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# Building the World: Mapping Infrastructure Demand

- Growth in income per capita and urbanization will drive demand for infrastructure across the BRICs, N-11 and GCC countries over the next decade.
- At the high end, fast-growing and rapidly urbanizing countries like China and Vietnam could see annual growth rates of more than 15% in air travel, 8%-10% in electricity and technology, and 5% in roads. In already-rich and urban countries, such as Korea and the GCC states, annual growth could run at 1%-6%.
- China will be the source of one-half to three-quarters of total incremental demand, although its share should decline slightly over the decade. India will be the dominant source of demand outside of China.
- As a rough measure, total investment could be on the scale of $4.35trn over the decade. Of this, China would account for some $2.7trn (60%), India for $620bn (14%), and the N-11 and GCC together for $670mn (15%).
- Our equity analysts identify a list of companies that should benefit from infrastructure investments. Sustained demand will have other important consequences for global markets, by intensifying pressure on commodities markets and fuelling the global expansion of firms based in the BRICs, N-11 and GCC. Financing needs could support the development of domestic capital markets, especially in China and India.



Thanks to Dominic Wilson, Sarah Forrest and Andrew Howard

**Sandra Lawson and Raluca Dragusanu**



**April 24, 2008**

# Building the World: Mapping Infrastructure Demand

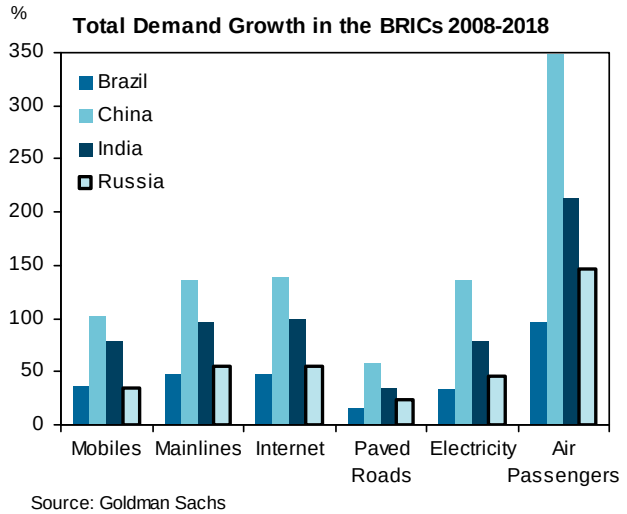
## I. Introduction: A World of Growth Ahead

Infrastructure is both a cause and a consequence of economic growth, making it a key aspect of our long-term projections. Physical infrastructure is essential for manufacturing, services, trade and even human capital, while rising incomes and rapid urbanization drive demand for electricity, transport, telecoms and housing.

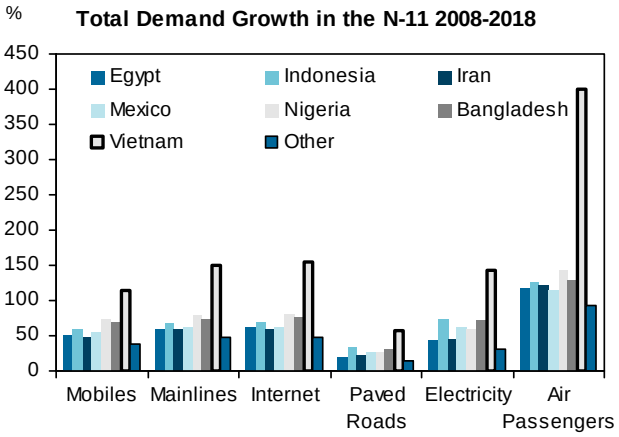
In this paper we estimate infrastructure demand over the next decade, modeling it as a function of growth in income per capita and of urbanization. This is a variation on our earlier work, which looked at the level of investment in infrastructure that would be needed to sustain rapid economic growth.[1] Our current projections are meant to be illustrative rather than strict point forecasts, and they highlight some of the dynamics in the global economy over the next decade.

Rapid income growth across the BRICs, N-11 and GCC countries,[2] and rapid urbanization in some of them, will drive enormous demand for infrastructure investment across a range of sectors, including electricity, air travel, roads, telecoms and internet use. At the high end, in countries such as China and Vietnam, our projections point to annual growth rates of more than 15% in the number of air passengers carried, 8%-10% in electricity installed capacity, mainline and mobile phone subscribers and internet users, and 5% in the stock of paved roads. At the low end, in already-rich and already-urban countries, such as Korea and the GCC states, average annual growth rates could be in the range of 1%-6%.

China dominates our projections in absolute terms, due to its size, rapid growth and urbanization. Only Vietnam has higher growth rates, but its far smaller population (less than 10% the size of China's today) means that the absolute numbers will be just a fraction of China's. India will be China's closest rival in terms of incremental demand, but the gap between the two is vast, and on a per capita basis China's gains will outstrip India's. However, China's share of total incremental demand is likely to decline slightly in four of the six sectors as growth elsewhere accelerates over the decade.




Source: Goldman Sachs




* Other countries includes countries with average growth of less than 50% (in descending order: Philippines, Pakistan, Turkey, Korea, GCC)
Source: Goldman Sachs

1. See our *Global Economics Weekly 06/22,* 'Building the World: Opportunities in Infrastructure', June 14, 2006, which estimated new investment and maintenance needs for the G6, BRICs and N-11 countries in aggregate, from 2006 to 2010.
2. BRICs are Brazil, Russia, India and China. N-11 (or 'Next 11') are Bangladesh, Egypt, Indonesia, Iran, Korea, Mexico, Nigeria, Pakistan, Philippines, Turkey and Vietnam. The Gulf Cooperation Council (GCC) states are Bahrain, Kuwait, Oman, Saudi Arabia and UAE (as well as Qatar, which we have not included in our analysis due to data issues).

Among the N-11 countries, we expect growth rates in Vietnam to be head and shoulders above the rest. Nigeria, Bangladesh and Indonesia trail Vietnam, but their high growth is often from a very low starting point. In absolute terms, even in the aggregate, we forecast that demand from the N-11 and the GCC will be overshadowed by China.

We are able to estimate costs for a decade's worth of investment in five of the six sectors mentioned above, excluding air travel. Again, these estimates are rough guides to the magnitude of the investment needed, rather than specific forecasts.

- Total infrastructure investment across the five sectors over the decade will be roughly $4.35trn.
- China will account for about 60%, or $2.66trn, with India a further 14%, or $620bn.
- An additional 15%, or $645bn, will be in the N-11 countries, with Indonesia and Mexico together accounting for one-third of this. Vietnam would account for just 2% of the total.
- Investment in the GCC would total $25bn, or less than 1% of the total.

This need for investment and financing will have important implications for global markets. Most obviously, it will create enormous opportunities for infrastructure suppliers, and we are likely to see the emergence of some 'domestic champions' in the countries with the highest growth rates. Infrastructure growth on this scale will maintain pressure on global commodity markets. It is also likely to intensify growing bottlenecks in the supply of skilled labor and expertise needed to make the best use of these investments. Financing needs should drive market innovation in developed and developing countries alike, and could boost the growth of domestic debt capital markets, particularly in China and India. Domestic investment needs within capital-account-surplus countries may also help to ease the global imbalances that have plagued the world economy in recent years.

We conclude the paper with a list of companies with exposure to global infrastructure opportunities, as identified by our equity analysts.

## II. Infrastructure Is Both Cause and Consequence of Economic Growth

Infrastructure is both a cause and a consequence of economic growth. In this paper we focus on the 'consequence' angle: the way in which economic growth drives demand for infrastructure investment. But it is worth mentioning the ways in which infrastructure contributes to growth, because this mutually reinforcing relationship itself helps to support higher demand for investment. Infrastructure's role in integrating countries into the global economy, through electricity and transportation infrastructure, is clear. Infrastructure can also raise the quality of human capital, which is a key factor in our long-term growth models. Improvements in the quality and quantity of infrastructure have a disproportionately positive impact on the poor, and thus play a vital role in reducing income inequality.

The impact is striking. The World Bank estimates that a 1% increase in infrastructure stock is associated with a 1% increase in GDP. Other studies have found that differences in the use of infrastructure (relating to the quality as well as the quantity) account for 25% of the growth differential between East Asia and Africa between 1970 and 1990, and for more than 40% of the growth differential between high-income and low-income countries over the same

period. Additional work attributes a major part of the per capita output gap that developed between Latin America and East Asia over the 1980s and 1990s to inadequate investment in infrastructure.[3]

## III. The Decade Ahead: Income Growth and Urbanization

### People are getting richer . . .

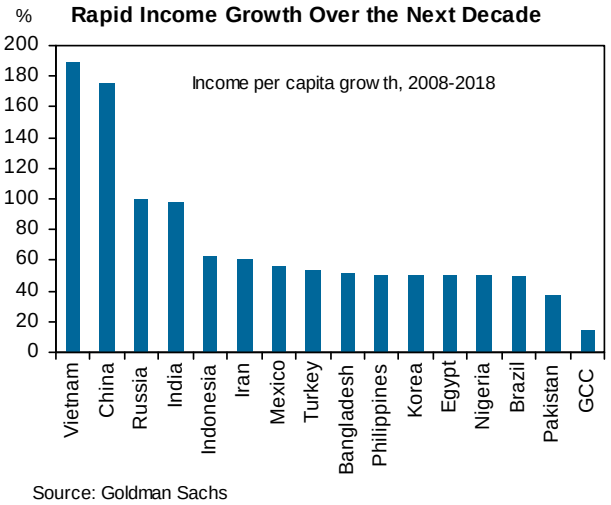
Rapid growth in per capita income is one of the critical points of our long-term story for the BRICs, N-11 and GCC. If economic growth plays out as we project over the next decade, per capita income will rise by more than 190% in Vietnam and 175% in China, and it will double in India and Russia. Income per capita in China will reach $7,600 (in 2006 US$), which is slightly lower than Mexico's today. Vietnam's will reach about $2,300 (where China stood last year). In the other BRICs and N-11 countries, per capita income should rise by 50%-60% over the decade. The laggards are Pakistan, where income is likely to rise by about 35%, and the GCC, at 15%.

As incomes rise, consumers will have more disposable income, meaning that middle-class purchasing habits are likely to spread. We estimate that the middle class (defined as income above $3,000 per capita) in the BRICs alone could reach 1.4bn people by 2020, up from about 300mn today.

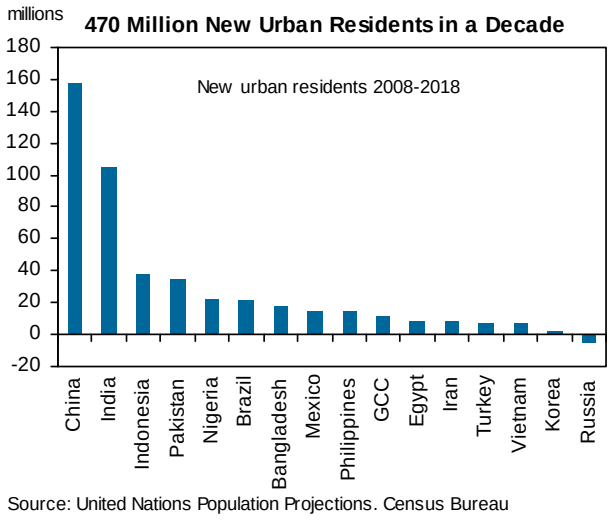
### . . . and more of them will be found in cities

Economic growth is driving urbanization—and vice versa—in India and China, where 70% and 55% of the population, respectively, is still rural, as well as in Bangladesh, Egypt, Nigeria and Vietnam, where more than half the population still lives in the countryside.

Growth of the urban population will be one of the most important demographic shifts of the next few decades. By 2018, Chinese and Indian cities will grow by about 30% (265mn people in total). Urban population growth will be even more dramatic in some of the N-11 countries. In all, by 2018 the BRICs will have an additional 280mn people living in cities, and the N-11 an additional 180mn. Even in countries that are highly urban today, natural population growth will be significant, with cities in Pakistan gaining another 35mn residents, and cities in Brazil another 21mn. Even the GCC cities will gain 13mn. This flood of new urbanites will require investment on a massive scale, in electricity, housing, water, sanitation and a host of other public services.




Source: Goldman Sachs




Source: United Nations Population Projections. Census Bureau

3. World Bank, The World Development Report, 1994: Infrastructure for Development; Hulten, 'Infrastructure Capital and Economic Growth: How Well You Use It May Be More Important than How Much You Have', *NBER Working Paper* 5847, December1994; Calderon and Serven, 'The Output Costs of Latin America's Infrastructure Gap,' in The Limits of Stabilization: Infrastructure, Public Deficits and Growth in Latin America, World Bank, 2003; and Rioja, 'The Penalties of Inefficient Infrastructure,' *Review of Development Economics* 7(1), 2003.

## Modeling Infrastructure Demand

We have developed an econometric model that draws on expected growth in income, urbanization and population in order to project future demand for six infrastructure variables. These are electricity installed capacity, air travel, mainline and mobile phone subscribers, internet users and the stock of paved roads. The data comes from the World Bank's World Development Indicators and the Energy Information Administration. Our baseline model uses real income per capita as an independent variable and controls for urbanization in the case of mobiles, mainlines, internet, paved roads and electricity, and for population in the case of air passengers. Econometrically, we have two versions of the model:

- **Mobiles, mainlines and internet**: We use a cross-sectional data set to estimate the sensitivity of demand for these variables to changes in income per capita and urbanization. Although data availability would have allowed us to use a panel data set, we opt for estimating a cross-section of recent data. The dramatic shift in the uptake of technological penetration over the last decade means that the nature of the relationship between demand for technology and income is changing over time, and we are unable to project forward the rate of technological uptake for the coming years.
- **Electricity installed capacity, air passengers and roads**: We use an unbalanced panel with country fixed effects, to control for geographical differences and other country-specific factors.

As shown in the table below, we find that:

- **Electricity installed capacity** is extremely sensitive to urbanization, which here works roughly as a proxy for industrialization: a 1% increase in the urban share leads to a 1.8% increase in installed capacity. Electricity is also sensitive to income: a 1% increase in income per capita leads to a 0.5% increase in installed capacity.
- **Air travel** is by far the most sensitive of all six sectors to income: a 1% increase in income per capita leads to a 1.4% increase in the number of passengers traveling by air. Accordingly, this sector is likely to see the highest growth rates.
- **Telecoms** show an interesting divergence between mainlines and mobile phones. We find that mainline phones are considerably more sensitive to income than to urbanization, while the reverse is true for mobiles. The lower sensitivity of mobiles to income suggests that penetration effects (akin to network effects) may be more important for this sector. It also may reflect the falling costs of mobile use, which have made phones widely available to low-income consumers.
- The number of **internet users** is considerably more sensitive to income (as much as mainlines are) than to urbanization.
- **Roads** is the sector least sensitive to income and the slowest-growing of the six. Its sensitivity to urbanization is comparable to that of mobile phones, but half that of electricity.

**Modeling Infrastructure Demand**

| | Total Electricity Installed Capacity | Air transport, passengers carried | Telephone mainlines (per 1,000 people) | Mobile phone subscribers (per 1,000 people) | Internet users (per 1,000 people) | Roads, total network of paved roads (km) |
|---|---|---|---|---|---|---|
| **Estimation Method** | Country fixed effects | Country fixed effects | Cross-section | Cross-section | Cross-section | Country fixed effects |
| **GDP per capita** | **0.53** | **1.40** | **0.71** | **0.49** | **0.71** | **0.29** |
| | *0.03* | *0.03* | *0.06* | *0.04* | *0.06* | *0.04* |
| **Urbanization** | **1.79** | - | **0.42** | **0.79** | **0.50** | **0.80** |
| | *0.06* | - | *0.18* | *0.12* | *0.17* | 0.11 |
| **Population** | - | **1.33** | - | - | - | - |
| | - | *0.03* | - | - | - | - |
| **Observations** | 2817 | 3671 | 139 | 172 | 154 | 1594 |
| **R-Squared** | 98% | 95% | 74% | 79% | 77% | 99% |

Note: Dependent and independent variables in natural logarithms

## IV. Income and Urbanization Drive Infrastructure Growth

We have modeled demand for infrastructure as a function of both income growth and urbanization, using our own projections for growth in GDP per capita and the UN's projections for urbanization and population. The details of the model and the results of the analysis are shown in the Box on page 5.

Looking at the results of our analysis and the implications for infrastructure growth by sector, we find that:

- Thanks to rapid urbanization and high income growth over the next decade, **electricity installed capacity** should increase by around 140% in both China and Vietnam, and by 80% in India. With growth running above 9% per year off a high base, China could account for about three-quarters of the total increase in the BRICs and more than four times the aggregate incremental demand from the N-11 and GCC. With annual growth averaging 6%, India will be the second-largest source of incremental demand in this sector, but in absolute terms it will add just 15% as much capacity as China. Vietnam will also enjoy annual growth rates in excess of 9%, but in absolute terms it will be smaller still, with only a fraction of India's installed capacity by 2018. Installed capacity in Bangladesh and Indonesia rise by 75%, but from a low base.

- **Air travel** is the most sensitive of the six sectors to income, and thus shows the highest growth rates based on our model. Annual average growth could reach 17% in China and Vietnam, while even the lowest annual rate, 4.5% in the GCC, is still quite high. The number of new passengers will grow by an average of 77mn each year in China, where more than one billion people could take to the skies in 2018 (for a remarkable cumulative growth of 350%). India will be the second-largest source of incremental demand, with the number of air passengers tripling to about 160mn in a decade's time. On a per capita basis, China had 120 travelers for every 1,000 people in 2006; by 2018 this should jump to 730 per 1,000. Vietnam will go from 62 per 1,000 in 2006 to 390 per 1,000. But only 2%-3% of the population will fly in Nigeria and Bangladesh, despite 8%-9% annual growth in each. The GCC group will exhibit the lowest annual growth rates (about 4.5% on average), but on a per capita basis, it already dominates this entire group of countries.

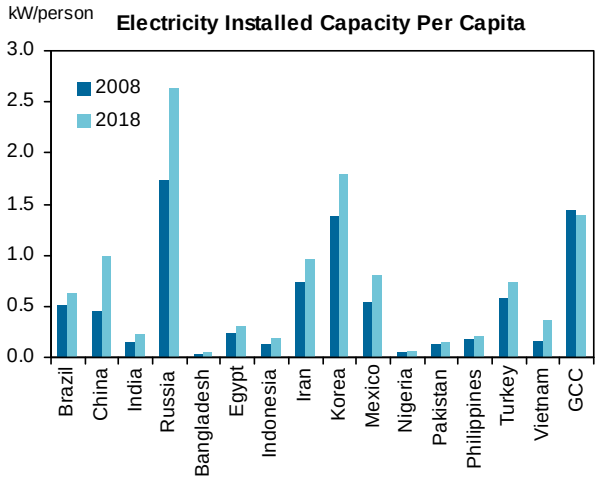
- **Telecoms** show an interesting divergence between mainlines and mobile phones. Mainlines are considerably more sensitive to income than to urbanization, while the reverse is true for mobiles. Thus, despite the explosive global growth in mobile telephony since the mid-1990s, our projections point to higher growth rates in mainline phones ahead. However,

**BRICs and N-11 to See Rapid Annual Growth Rates in Each Sector**

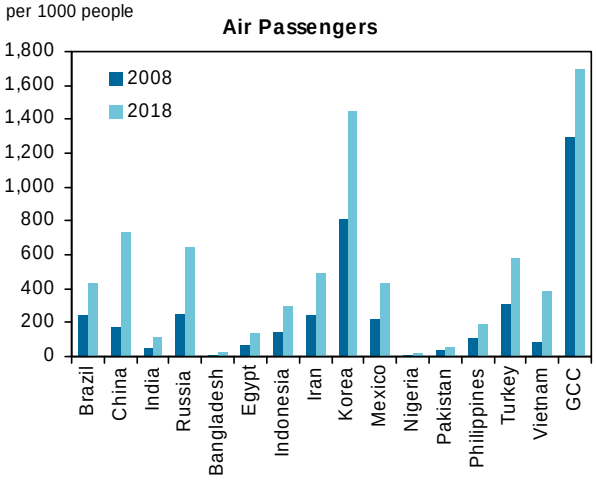
| average annual growth rates 2008-2017 (%) | Electricity | | Air passengers | | Mainlines | | Mobiles | | Internet | | Roads | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | China | 9.4 | Vietnam | 17.6 | Vietnam | 9.7 | Vietnam | 8.0 | Vietnam | 9.9 | China | 4.9 |
| 2 | Vietnam | 9.3 | China | 17.0 | China | 9.3 | China | 7.6 | China | 9.6 | Vietnam | 4.7 |
| 3 | India | 5.9 | India | 12.1 | India | 7.0 | India | 5.9 | India | 7.1 | India | 2.9 |
| 4 | Indonesia | 5.9 | Russia | 9.7 | Nigeria | 5.9 | Nigeria | 5.6 | Nigeria | 6.1 | Indonesia | 2.9 |
| 5 | Bangladesh | 5.5 | Nigeria | 9.2 | Bangladesh | 5.6 | Bangladesh | 5.4 | Bangladesh | 5.8 | Bangladesh | 2.6 |
| 6 | Mexico | 4.9 | Bangladesh | 8.5 | Indonesia | 5.3 | Indonesia | 4.9 | Indonesia | 5.5 | Mexico | 2.5 |
| 7 | Nigeria | 4.6 | Indonesia | 8.5 | Mexico | 4.9 | Mexico | 4.5 | Mexico | 5.0 | Nigeria | 2.2 |
| 8 | Iran | 3.9 | Iran | 8.4 | Iran | 4.8 | Pakistan | 4.2 | Iran | 4.9 | Russia | 2.1 |
| 9 | Russia | 3.8 | Philippines | 8.1 | Egypt | 4.8 | Egypt | 4.2 | Egypt | 4.8 | Iran | 2.0 |
| 10 | Turkey | 3.4 | Egypt | 8.0 | Philippines | 4.7 | Iran | 4.0 | Philippines | 4.7 | Turkey | 1.8 |
| 11 | Egypt | 3.4 | Mexico | 7.9 | Russia | 4.6 | Philippines | 3.9 | Russia | 4.6 | Egypt | 1.7 |
| 12 | Pakistan | 3.4 | Turkey | 7.4 | Pakistan | 4.5 | Turkey | 3.6 | Pakistan | 4.6 | Pakistan | 1.7 |
| 13 | Korea | 2.9 | Brazil | 6.9 | Turkey | 4.3 | Brazil | 3.2 | Turkey | 4.3 | Korea | 1.5 |
| 14 | Brazil | 2.9 | Pakistan | 6.9 | Brazil | 3.9 | Russia | 3.0 | Brazil | 4.0 | Brazil | 1.5 |
| 15 | Philippines | 2.7 | Korea | 6.4 | Korea | 3.4 | Korea | 2.6 | Korea | 3.5 | Philippines | 1.4 |
| 16 | GCC | 1.4 | GCC | 4.5 | GCC | 2.7 | GCC | 2.6 | GCC | 2.7 | GCC | 0.8 |

Source: GS Projections

## Significant Increases in Per Capita Measures of Infrastructure by 2018




Source: WDI; Goldman Sachs

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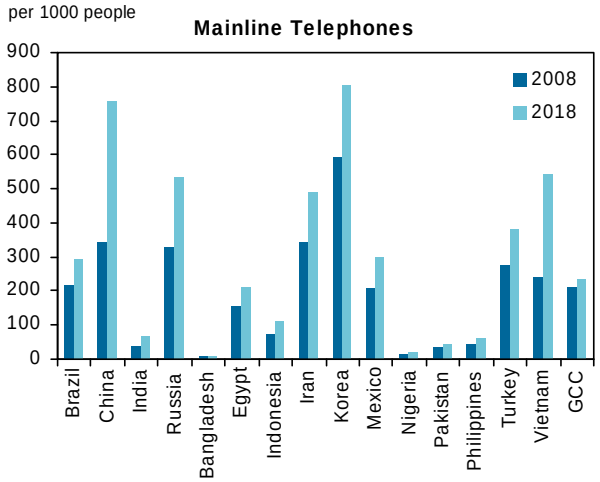


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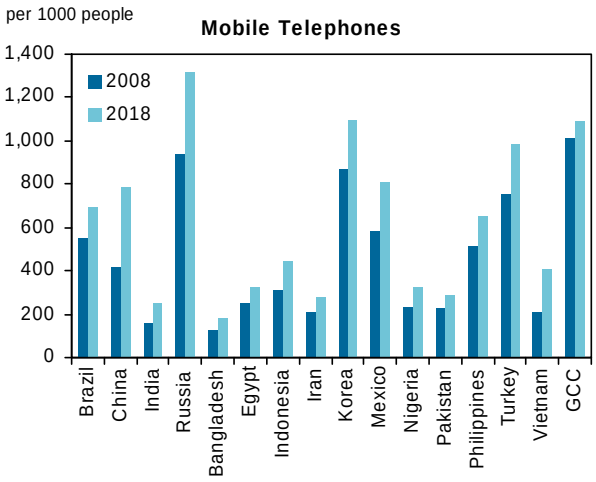


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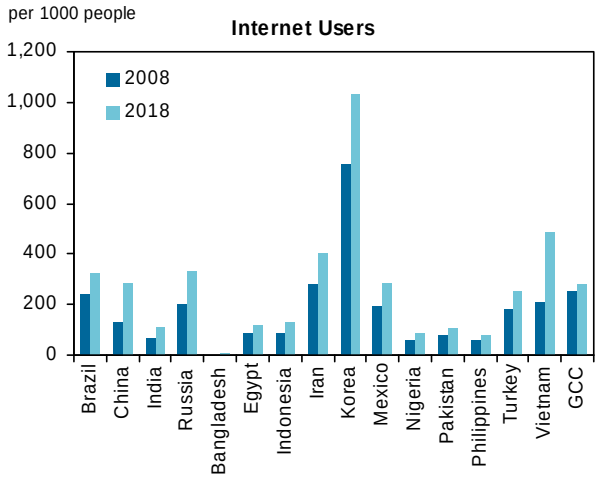


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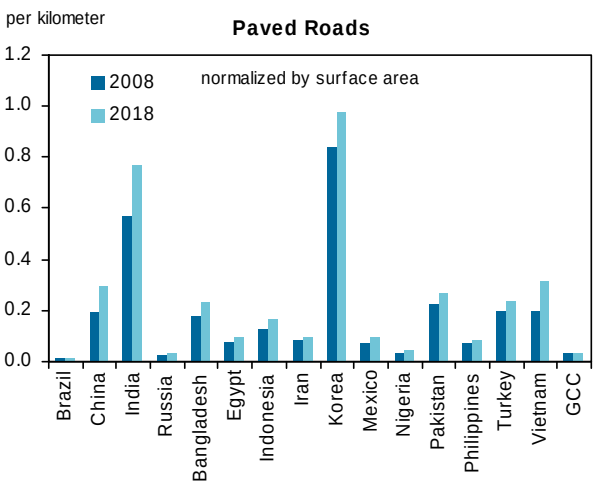


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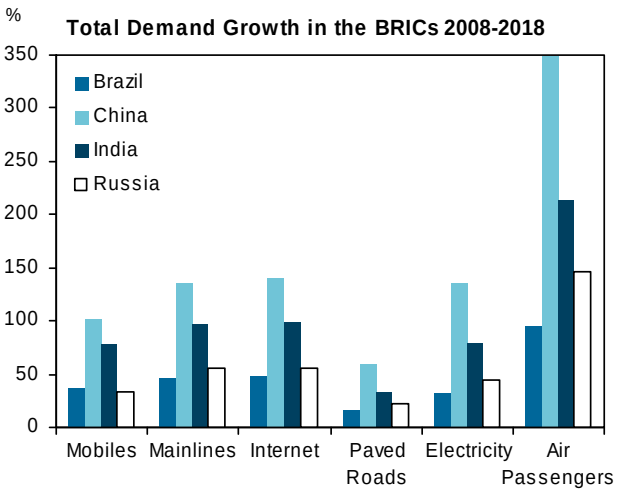
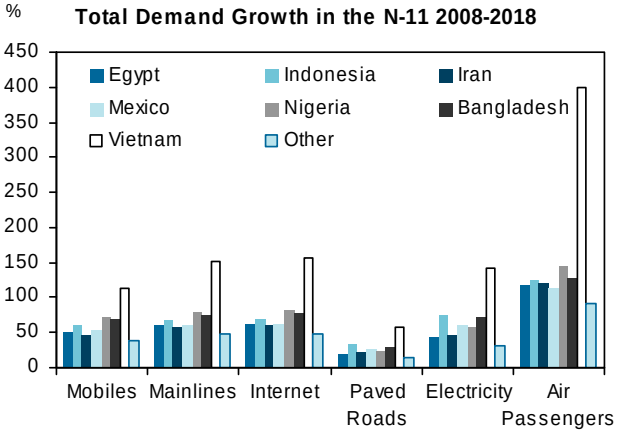



Source: Goldman Sachs




* Other countries includes countries w ith average grow th of less than 50% (in descending order: Philippines, Pakistan, Turkey, Korea, GCC)
Source: Goldman Sachs

our projections most likely underestimate the growth in mobiles in the near-term since they do not account for penetration effects, which have been the major driver behind the explosive growth in mobiles over the past decade. On a per capita basis, in rich and poor countries alike, mobile penetration rates will remain higher, with mainline penetration not going much beyond 50% anywhere except Korea and China.

- China, Vietnam and India are set to experience the most rapid growth in **internet users**, with the number rising by about 150% in China and Vietnam and 100% in India. The GCC will see the lowest growth, although its current numbers are not particularly high. Elsewhere, the number of users will rise by about half. In Korea, which already has one of the highest internet penetration rates in the world, the entire country could be online by 2014.

- **Paved roads** is the slowest-growing of the six sectors, but the gains will still be appreciable. By 2018, the stock of paved roads should rise by about 60% in China and Vietnam, and by 30% in India, Indonesia and Bangladesh. Outside these countries, growth is likely to be 15%-25%, and just 8% in the GCC. In all likelihood, much investment will go into upgrading existing roads, rather than into new construction, and this may not be captured in the available data.

## V. Country Profile Highlights the Changing Face of the World Economy

Looking at our projections by country highlights the changing dynamics of the world economy, the growing gap between China and the rest of the BRICs, and the much smaller impact of the N-11 and GCC countries.

### BRICs: It's a China story, with India a distant second

China dominates the projected infrastructure investment across all sectors, due to its high income growth rates, rapid pace of urbanization and absolute size. Its per capita income should rise 175% over the next decade, and its cities add another 160mn residents; thus we estimate that China's infrastructure will double or more in five of the six sectors we analyze (except roads). Most remarkably, as we discussed above, air travel would grow so rapidly that by 2018, the one billion air travelers in China would outnumber the 790mn in the rest of the countries put together.

Compare this with India, where per capita income should double off current levels by 2018 and where the cities should add another 105mn people. This could lead to a tripling of air passengers, a doubling of the mainline phones and internet use, some 80% more mobile phones and electricity installed capacity, and 34% more paved roads. But China's considerably faster pace of income gains means that it could add 13 *times* as many mainline phones as India, seven times as many air passengers, six times the electricity capacity and two to three times as many mobile subscribers and internet users. China will also build more roads, although India's gains will be much larger when adjusted for surface area.

Elsewhere in the BRICs, a doubling of per capita income in Russia over the decade (somewhat offset by a fall in the urbanization level) means that air travel should rise by about 150%, while internet users and mainline phones should rise by 55%, electricity installed capacity by 45%, mobiles by 35% and paved roads by 25%. In Brazil, where we expect income per capita to rise by half and where the population is already almost entirely urban, growth in infrastructure will accordingly be lower. Air travel could double, while electricity and technology measures could rise by 30%-50%.

## N-11's impact remains small in a world dominated by the BRICs

Our analysis reinforces a point we have made before: the N-11 are not 'mini-BRICs'. Despite solid growth in per capita income, the N-11 together will not rival even China alone as an infrastructure story. Today China's population is slightly (6%) larger than that of the N-11 in aggregate, while its income is slightly (5%) lower than the N-11 average. However, over the next decade China's per capita income gains will outstrip the N-11's. On our projections, China's infrastructure growth, in absolute terms, will be significantly higher—two to six times higher—than that of the N-11 in aggregate.

- The standout among the N-11 is **Vietnam**, where infrastructure growth rates will exceed even China's, thanks to comparable rates of growth in income and urbanization, but its absolute levels will be much smaller. We expect the number of air passengers to rise fivefold, and the electricity and technology variables to rise by 110%-150%. Viewed within the N-11 universe, Vietnam could account for 30% of all new mainline phones, 25% of new internet users and 12% of the additional electricity capacity—despite having just 7% of the total N-11 population.

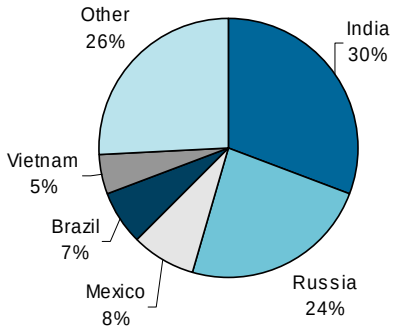
- **Nigeria** has the second-highest growth rates in most sectors, with the number of air travelers rising by 140%, electricity installed capacity by 60% and the technology sectors by 70%-80%. Even so, because this growth is off a very small base, Nigeria will account for just a small share of the total growth in the N-11. Similarly, **Bangladesh** will also show rapid growth from very low starting levels.

- **Indonesia**, the most populous country in the group, also has high growth rates. In some sectors, Indonesia will add more infrastructure stock than Vietnam. But on a per capita basis, Indonesia will continue to lag Vietnam by a large margin in most sectors, leading only in mobiles.

- Growth will be slower in already-wealthy **Korea** (where infrastructure stocks today are far higher than the N-11 average), along with **Philippines** and **Pakistan**, both of which will see relatively slow income growth. **Turkey's** growth rates are also towards the bottom of the list, in part because its population is already highly urban.

# India, Russia, Vietnam and Indonesia Will Dominate Infrastructure Demand Outside China

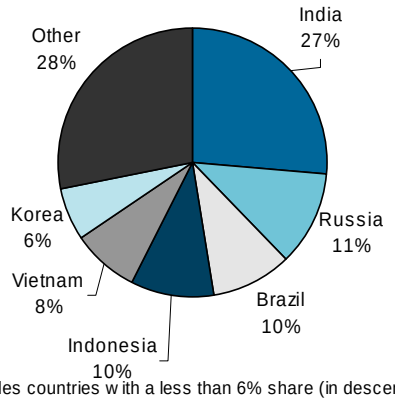
### Electricity Capacity Incremental Demand 2017




*Other includes countries w ith a less than 5% share (in descending order: Indonesia, Iran, Korea, Turkey, Egypt, GCC, Pakistan, Phillippines, Bangladesh, Nigeria)

Source: Goldman Sachs

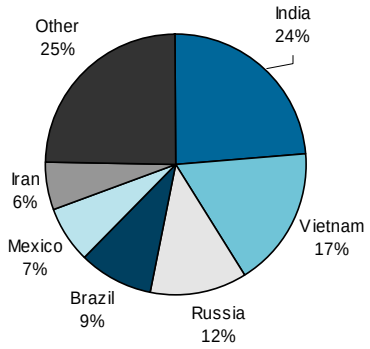
### Air Passengers Incremental Demand 2017




*Other includes countries w ith a less than 6% share (in descending order: Mexico, GCC, Turkey, Iran, Philippines, Egypt, Pakistan, Bangladesh,Nigeria)

Source: Goldman Sachs

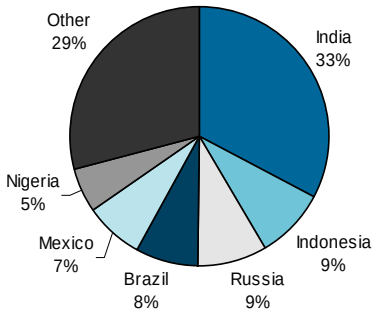
### Mainline Incremental Demand 2017




*Other includes countries w ith a less than 6% share (in descending order: Indonesia, Korea, Turkey, Egypt, Pakistan, Philippines, GCC, Nigeria, Bangladesh)

Source: Goldman Sachs

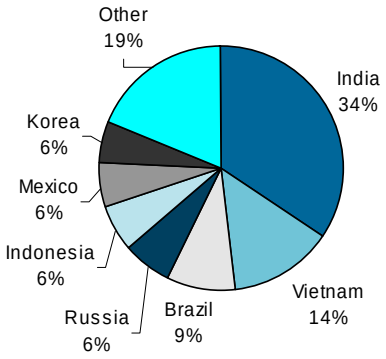
### Mobile Incremental Demand 2017




*Other includes countries w ith a less than 5% share (in descending order:Vietnam, Philippines Turkey, Pakistan, Bangladesh, Egypt, Korea, GCC, Iran)

Source: Goldman Sachs

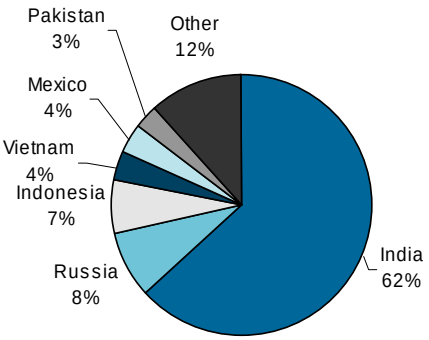
### Internet Incremental Demand 2017




*Other includes countries w ith a less than 5% share (in descending order: Iran, Pakistan, Nigeria, Turkey, Egypt, Philippines, GCC,

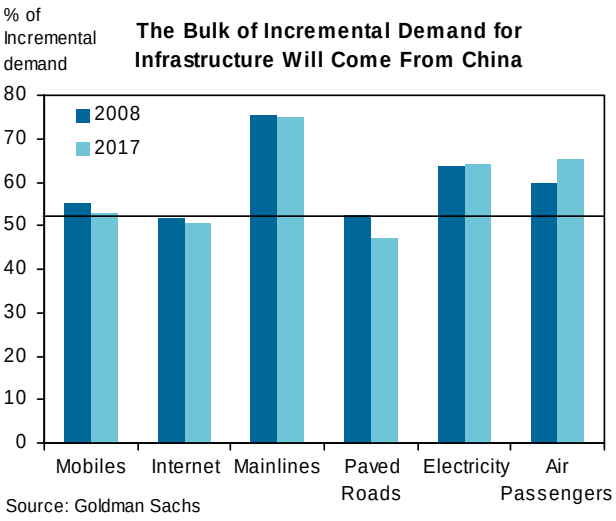
Source: Goldman Sachs

### Paved Roads Incremental Demand 2017




*Other includes countries w ith a less than 3% share (in descending order: Turkey, Iran, Egypt, Brazil, Korea, Nigeria, Bangladesh, GCC, Philippines)

Source: Goldman Sachs




Source: Goldman Sachs

- The **GCC** has the lowest growth rates across all sectors. Its highest growth will be seen in air travel, where it will add 27mn passengers over the decade. Elsewhere, per capita growth in infrastructure will be in the single-digits.

## Changing patterns of incremental demand

Comparing the breakdown of aggregate incremental demand by country in 2008 and 2018 provides insight into the changes that will occur in the global economy over the decade.

- **China** dominates incremental demand today, and it will continue to do so in the future, although its share looks set to decline slightly over the decade. By 2018, China could still be the source of three-quarters of the total incremental demand in mainlines, two-thirds of the incremental demand in electricity installed capacity and air travel, and around half of total demand in mobiles, internet users and roads.

- **India** is likely to increase its share of total incremental demand in all categories. Outside of China, India will become the dominant source of demand growth: by 2018, it will account for 60% of the new roads (ex-China), and 25%-35% of the growth in air travel, electricity installed capacity and technology.

- **Russia** and **Brazil** are the biggest losers of market share in all sectors except roads, reflecting Brazil's slower pace of income growth and urbanization, as well as the decline in Russia's urban population share. But despite its declining share, in absolute levels, Russia will remain a key source of demand. For electricity installed capacity, for instance, Russia will be the third-largest source of incremental demand, trailing China (by a factor of seven) and India.

- The **N-11's** total share of incremental demand is essentially steady over the decade. The N-11 will account for a higher share of demand in the technology variables but a slightly lower share in roads, electricity and air passengers. Within the N-11 on its own, relative shares will remain largely unchanged, with Vietnam gaining and Korea losing.

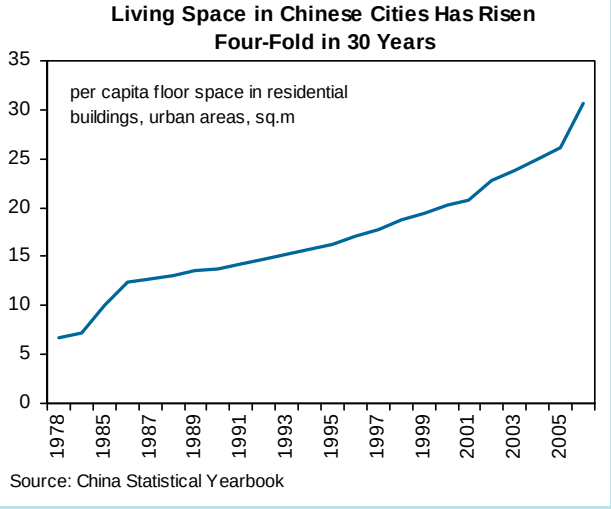
- The **GCC's** share of incremental demand will rise in electricity and air passengers, and decline in all other categories.

### What's Missing: Housing and Water

One critical area of infrastructure that is difficult to project with any specificity is housing. Both urbanization and income growth will feed what we expect to be enormous demand for housing over the next decade and more. The 280mn new urban residents in the BRICs (160mn in China alone) and the 180mn in the N-11 will require shelter. The estimated 650mn or more people living in slums today will generate additional demand for proper housing.

Moreover, richer urban residents will increasingly upgrade their homes and/or demand more space. In China, for instance, urban housing rose from 3.5 square meters per capita in 1978 to 25 square meters in 2004. Although demand may grow more slowly in countries with slower income growth, the same dynamics will be in play. Thus, we expect to see high demand for urban housing, from basic shelter to luxury housing.

Water is also difficult to project. This is partly because data are reported by household, rather than by individual, but particularly because of the nature of what is recorded. According to the World Bank, more than 90% of the urban population in the BRICs have access to 'improved' sources of water, and 60%-90% have access to 'improved' sanitation. 'Improved' is a relative concept, and many cities in the BRICs and N-11 will likely have scope for further improvement. At a minimum, the new urban residents in the BRICs and the N-11 will need access to local water sources and (ideally) to proper sanitation systems.




## VI. Putting a Number on Infrastructure Spending

How much will all of this investment cost? We estimate roughly $4.35trn over the decade in five of the six sectors, excluding air passengers.

To assign dollar values to infrastructure spending, we rely on cost estimates from the OECD and the World Bank, with the latter indexed for inflation since 2003.[4] Our calculations are meant to provide a guide to the magnitude of the investment needed, and are not specific forecasts.

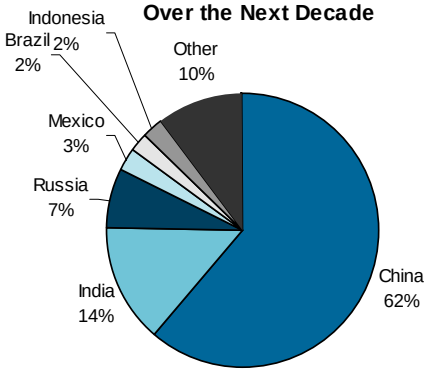
There are several caveats to using these cost estimates. First, our commodities research analysts expect continued price pressure in most commodities sectors. Second, it is difficult to imagine that the World Bank's estimated 'best practice prices' will be available across the wide range of countries we survey, especially as supply shortages and bottlenecks in skilled labor and equipment develop. And third, these estimates ignore 'rehabilitation' and significant upgrades to existing stock. This is especially relevant for roads, though less so for air travel, mobile networks and internet users.

Thus, our rough numbers suggest that:

- In aggregate, **total infrastructure investment** could be in the range of $4.35trn, of which about 85%, or nearly $3.7trn, would be in the BRICs, with the remaining $670bn in the N-11 and GCC.
- **China** could be responsible for a remarkable 60% of the total investment, or $2.66trn, with **India** a distant second at 14%, or $620bn.

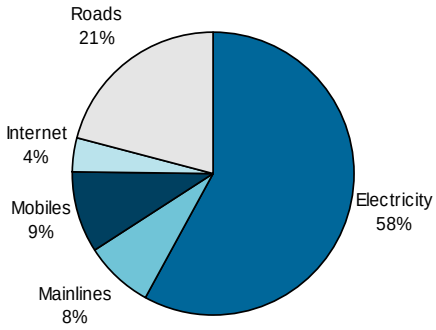
4. OECD, 'Infrastructure to 2030: Telecom, Land Transport, Water and Electricity,' 2006; and Fay and Yepes, 'Investing in Infrastructure: What Is Needed from 200 to 2010?', World Bank Policy *Research Working Paper* 2003. The cost estimates for mobile phones may be on the high side, given the rapidly declining unit cost of mobile penetration. We exclude air transport from this exercise due to difficulties in identifying globally applicable prices.

**Infrastructure Spending by Country Over the Next Decade**




*Other includes countries with less than 2% of the total infrastructure spending (in descending order: Vietnam, Iran, Korea,Turkey, Pakistan, Egypt, GCC, Nigeria, Phillippines, Bangladesh)
Source: Goldman Sachs

**Infrastructure Spending by Sector Over the Next Decade**




Source: Goldman Sachs

- **Indonesia and Mexico** would lead the N-11, together investing $220bn, or 5% of the total (and one-third of the N-11 pool).
- Despite having the fastest infrastructure growth rates across the N-11, **Vietnam** would account for just 2% of the overall spending (and 13% of the N-11 total), due to its much smaller population.
- The **lowest-ranked five countries** together (Egypt, GCC, Nigeria, Philippines and Bangladesh) would account for less than 3% of the total.
- Investment looks likely to be concentrated in **electricity**, which could absorb close to 60% of total investment, or $2.52trn. Electricity will take the largest share of investment in each country (except India and Nigeria), and richer countries will invest proportionately more in this sector. For instance, in Korea, electricity could consume nearly 70% of the aggregate investment, compared with 40% in India, Indonesia and Pakistan, and one-third in Nigeria.
- **Roads** would be the second-largest sector, but a distant second, absorbing $900bn, or 21% of the total. This will be a significant sector for India (more than 40% of total projected spending) and for Indonesia and Pakistan (one-third).
- **Mainlines and mobiles** together could take 17% of the total. Despite the higher growth rates that we project for mainlines, mobiles would generally absorb a larger share—sometimes a much larger share—of spending in each country. This could be as much as 40% of total investment in Nigeria and Philippines.
- The smallest share would go to **internet** users: we forecast it at 4% of aggregate spending, ranging from 1% in Bangladesh to 11% in Vietnam.

**Infrastructure Spending by Sector (% of total country spending)**

| % | Brazil | China | India | Russia | Bangladesh | Egypt | Indonesia | Iran | Korea | Mexico | Nigeria | Pakistan | Philippines | Turkey | Vietnam | GCC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Electricity** | 63 | 61 | 40 | 74 | 46 | 52 | 41 | 64 | 68 | 64 | 33 | 40 | 46 | 53 | 46 | 64 |
| **Mainlines** | 8 | 10 | 3 | 4 | 2 | 10 | 5 | 8 | 7 | 5 | 2 | 3 | 4 | 7 | 15 | 4 |
| **Mobiles** | 15 | 8 | 9 | 6 | 32 | 13 | 17 | 4 | 8 | 12 | 39 | 18 | 39 | 15 | 9 | 18 |
| **Internet** | 8 | 3 | 4 | 2 | 1 | 5 | 5 | 6 | 8 | 4 | 10 | 6 | 5 | 4 | 11 | 4 |
| **Roads** | 7 | 17 | 44 | 14 | 19 | 20 | 32 | 18 | 9 | 15 | 15 | 33 | 6 | 21 | 18 | 10 |

Source: Goldman Sachs

## VII. Financing Needs Can Drive Market Innovation

How will the BRICs, N-11 and GCC finance these ambitious infrastructure needs?

Financing infrastructure projects is a contentious and politically challenging issue. Once seen as solely a public-sector responsibility, infrastructure turned toward private financing in the early 1990s, as governments privatized state assets and expected the private sector to step in to supply adequate services at a reasonable cost.

Despite some early successes, this turned out not to be the case. After a strong start, private-sector financing for infrastructure fell off sharply during the 1997-1998 financial crisis, and the recovery has been slow. Since 2000, private-sector investments have been fairly small, averaging about $45bn per year into telecoms, energy, transport and water in total across all developing countries, according to World Bank data. The private sector now supplies 20%-25% of infrastructure financing in developing countries, according to World Bank and other estimates, with public funds and official development assistance still bearing 75%-80% of the cost.

The vast needs for infrastructure financing in the coming decade will likely lead to the development of more creative financing structures. This may include wider use of public/private partnerships, government credit guarantees, and co-investment by governments alongside private finance. Sovereign wealth funds may also be deployed to finance infrastructure, both domestically and externally.

To attract the needed capital, the BRICs, N-11 and GCC (as well as other developing countries) may well need to adapt their regulatory systems and move towards market pricing—even in politically sensitive sectors such as water and electricity. Governments will need to lead a shift in the public perception of infrastructure as free or nearly-free 'public goods'. Subsidized electricity and water for farmers, and cheap urban water and waste systems, should come under review.

One of the most important long-term effects of massive infrastructure investment could be the growth of domestic capital markets.[5] A local bond market is a natural home for infrastructure financing. In India, which has plans to invest nearly $500bn in a broad range of infrastructure projects over the next five years, the government considers the domestic bond market to be an important source of finance and sees infrastructure as a catalyst for the market's growth. This could be true in China as well, and in the GCC, where governments are seeking to deepen their own domestic markets. If infrastructure offers attractive investment opportunities at home, it may also be able to absorb some of the capital that has gone into US assets in recent years, reversing some of the capital flows that have fuelled global imbalances.

5. See our *Global Economics Paper* 161, 'Bonding the BRICs: A Big Chance for India's Debt Capital Market,' November 7, 2007; and *Global Economics Paper* 149, 'Bonding the BRICs: The Ascent of China's Debt Capital Market,' November 20,2006.

### Can the World Cope?

Our projections of a steady increase in infrastructure demand—not just in the next decade but beyond—imply that natural resources and environmental concerns will not be binding constraints. But urbanization will deplete the supply of arable land; shifting agriculture towards biofuels will heighten pressures on global food supplies and stoke inflation; and higher energy consumption will, in all likelihood, increase air pollution. Thus, we need to ask: is the ambitious infrastructure roll-out that we project in fact possible?

Pressures on natural resources, including oil, metals and land, are unlikely to abate over the next decade, or at least in the next few years. Although high commodity prices are encouraging R&D and investments in capacity, the long lead times required make it unlikely that supply will outstrip demand any time soon. But the experience of the past decade suggests that price, at least, will not significantly deter consumption. Most obviously, soaring oil prices have not dented global oil demand, despite a roughly tenfold increase in the price of oil since the late 1990s. We do not expect the world to 'run out' of resources over the next decade.

Environmental concerns could be a more serious obstacle. Certainly a 75% increase in electricity installed capacity across the BRICs, N-11 and GCC would create enormous air pollution. Public opinion is beginning to embrace environmental concerns in some of these countries, and this may increase the pressure for cleaner technologies and greater energy efficiency. Fast-growing countries may find that environmental issues become tangled up in their international relations, which would boost the incentives to address climate change and control emissions. This highlights the already-growing pressure on China and India to participate in a post-Kyoto agreement.

On balance, however, we think that the impetus from rising incomes and the entirely natural impulse to enjoy a higher standard of living—one that uses more electricity—will outweigh environmental concerns in the countries we discuss here. Damaging giant projects such as the Three Gorges Dam may become politically impossible, but it is hard to imagine that a growing middle class will slash its electricity consumption or forgo cars.

The solution will need to lie in technology that improves energy-efficiency and reduces reliance on natural resources. This ultimately may be the biggest opportunity arising from future infrastructure demand.

## VIII. Investment Implications: Opportunity Abounds

With rapid income growth and ongoing urbanization driving the enormous need for infrastructure investment over the next decade, the impact will be felt across many global markets and companies:

- Investment of some $4.35trn over the next decade will offer new sources of growth for multinational companies, particularly in the more specialized and technology-oriented markets, such as water systems and air travel.
- At the same time, the shift in global spending power towards fast-growing emerging markets will provide a clear opportunity for domestic companies. The emergence of 'domestic champions' could effectively restrict the extent to which multinational firms can compete.
- Firms based in the BRICs as well as the N-11 and the GCC may emerge as global players and major drivers of cross-border M&A—as they have already begun to do in the past few years.
- Demand for raw materials is unlikely to abate, which will sustain pressure on commodity markets and strengthen the hand of commodity exporters in global trade.
- Expanded opportunities for the private sector in financing infrastructure should support the growth and performance of infrastructure funds in the developed world. However, domestic investors—including sovereign wealth funds—are likely to supply a good share of the required capital.
- If infrastructure investment does support the growth of domestic capital markets as we expect, financial industries in countries with the largest infrastructure needs (namely China and India) are also likely to benefit.

## Who Benefits? GS SUSTAIN Identifies Long-Term Winners From Structural Trends

Our equity analysts have identified a number of companies that look set to benefit from infrastructure investment growth over the long term, through the use of their GS SUSTAIN analysis. This brings together their work on the sustainability of corporate performance. It includes a proprietary framework for analyzing competitive advantage in mature industries and the identification of winners in emerging industries as they evolve in response to a rapidly changing, globalizing world.

In mature industries, GS SUSTAIN identifies leaders best positioned to sustain competitive advantage and above-average returns in the future. The proprietary framework combines analysis of cash returns; structural change in industries; and environmental, social and governance (ESG) performance. To date, they have applied this framework to eight global industries: Mining & Steel, Energy, Food & Beverages, Media, Insurance, Pharmaceuticals, Capital Goods and Technology.

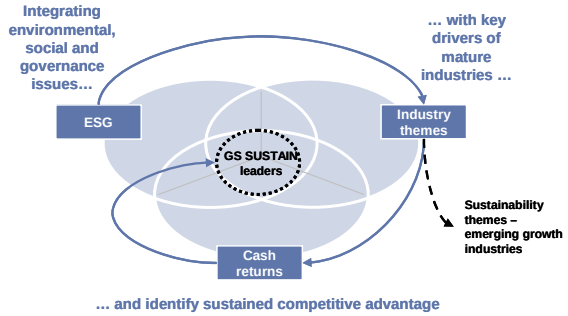
In emerging industries, GS SUSTAIN identifies companies best positioned to deliver above-average growth by analyzing the most attractive growth industries stemming from structural change, and identifying the companies best positioned to execute those growth expectations. To date, they have focused on three emerging industries: Alternative Energy, Environmental Technology and Biotechnology.

The GS SUSTAIN focus list incorporates 37 companies from mature industries, which are well positioned to maintain industry leadership and superior financial returns, and 25 emerging industry leaders offering attractive exposure to growth opportunities stemming from structural change.

Companies on the focus list with exposure to opportunities in global infrastructure include:

- **Basic materials**: BHP Billiton, Rio Tinto
- **Energy**: BG Group, ENI, Petrobras, StatoilHydro, D1 Oils
- **Electricity**: ABB, First Solar, Gamesa, Hansen Transmission, Meyer Burger, Nordex, Ormat, Roth & Rau, SunPower, Suntech Power, Vestas
- **Water**: Epure
- **Mobiles**: Nokia
- **Other infrastructure**: 3M, Emerson, Sandvik, United Technologies

For more on the GS SUSTAIN focus list, see https://portal.gs.com/gs/portal/research/teams/sustain/




Source: Goldman Sachs Research

- Skilled labor will increasingly matter as a potential bottleneck—or as a source of competitive advantage. This should raise the returns to investment in education, particularly in science, technology and engineering.

- A 75% increase in aggregate electricity demand (along with the increase in developed economies) will increase pressure on the environment, particularly in air pollution. This only underscores the importance of addressing emissions and climate change issues today, and of engaging China and India in post-Kyoto negotiations from the start.

**Sandra Lawson and Raluca Dragusanu**

# Appendix: BRICs, N-11 and GCC Over the Next Decade

**BRICs, N-11 and GCC Over the Next Decade**

| | Real GDP (2006 US$bn) | | GDP Per Capita (2006 US$) | | Population (mn) | Urban Share of Population (%) | New Urban Residents by 2017 (mn) |
|---|---|---|---|---|---|---|---|
| | 2007 | 2017 | 2007 | 2017 | 2007 | 2007 | 2017 |
| **Brazil** | 1,165 | 1,896 | 6,242 | 9,295 | 190 | 85 | 21 |
| **China** | 3,160 | 9,821 | 2,425 | 7,030 | 1,322 | 42 | 158 |
| **India** | 984 | 2,253 | 877 | 1,730 | 1,130 | 29 | 105 |
| **Russia** | 1,111 | 2,153 | 7,937 | 16,102 | 141 | 73 | -5 |
| **Bangladesh** | 69 | 124 | 456 | 686 | 150 | 26 | 18 |
| **Egypt** | 110 | 192 | 1,387 | 2,074 | 80 | 43 | 9 |
| **Indonesia** | 351 | 632 | 1,503 | 2,432 | 235 | 50 | 38 |
| **Iran** | 259 | 463 | 3,959 | 6,436 | 65 | 68 | 8 |
| **Korea** | 927 | 1,455 | 19,092 | 29,091 | 49 | 77 | 2 |
| **Mexico** | 847 | 1,464 | 7,761 | 12,047 | 109 | 50 | 15 |
| **Nigeria** | 131 | 249 | 972 | 1,454 | 135 | 36 | 23 |
| **Pakistan** | 140 | 229 | 829 | 1,126 | 169 | 64 | 35 |
| **Philippines** | 138 | 242 | 1,526 | 2,288 | 91 | 81 | 15 |
| **Turkey** | 388 | 652 | 5,498 | 8,419 | 71 | 68 | 8 |
| **Vietnam** | 61 | 197 | 719 | 2,099 | 85 | 27 | 8 |
| **GCC average** | 728 | 1,044 | 27,606 | 30,929 | 37 | 84 | 12 |

Source: UN, Goldman Sachs

**Goldman Sachs Economic Research Group**

**[1] Jim O'Neill, M.D. & Head of Global Economic Research**

| | |
|---|---|
| **Global Macro & Markets Research** | [2] Dominic Wilson, M.D. & Director of Global Macro & Markets Research<br>[1] Francesco Garzarelli, M.D. & Director of Global Macro & Markets Research<br>[2] Sandra Lawson, V.P. & Senior Global Economist<br>[2] Jens J Nordvig-Rasmussen, V.P. & Senior Global Markets Economist<br>[1] Binit Patel, E.D. & Senior Global Economist<br>[1] Thomas Stolper, E.D. & Senior Global Markets Economist<br>[2] Peter Berezin, V.P. & Global Economist<br>[1] Kevin Edgeley, E.D. & Technical Analyst<br>[1] Fiona Lake, E.D. & Global Markets Economist<br>[1] Salman Ahmed, Associate Global Markets Economist<br>[1] Themistoklis Fiotakis, Associate Global Markets Economist<br>[1] Michael Vaknin, Associate Global Markets Economist<br>[1] Sergiy Verstyuk, Associate Global Markets Economist<br>[1] Swarnali Ahmed, Research Assistant, Global Macro<br>[2] Raluca Dragusanu, Research Assistant, Global Macro |
| **Americas** | [8] Paulo Leme, M.D. & Director of Emerging Markets Economic Research<br>[2] Jan Hatzius, MD & Chief US Economist<br>[12] Luis Cezario, V.P. & Senior Brazil Economist<br>[2] Edward McKelvey, V.P. & Senior US Economist<br>[2] Alberto Ramos, V.P. & Senior Latin America Economist<br>[2] Andrew Tilton, V.P. & Senior US Economist<br>[7] Alec Phillips, V.P. & Economist, Washington Research<br>[2] Pablo Morra, V.P. & Latin America Economist<br>[2] Malachy Meechan, Associate, Latin America/Global Markets<br>[2] Seamus Smyth, Associate US Economist<br>[2] Kent Michels, Research Assistant, US<br>[2] Shirla Sum, Research Assistant, US |
| **EMEA** | [1] Erik F. Nielsen, M.D. & Chief European Economist<br>[1] Ben Broadbent, M.D. & Senior European Economist<br>[4] Rory MacFarquhar, M.D. & Senior Economist<br>[9] Dirk Schumacher, E.D. & Senior European Economist<br>[1] Ahmet Akarli, E.D. & Economist<br>[11] Ashok Bhundia, E.D. & Economist<br>[1] Kevin Daly, E.D. & European Economist<br>[1] Dambisa Moyo, E.D. & Economist<br>[1] Javier Pérez de Azpillaga, E.D. & European Economist<br>[3] Natacha Valla, E.D. & European Economist<br>[1] István Zsoldos, E.D. & European Economist<br>[1] Saleem Bahaj, Research Assistant, Europe<br>[1] AnnMarie Terry, Research Assistant, Europe<br>[1] Anna Zadornova, Research Assistant, Europe |
| **Asia** | [1] Tetsufumi Yamakawa, M.D. & Co-Director of Asia Economic Research<br>[5] Michael Buchanan, M.D. & Co-Director of Asia Economic Research<br>[5] Hong Liang, M.D. & Co-Director of Asia Economic Research<br>[6] Naoki Murakami, V.P. & Senior Japan Economist<br>[5] Enoch Fung, V.P. & Asia Pacific Economist<br>[10] Tushar Poddar, V.P. & Economist<br>[13] Goohoon Kwon, V.P. & Korean Economist<br>[6] Yuriko Tanaka, V.P. & Associate Japan Economist<br>[6] Chiwoong Lee, Associate Japan Economist<br>[5] Helen Qiao, Associate Asia Pacific Economist<br>[5] Yu Song, Associate Asia Pacific Economist<br>[5] Mark Tan, Associate Asia Pacific Economist<br>[5] Eva Yi, Research Assistant, Asia Pacific<br>[10] Pranjul Bhandari, Research Assistant, Asia Pacific |
| **Admin** | [1] Linda Britten, E.D. & Global Economics Mgr, Support & Systems<br>[1] Philippa Knight, E.D. & European Economics, Mgr Admin & Support |
| **Location** | [1] in London +44 (0)20 7774 1160<br>[2] in NY +1 212 902 1000<br>[3] in Paris +33 (0)1 4212 1343<br>[4] in Moscow +7 495 645 4000<br>[5] in Hong Kong +852 2978 1941<br>[6] in Tokyo +81 (0)3 6437 9960<br>[7] in Washington +1 202 637 3700<br>[8] in Miami +1 305 755 1000<br>[9] in Frankfurt +49 (0)69 7532 1210<br>[10] in Mumbai +91 (22) 6616 9000<br>[11] in Johannesburg +27 (11) 303 2745<br>[12] in São Paulo +55 (11) 3371 0778<br>[13] in South Korea +82 (2) 3788 1000 |

## GOLDMAN SACHS GLOBAL RESEARCH CENTRES


**New York**
Goldman Sachs & Co.
New York Plaza, 45th Floor
New York, New York 10004, USA
Tel: +1 212 902 1000

**Washington**
Goldman Sachs & Co.
101 Constitution Ave, NW
Suite 1000 East
Washington, DC 20001
Tel: +1 202 637 3700

**London**
Goldman Sachs International
Peterborough Court
133 Fleet Street
London, EC4A 2BB, England
Tel: +44 (0)20 7774 1000

**Frankfurt**
Goldman Sachs & Co. oHG
MesseTurm
D-60308 Frankfurt am Main,
Germany
Tel: +49 (0)69 7532 1000

**Moscow**
Goldman Sachs OOOGS
14th floor, Ducat III
6, Gasheka Street
Moscow 125047
Russian Federation
Tel: +7-495-645-4000

**Paris**
Goldman Sachs Inc et Cie
2, rue de Thann
75017 Paris, France
Tel: +33 (0)1 4212 1341

**Hong Kong**
Goldman Sachs (Asia) L.L.C.
Cheung Kong Center,
68th Floor
2 Queen's Road Central
Hong Kong
Tel: +852 2978 1000

**Tokyo**
Goldman Sachs Japan Co, Ltd.
Roppongi Hills Mori Tower
47th Floor, 10-1, Roppongi 6-chome
Minato-ku, Tokyo 106-6147, Japan
Tel: +81 (0)3 6437 9960

**Singapore**
Goldman Sachs (Singapore) Pte.
1 Raffles Link, #07-01 South Lobby,
Singapore 039393
Tel: +66 889 1000

**South Africa**
Goldman Sachs International
13th Floor, The Forum
2 Maude Street
Sandton 2196
South Africa
Tel: 27-11-303-2700