Reinventing the City to Combat Climate Change

How the world’s cities develop their infrastructure over the next 30 years will determine the future path of global warming.

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How the world’s cities develop their infrastructure over the next 30 years will determine the future path of global warming.
As we address the potentially catastrophic consequences of climate change over the next three decades, cities will be the decisive factor. Nearly 80 percent of carbon dioxide emissions — the main cause of global warming — already emanate from cities, and that number is expected to grow as the world’s population moves toward the 9 billion mark and congregates increasingly in urban centers.

We have opportunities to change this potentially disastrous course, provided that policymakers and business leaders take action soon. The key is in urban infrastructure: the systems of transportation, energy, water, building, and communications that support cities, distinguish them, and contribute so much to their vitality. Estimates from a new research study suggest that cities will have to spend an astonishing US$350 trillion — seven times the current global GDP — on building, operating, and maintaining these infrastructure systems over the next 30 years to accommodate the growth in their population. (See “Cities and Global Warming: Doing the Math,” page 5.) If this investment is managed along a business-as-usual path, cities will become a growing force for environmental destruction. If, on the other hand, government and business leaders direct enough of this spending to significantly lower-carbon initiatives, then the cities of the world will become a primary source of ecological rejuvenation.

The Three Prerequisites for Change

Cities are immensely diverse, but the case for a new approach to sustainable urban infrastructure is universal. Whether in Sweden or China, Germany or Nigeria, urban leaders need to focus their infrastructure spending on three kinds of activities. These three practices, taken together, represent “must-do” prerequisites for any green strategy — especially one that hopes to avoid the disastrous consequences of climate change.

- Adopting aggressive energy reduction plans and setting goals for both new and existing infrastructure
- Investing in cutting-edge technological advances
- Implementing innovative financing strategies

These conclusions come from “Reinventing the City,” the 2010 global study conducted by the World Wide Fund for Nature (WWF) and supported by Booz & Company. The study analyzed data on population, environmental measures, construction and infrastructure investments, and the best practices that successful cities use when tackling the challenge of sustainability.

We expanded on this analysis by interviewing city officials in different regions about their experiences as they implemented policies to improve planning, tech-
nology adoption, and investment. We then identified clear success factors. The most successful cities are those that combine efforts to reduce carbon emissions in the future with a focus on improving livability for their citizens today. They also take a long-term view in formulating plans and policies, and work to make them relevant to their own particular situations. The cities described in this article are far-flung and have vastly different populations and resources, and none of them have a perfect record in pursuing sustainability. But they share a commitment to reshaping our common urban future and exploring the opportunities that will arise. They are the pathfinders that all cities — especially the fast-growing categories — can and must learn from.

**Aggressive, Aspirational Planning**

In order to control emissions while meeting the challenges of urban growth, cities will need to shift their spending from high-carbon infrastructure to green infrastructure. This will require the creation of long-term low-carbon emissions plans. No matter their size, population, history, or geography, the dynamic ecosystems we call cities will require detailed action plans to meet their goals; planning is by far the best way to have an impact.

Consider, for example, the effect of urban planning on emissions. When U.S. cities experienced their great expansion during the 1950s, urban planners designed cities in which individuals would largely own and drive their own automobiles. In contrast, European cities were largely planned before car ownership became the norm. Tax policy also played a role, with much higher fuel taxes in Europe. As a result, transportation emissions per capita are almost three times as high in the U.S. as in most European countries, such as Germany, the United Kingdom, and France.

Planning clearly pays off, and more and more cities are doing it. In 2009, some 500 European leaders representing 120 million citizens in 36 countries agreed to create carbon action plans for their cities. Together they wrote and signed a covenant to reduce carbon emissions by more than the 20 percent target that had already been set by the European Union. This “Covenant of Mayors” requires the cities — which vary tremendously in size — to submit detailed sustainability strategies. As a result, the need for plans and goals has been formalized, and low-carbon action plans are becoming a routine part of many cities’ green strategies both in the E.U. and elsewhere around the globe.

As a general rule, urban low-carbon plans will differ depending on the city’s level of development. Cities follow a predictable life cycle as they grow. During their early stages of development, the bulk of expenditures and emissions come from the construction of infrastructure for transportation, housing, and commercial activities. As the city matures physically and economically, energy use increases until the bulk of expenditures and emissions come from existing infrastructure. At that point, the power of population density can be leveraged to promote energy efficiency, particularly in the areas of transportation and housing.

It is during this formative period that opportunities to affect long-term infrastructure expenditures and emissions are most dramatic. Developing cities with more needs and faster-growing populations have more challenges, but they also have more opportunities to create themselves anew as greener, more livable entities. By restricting car use and limiting parking spaces, making cycling and walking attractive, and providing easy and cost-effective access to energy-efficient public transportation, high-density cities in emerging markets can meet the mobility needs of growing populations while managing both congestion and their carbon footprint.

“Developing nations should leapfrog ahead of the U.S. sprawl pattern and create higher-density, greener development,” says sustainability strategist and green real estate authority Charles Lockwood. “By embracing greener development practices today, they can save money for things that really matter — and probably gain a competitive advantage over some of today’s developed nations.”

For developed cities whose footprint and infrastructure are already in place, the challenges are different. They must rebuild and redesign their existing infrastructure to reduce emissions, while strengthening their capacity to support growth and meet the needs of expanding populations. Cities in the later stages of the urban infrastructure life cycle should set up and prioritize large-scale programs designed to reduce the emissions produced by existing infrastructure, while simultaneously setting ambitious and challenging standards for their future investments.

All of these investments, in all types of cities, must promote livability along with sustainability. Sustainable cities do not just view green initiatives through an environmental or even an economic lens — they are fundamentally concerned with creating livable, functional communities that meet the needs of their in-
Cities and Global Warming: Doing the Math

Climate scientists and environmental policymakers are reaching a growing consensus that the average global temperature must not rise more than 2 degrees Celsius over pre-industrial levels if we are to avoid dangerous changes in the world’s climate. To have a better than 50 percent chance of forestalling such a rise, cumulative global carbon emissions must be limited to 870 gigatons of CO₂ equivalent between 2009 and 2100. However, without serious changes in the way that urban infrastructure is created and used, the growth of our cities will create roughly half that amount in the next three decades alone, as shown in the chart.

Over those same three decades, however, we estimate that cities worldwide will spend US$350 trillion on the construction, operation, and maintenance of urban infrastructure, including power production and distribution, residential and commercial buildings, water and waste systems, roads and transportation, and supporting information and communications technology.

By making up-front investments in cutting-edge, lower-carbon technologies, cities could realize dramatic future economic and environmental gains. Our analysis shows that if an additional $22 trillion were spent on green residential and transportation technology right now, cities would save a net $33 trillion over the lifetime of the infrastructure by lowering operating costs, and could reduce future emissions by as much as 50 percent.

—N.P., S.A., S.H.
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a fundamental change in perspective. “We shifted the focus from environmental sustainability being about problems and about sacrificing things, to sustainability actually being about creating a better place to live. That became the key driver for progress, and it is very much mainstream now.”

Malmö’s success is a direct result of its strategy to rejuvenate its neighborhoods. One intensive effort turned Western Harbor, a former abandoned and contaminated industrial area, into a neighborhood that is now considered a model of sustainability. Western Harbor is run on 100 percent locally produced renewable energy, and its homes — some of which rely on passive solar energy to replace traditional energy sources — are designed with energy efficiency in mind. Electricity is generated by wind power and photovoltaic cells, and a heat pump recovers energy from seawater. Parks throughout the neighborhood support biodiversity; bikes far outnumber cars.

In Augustenborg, another of Malmö’s neighborhoods, old building facades are covered with external insulation and steel sheeting, helping to control moisture, ventilation, and temperature. Green roofs are constructed with soil and plants to minimize runoff, insulate homes, and increase biodiversity. They also give a unique aesthetic element to the neighborhood and act as added parkland.

New neighborhood schools are constructed with natural materials, and feature high levels of natural lighting, ground source heat pumps, solar thermal panels, and composting toilets. Since 2001, inhabitants have managed a carpool powered by renewable energy. Today, Malmö attracts a stream of policymakers and urban leaders who seek sustainable ideas for their own cities.

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“Dirty old Malmö” has reinvented itself.

The Freiburg and Malmö examples show that just as the climate change problem was not created overnight, it cannot be fixed overnight. For that reason, successful planners seeking urban sustainability take a long-term view of progress and are prepared to work for green solutions for years to come. Portland, Ore., in the northwestern U.S., also emphasizes a long-term perspective and a focus on neighborhoods in its planning.

With nearly 600,000 inhabitants, Portland has committed to lowering its carbon emissions by 80 percent by 2050. To meet that goal, city planners built the city around neighborhoods in which inhabitants can walk and bike between their homes and essential activities within 20 minutes. Thanks to its comprehensive and cost-effective mass transit system, which integrates light-rail trains, buses, and streetcars into the urban fabric, the growth rate of car use in Portland is among the lowest in the United States.

In addition, Portland’s rate of bicycle commuting has tripled in the last decade, and is the highest of any major U.S. city. All buses and trains have room for bikes; a planned network of bicycle boulevards aims to make cycling easier and safer. Other transport initiatives include a recently passed ordinance requiring all diesel fuel sold within city limits to contain 5 percent biodiesel, and a public–private partnership undertaking the construction of 1,000 charging stations for electric vehicles.

To limit urban sprawl, Portland has created a growth boundary limit around its metropolitan area. As it accommodates about 3,000 new units of housing each year, Portland focuses on building up, not out. It has adopted stringent policies for new construction, emphasizing high-density, livable buildings that are mostly...
multifamily, and it has sought creative approaches to foster energy efficiency in the city's existing buildings and infrastructure.

For example, in 2000, Portland passed a law requiring all new buildings and all businesses receiving tax increment funding — which pays for current development from anticipated increases in taxes — to meet the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) construction standards. LEED is part of an internationally recognized certification program for buildings that meet strict standards for energy savings, water efficiency, low CO₂ emissions, indoor environmental quality, and stewardship of resources. Today, the city has approximately 300 LEED-certified commercial buildings and is a worldwide leader in LEED architecture.

Another example of the power of planning for a rapidly growing city in the developing world can be found in Lagos, Nigeria — a city of 24 million people that is on track to become the world’s largest metropolis by 2015. As recently as the early 2000s, Lagos was known for urban neglect, diesel fumes, and chaotic traffic patterns. Then, reaching across sectors to create partnerships, the city’s leaders embarked on a major environmental awareness campaign. The city’s rallying cry: “Eko O Ni Baje,” or “Lagos shall not deteriorate.”

Faced with a dangerous and unsustainable growth pattern, Lagos redesigned its bus rapid transit system to be safer and more effective and to reduce emissions. The first phase of the system became active in 2008. The city also significantly improved its waste management systems, created green spaces, and installed solar-powered infrastructure. Lagos still has a long journey ahead, but it is on its way to becoming a sustainable city. Cities such as Lagos that have a deliberate plan are more likely to arrive at a sustainable destination than those that simply accept organic and unruly growth.

**Energy-efficient Technology**

Energy-efficient technology is the single strongest weapon that cities possess in the fight against climate change. And cities will need to develop and apply energy-efficient technologies at an unprecedented rate if they are to enable smart growth and sustainable lifestyles.

The small, incremental improvements of the past — for example, the use of hybrid vehicles, better models of air conditioning, and other energy-efficient technologies — may offer a few more miles per gallon or slightly fewer kilowatt-hours of electricity usage, but they cannot provide the absolute emissions reductions necessitated by our booming cities and increasing consumption levels. Incremental improvements can even be a threat; they can dig urban centers deeper into existing unsustainable infrastructures and delay critical transformative infrastructure changes.

Instead, cities must invest in technological advances that enable the planning, construction, and usage of low-carbon urban infrastructure. These advances will likely feature a diversified portfolio of intelligent and integrated renewable energy solutions, including solar, wind, geothermal, ocean, and biomass. Increased electrification may also be necessary in order to dramatically increase efficiency and enable a larger share of renewable energy input through smart grids, which can boost efficiency and lower costs further by adding two-way communications capabilities, intelligent monitoring systems, and the ability to integrate renewable electricity into conventional electric power systems.

Policymakers should view the projected $350 trillion in global spending on construction, operation, and maintenance of urban infrastructure over the next 30 years as an opportunity for their cities to become early adopters and investors in transformational solutions — and, by extension, to create healthier and more sustainable lifestyles.

Our analysis has shown that the most successful cities tailor their sustainability approach to their unique resources and challenges. Although developed cities may choose energy-efficient technologies that work with existing infrastructure, smaller cities in developing nations can use their developmental window of opportunity to invest in ambitious energy models that capitalize on their particular energy assets. Cities in Africa, for instance, can leverage solar technology better than those in Ukraine, which may instead rely on wind power.

“If you identify what your city has and what it can
“use,” says Malmö’s Trevor Graham, “then you can actually get it to work.” For its part, Malmö harvests its natural wind energy and generates 50 percent of its heat from the city’s waste. Similarly, in France, the city of Lille turns biomass into enough methane gas to power about a third of its buses.

The city of Dezhou in China’s northeastern Shandong province is a testament to harvesting the power of the sun. The city’s roofs are a landscape of solar panels; everything from buildings to tourist carts is powered by photovoltaics. Dezhou’s solar technology helps cut down on greenhouse gases and is already highly cost-effective: A solar heater pays for itself in just over five years and costs nothing to operate afterward.

Dezhou’s commitment to solar technology has done more than provide the city with environmental benefits; it has spawned a vibrant green industry. In fact, the early adoption of green technologies allows cities to serve as entrepreneurial hubs, creating both jobs and tax revenues. In 2007, the solar industry in Dezhou employed 800,000 people — a figure that is expected to nearly double by 2020. Dezhou is home to the world’s largest solar water heater manufacturer, Himin Solar Energy Group, with 2007 profits of nearly $10 million. It was Huang Ming, the Himin Group’s founder and CEO, who proposed the Renewable Energy Law of the People’s Republic of China, passed in 2006, which laid the foundation for China’s climate change strategy. Companies such as the Himin Group are reducing China’s reliance on coal and creating a template for trans-
Transformational technologies create a win-win situation in global environmental protection and local development needs. For example, the Chinese city of Baoding, with a population of 11 million, is building its economy by providing clean technology to other cities. Solar photovoltaics, wind power, and other energy-efficiency industries have been a major source of Baoding’s green growth engine for the past five years. Baoding, dubbed the Green Electric Valley of China, has seen its green energy companies expand from 64 in 2005 to 200 in 2008, and its green revenues quintuple in the same period, from $700 million to $3.5 billion. At the same time, these companies created 13,500 new jobs.

Although the city’s green industry does produce carbon emissions, preliminary findings from the WWF’s local chapter show that the solar and wind energy products the city had manufactured by 2008 — which have been installed globally and are providing energy that otherwise would have been produced by fossil fuels — will, in use, reduce global CO₂ emissions by a greater amount than the entire city of Baoding itself produces.

As they adopt such green technologies as solar heating, cities of the near future will most likely have a smart grid at their hub, allowing electricity to flow where it is most needed. Electric vehicles could be connected to the grid, storing energy when a surplus is produced and feeding the grid when there is an energy deficit. Buildings could serve as both housing and power plants.

As an essential enabler of smart grids, information and communications technology (ICT) will be a significant part of the drive to achieve urban sustainability. ICT can play an important enabling role by supporting energy-efficient construction with sensors and controls that tailor energy use to demand. ICT also provides tools for effective urban planning — a fundamental component of a city’s sustainability efforts. In addition, as a dynamic and powerful new sector, ICT has a key position as a “big brother” of the clean tech boom. And with companies such as Intel and Google racing to invest in clean tech, there is a strong likelihood that ICT will be a critical catalyst for change.

**Green Incentives and Investments**

Investing in green technology today can provide powerful economic and environmental benefits for cities. As noted, we estimate that the world’s cities will spend $350 trillion over the next 30 years on building, operating, and maintaining urban infrastructure. Our analysis also shows, however, that increasing up-front investment in green urban transportation and residential technology by $22 trillion would reduce future infrastructure spending by a cumulative $55 trillion by lowering future lifetime operating costs — for a net savings of $33 trillion over the lifetime of the infrastructure. At the same time, this investment would lower lifetime carbon emissions from infrastructure operation by 50 percent. The equation is simple: A relatively small investment will yield an enormous environmental and economic payoff. Even with such promising expected returns on investment, however, gaining political support for major capital investments remains challenging.

Although new public and private energy financing opportunities are emerging as climate change rises to the top of the global agenda, scarce resources and competing agendas pose continued challenges. That being the case, innovative financing strategies are needed to provide funding for up-front capital costs.
Consumers must have incentives in order to choose energy efficiency over energy guzzlers. “We’ve found very clearly that if people ever get $10,000 to improve their home, they fix up their kitchen,” explains Susan Anderson, director of Portland’s Bureau of Planning and Sustainability. “They don’t insulate their homes or replace their furnace.”

As a result, programs such as Portland’s Clean Energy Works give property owners an opportunity to borrow money to install energy-efficient upgrades, paying off the loans over time through their energy bill. Similarly, the Property Assessed Clean Energy program in Berkeley, Calif., offers loans to install sustainable technology solutions such as solar panels. In Berkeley’s case, consumers repay the loan through a special fee on their property tax bills.

Creative solutions are also being offered in the developing world. In Eritrea, a country in the Horn of Africa, indoor cooking on woodstoves is common, but it emits unhealthy fumes. So the government has partnered with nongovernmental and business organizations to produce new fuel-efficient stoves, which are then carbon certified. The certified carbon credits are sold on the voluntary emissions reduction market, and the funds raised are used to import and install solar-powered electrical systems in homes and other buildings. By reducing CO₂ emissions as well as harmful fumes, the plan confronts an essential quality-of-life challenge even as it helps the environment.

Every city has its own set of opportunities and challenges, but information sharing and cross-sector collaboration can help pinpoint best practices and appropriate solutions. Pilot initiatives should be evaluated for effectiveness, and successful programs should be brought to scale — with the understanding that progress will not happen overnight.

A Prescription for Healthy Growth
By directing the enormous expenditures earmarked for urban infrastructure and usage toward energy-efficient technology, policymakers will be able to accomplish several important goals: First, they can make progress in limiting climate change. Second, they can enhance the livability of urban areas. Finally, they can ensure their city will serve as an innovation platform and hub of green entrepreneurship, building the economic base and creating jobs by attracting green industry.

And although the greatest opportunities lie in new construction, every city — regardless of its size or level of development — can make smart choices in the sustainable rejuvenation of its existing infrastructure.

Although it will require many different approaches to whittle down society’s impact on the planet, the three best practices highlighted in this article — urban planning, technology, and investment — are essential in the drive to achieve a low-carbon lifestyle and to ultimately reach the goal of zero-carbon living. In addition, cities must view these practices through a lens of livability, finding synergies between initiatives that promote quality of life and ecological and economic health. In so doing, they must leverage their unique assets and set long-term planning horizons. By galvanizing all our intellectual, technological, and financial resources, we can avert environmental destruction and build a sustainable foundation for future growth, at the same time that we meet tomorrow’s urban challenges.

Resources

Viren Doshi, Gary Schulman, and Daniel Gabaldon, “Lights! Water! Motion!” s+b, Spring 2007, www.strategy-business.com/article/07104: Rebuilding the world’s urban infrastructure can be done only by integrating energy, transportation, and water.


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