ANNEX II: INFRASTRUCTURE INVESTMENT "NEEDS"

A. Setting the objective against which needs are to be measured

A2.1 **How much infrastructure investment is needed depends on the objective set, and the objective can be set in a variety of ways.** The objective can be to achieve a particular level of coverage or quality of service, deemed desirable or attainable. Or it can be an income growth or productivity gain objective, for which improved infrastructure is deemed necessary. As such the expression "investment need" should be used in tandem with the question "for what"? Annex Table 8 illustrates this, using the example of Mexico, where this exercise was recently undertaken in the context of a public expenditure review.

A2.2 **A first option is to use simple benchmarking.** This can entail comparing a country to its peers (as defined say by income levels) or to a country that offers a promising example (say a newly industrialized country such as Korea), and asking how much it would cost to achieve the service coverage or quality of the comparator country. The comparison can be on the basis of coverage or quality or of expenditure flows.

Annex Table 8: Different approaches to estimating expenditure needs in infrastructure – the example of Mexico.

	"Benchmarking"	Set target
Costing exercise	Ex: - **Stock target**: what would it cost to get Mexico's infrastructure (per capita; per unit of GDP; per km2) to the level of the LAC leader; or to the level of the East Asia median? - **Flow target**: how does Mexico's expenditures on infrastructure compare to peers.	Ex: What would it cost for Mexico to achieve universal service coverage in water and sanitation, electricity and access to year round roads?
Model	**Econometric:** **Growth:** What level of infrastructure coverage is needed to achieve x% level of growth and reduce inequality by z%. Model developed by Calderon and Serven (2004) could be used for this. **Demand***:* What level of infrastructure coverage will be demanded by firms and consumers, for given growth projections. This is the approach followed in Fay and Yepes, 2003.	**Engineering-economic models:** These are "set" targets inasmuch as the target is a particular level of coverage and quality as defined through engineering-economic models **Power sector:** well defined international methodology, applied by CFE in Mexico, which estimates the investment needed to maintain the integrity of the network and satisfy predicted expansion in demand. **Water/sanitation:** financial model that estimates investment needed to attain the coverage goals set in National Hydraulic Plan. **Roads:** well defined methodology for rehabilitation/maintenance expenditures; combined with road sector expert opinion on definition of major corridors and investment needs for their completion.

Source: World Bank 2005

A2.3 **The benchmarking can also be sophisticated, and rely on econometric models.** This is what Fay and Yepes (2003) do when they ask the question of how much investment may be needed to satisfy firm and consumer demand triggered by predicted GDP growth. This is benchmarking inasmuch as the relationship between income level and infrastructure service demand is established on the basis of past observed behavior in a sample of countries and extrapolated to the future using predicted income growth.

A2.4 **Objectives can also be set arbitrarily, on the basis of social desirability for example.** The Millennium Development Goals are an example of objectives set on the basis of a combination of social desirability and feasibility.[6] Alternatively, in Mexico, the question was how much it would cost to achieve universal coverage of water, sanitation, and electricity.

A2.5 **Objectives can be based on economic-engineering "rules" about networks and their integrity.** The electricity sector has sophisticated economic-engineering models that estimate the investments required to maintain the integrity of a network facing demand expansion. 7 In Mexico, roads investments needs were based on the estimated cost of rehabilitation needs (bringing the entire federal network to good or fair conditions) and the completion of what sector experts defined as major corridors. While it wasn't as formal a model as in the electricity sector, the investment needs were defined on the basis of recognized methodology for defining major corridors and appropriate quality targets.

A2.6 **In addition, maintenance expenditures must be included in any calculation of expenditure needs.** Rather than investment needs, countries should focus on overall expenditure needs which includes maintenance expenditures. Maintenance expenditure standards are well known and result in very predictable annual expenditure outlays when averaged over an entire network. Appropriate, but by no means generous, standards are approximately 2% of the replacement cost of the capital cost for electricity, roads and rail; 3% for water and sanitation and about 8% for mobile and fixed lines.

B. Costing the goal of bringing LAC to Korea's level of productive infrastructure coverage

A2.7 **For LAC to reach productive infrastructure coverage levels similar to Korea's would require annual investments of 4% and 6% of GDP per annum over the next twenty years (Annex Table 9).** Using data from Calderón and Servén (2004), we look at the stocks of roads (paved or total), electricity generating capacity, and telephone (fixed and cellular) for Latin American countries to reach the coverage level that Korea has today. In the case of roads, the goal is set to one third the road density of Korea –Korea's population density is much higher than that of most Latin American

[6] The one Millenium development goal pertaining directly to infrastructure is to "halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation."

[7] Mexico uses the Wien automatic system planning package (WASP IV), a widely used model that analyzes generating system expansion options, primarily to determine the least costly expansion path that will adequately meet the demand for electric power, subject to user-defined constraints. Other similar models are SUPER/OLADE/BID and MPODE, which are used by Colombia and Ecuador for example.

countries so that achieving the same road density may not be an appropriate goal. We also assume a rather optimistic growth scenario of 2.7% annual GDP growth.

Annex Table 9: How much would be needed for LAC to reach levels of infrastructure per worker levels similar to those of Korea (as a share of GDP)

	Total cost for Telephones (fixed and cellular) electricity generating capacity and		Annual cost if spread over 20 years/1	
	all roads	**paved roads**	**With all roads**	**With paved roads**
Argentina	75%	123%	3%	4%
Brazil	155%	234%	6%	8%
Chile	99%	153%	4%	5%
Colombia	180%	246%	6%	9%
Costa Rica	63%	77%	2%	3%
Mexico	48%	63%	2%	2%
Peru	202%	315%	7%	11%
Venezuela	73%	107%	3%	4%
Latin America	106%	156%	4%	6%

Source: own calculations based on data from Calderón and Servén (2004).
Notes: The cost for total roads, paved roads and rail is that of reaching a road/paved road/rail density equal to **one third** that of Korea - this is because for Korea's population density is much superior to that of LAC. This assumes an annual growth of GDP of 2.7% per annum over the next 20 years. See Annex Table 12 for detailed country and sector results.

A2.8 **While ambitious, this is not unrealistic. S**imilar increases were in fact achieved by Korea (as well as China, Indonesia, and Malaysia) over the 20 year period from the late 1970s to the late 1990s. Indeed, Korea's infrastructure endowments 25 years ago were substantially worse than Mexico's, Argentina's or Brazil's at the time. And if Calderón and Servén (2004) are right, the payoffs in terms of growth and decreased inequality would be substantial.

C. Universal water, sanitation and electricity coverage

A2.9 **Achieving the socially desirable goal of universal water and electricity coverage by 2015 would cost Latin America a mere 0.24% of GDP (Annex Table 10).** This includes 0.12% of GDP for electricity, 0.04% of GDP for water and about 0.08% for sanitation. This relied on UN population projections and a GDP growth scenario of 2.7% per annum. It is unfortunately impossible to estimate the needed rehabilitation and upgrading, which is likely to be very large particularly in water and sanitation given the generally poor maintenance in these two sectors.

Annex Table 10: Investments needed to achieve universal coverage in water, electricity and sanitation in Latin America by 2015 (percent of GDP)

	Safe Water	Sanitation	Total Water and Sanitation	Electricity	Total water, sanitation, electricity
Argentina	0.02%	0.03%	0.05%	0.05%	0.10%
Brazil	0.03%	0.09%	0.12%	0.11%	0.23%
Chile	0.02%	0.02%	0.04%	0.06%	0.10%
Colombia	0.06%	0.13%	0.19%	0.30%	0.49%
Costa Rica	0.03%	0.05%	0.08%	0.11%	0.19%
Mexico	0.02%	0.06%	0.08%	0.05%	0.13%
Peru	0.08%	0.16%	0.24%	0.28%	0.52%
Venezuela	0.04%	0.09%	0.13%	0.08%	0.21%
LAC	**0.04%**	**0.08%**	**0.12%**	**0.12%**	**0.24%**

Source: Own calculations based on World Development Indicators Data.
See Annex Table 13 for full sample.

A2.10 **These estimates are modest partly because they rely on alternative technologies in circumstances where the price of a connection to the grid or the network would become prohibitive.** For electricity, it assumes an average price of $1,000 per new connection (and for associated network costs), which implies that households too far from an existing network to be connected at a price inferior or equal to $1,000, would be served by alternative off-grid technologies.8 In the case of water and sanitation, it also assumes that households in low density areas would not have access to sewerage connections but alternative sanitation systems (e.g. latrines) and that a proportion of households would have access to water but not necessarily in house connections

D. Responding to firms and individuals' demand for infrastructure services

A2.11 **Responding to the derived demand of firms and individuals would require a more modest 1.3% of GDP per annum (Annex Table 11).** Adding maintenance expenditures would increase the annual need for resources to about 2.4% of GDP per year. The Fay and Yepes (2004) approach described above develops an econometric model that estimates the relationship between a number of economic variables (income per capita, urbanization and sectoral composition of GDP) and infrastructure coverage for electricity, telephones, roads and rail. This is then used in combination with World Bank and UN population and GDP growth projection to estimate the derived demand for infrastructure services – which in turn is priced.

[8] Since there are still some households to be connected that are relatively close to existing grids and could be connected at lower prices (say $500 or so), the price that determines a switch to alternative off-grid technologies could be somewhat above $1000. However, what is certain, is that an average price of $1,000 per connection would not allow universal connection to a grid.

Annex Table 11: Investment needed over the 2005-2015 period to respond to firm and individual demand (as % of GDP)

	Electricity	Telephone (fixed and cellular)	Roads	Rail	Safe Water	Sanitation	Total
Investments	0.7%	0.3%	0.2%	0.0%	0.1%	0.1%	1.3%
Maintenance	0.4%	0.3%	0.2%	0.0%	0.0%	0.1%	1.1%
Total	1.1%	0.6%	0.4%	0.0%	0.1%	0.1%	2.4%

Source: Own calculations based on Fay and Yepes (2004) methodology, using World Development Indicators data except for water and sanitation for which the target is the one set for the Millenium Development Goals (half the proportion of the population without access to water and sanitation by 2015). Note: the model assumes a 2.7% per annum GDP growth. See Annex Table 3 for other regions.

E. Pulling it all together

A2.12 **Annual expenditures of about 3% of GDP should suffice to respond to expected growth in demand from firms and individuals, maintain existing infrastructure and achieve universal service for water, sanitation and electricity over 10 years.** This is based on adding up the Fay and Yepes projections (2.4%) to the estimated cost of universal coverage (0.24% of GDP). Note that this does not include the cost of rehabilitation, nor does it cover urban transport, ports and airports.

A2.13 **A much higher amount (5% to 7% of GDP) would be required to bring LAC to Korea's level of coverage over 20 years and fund adequate maintenance.** This is based on the estimated cost of bringing LAC to Korea level (4% to 6% of GDP) to which the estimated cost of maintenance is added (about 1% of GDP per annum). Again, this does not include the cost of rehabilitation.

Annex Table 12: The cost of investments needed for LAC to reach infrastructure coverage per worker levels similar to those of Korea (as a share of GDP)

	Telephone Mainlines	*Mobile Phones*	*Electricity Generating Capacity*	*Total Road/1*	*Paved Road/1*	*Railroad/1*	*Total (excluding rail)*		*Total (excluding rail) Annual investment if spread over 20 years/2*	
							(all roads)	*(paved roads)*	*(all roads)*	*(paved roads)*
Argentina	2%	4%	23%	45%	94%	20%	75%	123%	3%	4%
Bahamas, The	1%	2%	14%	12%	26%	5%	30%	43%	1%	2%
Barbados	2%	4%	23%	1%	2%	0%	30%	31%	1%	1%
Belice	4%	7%	40%	116%	241%	50%	167%	291%	6%	10%
Bolivia	16%	30%	177%	600%	1246%	258%	823%	1469%	30%	53%
Brazil	6%	11%	65%	74%	153%	32%	155%	234%	6%	8%
Chile	4%	7%	39%	50%	104%	21%	99%	153%	4%	5%
Colombia	9%	16%	94%	61%	127%	26%	180%	246%	6%	9%
Costa Rica	4%	7%	39%	14%	28%	6%	63%	77%	2%	3%
Dominican Rep.	7%	12%	71%	10%	21%	4%	100%	110%	4%	4%
Ecuador	9%	17%	99%	59%	123%	25%	184%	247%	7%	9%
El Salvador	8%	14%	83%	7%	14%	3%	111%	118%	4%	4%
Guatemala	8%	14%	85%	23%	47%	10%	129%	154%	5%	6%
Guyana	18%	33%	193%	1323%	2747%	569%	1567%	2991%	56%	108%
Haiti	37%	69%	404%	34%	70%	15%	544%	580%	20%	21%
Honduras	15%	27%	160%	77%	159%	33%	278%	361%	10%	13%
Jamaica	6%	12%	69%	6%	12%	3%	93%	99%	3%	4%
Mexico	2%	5%	27%	14%	29%	6%	48%	63%	2%	2%
Nicaragua	20%	37%	215%	141%	293%	61%	412%	564%	15%	20%
Panama	4%	7%	42%	28%	58%	12%	82%	112%	3%	4%
Paraguay	12%	22%	127%	260%	540%	112%	421%	701%	15%	25%
Peru	7%	13%	77%	105%	218%	45%	202%	315%	7%	11%
Suriname	8%	14%	85%	922%	1914%	397%	1029%	2021%	37%	73%
Trin. and Tobago	3%	5%	27%	3%	5%	1%	37%	40%	1%	1%
Uruguay	3%	6%	34%	42%	86%	18%	84%	129%	3%	5%
Venezuela	3%	6%	33%	32%	66%	14%	73%	107%	3%	4%
Latin America	4%	8%	47%	47%	97%	20%	106%	156%	4%	6%

Source: own calculations based on data from Calderón and Servén (2004).

Notes: 1/ The cost for total roads, paved roads and rail is that of reaching a road/paved road/rail density equal to **one third** that of Korea. This is because for Korea's population density is much superior to that of LAC (187 for Korea as opposed to 26 for LAC) and the difference is even larger when using labor force rather than population (245 vs 11).

2/ This assumes an annual growth of GDP of 2.7% per annum over the next 20 Years.

Annex Table 13: Estimated annual investment needs to achieve universal access to water, sanitation and electricity in LAC by 2015 (% of GDP)

	Safe Water	Sanitation	Total Water and Sanitation	Electricity	Total water, sanitation, electricity
Argentina	0.02%	0.03%	0.05%	0.05%	0.10%
Belize	0.05%	0.16%	0.21%		
Bolivia	0.20%	0.47%	0.67%	0.92%	1.59%
Brazil	0.03%	0.09%	0.12%	0.11%	0.23%
Chile	0.02%	0.02%	0.04%	0.06%	0.10%
Colombia	0.06%	0.13%	0.19%	0.30%	0.49%
Costa Rica	0.03%	0.05%	0.08%	0.11%	0.19%
Dominican Rep.	0.03%	0.09%	0.12%	0.29%	0.41%
Ecuador	0.11%	0.37%	0.48%	0.36%	0.84%
El Salvador	0.10%	0.15%	0.25%	0.31%	0.56%
Guatemala	0.12%	0.24%	0.36%	0.44%	0.80%
Guyana	0.07%	0.18%	0.25%		
Haiti	0.68%	1.52%	2.20%	2.20%	4.40%
Honduras	0.18%	0.43%	0.61%	0.89%	1.50%
Jamaica	0.07%	0.09%	0.16%	0.10%	0.26%
Mexico	0.02%	0.06%	0.08%	0.05%	0.13%
Panama	0.03%	0.05%	0.08%	0.14%	0.22%
Paraguay	0.18%	0.23%	0.41%	0.60%	1.01%
Peru	0.08%	0.16%	0.24%	0.28%	0.52%
Trin. and Tobago	0.02%	0.03%	0.05%	0.02%	0.07%
Uruguay	0.01%	0.02%	0.03%	0.04%	0.07%
Venezuela	0.04%	0.09%	0.13%	0.08%	0.21%
LAC	**0.04%**	**0.08%**	**0.12%**	**0.12%**	**0.24%**

Source: Own calculations based on data from World Development Indicators