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INNOVATIVE BUSINESS MODELS FOR EXPANDING FIBER-OPTIC NETWORKS AND CLOSING THE ACCESS GAPS

December 2018
OVERVIEW



WORLD BANK GROUP

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Foreword

It is my pleasure to present this flagship report on *Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps*.

For decades, the World Bank Group has been engaging with client governments around the world to improve digital connectivity and access, supporting policy and regulatory reforms and investments for broadband communications infrastructure. In the process, we have personally witnessed the evolution of mobile services and broadband Internet from being a luxury service to becoming an important part of many people's lives, and a key driver of economic and social development.

By creating new business models, products, and services, digital innovation provides unprecedented opportunities for countries to accelerate growth and skip the traditional stages of development. In fact, the digital economy is expected to account for a quarter of the world's GDP within the next decade.

Digital technologies are also bringing entirely new solutions to complex global challenges like gender inequality, climate risk, and unemployment. In addition, new and emerging technologies, such as artificial intelligence (AI), blockchain, and wireless systems are quickly transforming the way we are delivering services, including to poor and marginalized populations.

Of course, none of this is possible without efficient and reliable connectivity. While the UN Sustainable Development Goals (SDGs) aim to achieve affordable and universal Internet access by 2020, we still have a long way to go. Today, approximately 4 billion people live without Internet access, 90 percent of whom live in developing countries. The urban-rural divide remains a challenge, and digital inclusion of women is lagging in developing countries. Further, the high price of Internet services in many countries continues to undermine broadband adoption, particularly for the poor.

After years of rapid expansion, the next stage of broadband development will be more complex. Extending broadband access to rural areas and poorer and marginalized populations will require new business models, creative thinking, and active cooperation between all relevant stakeholders.

This report was prepared as a joint effort between the World Bank and the International Finance Cooperation (IFC), with support from our Digital Development Partnership (DDP) donors. It provides a comprehensive overview of the various business models that have been adopted globally to support high-quality digital infrastructure, and will serve as a reference tool for policy makers to tailor these solutions to their country's circumstances and needs.

The report reviews 70 case studies from across the world, spanning all segments of the broadband value chain—international connectivity, national backbone, middle mile and last mile connectivity—and proposes a framework to analyze how they can be replicated elsewhere. With wireless technology leading the way in connecting individuals, it also analyzes key trends related to spectrum policy and planning.

I am confident this report can become a powerful tool for countries to fulfill their digital potential and build the foundations for vibrant, inclusive digital economies.

Boutheina Guermazi

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The findings and analysis presented in this report would not have been possible without the various consultation opportunities supported under the Digital Development Partnership. The global consultation in March 2018 connected around 70 participants, in person and remotely, that ranged from client countries (for example, Afghanistan, Uzbekistan, Kyrgyz Republic, Ukraine, Nigeria, Nicaragua), private sector operators, the United States Agency for International Development, the World Economic Forum, Microsoft, GSMA, and World Bank Group staff. We are especially grateful to the DDP partners who remain engaged throughout the process, including representatives of GSMA and Microsoft.

Executive Summary

The increasing importance of the Internet—not only for tasks related to information search, storage, and sharing, but also for connecting people and business, domestic and international trade, education, entertainment and social interactions—has led governments around the world to include Internet connectivity in their priority policy agendas and infrastructure plans. Today, access to the Internet is no longer a luxury, but is increasingly considered an essential service, as important as building transportation and utility networks. However, more than four billion people, overwhelmingly in developing countries, still lack Internet access.

For the past decade, policy makers have sought ways to best create an enabling environment to direct national resources and engage the private sector to effectively expand access to the Internet. In doing so, policy makers and regulators face a unique combination of priorities, resources, market structures, and geographies that will affect their national plans. Experience shows that no one-size-fits-all approach exists, but past and current experience can be analyzed for common factors contributing to success or failure to support similar endeavors in the future.

This report reviews and provides guidance on innovative business models and approaches to the deployment of high-speed broadband networks and highlights global trends related to terrestrial spectrum resources that can be leveraged to meet expected future demand and close existing Internet access gaps. It is intended to serve as a reference tool to help policy makers and regulators assess alternatives for infrastructure deployment and adopt decisions tailored to their country's circumstances and needs.





New Business Models for Broadband Infrastructure Deployment

Over the past several years, new business models have expanded Internet access and helped to ensure that technology developments are deployed in areas typically not served through traditional approaches to broadband network buildout. Private actors, governments, and international organizations have sought solutions to the challenges confronted to serve communities that are not receiving the full benefits of broadband because the deployments are not financially viable for the private sector to invest in alone. However, the menu of solutions is not static as technological change continually generates new opportunities and undermines traditional business models.

KEY TRENDS IN SPECTRUM POLICY AND PLANNING

Wireless technologies are the most common means of accessing the Internet. As such, regulators and policy makers need to ensure timely and adequate access to spectrum under transparent, reasonable, and flexible use terms and conditions in order to enable the expansion of broadband access and facilitate the deployment of new and innovative applications.

Multiple levers can be adjusted to encourage effective use of spectrum resources and wireless technologies. To this end, chapter 2.1 focuses on wireless infrastructure and global trends in spectrum policy and planning, touching on key technologies that are enabling and expanding terrestrial wireless broadband Internet access. Although not intended as a detailed review of global spectrum considerations, this focused examination of key spectrum issues is crucial to understanding the trends affecting the wireless technologies that currently represent the most common means of accessing the Internet:

- **Spectrum for 5G and the IoT.** Internet access is moving towards a connected society, with smart applications provided by different Internet of Things (IoT) use cases. The deployment

of 5G networks will further enable the move toward ubiquitous connectivity. As such, global stakeholders are working to identify spectrum to enable the next wave of wireless broadband growth, and the next tranche of spectrum for mobile services, intended to enable 5G services and facilitate the IoT. This includes existing spectrum identifications below 6 GHz, and new spectrum ranges under study between 24 GHz and 86 GHz.

- **Alternative Models of Authorizing Spectrum Use.** On the licensing side, policy makers continue to issue spectrum licenses for the deployment of large mobile networks and fixed wireless services. In order to address the growth of spectrum demand, alternative authorization and spectrum-use models continue to evolve, such as the use of unlicensed spectrum, commonly considered for short-range, last-mile connectivity, as well as spectrum trading and spectrum sharing.
- **Spectrum Repurposing and Refarming.** Spectrum usage should be monitored to ensure its continuous efficient use. Spectrum available for older generations of mobile broadband can be refarmed to allow its use by newer technologies. Regulators are also revising existing spectrum arrangements and rules, to repurpose the spectrum used by other services and enable the deployment of mobile broadband. A key example is the low-band spectrum newly available for use following technical improvements to television broadcasting (known as the digital dividend) and which is particularly attractive for expanding wireless network coverage.

These trends will inform ongoing global developments that enable both the identification of new spectrum and additional options for enabling the most efficient and innovative uses of existing spectrum resources. It is critical that regulators consider how these developments are already taking shape, and the potential impacts on national ICT sectors and regulation.

SPECTRUM-SPECIFIC PRINCIPLES

In considering how best to leverage spectrum resources, the following core set of spectrum principles were used to develop the recommendations set out in this report:

- **Leverage flexibility to enable the introduction and growth of emerging technologies, notably 5G and IoT.** Although 5G technology has been in development for several years and IoT devices and services are already in use, both technologies are expected to experience considerable further development and growth. Regulators and policy makers should ensure that their actions not only do not constrain such growth but, rather, facilitate and encourage it, building frameworks that maximize flexibility, enable innovation, minimize administrative burdens, and take into account the characteristics that make these technologies different from earlier innovations.
- **Maximize spectrum access for wireless broadband services.** Demand for wireless broadband services has continued to grow unabated, driven in part by the continuing improvement of wireless technologies and their new applications, and the increasing ability to use spectrum flexibly to serve different needs and users. Policy makers and regulators seeking to expand access to

broadband should keep in mind that the most important method by which to increase capacity and improve the user experience is to ensure the availability of appropriate spectrum for use by wireless broadband services. In addition, regulatory frameworks should facilitate flexible use, allowing for pooling and sharing, to maximize use and efficiency, while at the same time promoting competition.

- **Implement strategies specifically targeting unserved and underserved populations.** Reaching areas and populations that continue to lack adequate—or any—broadband access will require new, more flexible approaches and reconsideration of the role of government. The advent of new wireless technologies with different characteristics and use cases than existing mobile networks should prompt actions that can strengthen existing successful approaches and leverage new technologies, business models, and spectrum authorization approaches to provide governments and regulators with a flexible set of tools with which to develop new sector strategies.

TECHNOLOGY TRENDS IMPACTING NEW BUSINESS MODELS

A number of technology trends strongly impact existing business models or inspire new ones:

- Technological advancements continuously challenge the notion of what constitutes a financially nonviable service area. As unit costs of service provision fall, areas previously considered uneconomic may become profitable for service providers with fewer government incentives or less intervention.
- Virtuous circles of bandwidth deployments are created. Higher bandwidth international and core network support cheaper and more compelling end-user service offerings. Higher bandwidth access technologies deployed more broadly in rural/suburban areas lead to greater capacity requirements in international, national core network and middle-mile networks.
- Legacy investment may be sunk, but historic deployments still may stand in the way of innovation. In markets in which incumbents have significant copper access infrastructure, rollout of superfast fiber networks may be delayed.

- Wi-Fi as an established relative low-cost wireless technology has inspired a breed of new innovative business models.
- New low-cost satellite deployments are promising to change the relatively limited performance and expensive broadband services delivered via satellite.
- TV white spaces is a low-cost alternative technology for rural coverage that has gained some momentum in recent years due to standardization by the Institute of Electrical and Electronics Engineers (IEEE), but there are no large-scale deployments yet.
- Drones, balloons, and other nonpermanent structures are being developed for middle/last-mile access; however, most are still in concept development.
- Using open-source software applications and out-of-the box small cell solutions rather than traditional cellular technology are providing opportunity for lowering the network costs for extension networks in rural areas.

These technology trends are further explored in chapter 2.2.

BUSINESS MODELS REVIEWED

This report reviews 70 Internet-related infrastructure projects¹ from around the world spanning the entire broadband infrastructure value chain (see appendix): crossborder, national backbone, middle mile, and last mile. These initiatives were categorized in terms of the primary attributes that may contribute to a deployment's relative success and evaluated according to a variety of success measures, as shown in table 0.1.

Table 0.1: Attributes and Success Measures

Primary attributes	Success measures
<ul style="list-style-type: none"> • The market structure in which the deployment operates; • The economic context (for example, strength of demand); • The regulatory and policy efficacy, that is, how well policy, regulation and enforcement align with objectives of the deployment; • The degree and nature of infrastructure-sharing; and • The business model, which may include one of a number of approaches. 	<ul style="list-style-type: none"> • Geographic reach of network; • Increase in installed bandwidth; • Volume of national traffic; • Utilization of network relative to legacy network(s) replaced; • Prices of network services relative to legacy prices and affordability; • Investment and unit investment (for example, per fiber kilometer); and • Performance to plan.

Source: TMG/Saliency Consulting.

¹ The term “project” is used generally throughout the study to indicate cases of infrastructure deployment. It may refer to specific deployment activity, initiatives, or companies engaging in infrastructure deployment.

Findings and Recommendations

In determining a best-fit approach for facilitating infrastructure deployment and leveraging spectrum resources to expand Internet access, the following recommendations were developed, based on the assessment of the 70 projects and relevant spectrum trends.

GENERAL RECOMMENDATIONS

There are five key principles that should form the basis of any policy for promoting broadband deployment:

- **Limited, incremental state intervention.** Governments should intervene only in cases of clear market failure and only to the extent necessary to overcome market failure and complement private investment. In such cases, the government should attempt to achieve its objectives through the least disruptive means possible and should only increase the scale or degree of intervention if the market failure proves persistent.
- **Minimize regulatory failure.** Governments can take many actions to encourage infrastructure deployment that do not require any direct intervention in the market. The state should first consider the result of measures to obviate or minimize *regulatory* failure before it concludes that *market* failure exists.
- **Consensus on a coherent vision, political will, and leadership.** Intervention should be based on clear policy objectives for the sector, be conducted with commitment on the part of leadership, and flow through to regulation consistent with the policy objectives.
- **Governments should take a sober view of what activity it can credibly and reliably carry out.** All states will have limits as to the skill sets, finances, and legal authority, among others,

available to actively participate in infrastructure deployment. Governments should assess these capabilities and craft their participation accordingly.

- **Promoting competition.** Government intervention should be directed at increasing competition, through service-based competition when infrastructure competition is not viable. When infrastructure competition is not feasible, governments should generally support open access wholesale arrangements.

SPECTRUM-SPECIFIC RECOMMENDATIONS

The following recommendations, built upon the spectrum principles and trends identified above, are intended to assist stakeholders, particularly regulators and policy makers, when considering new technologies and trends in the context of spectrum policy. Comprehensive approaches to ensuring Internet access for all will benefit from early consideration of principles to make effective and efficient use of spectrum resources:

- **Promoting 5G and IoT deployment:** Implement policies that enable stakeholders to innovate and leverage emerging technologies made possible by advances in wireless broadband technologies, such as 5G and the IoT.
- **Supporting expected demand growth:** Enable and encourage wireless broadband networks to supply adequate capacity and coverage to meet expected demand for broadband connectivity.
- **Expanding wireless broadband to unserved and underserved areas:** Enable and promote the efficient and innovative use of spectrum and business models that can strengthen existing and new approaches and wireless broadband deployments.



INFRASTRUCTURE-SPECIFIC DEPLOYMENT RECOMMENDATIONS

The five general recommendations above are relevant to most interventions the government might consider, regardless of sector or objective. The analysis of the 70 broadband infrastructure projects also suggests some specific recommendations for infrastructure deployment, should the state decide it must intervene in ways that go beyond the use of standard tools of regulation. The following five specific recommendations are based on examination of the primary attributes and success criteria of the 70 Internet-related infrastructure projects examined in this study.

- **Private sector participation.** Government intervention in infrastructure deployment should involve the private sector wherever possible. The advantages of private-sector participation include the sharing of costs and risks, building expertise, and adding critical financial insight and caution that might not exist without it. Even where government intervention is indirect, implemented through policies such as taxation, subsidization, or regulatory obligation, the private sector impacts should be taken into consideration. The projects reviewed include numerous public-private partnerships (PPPs) where the initiative was simply not possible without private capital or benefited significantly in terms of rollout and financial viability from having private entities involved in constructing and running the network.
- **In the presence of state-owned incumbents, structural changes should be considered as part of the overall national plan.** If the state-owned incumbent operator is part of the solution, then it is quite likely that some sort of restructuring of the operator will be necessary to better position the incumbent to meet the broadband deployment goals.
- **Utilities collaboration and enabling reuse.** In many cases, the government has existing or planned utility infrastructure that is not factored

in or not recognized when planning national broadband. Public utilities have valuable assets for broadband deployment purposes, such as ducts and poles, buildings, land rights, and even fiber networks that could be leveraged for cost-effective deployment of new broadband infrastructure. Particularly with a limited budget, the more infrastructure that is reused, the more homes and businesses could be covered. Also, telecommunications and other utilities' networks could be deployed via a single civil works initiative.

- **Justification should be based on a realistic business case and socioeconomic cost-benefit analysis** with a view to local, national, and regional trends in the future. Governments should intervene with the objective of mimicking risk-adjusted, externality-adjusted market outcomes. In other words, economic net present value (ENPV) should be calculated and the initiative reconsidered or abandoned if not positive.
- **One business model's failure can lead to another's success.** The history of telecommunications infrastructure is filled with examples of overbuild, asset stranding, underutilization, and failed commercial endeavors of all sorts. While in the short run some projects may be wasteful, nevertheless, in the context of increasing long-term demand, long-lived assets can often be repurposed, commercialized, or otherwise brought back into productive use and facilitate new entry for the benefit of all. This notion applies to much of the infrastructure of utilities, government-owned networks and facilities of bankrupt public service providers. Policy makers can act to reduce the time that assets lay idle by (re)commercializing and reducing barriers to cross-sectoral engagement.

Finally, the business models reviewed provides a rich collection of **lessons for policy makers seeking to intervene to deploy in underserved areas**. This report provides a decision-making tool (see figure 0.1) to identify experiences that may be particularly

relevant for policy makers, given the attributes of the particular infrastructure challenge that they may encounter. In particular, the tool suggests various options for business models—segmentation, financing, management, and revenue generation—that can contribute to successful infrastructure deployment.

The decision-making tool considers seven scenarios, as well as a “**null**” **scenario** where the state should reconsider any proposed intervention. Where there is no demonstrable market or regulatory failure to address, state action is generally not justified. There are at least three examples in the list of reviewed projects where the state may have been unnecessarily ambitious in its objectives—the second phase of Rwanda NBFON (involving the pursuit of a single wholesale mobile network for 4G), Peru RNDFOF, and South Africa’s Broadband InfraCo. In the latter two, state investment was made in national backbones in markets in which the private sector was capable of delivering infrastructure on its own.

Scenario 1 results when there is no inherent market failure, but counterproductive regulation, unnecessary legal constraints, or unduly burdensome financial obligations are imposed by the state. In this scenario, the state’s role is simply to eliminate or minimize the self-created cause of infrastructure inadequacy. In most cases, this amounts to improving licensing—simply authorizing the entry of new players, ensuring spectrum is available, and so on.

Scenario 2 is the case of market failure primarily arising from dominance in the market. Here more active regulatory intervention may be required. This may take the form of more active encouragement of private sector competitors, for example, the creation of WIOCC in the crossborder market of East Africa, mandated access of dominant player networks, or more radical solutions such as structural separation.

Before addressing other, more interventionist, roles that the state may play in infrastructure development, the state has to answer the question of whether it

is capable of taking on such a role to create missing markets or infrastructure. The vast majority of states are in some way capable of playing a constructive role; however, there are states that have severe institutional issues, or an inability to commit to required policy or provide appropriate leadership. In these cases (**Scenario 3**) dealing with fundamental governance weaknesses must be a central part of any development program implemented.

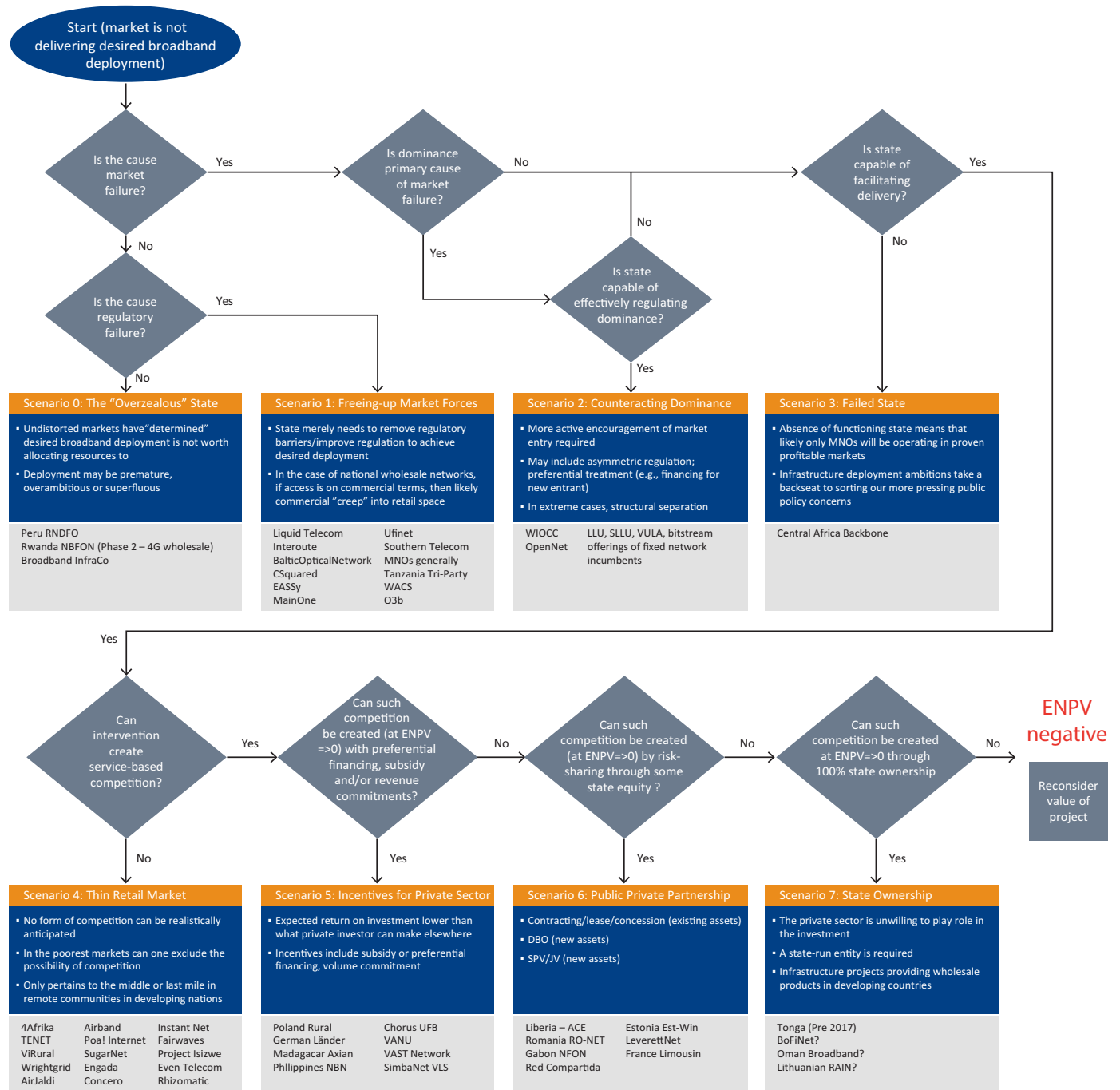
Consistent with the principle of promoting competition, the next question is whether a more active role for the state can be used to create service-based competition. If the market cannot even support service-based competition (**Scenario 4**), then it is probably very thin. These cases tend to be remote local markets. There are a number of innovative technologies and business models discussed in this report that address these particular circumstances.

Scenario 5, 6, and 7 address state action that is progressively more interventionist. In each case, the state’s financial commitments should be justified on the basis of a robust cost-benefit analysis. **Scenario 5** is the case where the state can limit its intervention to subsidy, preferential financing, or sales commitments, which offset low or uncertain nonstate revenues. In this case, the state can stay out of the management or ownership of the entity undertaking the project. Ideally, incentives would be competed for through an appropriately structured tender process.

Scenario 6 represents those cases in which the subsidy required to interest the private sector in taking up the opportunity is too high for the state to afford. In these cases, the state must take on more of the project risk in order to attract the private sector.

Scenario 7 is limited to those instances in which the state cannot build a sufficiently attractive offer of financial incentives and risk-sharing to interest the private sector. This would be a very small set of cases indeed. Of all the projects reviewed in this report, arguably, only one may have met this criterion.

Figure 0.1: Decision-Tree for Scenarios for the State's Role in Infrastructure Deployment



Source: TMG/Saliency Consulting.



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