Reinventing Cities for People and the Planet: A Global Leadership Role for Asia

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1. Introduction

“The battle for the environmental future of our planet,” in the words of Earth Summit Chair Maurice Strong, “will be won or lost in the cities, particularly the cities of the developing world.”¹ Nowhere is this clearer than in the case of urban energy use, which affects both people who live in cities and the planet that supports them. Energy use contributes to urban air pollution that continues to exceed health guidelines in many cities, especially those in developing nations.² At the same time, fossil fuel burning in cities produces the bulk of global emissions of carbon dioxide, which warm the atmosphere; urban centers of the developing world are expected to account for as much as three-fourths of the growth in the output of this gas over the next 20 years.³

The first two sections of this paper provide an overview of problems caused by urban energy use, and some potential solutions from around the world. The final section highlights the lead Asia could take in lightening the burden that cities place on the planet while at the same improving the quality of life of their citizens.

2. Urban Energy Use: Problems

Energy – to heat buildings, power industries, and transport goods and people – has shaped urban history. Before the Industrial Revolution, when cities were fueled by wind, water, wood, human, and animal power, their populations remained below 1 million. With the advent of coal, which fueled steam engines, gigantic urban factories became possible. And while coal and steam concentrated populations in the industrial cities of the 18th and 19th centuries, the rise of the petroleum-fueled automobile allowed cities to spread beyond the dense urban core in the 20th century.⁴ Energy is just as essential to the functioning of cities today, although there is greater awareness of the serious problems urban fuel burning creates.

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2.1 Local Problems

When fossil fuels are combusted, pollutants are released. For example, sulfur dioxide, a corrosive gas generated mainly by the burning of coal and fuel oil, threatens human health, damages lakes, forests, and crops, and corrodes the metal and stone of buildings. Over the past several decades, clean air laws have prompted declines in sulfur dioxide levels in most industrial nations, but this pollutant remains a large and growing problem in Asia. Between 1980 and 1995, emissions of sulfur dioxide from fuel burning fell sharply in Europe and the United States, but more than doubled in Asia, despite reductions in Japan. (See Table 1.)

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Source: See Note 6.

As the global fleet of motor vehicles continues to expand, pollution from motorcycles, cars, and trucks plagues many cities. Studies in Europe show that pollution from motor vehicles can actually kill more people than vehicle accidents do. Although a greater share of the population uses cars in wealthy cities, vehicles tend to be more polluting in urban centers of the developing world, where two- and three-wheeled vehicles prevail. Most of these are motor scooters and carts powered by simple but dirty “two-stroke” engines, in which much of the fuel goes unburned and is released with the exhaust. Vehicles with these engines emit more than 10 times the amount of fine particulate matter per vehicle-kilometer as a modern car and only slightly less than a diesel truck.

Fuel use in developing countries has contributed to health problems on an unprecedented scale. Some 1.1 billion people in the developing world choke on unhealthy levels of air pollution. Researchers estimate that air pollution in 36 large Indian cities killed some 52,000 people in 1995, a 28 percent increase from the early 1990s. China reported at least 3 million deaths from urban air pollution between 1994 and 1996. An examination of 207 cities by the World Resources Institute ranked Mexico City, Beijing, Shanghai, Tehran, and Calcutta as the five worst in terms of exposing children to sulfur dioxide, nitrogen oxides, and particulates. Just by breathing the air in their homes and streets, these children inhale the equivalent of two packs of cigarettes each day.

2.2 Global Problems

Urban energy use affects not just the health of city inhabitants but the health of the planet. Roughly 78 percent of carbon emissions from fossil fuel burning and cement manufacturing worldwide occur in urban areas. Between 1990 and 1998, road transportation was the fastest growing source of carbon emissions from fuel burning. (See Figure 1.)
Figure 1. Change in World Carbon Emissions by Sector, 1990-98

Carbon emissions from cities stoke the atmospheric warming that threatens to destabilize global climate. If average temperatures continue to rise as scientists project, the consequences are likely to include sea-level rise, deadly heat waves, and an expanded range for disease vectors.\(^{15}\)

3. Urban Energy Use: Solutions

3.1 Greater Reliance on Local Sources of Clean Power

One set of policies to reduce pollution and carbon emissions from energy use promotes local sources of clean power. Energy supply lines reached new lengths in the twentieth century, as production became ever larger and more centralized. Although these large systems can produce much electricity with few people, they also require complex distribution routes, with use occurring far from generation. Today, electric grid systems depend on large power plants and long transmission lines, which makes them vulnerable to various kinds of breakdown.\(^{16}\) Clean, locally produced energy can not only provide environmental benefits to a city, but also increase income and security for its inhabitants.

Several current and future clean energy technologies hold promise for urban use. Solar photovoltaic (PV) panels, for example, can be mounted atop urban roofs, and the newest technologies can even be integrated into standard building materials such as roofing shingles, tiles, and window glass -- turning the building surface into a nearly invisible power generator. While PVs remain a minor source of power, producing less than 1 percent of electricity worldwide, the market has been growing at double digit rates over the last decade. Solar power has long been economical in remote areas, but as the price of PVs came down in the 1990s, many more were shipped to consumers, and thousands of solar panels were hoisted atop homes and office buildings in cities such as Tokyo, Berlin, and Zurich -- places that are already well served by an electrical grid. (See Figure 2.) Geothermal heat pumps and small natural gas turbines that generate both heat and electricity are available for use in buildings now, and hydrogen fuel cells are likely in the near future.
Clean, decentralized energy must overcome barriers. Most utilities discourage small power producers and do not let them connect to the grid. Efforts under way in some countries to standardize such interconnections will help. And the restructuring of electric power markets that is now sweeping the globe may open up new opportunities. Now available in Japan, Switzerland, and half of the U.S. states is a key financial incentive to level the playing field for solar power, "net metering," in which electric companies purchase electricity produced by individual solar rooftops at the same price they charge consumers.

Cogeneration of heat and electricity with an older and uniquely urban technology, district heating, saves considerable energy in northern European cities. In conventional power plants, more than half of the energy is wasted; with district heating systems, excess heat from electricity generation warms water that is piped to buildings throughout the city. In Copenhagen, district heating meets most of the city’s space heating demands.

Energy efficient buildings, designed for the local climate, can complement locally produced solar power and district heating. In the town of Kemalpasa, Turkey, traditional underground or semi-buried homes take advantage of the Earth's natural heating and cooling -- and as a result use at least 75 percent less energy than new houses.

Energy efficient appliances also reduce a building’s power needs. One example is compact fluorescent lightbulbs (CFLs), which last about 10 times longer than regular, incandescent bulbs, and use only one quarter of the electricity to provide the same amount of light. By replacing regular bulbs, the CFLs sold each year save the equivalent electrical output of about 28 medium-sized coal-fired power plants.

Landscaping around a building helps determine how much energy its residents will need for heating and cooling. The United States Forest Service estimated that planting 95,000 trees in metropolitan Chicago would result in net savings of $38 million over a 30-year period in avoided energy use and other environmental benefits. Vegetation can also be planted directly on buildings for this purpose. Ecological roof gardens planted with native grasses are becoming fairly commonplace in Germany and the Netherlands. Unlike traditional roof gardens that require maintenance, these typically need little or no irrigation or fertilizer. In Malaysia, a 15-story skyscraper is covered with tropical plants that cool the building naturally, thus reducing energy needs.
Local energy production and energy efficiency businesses have the potential to invigorate city economies. According to analysis by the Institute for Local Self-Reliance, money spent on energy tends to remain in the local economy for less time than money used for food or other items. Studies in two U.S. cities found that only 15 cents of each dollar spent on energy returned to benefit the local economy.26

3.2 Reducing the Need for Cars

Much wasted energy and air pollution stem from a city's failure to link transportation and land use decisions in a sensible way, so that people must use private vehicles to traverse the city. To reduce the need for cars, governments could steer new development toward places easily accessible by public transit. They could also provide safe and attractive streets for pedestrians and bicycles, while making sure that connections between cycling, rail, bus, and other forms of transportation, including paratransit, are convenient.

Coordinated transportation and land use policies can lessen the need for travel. In the Netherlands, for instance, cities follow a national “ABC” policy that ranks potential development sites, from the most accessible “A” locations in the “Randstad” ring of cities (including Amsterdam, Rotterdam, and Utrecht), which are the best served by public transportation and bicycle paths, to relatively remote “C” locations reached only by automobile. Companies with a large number of employees must be located in “A” sites. When the Dutch government followed its own policies and moved government offices to a central site well served by public transport, its employees drove substantially less.27

Curitiba, Brazil offers an excellent example of this sort of forward planning in a developing country. Starting in the 1970s, Curitiba built a bus network on lanes separated from other traffic, allowing speedy travel. The city zoned for higher-density development along those thoroughfares. Before the buildings along the transportation corridors were fully developed, the city bought up strategic land and set it aside for affordable housing. By the mid-1990s, although Curitiba had one car for every three people, two thirds of all trips in the city were made by bus, and the city enjoyed better air quality and more parks for its 2.5 million people.28

Today, other Latin American cities are adapting elements of Curitiba's system. Bogotá, Colombia, has recently launched a similar bus system, the TransMilenio, and tried a bold “car-free” day, where in the middle of the work week, the city of 6.8 million functioned as normal - but without cars.29

Cities can actively promote walking and cycling by investing in bike paths and racks, slowing cars, and making streets physically appealing. Studies of cycling investments in Amsterdam, Bogotá, Morogoro (Tanzania), and Delhi, found that small investments can yield great benefits. The rewards of traffic taming have been demonstrated in the Netherlands, where a professor conceived of a street called a woonerf or “living yard,” in 1963. Trees and flowers, planted strategically alongside and within the street, and speed bumps to slow cars, made the woonerf more inviting than a typical street. After a number of cities tried this idea and met with success, the Dutch government adopted it nationwide. The concept spread to Germany and Austria as the Wohnstrasse or “livable street” in the 1970s, and then to the United Kingdom as “home zones.”30

One type of public transportation choice that is particularly well suited to spread-out metropolitan areas is paratransit. This category embraces a range of vehicles with flexible pick-up and delivery stops—-from cycle rickshaws and pedicabs to taxis and shuttle buses. In the developing world, these services employ people who need jobs and fill needs not met by regular transit routes, especially people who live in slums. The most popular type of service is a minibus or van that plies a fixed route but stops whenever a passenger wants to get on or off: Nairobi’s matatus, Manila’s jeepneys, and Buenos Aires’ colectivos, for example. Despite the important niche paratransit fills by meeting
the needs of the poor, governments often try to restrict it to make room for growing car fleets catering to the privileged.31

Wealthier cities are looking to computer-aided paratransit. Advances in electronic navigation, automated dispatching, and communications are making it easier for a central switchboard and computer to electronically match drivers and riders. Engineers have been applying these innovations to make “dial-a-ride” taxi services more affordable and efficient, and even design a form of personal rail transportation. A team at the University of Bristol in the United Kingdom has been developing a “personal rapid transit” system in which electrically powered four-person carriages run along a guideway. Passengers get on at any station, and their carriage stops only at their final destination. Local governments will need to reform laws governing bus and taxi routes in order to allow these new forms of public transportation to take root.32

The success of any type of public transportation network, from cycling to personal rapid transit, depends on having a minimum number of people within a certain area. Buses or trains only benefit the environment and the economy when lots of people use them. Researchers at Australia’s Institute for Sustainability and Technology Policy (ISTP) have identified a critical threshold 30 of people per hectare below which public transit is not viable. Recognizing that the success of public transportation depends on population density, cities such as Copenhagen and Portland, Oregon are requiring new development to take place within a minimum distance from existing public transportation networks. 33

Connections to other transport modes are also crucial to making public transportation useful. One of the shortcomings of Bangkok’s new Skytrain, an elevated rail system that opened in 1999, is that it lacks adequate bicycle parking and connections to bus routes. Connections between cycling and transit make both these options more attractive. Bicycles are inconvenient for long trips or in bad weather, and buses and trains are limited to fixed routes. But bicycles and transit complement each other when people are able to carry their bikes aboard buses or trains, or to park them at stations.34

3.3 City-to-City Cooperation

Some research suggests that a group of local governments committed to a goal such as reducing air pollution may drive each other to succeed. For instance, a study of international environmental regimes in Europe by the International Institute for Applied Systems Analysis (IIASA) in Austria found that nonbinding agreements among a small group of governments have spurred progress beyond the modest targets of binding treaties. The authors conclude that focused cooperation among a few motivated parties, or "minilateralism," can be effective.35

Cooperation among cities is not exactly the same type of minilateralism observed by IIASA, but coordinated campaigns of local governments worldwide have yielded significant results. Michael Shuman of the Washington, DC-based Institute for Policy Studies cites the example of international city campaigns to divest from firms doing business in South Africa. He has coined the term "interlocalism" to describe such cooperation.36

Such "interlocalism" on environmental issues is not new, but it has gained force in recent years. City networks for information exchange on environmental technologies and policies have a long history. For instance, nineteenth-century sanitary reforms gained momentum as scientists and local authorities from cities such as London and New York compared notes. Various types of urban exchange to promote sustainable development have been exploding since the 1990s.

In the last decade, a pledge made by the city of Toronto to reduce its carbon emissions by 20 percent of the 1988 level by 2005 has been copied and modified by city governments worldwide. In the early 1990s, 13 cities in Canada, the
United States, Europe, and Turkey joined Toronto in drawing up plans to slash carbon emissions. City-to-city networking led by the Toronto-based International Council on Local Environmental Initiatives (ICLEI), helped to multiply this effort. In 1993, ICLEI launched a campaign to help more local governments devise their own plans to reduce emissions.37 As of October 2001, some 500 cities, responsible for an estimated 8 percent of global carbon emissions, had signed up.38

Recently, this campaign has begun to help cities in rapidly industrializing economies fix inefficient buildings, transportation, and energy systems that not only release carbon dioxide, but also waste money and create air pollution. For example, Cebu City, in the Philippines, is calibrating the engines of all of its city-owned vehicles. Local officials expect improved engine efficiency to cut municipal fuel costs by 12 percent, roughly $60,000, annually, and improve air quality. Building on this, Cebu City aims to cut carbon emissions to 15 percent below the 1994 level by 2010.39

4. Leadership Role for Asian Cities

At least three factors point to a leadership role for Asia in stimulating global progress in the technologies and policies described in this paper that could result in cleaner, more energy-efficient cities in the coming century. First, there has been strong growth in manufacturing of renewable energy and energy efficiencies technologies in the region. Second, Asia has a tradition of bicycle and rail connections. Finally, the region has large and growing number of urban dwellers.

4.1 Growth in Renewable Energy and Energy Efficiency Technologies

Some important clean energy and energy efficiency technologies have taken hold in Asia. Japan has surged past Germany and the United States to become the largest producer of solar photovoltaics (PVs) in the world, producing 44 percent of the global supply in 2000.40 Strong Japanese government support, coupled with falling prices for PVs, have stimulated the domestic market for this product, which puts Japanese companies in place to further stretch their lead over competitors.

The strongest growth in an energy-saving technology, efficient compact fluorescent lightbulbs (CFLs), is also in Asia. China now manufactures more than 80 percent of the world’s CFLs, and the market for them grew by more than 350 percent in China between 1996 and 2001.41 Booming sales have stimulated competition, which has reduced prices and improved quality. While regular, incandescent bulbs still outsell CFLs by 25 to 1, the long life of these bulbs means that they account for more than a third of the lighting capacity sold.42

4.2 Tradition of Urban Transportation Centered on Bicycle and Rail Connections

Asian cities are already more compact than those of other regions, with strong traditions of cycling and rail ridership. Researchers studying transportation and land use in cities worldwide find higher carbon emissions per person in less densely populated, sprawling urban areas.43 Compact, densely populated Asian cities boast some of the lowest per capita carbon emissions in the world. (See Figure 3.)
The top three bicycle producing nations are China, Taiwan, and India, which together manufactured nearly two thirds of the 95 million bicycles produced worldwide in 1999. Asia also leads in the production and use of electric bicycles, which have a small, rechargeable motor that helps riders pedal if they get tired. Some 68 percent of the electric bikes sold in 2000 were sold in China, where they are an attractive urban commuting option.

Asia is also a world leader in rail ridership and technology. India, China, and Japan together account for more than half of all passenger rail travel in the world. (See Figure 4.) Japan’s first shinkansen, or “bullet train” line opened in 1964, linking Tokyo and Osaka, and the high-speed rail network has since been expanded and upgraded. China plans to boost its rail network, and has lifted restrictions on foreign investors. Between 1997 and 2000, Chinese railways raised speeds three times and started scheduling more overnight trains. Future plans include a high-speed link between Shanghai and Beijing. Korea is also developing a high-speed project.
4.3 Increasingly Urban Population

Most of Asia’s people today live in rural areas, but the region is still home to 1.4 urban dwellers, more than all the people living in urban areas in Europe, North America, and Latin America combined (1.2 billion). Moreover, demographers expect the dramatic rural-to-urban migration underway now to transform Asia into a predominantly urban region by 2030. Much modern urban infrastructure was built in response to nineteenth-century problems in the West, which hosted the world's biggest urban areas for a brief moment in history. In 1900, nine of the ten largest cities were in Europe and the United States; but by 2000, there were only two in the United States. (See Table 2.) Asia, which led world urbanization between 800 and 1800, is on the rise again, with 4 of the 10 largest cities in 2000.

| Table 2. Population of World’s 10 Largest Cities in 1000, 1800, 1900, and 2000. |
|-----------------------------------------------|----------------|-------------|-------------|-------------|
| (million people)                             | 1000          | 1800        | 1900        | 2000        |
| Cordova                                       | 0.45          | Peking      | 1.10        | London      | 6.5         | Tokyo       | 26.4        |
| Kaifeng                                       | 0.40          | London      | 0.86        | New York    | 4.2         | Mexico City | 18.1        |
| Constantinople                                | 0.30          | Canton      | 0.80        | Paris       | 3.3         | Bombay      | 18.1        |
| Angkor                                        | 0.20          | Edo (Tokyo) | 0.69        | Berlin      | 2.7         | São Paulo   | 17.8        |
| Kyoto                                         | 0.18          | Constantinople | 0.57       | Chicago     | 1.7         | New York    | 16.6        |
| Cairo                                         | 0.14          | Paris       | 0.55        | Vienna      | 1.7         | Lagos       | 13.4        |
| Bagdad                                        | 0.13          | Naples      | 0.43        | Tokyo       | 1.5         | Los Angeles | 13.1        |
| Nishapur                                      | 0.13          | Hangchow    | 0.39        | St. Petersburg | 1.4     | Shanghai    | 12.9        |
| Hasa                                          | 0.11          | Osaka       | 0.38        | Manchester  | 1.4         | Calcutta    | 12.9        |
| Anhilvada                                     | 0.10          | Kyoto       | 0.38        | Philadelphia | 1.4     | Buenos Aires | 12.6        |

Notes


22 Number of CFLs sold each year from Nils Borg, e-mail to Worldwatch, 11 January 2002. Worldwatch calculation based on 15-watt CFLs replacing 60-watt incandescents, used for four hours per day, and a “medium-sized coal-fired power plant” having a 440-megawatt output and operating 80 percent of the time.


34 “Bangkok’s Train, Running on Empty,” The Economist, 23 December 2000, p. 46.


41 Nils Borg, IAEEL, Stockholm, e-mail to Worldwatch, 11 January 2002

42 Global incandescent sales are estimated at 11 billion units in 1999; assumes life of 1,000 hours for an incandescent lamp and 10,000 hours for a CFL. Incandescent market estimate from Nils Borg, IAEEL, Stockholm, e-mail to Worldwatch, 17 January 2000.


53 Ibid.

55 Ibid.