes on such emissions. (*Source: The Economist,* 2006, "Can Coal be Clean?", 30 November, London.)

53. This is no easy task in practice, as noted by Thompson (2007).

54. For instance, a new European Union-funded project will see the introduction of driverless taxis at Heathrow, "cyber cars" in Rome and an automatic bus in Castellón, Spain. Under the auspices of the European Union's "Citymobil" project, companies and research institutes representing ten countries have come together to develop small automatic transportation systems. Currently, three model

projects are planned with funding of about EUR 40 million. (*Source: www.spiegel.de/international/0,1518,435805,00.html*.)

55. A good example of the difficulties involved is the "Big Dig" project in Boston. Big Dig is the unofficial name of the Central Artery/Tunnel Project (CA/T), a megaproject to reroute the Central Artery (Interstate 93), the chief controlled-access highway through the heart of Boston, Massachusetts, into a 3.5 mile (5.6 kilometre) tunnel under the city. The project also included the construction of the Ted Williams Tunnel (extending Interstate 90 to Logan International Airport), the Zakim Bunker Hill Bridge over the Charles River, and the Rose Kennedy Greenway in the space vacated by the previous I-93 elevated roadway. Initially, the Big Dig plan included a rail connection between Boston's two major train terminals (North Station and South Station, North-South Rail Link). The Big Dig is the most expensive highway project in the US. Although the project was estimated at USD 2.8 billion in 1985, over USD 14.6 billion had been spent in federal and state tax dollars as of 2006. The project has incurred criminal arrests, escalating costs, leaks, poor execution and use of substandard materials. The Massachusetts Attorney General is demanding contractors refund taxpayers USD 108 million for "shoddy work". The final ramp opened 13 January 2006. (*Source: http://en.wikipedia.org/wiki/Big_Dig*.)

56. As noted in Tukiainen *et al.* (2006), "cultures" may be viewed from a social science viewpoint as emerging and evolving in response to human need for answers to a set of problems common to all groups including issues related to basic assumptions concerning the relationship between mankind and nature; the nature of reality and truth; the nature of humanity; the nature of human activity; and the nature of relationships between persons. In order to survive and to exist as a social identity, every group, regardless of its size, has to find its solutions to these problems. These solutions then become distinctive for the group separating them from others. Closely intertwined and emanating from culture is the concept of "institutions". Institutions can be defined as relatively stable collections of practices and rules defining appropriate behaviour for specific groups of actors in specific situations. They consist of informal (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights). The major role of institutions in a society is to establish a stable (but not necessarily efficient) structure to political, economic and social interaction.

57. For instance, for the Sea to Sky bypass in British Columbia (BC), three consortia – Black Tusk Highway Group, S2S Transportation Group, and Sound Highway Development Consortium – bid for the project. Each of these entities was composed of several companies. A total of 32 were involved in the bid, eight of them with headquarters in BC, 11 elsewhere in Canada and the rest abroad in France, the UK, US, Germany, Australia, and Hong Kong, China. Each consortium involved large corporations such as Vinci Concession, a division of the French Vinci Groupe, with revenues over USD 22 billion in 2003. Vinci is a world leader in concessions. In Canada, it owns nearly half of the consortium responsible for financing, constructing and operating the Confederation Bridge. Through a local subsidiary, it has a stake in the USD 640 million Fredericton-Moncton Highway. In France, Vinci Concessions' biggest asset is a two-thirds stake in Cofiroute, a concessionaire that operates a 985 kilometre network in France, as well as toll highways in the US, the UK, Germany, Greece and Chili.

58. For instance, in the British Columbia Sea to Sky bypass project, SNC-Lavalin Group, a large engineering and construction firm, was hired as an advisor to the government, while it was bidding at the same time on another BC project, RAV.

59. Arbitration of overseas investment disputes is one of the fastest growing areas of international dispute resolution. The exponential growth of international

investment in recent years has led to the signature of over two thousand Bilateral Investment Treaties (BITs) between foreign states, in addition to a wealth of multilateral treaties and other forms of concession agreements. Disputes that have arisen are often resolved through the forum of international arbitration, and typically involve claims by an investor company for compensation when an investment has been illegally expropriated or adversely affected by the state's activities. (*Source:* McLachlan, Campbell *et al.*, 2007, *International Investment Arbitration: Substantive Principles*, Oxford University Press, forthcoming.)

60. See *www.macquarie.com.au/au/corporations/sfpc/infrastructure_funds/overview.htm*.

61. See *www.innovations-report.com/html/reports/economy_finances/report-66444.html*.

62. See for instance John Foot's 24 May 2006 testimony to the US Transport and Communication Committee regarding the privatisation of the Chicago Skyway. (*Source: www.ksg.harvard.edu/ksgnews/OntheHill/2006/foote_052406.htm.*)

63. Several definitions of "civil society" can be found in the literature. The term generally refers to all of the organisations which are not public or for-profit institutions. For instance, in Anheier (2004), civil society is defined as "the sphere of institutions, organisations and individuals located between the family, the state and the market in which people associate voluntarily to address common interests". Examples of groups in civil society include universities, non-governmental organisations, environmental movements, indigenous peoples' associations, organised local communities and trade unions.

64. Deliberative democracy rests on the core notion of citizens themselves, and their representatives, deliberating about public problems and solutions under conditions that are conducive to: reasoned reflection and refined public judgement; a mutual willingness to understand the values, perspectives, and interests of others; and the possibility of reframing interests and perspectives in light of a joint search for common interests and mutually acceptable solutions (O'Hara, 1998).

65. In the UK, the long delay to the building of Terminal 5 at London's Heathrow Airport is often cited by business as unacceptable in a modern economy.

66. In the case of France, an argument has also been made that the monolith model may be preferable from both an efficiency and a security perspective when heavy reliance is made on nuclear generation. Given the relatively limited role of nuclear generation at the global level, being able to build a large number of identical plants result in substantial economies of scale and offers opportunities to acquire considerable experience over time. This experience can be used to improve plant design, including safety features.

67. European Commission (2004), Proposal for a Directive of the European Parliament and the Council, amending Directive 91/440/EEC on the development of the Community's railways to gradually open up the market for international passenger services by rail – Extended Impact Assessment, Commission Staff Working Paper, COM(2004)139 Final.

68. For instance in London, Ontario, a relatively prosperous mid-size Canadian city, large amounts of untreated wastewater are still regularly dumped today in the Thames river when it rains because in the older part of the city the storm and sanitary sewers share the same pipes. (*Source:* London Free Press, 23 September 2006.)

69. In Canada, the contract between VIA and CN regarding access charges is coming up for renewal in 2007. There is a concern that VIA may face much higher charges, which will further undermine its financial viability.

70. This position is echoed for instance in a recent report to Canadian Council of Ministers on the Environment by Marbek Resource Consultants where it is argued that developing accounting and pricing rules that fully reflect the full cost of water and water sewage treatment is the single most important thing that municipal and regional governments could do to promote efficient water use. (*Source: www.ccme.ca/assets/pdf/ei_marbek_final_rpt_e.pdf*.)

71. In Santiago, Chile, for example, the municipal government introduced a "water stamps" programme that covers part of the cost of water for low-income residents. The result is that more people have access to water, and water use is more efficient. (*Source: www.globalexchange.org/campaigns/wbimf/Shultz.html* and *www.globalexchange.org/campaigns/wbimf/Shultz.html*.)

72. An additional advantage of water metering is that it can contribute to reducing water usage. According to Environment Canada, universal water metering has proven to reduce overall residential and ICI (Industrial-Commercial-Institutional) water consumption by 15 to 30%. (*Source: www.ec.gc.ca/water/en/manage/res/e_res.htm*.)

73. See *www.nhi.org/online/issues/76/books.html*.

74. The New York State Public Employment Relations Board (PERB) was created as an independent neutral agency to administer the Taylor Law.

75. The second phase of the scheme required European countries to submit to the European Commission a national plan of CO_2 quota allocations by the end of June 2006, so as to establish at the European level the volume of CO_2 that large industrial firms and electricity utilities (11 400 plants in Europe) will be allowed to release in the atmosphere over the 2008-12 period. The response of member countries has been mixed: some have met the deadline (*e.g.* UK), other are dragging their feet (*e.g.* France) while five countries (including Italy and Spain) still have to submit a plan and may be sued by the Commission before the European Court of Justice. (*Source: Le Figaro*, 30 November 2006.)

76. *Source: The Economist*, "Selling Hot Air", 7 September 2006.

77. *Source: The Economist*, "Moving Target", 17 August 2006.

78. *Source: Le Figaro*, 2 December 2006.

79. The IPCC special report on CCS (IPCC 2005) suggested that it could provide between 15% and 55% of the cumulative mitigation effort until 2100. The IEA's Energy Technology Perspectives (IEA 2006) uses a scenario that keeps emissions to near current levels by 2050, with 14-16.2% of electricity generated from coal-fired power stations using CCS. This would deliver from 24.7-27.6% of emission reductions. Sachs and Lackner (2005) calculate that, if all projected fossil-fuel plants were CCS, it could save 17 Gt CO_2 annually at a cost of 0.1% to 0.3% of GDP, and reduce global emissions by 2050 from their 554 ppm BAU to 508 ppm CO_2. IEA modelling shows that, without CCS, marginal abatement costs would rise from USD 25 to USD 43 per ton in Europe, and from USD 25 to USD 40 per ton in China, while global emissions are 10-14% higher. This highlights the crucial role CCS is expected to play. (*Source:* United Kingdom, 2006a, The Stern Review.)

80. *Source: The Economist* (2006), "Can coal be clean?", 30 November.

81. National grids are usually tailored towards the operation of centralised power plants and thus favour their performance. Technologies that do not easily fit into these networks may struggle to enter the market, even if the technology itself is commercially viable. This applies to distributed generation as most grids are not suited to receive electricity from many small sources. Large-scale renewables may

also encounter problems if they are sited in areas far from existing grids. Carbon capture and storage also faces a network issue, though a different one; the transport of large quantities of CO_2, which will require major new pipeline infrastructures, with significant costs. (*Source:* United Kingdom, 2006a, The Stern Review.)

82. If a decision is expected at some point in the future about whether or not a new climate change policy will be introduced, a company which makes its investment decision now, risks a loss later if it makes the wrong call on policy. If it waits until the policy is agreed, it can make a more informed choice. Given this uncertainty, a much higher expected profit level would be required to trigger the investment now. In the energy sector, such delays in investment could create serious problems for a country's security of supply. Modelling work by Blyth and Yang (2006) indicates that an increase in the period of relative carbon price stability from 5 to 10 years (which could equate to increasing the length of an allocation period in a trading scheme) could reduce the size of the investment thresholds arising from uncertainty by a factor of two or more. (*Source:* United Kingdom, 2006a, The Stern Report.)

83. Eiffage is one of the largest construction groups in Europe with annual sales of EUR 8.5 billion and a staff of 50 000 employees in 2005.

84. Examples of contracts where risks have been passed on from the public sector at some cost to the private sector include the London Tube PPP (see Box 2.3) where one of the two private consortia is facing penalties, and the construction of Wales' Millennium Stadium in Cardiff.

85. Another interesting development has been the creation of a secondary market in PFI contracts, mainly for UK projects. While this unsettles some stakeholders who anticipate long-term commitments from the initial private partners, it can also be read as an expected outcome in a dynamic market where risks and responsibilities will come to reside with those most willing and able to nurture the contract. This market development underlines the need for the government to negotiate well-constructed contracts which ensure continuity of service, including provisions for equitable sharing of benefits as appropriate if the project is refinanced post completion.

86. *Source: The Economist*, 20 January 2007, p. 79.

87. *Source: www.treasurer.ca.gov/calbuild/calbuild.pdf#search=%22infrastructure%20pension%20funds%22.*

88. For instance, Michael Wilkins of Standard and Poor's, a rating agency, gave warning last year: "The infrastructure sector is in danger of suffering from the dual curse of overvaluation and excessive leverage – the classic symptoms of an asset bubble." He estimated that USD 100 billion-150 billion of capital was raised last year to invest in infrastructure. As money pours into the industry, prices are going up and future returns are being revised down.

89. Vives (1999) suggests in this regard that an ideal financial instrument could be securities of a fund invested in many carefully selected projects, with some form of credit enhancement (*e.g.* multilateral participation, credit guarantees, political risk insurance) over several sectors (heavy on energy, light on water, with a mix of transportation subsectors), covering several countries, mostly in operation stage, with shares quoted in some exchange, preferably in a developed market.

90. The CSIF is a USD 4 billion fund directed at projects of major federal and regional significance in areas that are vital to sustaining economic growth and enhancing the quality of life of Canadians. Maximum federal funding is 50% except for broadband and Northern infrastructure projects where it is 75%. Special conditions are imposed

on the use of these funds. For instance: mass transit projects must explore option for transit demand management strategies as a condition of federal funding; water systems must address issues of metering and pricing; new municipal buildings must exceed energy efficiency requirements codes.

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ANNEX 2.A1

The Impact of Deregulation on the Electricity Sector

At the end of the 1990s, the outlook for deregulation in the electricity sector was rather upbeat. For instance, a study conducted at the time by the International Energy Agency (IEA) to examine how electricity reform was expected to reduce generation costs confirmed the scope for cost improvements, although it was pointed out that it is the market which ultimately will determine their extent (IEA, 1999).

The study also considered how investment in the power sector would be affected by market liberalisation. It was acknowledged that some observers feared at the time that the additional uncertainties to which the transition gives rise would result in inadequate investment in new generation capacity or an inappropriate plant mix. The IEA analysis suggested that these issues would not deter investment, provided reform was well designed in the first place and effective regulation was put in place. However, the IEA warned that a residual responsibility rested on governments to monitor market developments and maintain an adequate regulatory framework. Governments must ensure that adequate incentives are in place to attract new investment well before capacity shortages appear. The IEA study concluded that, in the end, experience will demonstrate how well electricity reform measures up to expectations, but the authors were of the view that their analysis provided good grounds for confidence in the benefits of deregulation.

Observers are less upbeat today. The outlook for deregulation does not seem as rosy as it did then. Indeed, the impact of deregulation in the electricity sector is generally viewed as "mixed". On the one hand, there is some evidence that, on balance, deregulation has been beneficial in some countries at least. For instance, Coulson (2006) finds that panel regressions indicate that state electricity deregulation in the US is associated with higher housing prices, increased activity in the housing market, and lower wages, all

of which are consistent with a model of compensating differentials wherein deregulation (which is shown to indeed lower electricity prices) increased the utility of state residents.

There is also some empirical evidence that the rate of technical change in the sector is higher in a deregulated environment than under a rate-of-return regulatory regime. This is found for example by Frank (2003) in the case of Texas, a state which offers a rather unique opportunity to assess historically the impact of regulation on innovation. In Texas, regulation was relatively limited until 1975, after which time state legislators imposed rate-of-return regulation. Utilising a translog cost framework on annual data covering the years 1965 to 1985, Frank was able to compare the rate of technological change both before and after the imposition of rate-of-return regulation. The findings indicate that before the implementation of rate-of-return regulation, costs decreased significantly because of technological progress. After the implementation, however, it was found that costs increased significantly due to technological regress brought on by regulation.

Other studies, however, draw a very different picture. In the case of New Zealand, there is evidence that "light-handed regulation" (limited to mandatory information disclosure) over the 1994-2003 period has resulted in large increases in the price-cost margin (Bertram *et al.*, 2005). The authors found that this regime has allowed profits to exceed the levels which would have been acceptable under the old rate-of-return regulatory framework, by about USD 200 million per year, on an ongoing basis.

Some authors are also rather critical of the impact of deregulation in the UK. In particular, it is noted that an expected result has not been fulfilled, that is, the replacement of monopolies in some areas by markets and price-setting using a simple incentive formula has not lead to "light" regulation. Incentive regulation has evolved into a complex and intrusive form of rate-of-return, while regulation of industry structure has allowed the industry to descend into a concentrated, vertically integrated structure, at odds with the aims of the reforms (Thomas, 2004).

Banks (2004) also raises questions regarding the deregulation of electricity in Sweden. The author notes that since the beginning of the deregulation 'experiment', the trend price of electricity has increased much faster than the consumer price index, especially during recent years. More importantly, because of: 1) the lack of investment in domestic generating (and perhaps transmission) facilities by Swedish power companies; 2) the questionable strategy employed by these firms to manage hydroelectric reserves; 3) increased and to some extent irrational energy taxes; and 4) the beginning of nuclear "disengagement", households and businesses are vulnerable to a prolonged "spike" in electricity prices.

In addition, concerns have been raised in the US that while some investors have profited handsomely by buying and sometimes quickly reselling "unbundled" power plants, electricity customers, who were supposed to be the biggest beneficiaries of the new system have not fared so well (Johnston, 2006). Indeed, the expectation that customers would benefit from healthy competition among a growing number of electricity producers has not been realised because not enough new competitors have emerged. Many of the new power plants failed because, unlike many of the old plants, they almost all used natural gas to produce electricity. Demand for natural gas soared, and the price for that fuel tripled, making electricity from these plants too costly to be competitive.

Moreover, many of the power plants that were sold by utilities are still owned by the utilities' parent companies; they were simply transferred from the regulated utilities to unregulated sister companies. Some regulators allowed utilities to favour the sister companies with long-term contracts, even if they did not offer the best price for electricity. As a result, truly independent electricity producers face significant barriers to entry. They complain that their modern generating plants often sit idle, while older, inefficient plants owned by politically powerful utilities and their unregulated sister companies whir around the clock under long-term contracts.

Barriers to entry also result from the way power plants have been transferred from regulated utilities to unregulated sister companies. In a number of cases, the potential savings from a competitive electricity industry were undercut by favouritism that regulators showed to utility companies. For instance in Ohio, regulators allowed an extremely favourable price when unregulated sister companies acquired power plants. The lower the price a sister company pays for a power plant, the more difficult it is for an independent power producer that must build an expensive new plant to compete.

These developments have induced many consumer advocate groups to lobby for a re-regulation of the industry. Even the Cato Institute, a strong advocate of *laissez faire*, has been very critical of restructuring in the US, arguing that attempts by bureaucrats and politicians to force unbundling on the industry is bound to fail. As the best alternative, Cato Institute experts recommend total abandonment of restructuring and a more thorough embrace of markets than contemplated in current restructuring initiatives, allowing utilities in effect to structure their operations as they see fit and to exercise fully their market power. However, recognizing that such reforms would be politically difficult to achieve, they argue that a second-best alternative would be for those states that have already embraced restructuring to return to an updated version of the old, vertically integrated, regulated

status quo. In their view, it is likely that such an arrangement would not be that different from the arrangements that would have developed under *laissez faire* (Van Doren *et al.*, 2004).

This rather mixed picture of deregulation efforts to date that emerges from the literature suggests that the jury is still out on the gains that can realistically be achieved and the time it will take to achieve them. Whether deregulation and restructuring can deliver substantial benefits critically depends on three questions:

- How significant are the losses associated with vertical disintegration brought about by restructuring? In this context, the implementation of new technology could play a critical role. In particular, distributed generation and increased use of ITC should logically make arm's length operations more viable.
- To what extent can such losses be compensated by long-term contractual arrangements, appropriate market mechanisms and regulatory incentives?
- To what extent can barriers to entry for new comers in the industry be reduced to a minimum? These barriers have clearly played a critical role in preventing competition to emerge. As a consumer advocate puts it, utilities have been able to kill the market before it could be started.

While it would be unwise to abandon deregulation and restructuring, it is clear that greater efforts will be needed in the future to improve the regulatory framework, provide appropriate incentives and to reduce drastically the barriers to entry in the electricity generation segment of the electricity supply industry.

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