Curitiba Helsinki Penang Ulsan Yokohama

Five Cities Going Green:

How Are They Doing It?

Edited by Shahid Yusuf

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About the Editor

Shahid Yusuf is Chief Economist, the Growth Dialogue. Dr. Yusuf brings many decades of economic development experience to the Dialogue, having been intensively involved with the growth policies of many of the most successful East Asian economies during key periods of their histories. He has authored or edited 27 books on industrial and urban development, innovation systems, and tertiary education, which have been translated into a number of different languages. His most recent books include: *Some Small Countries Do It Better: Rapid Growth and Its Causes in Singapore, Finland, and Ireland* (co-authored with Kaoru Nabeshima 2012); *Development Economics through the Decades* (2009); and *Tiger Economies under Threat* (co-authored with Kaoru Nabeshima, 2009). Dr. Yusuf holds a PhD in Economics from Harvard University and a BA in Economics from Cambridge University. He joined the World Bank in 1974 and during his tenure, Dr. Yusuf was the team leader for the World Bank-Japan project on East Asia's Future Economy from 2000 to 2009. He was the Director of the *World Development Report 1999/2000: Entering the 21st Century*.

Foreword

Compelling evidence now demonstrates several key roles of cities—as engines of economic growth, as sources of job creation, and as principal emitters of carbon and other pollutants. Within the ambit of economic growth and development, the inexorable expansion of cities and the movement of populations towards those cities is also a well-researched phenomenon. New, however, is the growing convergence of developments in urbanization, city management, green growth possibilities, and global concerns about climate change. Thus, it is increasingly urgent to better understand the nexus of these challenges.

The Growth Dialogue, an endeavor that seeks to be at the forefront of economic growth challenges facing developing and emerging market economies, is pleased to enter the fray with *Five Cities Going Green*. In this volume, skillfully compiled by Dr. Shahid Yusuf, the Dialogue's Chief Economist, we attempt to discover how five illustrative cities have tackled the dual challenges of economic growth and sustainability. Each of these cities—from all around the world, and with unique geographic and sociopolitical challenges—have been successful in maintaining and managing economic growth without imposing steep additional costs on future generations.

The origins of this volume lie in a symposium that the Growth Dialogue co-sponsored with Think City and the World Bank Institute in Penang in 2012. That event generated a wealth of information on the greening of urbanization worldwide and insights on city-level successes, false starts, and failures. We are deeply grateful to our co-organizers for making this event possible. In particular, we want to thank Mr. Hamdan Abdul Majeed, Executive Director of Think City, for encouraging us to publish this volume and his staunch support throughout.

One of the basic findings that will encourage policy makers is that there is a range of interventions within traditional city management that can add economic value and make a difference in conserving energy and reducing emissions. In areas as diverse as transportation design, housing standards, and waste management, smart city administrators can find winning interventions. A good partner can be found in the private sector, which is a pivotal source of new and cost-effective technologies. These solutions can be productively harnessed if planning is farsighted, incentives are well designed, and all economic actors can be induced to cooperate and to coordinate their actions.

In conjunction with other activities of the Growth Dialogue, *Five Cities Going Green* is intended to deepen our understanding of the drivers of long-term growth, in particular, of the policies and institutions that could contribute to the greening of urban growth.

Danny Leipziger
Managing Director
The Growth Dialogue

Acknowledgments

The idea of preparing a number of case studies emerged from a stimulating symposium, which the Growth Dialogue co-hosted with Think City and the World Bank Institute in Penang on February 20–21, 2012. We thank our co-hosts, Hamdan Abdul Majeed and his staff and Raj Nallari and Evangeline Cuenco of the World Bank Institute, for making the symposium possible and for their contributions and encouragement during the writing phase of the monograph. Our thanks also to the symposium participants whose presentations and comments helped frame the issues addressed in the volume.

Diana Manevskaya managed the intricacies of production with extraordinary efficiency and dispatch; Michael Alwan improved and tightened the presentation with his fine editing; and Sachin Anand and Eva Poon provided valuable assistance with the research. We are greatly indebted to all four for bringing the monograph to fruition. Throughout the gestation period, Danny Leipziger's wise counsel and comments helped keep the project on the rails and enhanced the content.

Greening Urban Growth: An Overview

Greening urbanization is going to be a global imperative for the coming decades, because much of the world's population will be living in cities. These economic agglomerations will be the principal consumers of natural resources and emitters of global greenhouse gases (GHGs). The concept of green development has acquired considerable currency of late, but it remains somewhat inchoate, slowly acquiring content. As yet there is no theory of green development or growth differentiated from mainstream growth economics. Nor are there tried and tested models of such development, whether for the economy as a whole or for the urban sector. However, experience is beginning to accumulate, and it would appear that green theorizing, the empirical validation of hypotheses, and the crafting of viable green strategies will follow. These will largely be informed by the study of initiatives coming to fruition in a large number of cities that are recognizing the necessity of green development in the interests of sustainability and in order to enhance welfare.

The Challenge of Greening and Growing

National governments are having difficulty in setting forth coherent strategies of green development that are politically acceptable and deemed affordable. Uncertainty regarding future resource gaps and climate change, coupled with opposition from vested interests wedded to the status quo, also has hindered international negotiations aimed at achieving long-term sustainability for the planet as a whole. But while national governments dither and delay, municipal governments and local stakeholders have been willing to experiment with green initiatives, with or without the backing of national authorities. An increasing number of city-level policy makers have responded to public awareness of mounting problems that are threatening to undermine the quality of urban life. They are trying to make green urbanization a reality without waiting for a full-fledged, theoretically grounded recipe to light the way forward. Through energetic networking, enterprising city administrators are exchanging ideas and the preliminary results of their experiments. In the process, they are accumulating a practical knowledge on which to build urban development strategies that are green, growth promoting, and sustainable. In effect, urbanization is entering a new era, and a great deal of excitement and anticipation is in the air.

As the avalanche of scientific findings is demonstrating beyond a shadow of doubt, there is a lot at stake with respect to sustainability. If urban greening fails to gain traction because of a lack of political will, a shortfall of technological innovation, weak intergenerational altruism, or because legacy infrastructure and institutions present insurmountable obstacles, the

longer-term implications could be exceedingly serious. Thus, much hangs on the success and promulgation of the lessons of urban experimentation. The purpose of this book is to highlight the attempts by a few mid-sized cities to translate the promise of greening into improved urban outcomes. By their example, we hope to encourage others to follow suit.

Five Green Growth Cityscapes

There are many ways of classifying cities. For the purposes of this volume, a simple three-way classification is applied: pre-industrial, industrial, and post-industrial. Of the five cities viewed through the lens of green development, two—*Helsinki and Yokohama*—fall in the post-industrial category; one—*Curitiba*—is in transition from an industrial to post-industrial stage; and two—*Ulsan and Penang*—are industrial cities. The absence of a pre-industrial city in this volume is not accidental. Cities in the early stages of industrialization (mainly African, south Asian, and southeast Asian) are more focused on growth and only peripherally concerned, if at all, with greening. Sensitizing pre-industrial cities to the advantages of an early start at greening, and identifying potential sequences of actions, is one of the main purposes of this volume.

A second aim is to underscore the link between urban growth and greening. A reading of the admittedly limited experience with green urbanization suggests that the initially costly and sometimes disruptive green initiatives are more likely to be pursued by cities with the following strengths:

- are growing economically
- have an abundance of entrepreneurial and organizational capital

- exhibit the capacity to generate resources to finance greening projects
- incentivize through a system of governance departures from conventional practices and technologies.

Cities that are economically stagnant or in decline can also take up the challenge. But their greening will be more difficult and limited because of institutional hurdles, start-up fixed costs, and the premature obsolescence of some existing capital stock. The cities in our sample are interesting and highly instructive because they show the advantages of an early start. Early greening can create a path dependence that is advantageous over the longer term and minimize costly, late-stage retrofitting of legacy infrastructures. Each of the cities examined opens a window onto a specific set of issues demanding green solutions, most of which have yet to be fully devised.

Yokohama, once a major industrial powerhouse, is now largely devoid of the factories that contributed to its prosperity, but that also were responsible for the pollution that sparked the initial interest in greening. With a stable population (but one that may decline as Japan ages), it is coming to resemble a dormitory suburb of Tokyo and is dependent upon the affluence of the latter. Yokohama has the revenue base to continue with greening its infrastructure. However, the energy and innovativeness needed to drive greening (whether in manufacturing or services) will need to be harnessed through closer integration with and spillovers from Tokyo. Yokohama's predicament and achievements are of relevance for many cities in high-income countries that are looking for post-industrial economic sustenance and are weighing the costs of a greener future.

Helsinki is at the center of Finland's remarkably dynamic learning and innovation system. It is a post-industrial city with multiple linkages to industry throughout the country. Helsinki hosts a large information and communications technology (ICT) cluster and the headquarters and research establishments of most of Finland's leading companies. In the larger metropolitan area, it hosts the manufacturing activities that buttress the country's economic prowess and are responsible for its high international competitiveness rankings. Finland has a long-standing awareness of urban livability and the desirability of controlling urban congestion and pollution. Urban design and transport, emphasis on frugal energy use, and regulatory institutions all carry the imprint of this concern, which has sharpened in recent years. What Helsinki confronts (to a lesser degree than Yokohama) is the challenge of maintaining serial innovation capabilities even as the population ages, mainly because of low fertility and limited in-migration of knowledge workers. Gains in productivity are largely what drive Helsinki's growth and allow it maintain a suite of clustered, high-tech, cutting-edge firms. If the city can stay on its growth path of productivity and innovation, Helsinki could be a source of green technologies—hard and soft—and serve as a model for other mature mid-sized cities on the cusp of a post-industrial life change.

The third city in our sample, Curitiba, is approaching post-industrialization with a difference. It is post-industrial without having attained levels of industrialization that are the norm in Europe. In fact, the share of manufacturing activities in Brazil is a meager 16 percent of GDP; and in Curitiba, the country's

fifth-largest city, manufacturing is less than a fifth of municipal GDP. Like Yokohama, Curitiba began tackling the ills of traffic congestion, pollution, urban sprawl, and the decline in urban recreational amenities starting in the 1970s. It was easier in the past to manage urban land use and build a transport infrastructure that would control the use of private automobiles. More recently, Curitiba has adopted a more explicitly green approach to development. Continuing attention to containing energy consumption has been complemented by an increasing focus on recycling solid waste or disposing it in a sanitary landfill, and on arresting the spread of shantytowns on public lands exposed to flooding.

Like other cities in similar circumstances, Curitiba is finding that to pursue green urbanization, a flexible, long-term strategy is a necessary but not sufficient condition. Success also requires a powerful implementing agency; innovative and affordable solutions; and, most important, great political determination, sustained over multiple political cycles. In addition, the Curitiba case study highlights urban growth drivers (or their absence). Manufacturing, much of it concentrated in an industrial park, is a significant economic presence; however, the overall growth impetus it provides is weak and diminishing. Construction and other services are much more important, but whether they can be a sufficient source of growth and employment over the longer run is a burning and unresolved issue. Absent such an impetus from existing or new activities, the case for expensive greening initiatives might be harder to make.

Industrial cities in some emerging economies began to seriously consider the environmental downside of manufacturing

development and unplanned urbanization not much more than a decade ago. After three decades of prominence in the global electronics value chain, the Malaysian state of Penang realized that it was risking destruction of its rich cultural heritage, particularly in the capital of George Town. The state's scenic assets and livability were rapidly being compromised by unchecked construction activities, industrial pollution, and traffic congestion. Initial and still tentative efforts to stem and eventually reverse unsustainable trends are underway. These efforts are reinforced by awareness of the need to reduce the energy and resource intensity of development, while bolstering long-run urban livability through a variety of regulatory and technological measures that are well within reach. Penang is on the long road to greening, but as with other industrial areas, it is unclear whether the state will be able to muster the national-level support, political commitment, and planning and administrative capabilities to combine growth with greening. An added complication is the need to instill a culture of innovation, so that Penang can graduate from the assembly, packaging, and testing of electronic components to higher-order design and production activities. These will move it up the value chain, increase wage levels, and meet national aspirations. Innovativeness will be the touchstone of both greening and growth—as it is in Helsinki.

Ulsan is an industrial city of a different stripe. It is the hub of the Republic of Korea's auto, shipbuilding, and petrochemical industries. These have grown phenomenally since the 1960s, but have also been a source of immense pollution, which became intolerable by the late 1990s. In typical Korean top-down style, the national authorities responded to popular

demands by embarking on a crash program to dramatically reduce industrial emissions. Municipal authorities took the lead in enforcing standards and sharing the costs of pollution control with the central government. The early 2000s were also when greening of growth was coming into fashion, and Korea was quick to seize upon this in the interests of environmental management, the conservation of resources and energy, and technological advances that would benefit long-run productivity. At the same time, the Korean authorities saw a competitive opportunity through investment in green technologies that could propel industrialization to a new and higher stage. This led to the creation of an Eco-park and large investments in cleaning up bedrock industries that Korea viewed as crucial for its future economic prosperity

Ulsan is a changed and far more livable city today. Gone are the smoking chimneys that President Park Chung-hee visualized when he inaugurated the industrialization of what was then a small coastal township. Ulsan has greened growth and has demonstrated how, with sufficient resources, dogged municipal determination guided by stretch targets, and technological skills, a diehard industrial city could be pulled back from the environmental brink without sacrificing its key industrial activities. Accompanying this retrofit of Ulsan's industrial base is the notion of recycling of waste products into other productive uses, and a sense that growth need not be sacrificed with proper planning and engineering of greenness. It remains to be seen whether Korea's recipe for greening growth can be transferred to other countries, particularly those where the top-down approach is impracticable.

Concluding Observations

The greening of urban growth is still in its infancy. The theoretical underpinnings are weak and mostly borrowed from standard growth economics, combined with the pricing of externalities. Empirical evidence is scanty and policy recipes are scarce. But there are widespread (and piecemeal) attempts at introducing change—technological, regulatory, in city design, in land use, in modes of pricing, and in lifestyles. These efforts are producing a fund of practical lessons for green growth strategies, and they are sufficiently diverse to apply to cities from all parts of the industrial spectrum. Moreover, based on these cases, theory might catch up with practice, and provide the rigorous underpinning for the economics of long-term urban greening.

What is noteworthy about the experience of the five cities to date is that all the initiatives have drawn on variants of practices and technologies that are at least two decades old. There have been no technological leaps or paradigm changes, nothing that can be remotely described as disruptive. (The few experimental eco-cities, such as Masdar, and smart cities, such as Incheon, have yet to prove their viability; and Chinese low-carbon cities are low carbon in name only). Incremental change can make the greening of urban development more manageable, and we have the tools to deal with both pricing and behavioral issues. However, given the imminent and massive urbanization of the coming decades, it is a little alarming that we are still only talking about incremental changes. Even cities that recognize the necessity of greening have still to commit to implementing tried and tested solutions such

as dedicated bus lanes and bike paths; congestion charges and building upwards; installing scrubbers and filters; triple glazing, fluorescent bulbs, and thicker insulation; and carving out some green spaces, planting more trees, and encouraging roof gardens. Developers and urban planners in cities now on the move can draw inspiration and guidance from these case studies. The experiences and lessons discussed here can help initiate the greening of urban growth more widely. But it should be apparent that even the pioneering cities are a long way from having perfected strategies that will result in sustainable growth that is carbon neutral—or better yet, carbon negative. The greening of urbanization has only begun.

I

Greening Helsinki

Innovation for Sustainability

Shahid Yusuf

Cities want to be innovative for the same reason as countries: to enjoy greater prosperity and improve the quality of life. In fact, the economic growth of nations hinges increasingly on the productivity of cities, and a good part of such productivity derives from serial innovation by urban industries and services. Few cities achieve such an outcome, but the ones that do have a disproportionate effect on the performance of the countries to which they belong.

Becoming an innovative city is a process; it cannot be a goal. Through a process of industrial and institutional development, the building of knowledge and social capital, and by anticipating and responding strategically to opportunities, cities can become capable of sustained innovation, whether in one industry or more broadly. Becoming innovative is rarely linear. However, cities considered innovative have tended to adhere,

if only loosely, to a long-term vision. They incrementally assemble the building blocks of innovation, guided as much by political concerns and rewards as by an economic rationale. These building blocks can be described in the abstract, but it is more useful to demonstrate how innovation capability was created in a particular city over the course of a few decades—in this case the Helsinki metro region. It includes the cities of Espoo and Vantaa and some smaller cities (with a population of 1.35 million in 2010).

Helsinki is a telling example for a number of reasons. Before it embarked on the road to becoming the technologically dynamic and prosperous city that it now is, Helsinki had few of the locational advantages and other assets associated with cities traditionally viewed as innovative. In 1970, it was a mid-sized city (population about half million), the capital of a small country lying on the periphery of continent, and oriented more towards the Soviet Union than the technologically advanced Western European countries. It did not enjoy the agglomeration and scale advantages of a London or a New York, which can confer a productivity bonus of 3 percent of GDP or more. In the 1980s, Helsinki was not viewed as a regional epicenter of high tech manufacturing, and nor was it a financial center like Zurich or a major hub of commerce. It had no pretensions of being a knowledge city that housed a world-class university such as Boston or San Francisco or Cambridge, U.K. It could not claim to be a regional focus of creative activities and it was not also a corporate headquarter city of regional significance. Helsinki was an average, moderately industrialized, European city. That was in the 1970s and the 1980s. By 2001, with Finland ranked as one of the most competitive economies in the

world,[1] Helsinki's reputation as an innovative and green city was in the making.[2]

Helsinki's experience is instructive because shows middle-income countries how an ordinary industrial city could be transformed into a notable European center of innovation in little more than two decades. What Helsinki did cannot be rendered in the form of an infallible recipe.[3] In fact no such recipe exists, but by following the road taken by the Finnish capital, seven factors contributing to urban innovativeness can be identified:

1. An industrial base with a number of nascent medium-tech subsectors
2. A corporate culture increasingly oriented towards international competitiveness based on technological prowess
3. Supportive government macroeconomic, innovation and financing policies
4. The development of a learning system and the increasing concentration and improving quality of scientific and technical skills
5. An open urban environment attractive for the mobile creative class
6. Leveraging of information and communication (ICT) and green technologies, together with the emergence of specialized expertise in selected areas
7. Exploiting digital technologies to gather urban data to generate new value-adding services and apps.

These factors are not exclusive to Helsinki; one encounters them elsewhere. The difference is that in Helsinki they have all

come together quickly and effectively. At the outset, Helsinki (and Finland) enjoyed an advantage that many middle-income countries do not possess: a strong base of primary and secondary education already imbued with a spirit of high achievement (Sahlberg 2011).

The seven factors of innovation typified by Helsinki's success are discussed in more detail below.

Industrial Base

Historically, innovation is associated with certain branches of industry such as electronics, telecommunications, chemicals, biotechnology, transport, and engineering. More recently, ITC and business services have become important and might usurp the place of manufacturing in due course. Nevertheless, a base of manufacturing is a positive asset, and the more sophisticated and diversified this base, the wider the scope for innovation. Helsinki was fortunate in that Finland was a producer of wood products; meat, bakery, and other food products; ships; textiles; and electrical and other equipment. All of this activity nurtured technical, engineering, research, and production skills. Although Finland's manufacturing has declined, it still accounted for 20 percent of Helsinki's GDP in 2010, which was relatively high given the per capita income. The human capital that conceived and designed the manufactures and some of the equipment used for production was (and is) concentrated in Helsinki and its neighboring cities. Thus, through the 1980s and thereafter, a critical mass of production and technical skills, embodied in an ecosystem of input and services suppliers to the principal industrial firms, was tak-

ing shape in the Helsinki region. This is responsible for the explosive growth of knowledge-intensive business services and spawned high-tech clusters that will be the drivers of growth in the years ahead, including specializations such as mobility software, microelectronics, and nanotechnology. One cluster of more than 800 firms is located in the Otaniemi area in the City of Espoo adjacent to the Helsinki University of Technology.[4] It is home to leading research institutes, including the Finnish Innovation Center, the VTT Technology Research Center, and the Micronova Center; it is also the site of corporate headquarters and research facilities of companies such as Nokia, Kone, Fortum, Outokumpu,[5] and Tekla. Universities emerged as a major force for industrial upgrading and new entry from the early 1990s, and helped to create incubators and enterprise development centers (Chakrabarti and Rice 2003).

Corporate Strategy

To progress, industry requires a corporate culture that strives after excellence—in technical and other spheres—so as to achieve and sustain international competitiveness. Finnish companies were quick to realize that growth depended on penetrating foreign markets. Hence they incentivized research in order to assimilate technology from overseas and to gain an edge over competitors by way of innovation; and they emphasized product quality to build brand reputation (Aw, Roberts, and Xu 2011). The emergence of Nokia as a global leader in telecommunications,[6] and the world market share of Finnish companies such as Kone, Wartsila, Stora Enso, UPM-Kymmene, Metsaliitto, and Outakumpu, can be traced to a corporate

culture that brought Finnish industries to the technological frontier. From the 1990s onward, Finnish companies continued to advance that frontier in their areas of painstakingly cultivated comparative advantage. Helsinki benefitted from corporate vigor because it was home to much of this innovative activity.

Enabling Policies

Enabling policies were a third factor contributing to Helsinki's evolution as an innovative city. They included steps to ensure macroeconomic stability and reduce uncertainty, and policies and measures to facilitate access to patient capital for startups and small and medium-size enterprises (SMEs).[7] The collapse of the Soviet Union (Finland's principal trading partner prior to 1989) and a banking crisis in the early 1990s forced some wrenching changes; thereafter, a stable macroeconomic environment encouraged investment. Furthermore, good technological foresight and the accumulation of research capabilities in the 1980s enabled Finnish companies to catch the wave of opportunities in the mobile telecommunications sector. These same capabilities facilitated a reorientation of Finland's traditional industries towards other, faster growing markets. It is often overlooked that risk-reducing macroeconomic stability underpins corporate performance and encourages investment in specialized human capital and research infrastructure. Absent such stability, any city or country, no matter how well endowed with resources, will struggle to create an environment conducive to high-tech development.

Finland complemented macroeconomic stability with a farsighted strategy to induce innovation that rested on a firm

political consensus regarding the future drivers of economic growth. The strategy had four main components:[8]

1. A matrix of well-financed and influential agencies (TEKES, SITRA,[9] the Academy of Finland) that quickly honed a capacity to implement long-range technology policies; they worked in close coordination with politicians, the business sector, and universities, and promoted learning by catalyzing economic interaction
2. The expansion and strengthening of tertiary-level institutions in the main cities to buttress industrial change
3. The provision of incentives for R&D and of venture financing for start-up firms that could serve as vehicles for commercializing ideas emerging from research in universities and public or private laboratories[10]
4. Inserting Finnish researchers and firms into the global innovation system so that they could benefit from the circulation of new knowledge and research findings within international scientific networks (Nielsen 2012).

Finland recognized earlier than most that closing technological gaps and becoming a part of the innovative elite required active collaboration with researchers in other countries working in the same or complementary fields. Research by Keller (2012) and others suggests that international knowledge transfers can be more valuable sources of innovation and productivity growth than domestic sources. The important point to note is that the innovation strategy was anchored necessarily in the economies of a small handful of cities with Helsinki at the forefront. Success depended on the creation of one or more innovative cities that were integrated with the global innovation system.

Learning Economy and Quality

The quality of the graduates from secondary and technical schools and from universities (Sahlberg 2011) vitally underpinned technology and innovation policies and enabled Finnish firms to become world-class players. Here again, a national culture of excellence, which established exacting standards and encouraged students to aim high, was the driving force. High standards were aided by enlightened education policies emphasizing pedagogical techniques that brought out the best in students. Good teaching was made possible by attracting the very top students into the teaching profession and giving teachers autonomy, prestige, decent salaries, and a sense of mission (OECD 2010). And good teaching has delivered: Finnish students have done remarkably well on international tests (PISA and TIMMS[11]) for reading, science, and mathematics, and have surpassed their peers in virtually all the OECD countries. None of Finland's 20 universities figure in the top 150 research universities in the world. However, Finnish universities and vocational training institutes have done a fine job of turning school graduates into the highly competent workers, technicians, professionals, researchers, and entrepreneurs that have enabled Finnish companies to achieve world-class status. What distinguishes Finland from many other countries is its "learning economy." In Lundvall's words, this signals that

> "the most important change is not the more intensive use of knowledge in the economy but rather that knowledge becomes obsolete more rapidly than before; therefore it is imperative that firms engage in organizational learning and that workers constantly attain greater competence and new

> skills . . . both individuals and companies are increasingly confronted with problems that can be solved only by forgetting old methods and acquiring new ones." (Lundvall 2009: 14)

Finland's learning (and innovation) system is a model for other countries.

Urban Environment

One in four Finns lives in the Helsinki metro region, making the nation's capital the urban locus of the country's learning and innovation system. For Finland to retain its mobile (multilingual, English speaking) human talent and for Helsinki to serve as an important node of the global innovation system, the city must be seen and marketed as superior to global competitors. Ever since Richard Florida wrote about the "creative class" (Florida 2012), the urban environment has come to be viewed rightly as an essential attribute of an innovative (or smart, or intelligent) city. Helsinki offers an open, tolerant, and pollution-free environment. Offsetting its climatic drawbacks are excellent recreational amenities, public services, and regional connectivity.[12] The city encloses 3,500 hectares of green spaces within its borders and has 950 kilometers of bike paths. Commuters benefit from urban rail and streetcars and for those favoring muscle power, bike-sharing offers a convenient option. Housing is affordable and the city has taken a proactive role in providing business with the space to grow. Moreover, urban governance—conducted by an agile bureaucracy supported by state-of-the-art ICT infrastructure—is among the best in the world.

Urban Greening

Innovative cities around the world are vying to develop and apply green technologies.[13] Helsinki is among the frontrunners and has moved quickly to enlarge and harness the potential of ICT-based clean/green technologies. Green tech is likely to serve as the foundation for a fresh round of innovations, and possibly a new general-purpose technology platform that transforms many other activities (as the Internet and the semiconductor have done). Research on green technologies promises a stream of innovations for managing energy use by factories, buildings, and transport systems; increasing access to affordable sources of renewable energy; and enhancing the energy efficiency of cloud computing,[14] the construction industry, and transport services. The innovative reach of ICT also extends to health, education, and myriad service activities that are likely to be the principal sources of gains in total factor productivity over the longer term. From these pioneering efforts, Helsinki hopes to nurture new, productive activities that will replace some of the mature industries as these migrate to countries where wage costs are lower.[15]

Digital Technologies

A factor contributing to Helsinki's urban edge and innovative capabilities was the early and successful gathering and analysis of information with the help of evolving digital systems. This raised the efficiency of urban planning, the accuracy of technological forecasting, and the variety and productivity of urban services. As planners and city officials are discovering world-

wide, digital infrastructure provides them with the wherewithal to collect information on the precise utilization of urban services, on energy and resource use, greenhouse gas emissions, the state of the physical infrastructure, and on latent demands that can be the basis of value-adding, revenue-generating services. There is huge scope for savings and productivity increases from innovation that enables cities to more effectively utilize their infrastructure. Helsinki moved early to build and exploit the digital infrastructure,[16] which is also paying off in the form of new activities (such as the development of games and of apps). The city continues to forge ahead as sensors, actuators, mobile phones, electronic maps, and cloud computing enlarge the potential of digital infrastructure to collect and analyze data. This gadgetry provides the basis of digital value chains. For cities, an understanding of these value chains can lead to new industries and jobs, to ways of driving down costs, and down avenues to urban greening.

Other cities that have set their sights on building innovation capabilities can learn from Helsinki and take heart because the process need not take generations. Even ordinary cities—with some of the attributes listed above—can realistically try. There is much that cities can do themselves, and an agile and creative urban bureaucracy,[17] sound governance, and digital tools including ITC are tremendous assets. However, the experience of Helsinki and other smart and innovative cities around the world shows that national and corporate context matters. The flowering of innovation is as much a function of national macro and innovation policies and of corporate strategy and competitiveness as it is of metropolitan-level initiatives.[18] The financial crisis of 2008–09 also underscored the importance,

particularly for small countries, of the global economy. The global market stimulates innovation in products and services. For cities such as Helsinki, participation in the globalized innovation system is a vital source of information, ideas, opportunities, and competitive pressure on domestic firms.

Notes

1. Finland was ranked as the most competitive nation by the World Economic Forum in 2001 and ranked third by IMD. WEF put Finland in 6th place in its 2008–09 report and 4th in its report for 2011-2012. http://en.wikipedia.org/wiki/Global_Competitiveness_Report#2008-2009_rankings.
2. The Siemens–EIU Green City Index rated Helsinki as the seventh most livable city in 2011. It ranked highest in the quality of buildings, waste and land use, air quality, and environmental governance http://www.siemens.com/press/pool/de/pressemitteilungen/2009/corporate_communication/axx20091222e.pdf. Helsinki also is considered to be among the top 50 most innovative cities. In 2007, the creative industries in Helsinki had a turnover amounting to €9.6 billion. See http://www.innovation-cities.com/innovation-cities-top-100-index-top-cities/; http://en.wikipedia.org/wiki/World's_most_livable_cities.
3. Here we are comparing Helsinki with mid-ranked innovative cities and not with high flyers such as Boston, San Francisco, Amsterdam, Munich, and others in the top tier. http://www.innovation-cities.com/.
4. http://www.otaniemi.fi/portal/2.
5. Outokumpu is a leading producer of high-tolerance stainless steel headquartered in Espoo: http://www.outokumpu.com/en/AboutUs/Pages/default.aspx.
6. Until recently, Nokia dominated the global handset market (its share in the first quarter of 2012 was 20 percent). The firm accounted for 3.2 percent of Finland's GDP, 1 percent of total employment and 32 percent of the nation's R&D.
7. SMEs have been notable contributors to innovation and employment in Silicon Valley and Cambridge (United Kingdom) as well. See Mohr

and Garnsey (2011). Singapore is banking on such firms to launch its clean tech industry.

8. Fujita (2007) refers to an advertisement he saw on a visit to Finland. It stated:
   - The Bad News: The brain is the only natural resource in the Oresund region;
   - The Good News: The brain is the only natural resource that expands with use.
9. TEKES: The Finnish Funding Agency for Technology and Innovation; SITRA: The Finnish Innovation Fund.
10. This is discussed in detail in Yusuf and Nabeshima (2012).
11. PISA: Programme for International Student Assessment; TIMSS: Trends in International Mathematics and Science Study.
12. Mercer rated Helsinki third in its 2010 Eco-City rankings: http://www.globalsherpa.org/most-liveable-cities-quality-of-living-survey.
13. Nearby in Sweden, Malmo is an example of a city committed to environmental sustainability. Freiburg and Portland are two other cities that have aggressively pursued greening strategies. And on the Asian side of the world, Singapore, has taken a lead in greening the cooling of buildings using centralized plants for producing cool air that is piped to connected facilities, in using solar power, and in conserving and reusing water. See Pennell, Ahmed, and Henningsson (2010).
14. Helsinki claims to have some of the greenest server farms.
15. For example, two cities in China—Dezhou and Baoding—have built up thriving manufacturing activities supplying solar cells and solar heating equipment. Singapore has created a Clean Tech Park for firms engaged in producing equipment for water purification, recycling energy, and manufacturing biofuels.
16. The Greater London Authority through the London Datastore is exploiting the advantages of the digital. See also The Climate Group (2008) and Arup et al. (2011).
17. Charles Landry discusses the desired attributes of a twenty-first century urban public bureaucracy (Helgesen 2010).

18. See Garnsey (2009) on the experience of the Cambridge (UK) cluster. Garnsey (1998) also writes illuminatingly of how activities can self-organize in specific locations through interactions and shared learning or the exchange of knowledge, once they pass a certain threshold and the need to get them to such a threshold.

References

Arup, The Climate Group, Accenture and Horizon, University of Nottingham. 2011. "Information Marketplaces: The New Economics of Cities." Available at: http://www.arup.com/Publications/Information_Marketplaces_the_new_economics_of_cities.aspx.

Aw, Bee Yan, Mark J. Roberts, and Daniel Yi Xu. 2011. "R&D Investment, Exporting and Productivity Dynamics." *American Economic Review* 101(2): 1312–44.

Chakrabarti, Alok, and Mark Rice. 2003. "Changing Roles of Universities in Developing Entrepreneurial Regions: The Case of Finland and the US." MIT IPC Working Paper IPC-03-003. Massachusetts Institute of Technology.

Florida, Richard. 2012. *The Rise of the Creative Class Revisited.* New York: Basic Books.

Fujita, Masahisa. 2007. "Towards the New Urban Geography in the Brain Power Society." *Regional Science and Urban Economics* 37: 482–90.

Garnsey, Elizabeth. 1998. "The Genesis of the High Technology Milieu: A Study in Complexity." *International Journal of Urban and Regional Research* 22: 361–77.

———. 2009. "The Cambridge Tech Cluster: A Blueprint for the Future?" Presentation. Institute for Manufacturing, Centre for Technology Management, University of Cambridge, UK. Available at: http://www2.ifm.eng.cam.ac.uk/service/events/info/thursday_slides/081009garnsey.pdf.

Helgesen, Sally. 2010. "Charles Landry Knows What Makes Cities Great: Distinction, Variety, and Flow." *Strategy+business* 60. Available at: http://www.strategy-business.com/media/file/sb60_10306.pdf.

Keller, William. 2012. "The Transfer of Knowledge across Countries." *NBER Reporter* No. 1. National Bureau of Economic Research, Cambridge, MA.

Lundvall, Bengt-Ake. 2009. "The Danish Model and the Globalizing Learning Economy." UNU WIDER Research Paper No. 2009/18. United Nations University World Institute for Development Economics Research (UNU-WIDER).

Mohr, Vivian, and Elizabeth Garnsey. 2011. "How Do High-Growth Firms Grow? Evidence from Cambridge." Paper No. 2011/04. Institute for Manufacturing, Centre for Technology Management, University of Cambridge, UK.

Nielsen, Michael. 2012. *Reinventing Discovery.* Princeton University Press.

Organisation for Economic Co-operation and Development (OECD). 2010. *Lessons from PISA for the United States.* Paris: OECD.

Pennell, Nick, Sartaz Ahmed, and Stefan Henningsson. 2010. "Reinventing the City to Combat Climate Change." *Strategy and Business* 60.

Sahlberg, Pasi. 2011. *Finnish Lessons*. New York: Teachers College Press.

The Climate Group. 2008. "SMART 2020: Enabling the Low Carbon Economy in the Information Age." A report by on behalf of the Global eSustainability Initiative (GeSI). ©Creative Commons. http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf.

Yusuf, Shahid, and Kaoru Nabeshima. 2012. *Some Small Countries Do It Better.* Washington, DC: World Bank.

II

Greening Urban Growth

The Case of Yokohama

Shahid Yusuf

From a small fishing village in the mid-nineteenth century, Yokohama has come a long way. It is now Japan's second-largest city after Tokyo, and, with a population of 3.7 million, its most populous municipality.[1] Moreover, the Japanese government designated Yokohama an Eco-Model city in 2008 and the World Bank nominated it as one of the world's six Eco[2] Cities in 2010.[2] Unlike most other large Japanese cities, Yokohama's population continues to grow through inward migration. The municipality is distinguished by its efforts to improve economic performance in the face of industrial hollowing, while sparing no effort to ensure that future growth is eco-friendly. The greening[3] of Yokohama's development has been ongoing for almost 50 years. It is a model of patient and systematic

transformation of a long-term vision into a broad, well articulated, and politically viable strategy.

The purpose of this chapter is to briefly examine the unfolding of Yokohama's greening strategy; how this industrialized port was transformed into a post-industrial eco-city; the obstacles faced and overcome; and the challenges that lie ahead, challenges not dissimilar to ones confronting many other urban centers in middle- and high-income countries.

Historical Context

Following the arrival of Commodore Perry's "black ships"[4] in 1853, a peace treaty was signed in March 1854 that opened a few Japanese ports to trade with Western countries. The Tokugawa Shogunate then decided that Yokohama was to be one of the chosen port cities because of its location on Tokyo Bay close—but not too close—to Edo. The port of Yokohama opened for business in June 1859. Within three decades it had grown into a bustling city and was formally incorporated on April 1, 1889. It became the principal gateway for trade with the West in silk and other products, as well as an entry point for foreigners visiting Japan and for many who chose to live there.[5] Yokohama also was the first recipient of technological innovations new to Japan, such beer and ice cream production, the use of gas for lighting street lamps, Japan's first coal-burning power plant, modern water supply and sewerage systems, a telephone exchange, and Japan's first 19 miles of railway line that linked the port with Shimbashi in Tokyo.[6] By 1917, Yokohama port was the largest in Asia. Its economy was complemented by the

growth of manufacturing industries in the Keihin Zone, which spanned the coastal areas of Kanagawa and Tsurumi.

During the next 28 years the city was visited by two calamities. The Great Kanto Earthquake that struck Japan on September 1, 1923 largely demolished Yokohama; the restored city was extensively damaged by American bombing raids in May 1945. Port and manufacturing activities rebounded in the 1950s, aided by Yokohama's key role in the supply chain of American forces fighting on the Korean Peninsula. By 1955, industrial production had returned to prewar levels and it accelerated thereafter, increasing by 3.5 percent between 1955 and 1965.[7] Yokohama also benefitted from proximity to Tokyo, then and now the hub of the Japanese economy and a source of growth augmenting agglomeration economies.

The Long Road to Greening: Six Steps

By the mid-1960s, Japan was becoming aware of the negative externalities associated with its furious pace of industrialization, something that China also now perceives. Yokohama was among the first few cities to recognize the hazards of pollution[8] and to do begin doing something to ameliorate the problem. In 1964 the city entered into a Pollution Control Agreement with companies that were constructing manufacturing plants in reclaimed areas. Under the agreement, worsening air and water pollution was checked through the installation of smokestack scrubbers, and technologies were introduced by chemical factories to reduce and clean effluent discharges.[9] This was the first step in a long journey toward urban greening, and Yokohama

was one of the tiny band of urban pioneers. It set the stage for a long-term strategy that has defined Yokohama's sustainable development trajectory ever since. The Plan for the Future Development of the City of Yokohama, introduced in 1965, was comprised of six major projects:

1. Reviving the city's urban core
2. Relocating factories from core areas to adjacent reclaimed land in the Kanazawa Industrial Park and elsewhere with the help of central government funds for small and medium-size enterprises and the Japanese Environment Corporation
3. Establishing a new suburb—the Kohuku New Town—to absorb the growing urban population while containing urban sprawl
4. Developing an urban rail transport network connecting the inner city with the suburbs and facilitating intracity movement
5. Complementing the rail network with the building of expressways that ameliorated traffic congestion in the city center
6. Constructing a bridge linking Yokohama with Tokyo that bypassed the central business district.

The city's urban core was revived with the help of Minato Mirai 21 project, which integrated two areas of the city, downtown Kannai and the Yokohama Railway Station. The project relocated the shipyard and railway marshaling yards that separated the two areas, and developed the 186 hectares of land freed for residential and commercial purposes. The centerpiece of the mixed-use development project was the new Pacifico Yokohama convention center. More generally, Minato Mirai

21 created a unified urban space, restored some of Yokohama's cultural charm, increased the number of visitors, and injected energy into the commercial hub of the city.

Relocating the shipyard and railway warehouses helped to optimize the use of downtown space. Once the reclamation of the Kanazawa district was concluded in 1988, the area was transformed by the emergence of industrial clusters, housing estates, and recreational facilities, including a seaside park.

Both of these developments increased the urban density in the downtown areas and enlarged the supply of housing and commercial real estate. However, the city still needed to cope with a persistent problem of sprawl arising from the continuing growth of the population attracted by the job opportunities in the greater Tokyo Metro area. Sprawl was steadily eating into the forest and farmland to the north and northwest of Yokohama, and it was only a matter of time before the entire corridor leading to Tokyo was consumed by low-density housing. To avoid this outcome, the city introduced zoning regulations that allocated over 1,200 hectares to the creation of a new Kohuku township and set aside the remaining 1,300 hectares for agricultural and recreational purposes.

Downtown densification and the emergence of new suburbs quickly highlighted the need for an efficient rail rapid transit system. In particular, the system would knit together suburbs with commercial areas, facilitate intersuburban travel, and provide links with transit points for Tokyo. The rail network built up from the 1960s onwards provided Yokohama with a badly needed transport backbone. It also helped ward off the congestion and pollution[10] that is the bane of cities with

poor urban bus and rail services. The network is designed so that no resident is more than 15 minutes by foot from a metro station and all can reach the city center in 30 minutes.

The rapid transit system maximized intracity mobility while minimizing negative externalities. However, the city still needed to strengthen the transport links with Tokyo, both the suburbs and the downtown areas. The former was achieved by the construction of a new bridge spanning Tokyo Bay. The latter requirement was met by construction of an underground expressway that channeled traffic from the business district in the direction of Tokyo. This solution minimized pollution and the loss of valuable space to overland road infrastructure.

Regulating Urbanization

The six initiatives discussed in this section, conceived and begun in the mid-1960s and implemented in stages over the next 30 years, spearheaded the greening (as it is now called) of Yokohama's growth. They also helped to maintain the city's dynamism even as the urban economy was restructured by the departure of manufacturing activities. The formal adoption of a greening strategy occurred on July 22, 2008, when the Japanese government designated six Eco Model cities, including Yokohama. However, from the mid-1960s, urban greening was reinforced by a number of other measures and projects.

One measure was the Urban Environmental Design System, instituted in 1973, which enabled the municipality to control building height, floor area ratios, and the allocation of land for pedestrian and green spaces. A second initiative, begun

in 1972, was aimed at preserving historic buildings and their physical settings in the Kannai and Yamate Bluff areas of city. These long-running efforts culminated in the Yokohama City Landscape Vision and Act of 2008, which seeks to harmonize building design and standards with the nature of city locales. Japan's "Good Design Award" of 2006 duly recognized the strides made by Yokohama in creating an attractive urban environment. In 2009, Yokohama embraced the "Creative City of Art and Culture" vision; its purpose was to deepen the cultural and creative industries that are likely to be a future mainstay of economic activities in post-industrial cities.[11]

A third green initiative focuses on waste reduction and associated greenhouse gas emissions from incinerators and landfills. Starting in early 2000,[12] Yokohama targeted a 30 percent reduction in waste by 2010. Actions included separation of items into 15 separate types, recycling, and a deliberate effort by businesses to provide goods and services generating less waste. By 2007, waste was down by 39 percent; by 2010, it had dropped by 43 percent, with business waste cut by one half. CO_2 emissions fell by 840,000 metric tons between 2001 and 2007. In 2009, Yokohama embarked on a "Co-Do 30" program to reduce waste by a further 10 percent in 2025 as compared with 2009 and CO_2 emissions by 30 percent.

Yokohama complemented its waste reduction program with two additional initiatives. The first was to improve water conservation and increase recycling by strengthening watershed management, investment in water treatment plants, and measures to lessen the loss of water through leakage. The second initiative was to capture waste heat from wastewater,

including the capture of gas and heat from sewage. These various measures to minimize waste, conserve resources, capture waste-generated heat, and reduce carbon emissions are coming together in the recently launched Yokohama Smart City Project. The project emphasizes energy consumption from renewable sources;[13] it also promotes the use of new sensor and data analysis techniques that facilitate controlled use of energy in the home, commercial buildings, and by urban transport.

Thanks to these measures, Yokohama was highly ranked in the Siemens–EIU Asian Green Cities Index for 2011. It was top ranked in water quality and low rates of leakage. Energy consumption per dollar of GDP was 2.4 megajoules compared to the index average of 6 megajoules. The 53 kilometers of subway routes and 1,000 kilometers of bus routes put it well above the average for Asian comparators. Per capita waste generated was 301 kilograms, lower than the average of 380 kilograms. Finally, air quality, especially as measured by the prevalence of particulate matter, was also well above the average.[14]

Factors Leading to Success

Five factors explain much of Yokohama's success at greening over the past several decades.

A holistic, long-term vision. Yokohama defined a holistic, long-term vision, and pursued it consistently over decades, in spite of government turnover. The need for such a vision is now a commonplace but is extraordinarily difficult for most cities to achieve. Yokohama set forth a far-sighted strategy when the concept of sustainability was still in its infancy and green

urbanization was decades from discovery, and it parsed this strategy into a set of waypoints so as enforce implementation and monitoring. The efficacy of the strategy was enhanced by a two-pronged approach. First, there was a consultative process that fully involved the local citizenry, provided voice for citizen movements, and strengthened ownership. Second, Yokohama collaborated with the national government on financing, and on building or removing institutions that affected the implementation of the strategy.

Standards to control pollution. the city entered into agreements with industries and large producers that specified targets and standards to control pollution; the standards were then rigorously monitored and enforced. These initiatives not only checked pollution but also promoted technological advances that were adopted by new factories and later spread to established plants.

Building a capable local bureaucracy. Yokohama was highly effective in building a lean and agile local bureaucracy (responsive to local concerns) by recruiting and training talented staff and imbuing them with a sense of mission. Administrative quality went hand-in-hand with frugality. Yokohama has the smallest number of public officials per capita of any large Japanese city and its administrative costs per capita are also the lowest. Moreover, the city has also taken a lead in trimming the number of quasi-government organizations that can eat into the finances of the municipality while adding little value.

Expert advice. The city administration sought expert advice and from an early stage forged links with specialists and research institutes. These experts helped administrators better

grasp the nature of the problems they confronted and assisted them in identifying solutions.

Coordinated finance. Yokohama's greening strategy was predicated on successful interjurisdictional coordination and mobilization of finances from a number of sources. The first and foremost sources of funding and execution were the national government and national corporations. The city conceived the major projects; however, their financing and actual execution was left to national agencies. The financing of lesser projects and area development was done through public-private partnerships,[15] incentivized by the allocation of land to developers. The developers in turn were required to provide a number of public services and amenities, in line with the nature of the development, for the land that they developed. Additional financing for long-term and capital-intensive infrastructure was raised by selling bonds, with a strict eye to the level of debt servicing so that the city retained its market standing and kept fiscal burdens in check. The city's greening action plans were buttressed by a "green tax" levied on local incomes, the proceeds of which were spent on earmarked projects. Through these means, Yokohama was able to proceed with its ambitious plans and gradually increase its financial autonomy with respect to the national government—an asset for any city pursuing major long-term development schemes.

The Challenge Ahead and Some Lessons

Yokohama is a leader among cities that are helping to define how urban greening can be made a reality.[16] However, except possibly in the recent Japanese context, it is difficult to claim

that Yokohama has achieved green growth.[17] In 1997 and 2000, growth just touched 2 percent and in most other years, the city has struggled to exceed a 1 percent rate of growth. In fact, growth was negative in 1998–99 and 2001–02, and during 2007–10, the city barely recorded a positive GDP growth rate. This is a far cry from its performance during Japan's miracle years of the 1960s and 1970s when urban growth—including that of Yokohama—was roaring along. With very slow or no growth, the future of greening and its financing looks less certain.

The challenge for Yokohama, as for many other post-industrial cities that have embraced greening, is to keep up the pace of growth. Growth must occur even as cities implement greening by holding fast—to the extent feasible—to existing sources of industrial growth and attracting others to replace declining economic activities. The ideal outcome is when greening creates industrial spillovers; that is, the absorption of green technologies induces local innovation that in turn gives rise to new activities or injects fresh vigor into existing ones.[18] Local conditions can be improved by proactive regulatory, innovation, industrial and land management policies that incentivize growth-enhancing activities and pull in skilled workers. Several companies are already using Yokohama to showcase their green technologies, and if this activity gains traction, green industry could become a leading sector for the city. Panasonic is demonstrating home energy management systems; Toshiba is testing community energy management systems; Tokyo Gas is prototyping new energy infrastructure; Nissan is promoting the use of electric vehicles; and Meiden is taking the lead in building energy management systems.

Yokohama is continuing to benefit from in-migration because of its livability. However, many of the workers find jobs in Tokyo, so that the day and evening population differs by almost 350,000 people. In part this is because of industrial hollowing: the share of secondary industry declined from 37 percent in 1980 to 22 percent in 2005 and the downward slide has continued. In part also it is because the service sector jobs that have replaced industry are both lower paid and have smaller job multiplier effects. High-tech activities suitable for cities such as Yokohama seek the agglomeration economies and technological spillovers that Tokyo can offer in greater abundance.

Is there a solution or is Yokohama past a tipping point beyond which industry of the kind that is wanted will not return? The proximity to Tokyo is now having a strangling effect. This is because Japan's economy seems to have irreversibly slowed; what industry remains will likely crowd selectively into fewer cities offering the "right" combination of urbanization economies, producer services, and thick labor markets. Too energetic a policy of greening might have exacerbated the exodus of industry. Yokohama may need to strike a new balance between greening policies and growth—a balance that gives more weight to the development of economic activities than in the past. And like Copenhagen, Yokohama needs to build up its base of tradable green goods and services.

Two major lessons emerge from Yokohama's experience. The first is that the tools, technologies, and practical knowledge to promote urban greening are there for any city to harness if it can muster the political will and the resources, both human and financial. A second lesson is that greening must not be at

the expense of growth: the two need to be addressed together so that they can be mutually reinforcing. Greening and staying green requires resources and cities that are not growing—or worse, slipping backward—may soon find that green initiatives are unsupportable. A green strategy must attract economic activity that is compatible with the strategy and helps to finance it.

Notes

1. The city had a GDP of US$150 billion in 2010.
2. Yokohama hosted the first Eco^2 Cities International Conference in 2010.
3. Green urbanization as an explicit strategy is of more recent origin.
4. The term initially described Portuguese ships, the exterior hulls of which were coated with black tar. Perry's four coal-fired steamships earned the title because of the black smoke they emitted. Steamships were unknown to the Japanese prior to the arrival of the Americans.
5. Chinese were among the most numerous and they created Japan's first Chinatown (Chukagai), still the country's largest.
6. The first span of eight miles was constructed in Nagasaki by Thomas Blake Glover to demonstrate the technology. The Yokohama line was the first that operated commercially. It was financed through a loan raised in London and constructed under the supervision of Edmund Morel, who is remembered as the "father of Japanese railways."
7. This data is taken from MEIP (1996).
8. This was decades before "green growth" came into common use. The term became current following its first mention in the *London Economist* on January 27, 2000.
9. This agreement was the forerunner of the nationwide Air Pollution Control Law passed in 1968.
10. Photochemical smog induced by automobile pollution was recognized as a threat from the early 1970s. Consequently, city authorities began working with researchers and the auto companies to ameliorate the problem.

11. See www.unesco.org/bpi/pdf/memobpi25_culturalindustries_en.pdf; and O'Connor (2011).
12. The G30 Action Plan of 2003.
13. The Hama-Wing power station that generates 3 million KwH of electricity represents the city's efforts to tap renewable sources, a process that is still in its infancy with only 1 percent of electricity consumption is sourced from renewables.
14. Siemens–EIU (2011).
15. Unlike the majority of public-private partnerships, these appear to have been moderately trouble free.
16. Since the Fukushima nuclear incident, many other Japanese cities have embraced greening.
17. Yokohama also has some way to go in reducing CO_2 emissions. Although it is rated above average overall on the Asian Green Cities Index, its per capita CO_2 emissions exceed the average for 22 Asian cities (5.2 as against 4.6 metric tons), and 48 percent of Yokohama's energy consumption comes from gasoline use (Siemens–EIU 2011).
18. Kitakyushu is already exporting its expertise in recycling and water management technologies to China. Copenhagen has also been successful in this regard. It has not only harnessed green technology locally but also built up manufacturing and export-oriented services that generate DKK 18 billion (in 2009). Clean tech is the fastest-growing export sector in Denmark, with exports increasing by 98 percent between 2000 and 2010 (Green Growth Leaders 2012).

References

Green Growth Leaders. 2012. "Copenhagen—Beyond Green: The Socioeconomic Benefits of Being a Green City." https://www.mm.dk/copenhagen-beyond-green.

Metropolitan Environment Improvement Program (MEIP). 1996. "Yokohama: A Case Study." World Bank, Washington DC.

O'Connor, Justin. 2011. "The Cultural and Creative Industries: A Critical History." *Ekonomiaz* 78(3): 24–47. http://ideas.repec.org/a/ekz/ekonoz/2011303.html.

Siemens–EIU. 2011. Asian Green City Index. http://www.thecrystal.org/_download/Asian-Green-City-Index.pdf.

III

Ulsan

The Making of an Eco-Industrial City

*Shahid Yusuf and Bong-Hyeon Joo**

Ulsan has come a long way. This minor coastal town was first transformed into an industrial city par excellence and, since the turn of the century, has become the exemplar of the Republic of Korea's efforts at realizing the potential of green growth. Through the 1930s, Ulsan was an unremarkable fishing village with a focus on whaling activities that supported a small shipbuilding industry. During World War II, the Japanese developed the port infrastructure and some supporting engineering and other manufacturing activities. These facilities survived both the destruction wreaked by the World War and by the Korean War that followed soon after and served as the nuclei for later industrialization. The tempo of economic change in

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Korea accelerated in the 1960s with the coming to power of the regime of General Park Chung Hee. Ulsan, because of its location far from the Demilitarized Zone and its port, was identified as one of the four foci of the country's headlong rush to industrialize.

Korea's First Five Year Plan (FYP), launched in 1962, emphasized the modernization of industry. Ulsan was designated a special industrial zone to attract manufacturing, including through foreign direct investment (FDI). Subsequently, the state invested in a number of industrial complexes to provide firms with basic infrastructure.[1] However, it was not till later in the Second FYP (1967–71) and through the course of the Third FYP (1972–76) that the urban industrialization took off. Ulsan became the epicenter of Korea's strategy to develop a heavy and chemical industry base to support long-run diversification and in pursuit of greater self-sufficiency in the sphere of defense. In 1972, Hyundai Heavy Industries began construction in Ulsan of what remains the largest shipyard in the world. Hyundai Motor Company established its principal auto assembly plant in Ulsan, currently the world's largest, with an annual production capacity of 1.53 million vehicles.[2] Government encouragement, combined with targeted financing through the banking system and the newly created National Investment Fund,[3] induced other Korean companies such as Sunkyoung (now the SK Group), to follow Hyundai. By the early 1980s, Ulsan emerged as the premier industrial city in Korea, with firms producing a range of transport, engineering, and chemical products.

As of 2010, with a population of 1.15 million and a municipal area of 1,064 square kilometers, Ulsan was Korea's 7th

largest city. Its GDP was almost US$50 billion and its per capita GDP of US$45,000 was the highest in Korea. Moreover, it was Korea's premier trading city, with exports of US$101.5 billion and total trade in excess of US$187 billion per year. The presence of more than 700 firms, including several of Korea's conglomerates (chaebol), made Ulsan the nation's leading manufacturing center by a generous margin. It is also a major port, serving (as of 2010) more than 25,000 vessels annually, and an emerging oil hub for the North-East Asian region. But this industrial prowess that flourished after the mid 1970s came at a price. Starting in the early 1980s, air and water pollution were already testing public tolerance and by the 1990s, Ulsan was the most polluted city in Korea.[4]

The Long Road to Greening

A small start towards environmental management was made in 1977 with the establishing of a Pollution Prevention Section in the Health and Hygiene Division of the Ulsan government. Over time, as industrial pollution spiraled and awareness grew, this morphed into the Environmental Division in 1987 and the Environment and Health Bureau 10 years later. In 1998, the government was moved by rising concerns to create the Environmental Affairs Bureau. A Green Ulsan 21 Environmental Committee was formed, backed by a Research Institute for Health and Environment and a Regional Environmental Technology Development Center, to help monitor environmental conditions and to begin greening Ulsan's future industrial development.

Spurred on by rising public concerns, the newly created bureaucratic infrastructure began tackling the pollution chal-

lenge from the late 1990s. By this time, Ulsan was Korea's top-ranked metropolitan consumer of energy and the largest emitter among the leading Korea cities of sulfur dioxide. Already in 1981, sulfur dioxide emissions were 0.057 parts per million (ppm); the national standard was 0.02 ppm or below. Levels of particulate matter, volatile organic compounds (VoCs), and ammonia were also high. Water quality in the downstream reaches of the Taewha River flowing through Ulsan was also extremely poor, with the BOD (biochemical oxygen demand) exceeding 11.7 ppm in 1991 (the national standard was 10 ppm or below).

From the nadir reached in the mid-1990s, Ulsan has made a remarkable transition to a cleaner and greener city. The city has thus demonstrated that even the most extreme cases of industrial pollution are reversible. A joint effort by municipal and private entities, driven by strong public demand, can begin to show results in a matter of years.

Urban Environmental Restoration Programs

In order to contain and reverse the environmental diseconomies associated with the concentration of manufacturing activities without hollowing out the industrial base, Ulsan began crafting a vision for the city, which eventually culminated in the Ecopolis Ulsan Joint Declaration in 2004. This landmark achievement was the outcome of an ultimately fruitful collaboration among the municipal authorities, nongovernmental organizations (NGOs) and other citizen groups, and—most important—the business community. The Declaration identified

four major objectives. First, it advised a 30 percent reduction of carbon and other emissions by 2020, principally through the creation of Eco-Industrial Parks (EIPs). EIPs would green existing industries by "pursuing zero-emissions by recycling industrial by-products such as waste, waste heat and wastewater as raw materials for other businesses, thereby improving the quality of the environment and enhancing the competitiveness of industrial complexes" (Ulsan Metropolitan City 2008). Second, the Declaration proposed investment in the region's green technology R&D. More research would spur the transformation of existing manufacturing industries into producers of "greener" products likely to benefit from strong demand in the future. Third, the Declaration proposed creation of new high-tech green industries that would complement existing activities, contribute to the restructuring and reduced energy intensity of Ulsan's traditional heavy industries, and serve as leading sectors during the coming decades. Fourth, the Declaration recognized the importance of enhancing Ulsan's livability. This was to be achieved by adding to the green and recreational areas of the city and, with the help of bike paths, loosening the iron grip of private autos on commuting and intra-urban travel more generally. Fifth, the effort at controlling industrial pollution was to be reinforced by checking transport emissions, introducing greener vehicles, and increasing the usage of renewable energy. Thus, through its long-range sustainability program, Ulsan sought to mitigate the effects of its industrial past and ensure the region's continued economic growth.

To realize these objectives, the city initiated a number of programs and has since set the stage for further developments.

Eco-Industrial Parks

In 2005, Ulsan, with central government backing, established the first Eco-Industrial Park (EIP). The purpose of EIPs was to pioneer the conversion of existing industrial complexes so as to reduce environmental damage and eventually achieve zero emissions. This was to be achieved through a progressive recycling of industrial byproducts such as solid waste, waste heat, and wastewater, and where possible, making these available as raw materials for other businesses. The process would improve environmental quality and contribute toward the competitiveness of industrial complexes (Ulsan Metropolitan City 2008). It was expected that industrial efficiency would be further increased once firms began sharing information on techniques of minimizing waste and economies of scale and scope reduced the costs of pollution control (UNESCAP 2012).

The EIP model, currently being scaled up, is based on the concept of industrial symbiosis, which "describes the mutualistic interaction of different industries within a certain industrial cluster for exchange of resources resulting in economic and/or environmental benefits" (Lehtoranta et al. 2011). It does so by focusing on "transforming the waste of one company into the valuable input of another" (Lehtoranta et al. 2011). Industrial symbiotic activity is also optimized when companies are closely located. Given the number, diversity, and technological capabilities of the companies within the Ulsan industrial complex, opportunities to form by-product exchanges are high, allowing for increased efficiencies (Won et al. 2006). The ultimate goal of industrial symbiosis is a zero-emission system characterized by "complete cycling of materials without sending the waste outside the industrial complex" (Won et al. 2006).

The pursuit of energy recovery, and the transfer of energy among industrial users and from the industrial to the urban and commercial sector, is now gaining momentum. Incinerators supply steam to other users and waste heat released by smokestacks is captured and utilized for home heating and other purposes, with the target being to heat a third of homes through this means. Recycling of heat is thus saving fuel and cutting greenhouse gas (GHG) emissions. Similarly, landfill gas is being tapped as an energy source: wastewater is injected into the landfill and produces methane, which is collected through underground networks in the landfill. The gas is then sent to factories for use as an energy source, leading to an almost 40,000-ton reduction in GHGs and US$3 million in economic benefits.

From 2005 through 2010, Ulsan's EIP program produced significant economic and environmental results. Phase I of the program (2005–09) centered on converting five existing industrial complexes into EIPs by optimizing consumption of energy, raw materials, and other resources. Now in its second phase (2010–14), the program is expanding the concept to 20 other industrial complexes (UNESCAP 2012). During the first two stages of the EIP program, 16 successful projects were completed, producing economic gains of US$48.2 million and attracting new investment of US$52.5 million. The environmental benefits were just as impressive, with a 240,000-ton reduction in carbon dioxide emissions.

The traction demonstrated by the EIP program was largely because of the municipality's persuasive marketing, which helped to win over firms that initially were hesitant to be involved. Reluctance of companies to actively participate in the

program, owing largely to a lack of awareness of the initiative, represented the biggest challenge in Ulsan's EIP program (Park and Won 2007). Voluntary Environment Management Agreements were signed with a number of firms. This enabled them to accumulate points for pollution reduction, which in turn made them eligible for prizes, technical support, and freedom from regular inspections. The Agreements, launched in 2000, were concluded with 250 firms by the end of 2010, including such giants as Hyundai and SK, whose participation is critical to success. In parallel, a number of companies based in Ulsan have signed up for the Clean Development Mechanism introduced in 2007 and are committed to whittling away at the release of GHGs. By 2010, participating companies had reduced carbon emissions by 11 million tons.

The growing commitment of the major conglomerates to the EIPs is sending ripple effects through their supplier networks. Small and medium-sized companies are getting involved, and participation is growing among firms that are often the slowest to respond (Park and Won 2007). This could further grow the economic and environmental impact of EIPs.

Regional R&D Capability for Green Technology

The Ulsan region's R&D capacity is being augmented so as to both green existing industries and increase the share of green products and services in total output. The newly created research infrastructure is of particular benefit to small and medium-sized enterprises lacking in R&D capability. However, it also complements and helps orient the research conducted by larger firms. Industrial transformation was highlighted as a main component of Ulsan's green growth strategy, as its major

industrial sectors emitted 85 percent (56.3 million tons) of the city's GHGs.

Government pressure and increasing global agreement about the dangers of rising atmospheric carbon levels are pushing energy-guzzling industries to develop energy-saving technologies. Many of these innovations have high payback and are vital to the competitiveness of firms in the heavy industrial and chemical (HCI) sector. Firms in the HCI sector are also retrofitting factories with equipment that permits switching to cleaner fuels, particularly natural gas.[5] In this respect, expanded regional R&D capability can be a growth multiplier and a means of making green growth sustainable in Ulsan and in Korea more broadly.

Nurturing Green Industries

Beginning in 2000, R&D efforts have also been geared to identify and develop green products. A number of public R&D institutes, such as the Green Car institute, the Hydrogen Car Institute, Biochemistry Institute, and the IT Convergence Institute, have been invited into the EIP program. The greening of industrial output is concentrated on Ulsan's three biggest industries: automobile, shipbuilding, and petrochemicals. Korean planners, businesses, and the Ulsan municipality are hoping that through R&D-induced innovation, traditional industries will become the producers of green cars, green ships, green chemicals, and products to support the greening of energy production. Anticipated developments in green manufacturing include the following (see Han 2012):

- Green Car Industry: Ulsan's plan is to establish a green car auto belt in the southeastern part of the city where

hybrid car module parts could be produced. There would also be significant investment in R&D infrastructure for the development of electric cars.

- Green Chemical Industry: SK Chemicals, the leading conglomerate, is increasing its investment in the green chemicals with the construction of a new plant to be completed in 2015.
- Green Shipbuilding: At the core of the shipbuilding transformation is the establishment of a shipbuilding IT innovation center. The center would develop "next generation shipbuilding technologies and high value-add services such as reducing ship energy use and developing shipbuilding application technologies" (Han 2012).
- Rechargeable Battery Industry: The Ulsan city government is attracting major players in the battery industry, including Solvay and Samsung, to develop solar cell R&D centers and rechargeable battery plants.
- Solar Cell Development: for use by commercial establishments and homes
- IT/Recycling Technologies: for use in smart buildings.

Making Ulsan a More Livable City

While greening growth is one strand of Ulsan's strategy, urban livability is rightly given equal prominence. Restoring the Taehwa River's water quality has been pursued with some vigor. Measures have included the establishing of a master plan in 2005, construction of major sewage and wastewater treatment plants, dredging sludge, building of natural revetments, and creation of waterfront spaces for recreational purposes (more than 110 projects in all). An automatic water monitoring system now in place helps to assure that measures being taken are

producing results. Side-by-side with the cleaning of the river, the Ulsan municipality has engaged in the development of green spaces, spearheaded by the Taehwa River Ecological Park and the Ulsan Grand Park. The latter, a joint effort with the SK Corporation costing US$155 million, is larger than New York's Central Park. The Ecological Park helps to preserve the Spri Bamboo Forest and its associated ecosystem.[6] These and other parks (225 in all) provide Ulsan residents with a generous amount of green space per capita. Additionally, the 343 kilometers of bicycle paths offer ample opportunity for exercise and expand commuting options. Ulsan now offers its residents more green space than any other leading Korean city.

Livability is also benefitting from steady gains in the management of industrial and household waste. The setting of standards, the attention to recycling (46 percent of domestic waste in 2005), and the enforcement of regulations has led to a significant turnaround and to a cleaner environment.

Green Transport and Renewable Energy

Starting in 2005, Ulsan began replacing its diesel-powered buses with buses powered by natural gas in light of the health and environmental benefits over the longer term, although the step entailed a significant increase in operating costs (Kojima 2001). By 2007, 483 of the 580 buses were using natural gas. Moreover, as hybrid auto technologies have come into more widespread use, the purchase of hybrid cars is being encouraged. The shift toward cleaner fuels is being supported by projects to construct solar power generation and water heating facilities. Energy economies are also being realized with the help of district cooling and heating systems.

Conclusions

Ulsan's efforts at achieving environmental sustainability have underscored its recognition that economic growth based on industrialization cannot be the sole objective of urban development. Other industrial cities are also realizing that deferring pollution and emission controls is a costly mistake and there is a lesson here for late starters. After experiencing almost three decades of steady environmental degradation, Ulsan responded with a strategy that has produced results in a decade. As a consequence, Ulsan is no longer an outlier among Korean cities, but is close to the average with respect to emissions of various sorts. The success to date has been aided by a number of factors that can be a source of lessons for other cities confronting comparable challenges. First, public awareness of the extreme costs of pollution and demand for alleviation is a necessary trigger of reform and the means for sustaining it. Second, strong direction from the central government—and, as needed, financial support—can help strengthen the determination of municipal authorities and help build the administrative, regulatory, and research infrastructure. A thriving, forward-looking business community with the resources and the technological capacity to undertake the task of greening is a third ingredient. Fourth, municipal planning capacity must be built, as well as a coalition of public and private interested parties to drive complex changes. Finally, affordable technologies that offer attractive solutions are needed to initiate a virtuous spiral of greening that is in the interest of the business community and can be bankrolled by the municipality. If greening fails the economic test and if forced greening leads to industrial flight, then growth will grind to a halt and sustainability will prove elusive.

Ulsan's industrial sustainability program is focused on establishing EIPs to reduce the environmental impact of its industrial complexes, building up the region's R&D capability for green technology, and nurturing the development of green industries in its key industrial sectors. There have been noteworthy achievements thus far. Since its inception in 2005, Ulsan's EIP program has resulted in economic gains coupled with environmental benefits, including a 240,000-ton reduction in carbon dioxide emissions.

To strengthen the region's research and development capability in green technology, Ulsan set forth a comprehensive program for R&D development. The program brought together a number of governmental R&D institutes to help transform existing enterprises into more environmentally sustainable industries. As part of the city's continued economic growth plan, Ulsan is promoting industrial transformation of its key industries, which contribute to the majority of the city's GHG emissions. The automobile, shipbuilding, and petrochemical industries, along with an emerging rechargeable battery industry, are being developed as future green growth industries.

In an era of climate change and natural resource exhaustion, green technologies and green industries have become necessary considerations for Ulsan as part of a sustainable growth strategy. The case of Ulsan city illustrates that such a strategy can yield both economic and environmental benefits.

Notes

1. In 1962, the city of Ulsan was designated as a special industrial zone as part of Korea's First FYP to support industrial growth. The Onsan national industrial complex was established on a 26 square kilometer site in 1974, and the 46 square kilometer Ulsan-Mipo national industrial complex followed in the next year. In total, 70,125 square kilometers, comprising 23 industrial complexes, have been developed or are currently being developed in the city.
2. http://www.tyrepress.com/News/business_area/27/21620.html.
3. The government provided additional assistance trough the Machinery Localization Fund and the Plant Localization Fund, as well as support for exports through the Korea Export-Import Bank.
4. When President Park initiated the industrialization of Ulsan, pollution was viewed as a rite of passage to modernity. He is supposed to have said that when the sky over Ulsan was black with factory smoke and the air rang with the sound of hammers on metal, Korea would have emerged from centuries of poverty (Mathews 2012). Clearly, pollution was a price to be willingly paid (it might not even have been considered a cost) by a country in a hurry. The mindset in China until recently was much the same—although it may now be changing. But pollute first and clean up later might be a strategy whose time has passed.
5. By 2010, some 286 firms had made the transition to cleaner, low-sulfur fuels.
6. Nearly two third of the city's gross area is designated as forestland.

References

Han, Jin-Gyu (Director General of Environment & Parks Bureau, Ulsan Metropolitan City). 2012. "Strategies and Achievements for Low Carbon Green Growth in Ulsan." Presentation. Ulsan Metropolitan City. Available at: http://frkr-low-carbon.net/Presentation/PS2/PS2-4%20Jin-Gyu%20HAN.pdf.

Kojima, Masami. 2001. "Breathing Clean: Considering the Switch to Natural Gas Buses." Technical Paper No. 516. Work Bank, Washington, DC. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2002/01/18/000094946_0201040949174/Rendered/PDF/multi0page.pdf.

Lehtoranta, Suvi, Ari Nissinen, Tuomas Mattila, and Matti Melanen. 2011. "Evolution of 'Designed' Industrial Symbiosis Networks in the Ulsan Eco-Industrial Park: 'Research and Development into Business' as the Enabling Framework." *Journal of Cleaner Production* 19(16): 29–30.

Mathews, John. 2012. "Cities Will Drive the Green Industrial Revolution." The Conversation, April 25. http://theconversation.edu.au/cities-will-drive-the-green-industrial-revolution-5827.

Park, Hung-Suck, and Jae-Yeon Won. 2007. ""Ulsan Eco-Industrial Park: Challenges and Opportunities." *Journal of Industrial Ecology* 11(3): 11–13.

Ulsan Metropolitan City. 2008. "Vision of Ecopolis Ulsan." Ulsan Metropolitan City, Environmental Policy Division. Available at: http://search.korea.net:8080/intro_korea2008/society/pdf/02_16.pdf.

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). 2012. "Eco-Efficient and Sustainable Urban Infrastructure Development in Asia and Latin America." UNESCAP. Available at: http://www.unescap.org/esd/environment/infra/daproject.asp.

Won, Jae-Yeon, Jung-Hoon Kim, Sang-yoon Lee, and Hung-Suck Park. 2006. "Industrial Symbiosis as an Integrated Business/Environment Management Process: The Case of Ulsan Industrial Complex." Conference Publication, The 1st International Forum on Strategic Technology, October.

IV

Curitiba Greening

Sustainable Urban Development Brazilian Style

Shahid Yusuf

For mayors and planners in emerging economies who have set their sights on greening urban development, Curitiba is the city on the hill.[1] For more than two decades it has pioneered appropriate urban planning and transport technologies and established benchmarks of economic performance that other cities in Latin America have struggled to achieve, much less exceed. And by all accounts, Curitiba is not intending to rest on its laurels: it remains committed to achieving economic growth and ensuring that the fast-expanding city remains faithful to its own high standards of urban sustainability.

According to the Siemens–EIU Latin America Green Cities Index,[2] Curitiba was, not surprisingly, the "greenest" city in the region. The Index gave it the highest rating for waste disposal and air quality, and the city was ranked above average

with respect to water use and conservation, transport, sanitation, CO_2 emissions, and environmental governance. Carbon emissions from electricity consumption are a low 70 kilograms per capita, thanks to the availability of hydropower and the successful reduction of transmission losses. In spite of a high ratio of autos per person (0.5),[3] Curitiba had until recently coped fairly well with the traffic congestion. The city's traffic management regime includes a bus rapid transit (BRT) system that minimizes use of private cars for commuting and is the envy of cities around the world. A remarkable 45 percent of all trips are made by bus[4] (and 70 percent of commuters use bus services), 27 percent of trips are on foot, and just 22 percent are by car.[5] Low automobile dependence and a strict air quality code have contributed to relatively clean air and nitrogen oxide levels of 23 micrograms per cubic meter, which are well below the index range of 38 micrograms in other Latin American cities. Curitiba now recycles and/or disposes of 100 percent of its waste, even though the average resident produces 473 kilograms per year. Water consumption is 150 liters a day—the average in comparator cities is 274 liters—and 93 percent of the population has access to sanitation. The greening of Curitiba is the outcome of decades of systematic effort and it offers a number of lessons for other cities. Some of these resemble lessons drawn from the experiences of Yokohama and Helsinki.

The Emergence of Green Shoots

Curitiba was a center for the agricultural processing industry[6] in the 1940s and had a population of just 127,000 in 1943. The city expanded rapidly thereafter as it industrialized and absorbed migrants from the rural areas and overseas.[7] By 1955,

the population had risen to 360,000, and it continued to grow at almost 4.6 percent per year. After 2005, population growth began to slow, dropping to 1 percent by the end of the decade. In 2010, the population of Curitiba municipality was close to 1.9 million (16.5 percent of the population of Parana State) and that of the metro region (including 25 other municipalities) was over 3.2 million. The steep rise in population led overcrowding and the emergence of squatter settlements (or favelas[8]), many of which were built on marginal lands along waterways that crisscrossed the metro area. The influx of industry added problems of pollution and from the 1960s, the city had its first taste of traffic congestion as more and more families were able to afford car ownership.

A comprehensive urban development strategy—the Agache Plan[9]—adopted in the mid-1940s created a system of Parisian-style boulevards radiating out from the center of Curitiba. However, in other respects, the system proved inadequate to the needs and beyond the financial means of such a fast-growing city. In response, the city authorities crafted a far-sighted Curitiba Master Plan in 1965[10] that has provided the principles and framework for urban development since. To elaborate and adapt the Plan over time, define laws and regulations, coordinate its implementation, and ensure continuity across electoral cycles, the city took the vital step of setting up a regional planning body, the *Instituto de Pesquisa e Planejamento Urbano de Curitiba* or IPPUC. This agency was given the autonomy as well as the budgetary capacity to recruit the talent needed to fulfill its functions. Neither the Plan nor the IPPUC would have succeeded without the leadership and vision of a succession of mayors[11] who governed Curitiba and mobilized political

support for the greening of the city. Political mobilization was complemented by incentives that induced active participation by the public, who came to perceive the welfare advantages of good planning and efficient execution. Citizen participation was aided by the provision of timely and detailed information on land use and the impact of specific projects traffic, public infrastructure, and parking. By collecting information on land use, the city also ensured that the setting and collection of land and real estate taxes was broadly adequate for its needs.

How Curitiba Did It

Starting in the 1960s, Curitiba tackled three immediate issues. First, the city's economic base was broadened in the interests of long-term growth and to lessen the dependence on (nontradable) services. Second, there was greening of the urban transport system, which loosened urban transport constraints and contained pollution,. Finally, steps were taken to limit flood damage during the rainy season that hampered development near water courses.

Industrialization. An industrial park eight kilometers downwind of the city laid the groundwork for diversification. However, from the outset and in consonance with its green strategy, Curitiba excluded polluting industries. The park now hosts some 700 businesses, including manufacturers of autos, city buses and parts, and communications equipment. These businesses employ more than 50,000 workers, plus three times that number in associated activities.[12] The park is well served by nearby low-cost housing estates and linked to the rest of the city by the bus system. Moreover, firms located in the park ac-

count for the bulk of the industrial GDP, which was estimated at 18 percent in 2010. They are a major source of exports from the state of Parana and of tax revenue for the city. Thanks to the industrializing initiatives, Curitiba has maintained a respectable growth rate averaging four percent during 2005–10.

Urban Transport. The integration of urban transport and land use entailed the development of five major corridors[13] served by BRT radiating out of the city along the boulevards carved out by the Agache Plan.[14] This relatively low-tech system is widely seen as Curitiba's signature achievement and is frequently touted as a viable low-cost alternative to subway or light rail systems for cities in developing countries.[15] These corridors were integral to land use planning, especially along the transport corridors that sought to concentrate commercial and residential high-rise development in the core areas of the city with the help of zoning/floor area regulations. Each corridor is comprised of three (trinary) roads. The central road is devoted exclusively to high-speed bi-articulated (three cabin)[16] bus traffic[17] served by elevated boarding tubes (within which bus tickets are dispensed). The tubes were pioneered by Curitiba and significantly reduce the time each bus needs to spend at each stop, thus speeding up bus traffic.[18] On either side of the bus way are roads for all other traffic that provide access to businesses and residences. Parallel to these roads and a block away are one-way roads also open to all traffic that further facilitate movement in both directions.[19] Interdistrict and circumferential bus routes connect the bus corridors, which largely eliminates "dead zones" and ensures that no one in the municipality has to walk more than 500 meters to a bus stop. The high frequency of service is an added convenience. These features,

together with the quality of the buses and the use of gas and biofuels, provide Curitiba's inhabitants with an attractive, eco-friendly alternative to private cars. Furthermore, starting with a six-block stretch of a key downtown artery in 1972,[20] foot traffic has been encouraged by the conversion of some streets to pedestrian use only.

Green Spaces and Slum Management. Measures (including zoning[21]) to control flooding went hand-in-hand with the creation of green recreational spaces and the management of informal settlements. The city successfully protected forested areas along waterways and relocated slum dwellers who had built homes on flood-prone areas to safer locations. The reclaimed land was progressively converted into parks, playing fields, and bicycle paths. This served to minimize property damage and furnished the metro area with water meadows that provided a buffer against storm-induced surges in water levels. The meadows also serve as natural mechanisms for filtering out air pollutants and sequestering carbon. By 2007, Curitiba had increased the percentage of urban area devoted to green spaces (including 78,000 square meters of forest that help to preserve biodiversity) to 18 percent. The green space per urban inhabitant rose from less than 1 square meter in the 1960s to 64 square meters in 2007, and the city had 120 kilometers of bike paths in 2007.[22]

Slum management, which remains a struggle as migrants continue to trickle in, has involved both the provision of some low-cost housing and the purchase of land by the municipality for informal settlements. Such land is formally incorporated into land development planning. Dwellers are provided with an address and public services so as to inculcate a sense of own-

ership and encourage investment in other infrastructure that improves the quality of what remains a slum environment. Curitiba has not resolved the long-standing problem confronting all large Brazilian cities, but it has made more headway against urban slums/favelas[23] than most others.

These three initiatives, pursued over decades by a succession of mayors with the assistance of the IPPUC, have secured Curitiba's place in the pantheon of green cities. To these one must add a fourth and more recent program: to collect, recycle, and dispose of waste.

Recycling and Waste Control. The "Garbage That is Not Garbage" program has worked to sensitize and educate the public to recycle waste. The program has also worked to mobilize children and homeless so-called "eco-citizens" to collect recyclable material and bring it to collection points.[24] As a consequence, close to one quarter of all waste is recycled—including abandoned tires, which can serve as breeding grounds for *aedes aegypti,* the vector for dengue fever. Complementing the recycling effort is an aggressive program of garbage collection and disposal in sanitary landfills, paid for by households.

The Future of Growth and its Greening

Much like Yokohama and Helsinki, Curitiba needs growth as much as greening and both present challenges. The torrid growth rates of nearly 11 percent achieved in the 1970s have cooled. However, during 2007–10, Curitiba achieved a respectable growth rate of over 5 percent per year. As a result, GDP reached US$27 billion in 2010 and per capita income crossed US$10,300. Maintaining this rate of growth, while highly de-

sirable, will require a strengthening of the industrial base (18 percent of GDP and shrinking in 2010) and an increase in the share of tradable services. Curitiba—and Brazil—have made little progress in these areas and there is a risk that the recent growth momentum and the narrowing of income disparities could stall. Investment in productive activities is scarce, particularly high-tech and skill-intensive activities appropriate for upper–middle-income economies. Attracting such investment, including FDI, will be the key to growth.

One factor that may slow the city's economic performance and hamper green innovation is the absence of a leading research university that has the makings of a scientific and entrepreneurial powerhouse. The Federal University of Parana is ranked 11th in Brazil, but it is not known for its research prowess or as an incubator of startup firms. Curitiba has only one other institution in the top 50 in Brazil, which is the Federal University of Technology, ranked 43rd.[25] Although the city boasts a high literacy rate and school enrollments, a doubling of per capita GDP by 2025 will demand a deepening of technological capabilities and focused efforts at creating a business environment that will attract industry from the region and around the world. Successful greening that enhances the energy efficiency of buildings and infrastructure needs to be complemented with growth. Absent the latter, greening can easily stall as the economic base (and the revenues supporting urban services) stagnates, or worse, shrinks.

Growth and an upgrading of economic activities so as to generate a larger number of better-paid jobs is also the most effective means of narrowing income disparities and halting the barely contained march of favelas. According to a UN Habitat

report, the Gini coefficient for Curitiba in 2005 was 0.59.[26] It may have decreased since, in line with a lessening of inequality for Brazil as a whole. But economic activity that continues to disproportionately favor the few, contributes to social instability, and worsens the incidence of crime is already a rising concern in Curitiba. Although violent crime and drug addiction is largely contained in the favelas, there is the omnipresent threat of it spilling over. Thus the priority for growth policy is the creation of ladders that enable people to climb out of poverty and exit from the shantytowns.

Favelas, many on the outskirts of the city, highlight another problem, which is the restricted access of the poorest segment of the population to the city's bus system. The system is straining to meet the needs of those living on the expanding fringes of the metro area, and is also approaching capacity. Partly for these reasons, the use of private cars is on an upward trend. Curitiba seemed to have tamed private automobile overuse but the problem is returning, along with congestion and air pollution. Curitiba is planning to build an underground metro system in order to try and restore a precarious and now threatened equilibrium between public and private modes of transport.

Population pressures and the increasing numbers of low-income households are also compromising the efficacy of waste disposal and recycling services. Sanitary landfill space is scarce and recycling, while still high by Brazilian and international standards, is losing ground. Only by injecting renewed vigor into the program can a targeted one third of all waste be recycled.

The mood throughout Brazil is upbeat—unemployment is low, inequality has diminished, and growth performance

has been broadly positive since 2004, although it slowed after 2011. Curitiba shares in the mood. As one of the cities selected for the World Cup 2014, additional resources are being injected into infrastructure and services and greening issues are receiving renewed attention. Whether or not the city is on the threshold of a virtuous spiral of sustainable growth will depend on a number of factors. National policies and performance will be critical, and the World Cup and the Olympics will provide a one-time boost. However, as in the past, Curitiba's own efforts at creating an environment conducive to green growth will play a vital role. In this regard, the quality of human capital will be a major determinant of innovativeness and widely shared improvements in living standards.

Notes

1. Curitiba is the capital city of the state of Parana in the south of Brazil.
2. http://www.siemens.com/press/en/events/corporate/2010-11-lam.php.
3. Car ownership is the second highest in Brazil.
4. By 2007, buses transported 2.3 million passengers daily (Lubow 2007).
5. http://en.wikipedia.org/wiki/Modal_share. In other green cities such as Barcelona, 43 percent of all trips are on foot, 36 percent by public transport and 26 percent by car. In Toronto, the split is 7, 34 and 56 percent; in Seattle 8, 20, 63 percent; in Bogota, 15, 64, 14 percent; and in Budapest, 22, 30, 46 percent.
6. Agriculture now accounts for less than 1 percent of the city's GDP.
7. The composition of Curitiba's population reflects past immigration from Japan, Germany, Italy, Poland, and the Ukraine. Rural migration was triggered by the switch from labor-intensive coffee growing to capital-intensive soybean production.
8. The term appeared in the 1800s. However, favelas began to multiply starting in the 1940s with migration to cities. The process accelerated in the 1970s and many of the favelas in Curitiba date back to this period.

9. Named after the French architect Alfred Agache who devised it.
10. The Plan was approved in 1966.
11. Of the mayors who governed Curitiba, Jaime Lerner, an architect and urban planner was the most influential, serving three terms between 1971 and 1992. Others who left a mark on the city were Greca de Macedo and Cassio Taniguchi. Several of the mayors had engineering or other technical qualifications and contributed substantively to the greening of the city.
12. Fazzano and Weiss (2004). About 11 percent of Curitiba's population resides in the industrial park.
13. A sixth is being developed.
14. See Karis et al. (2006).
15. At US$3 million per kilometer, it is considerably less than the US$8–US$12 million per kilometer cost of a tram system and far less than the US$80–US$100 million per kilometer cost of a subway (World Bank 2010).
16. The maximum age of the buses is 10 years and the average is 5 years. City authorities are buying back old buses and converting them to other uses.
17. Bus stops are 500 meters apart and speeds average 20 kilometers per hour.
18. A fixed, periodically revised "social fare" covers journeys of all lengths and this formula subsidizes the travel of low-income riders travelling from the fringes of the city to the center. The fare is also calculated to ensure that the bus system is self-financing.
19. In the past, these were two-way roads, but they were converted by the IPPUC planners. One oversized road allowed for parallel parking; it has now been eliminated and additional narrow one-way roads created.
20. Mayor Jaime Lerner took the first step in promoting walkability (Lubow 2007).
21. A Zoning and Land Use Law was introduced in 2000.
22. Five percent of daily trips are made by bicycle.
23. The term also refers to a hardy, thorn-ringed, poisonous plant that grows wild in drier northeast region of Brazil.
24. A Green Exchange Program promotes collection of recyclable waste from favelas. Eco-citizens are compensated with food and bus tickets.
25. http://www.4icu.org/br/.
26. UN-Habitat (2009).

References

Fazzano, Alicia, and Marc A. Weiss. 2004. "Curitiba, Brazil: Metropolitan Economic Strategy Report." Global Urban Development. http://www.globalurban.org/GUD%20Curitiba%20MES%20Report.pdf.

Gustafsson, Hanna-Ruth, and Elizabeth Kelly. 2012. "Urban Innovations in Curitiba: A Case Study." Yale Law School.

Campbell, Tim. 2007. "Smart Cities: Curitiba." *Urban Land*, April. Urban Age Institute. http://urbanage.org/work-view/smart-cities-curitiba/.

Karis, Brian, Kelly McCartney, Jeff Veilleux, and Craig Yannes. 2006. "Curitiba, Brazil: Transportation Case Study." School of Engineering, University of Connecticut. http://www.engr.uconn.edu/~garrick/ce255/2006/Curitiba_1.pdf.

Lubow, Arthur. 2007. "Recycle City: The Road to Curitiba." *New York Times,* May 20. http://www.nytimes.com/2007/05/20/magazine/20Curitiba-t.html.

Rabinovitch, Jonas, and Josef Leitman. 1996. "Urban Planning in Curitiba." *Scientific American* 274(3): 46–53.

UN-Habitat. 2009 "Global Urban Indicators—Selected Statistics." UN-Habitat, Nairobi. http://www.unhabitat.org/downloads/docs/global_urban_indicators.pdf.

World Bank, 2010. *Eco² Cities. Ecological Cities as Economic Cites.* Washington, DC: World Bank.

V

Green Urbanization

The Case of Penang

*Hamdan Abdul-Majeed and Suraya Ismail**

Following the establishment of an English East India Company trading factory in 1786, the island of Penang evolved as a trading port with all the associated intermediary functions. In the mid-nineteenth century, the port expanded its entrepôt functions to include preparation of raw materials for the factories of industrialized Europe. In 1903, Penang became an important regional hub for the collection, processing, and transshipment of tin. The Straits Trading and Eastern Smelting companies established industrial-scale tin smelters in Butterworth and George Town, respectively. By 1930, rubber processing also involved industrial-scale proportions when Lee Rubber established its factory along the Pinang River.

George Town, the capital of Penang state, is a clear manifestation of this earlier gradual pattern of urban growth based

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on trade, resource-based industrial activities, and British urban planning. George Town began around the military cantonment Fort Cornwallis and developed into a thriving port city with a network of roads leading to plantations and gardens hugging the north and east coast of the island. On the mainland, Butterworth emerged as an important transport hub linked to the rest of Peninsular Malaysia by Malayan Railways and to George Town by a ferry service across the Penang Channel. George Town and Butterworth, the two main urban centers of Penang Island, were linked to small coastal villages and towns by a network of roads. At its zenith, George Town boasted electric-powered tramcars.

Industrial System and Growth

In the 1970s, Penang emerged as the hub of Malaysia's electronics industry. More recently, the state has embraced greening urbanization. The reasons for doing so include harnessing the growth potential of the new technologies, realizing gains from efficient resource use, and improving the urban environment. This chapter indicates how Penang hopes to sustain its growth with high-tech manufacturing activities, and also embark on green tech projects and transformative urban planning.

As of 2010, Penang state, with an 8.3 percent share of Malaysia's GDP, has a population of 1.56 million, with approximately 720,000 people residing on the island and the remaining 840,000 on the mainland (Seberang Perai) (Department of Statistics 2010). The state covers an area of 1,039 square kilometers and a built up area of 208 square kilometers (approximately 20 percent). The State is divided into 5 districts,

2 on the island (North-East and South-West districts) and 3 on the mainland (Seberang Perai North, Middle and South districts). George Town sits in the North East district and this district has the highest population density of 17.16 persons per acre.

Penang's roots as Malaysia's premier high-tech urban center date back to the late 1960s. After the city lost its free-port status in 1969, the state commissioned a study from Nathan Associates, a U.S.-based consultancy firm. The Nathan Report argued for the development of an export-oriented economy, and this proposal appealed to then Chief Minister Lim Chong Eu.

Penang benefitted from the initial wave of outsourcing by Western manufacturers, and achieved early mover advantages as it was one of the first economies to create a free trade zone (FTZ) in East Asia. Minister Lim, with foresight, targeted the electronics industry and set about creating an industrial base centered in Bayan Lepas. In August 1972, the Bayan Lepas FTZ was established, offering foreign investors duty-free access to imports and exemption from taxes on exports. In addition, investors could lease land at below market rates, were assured of an elastic supply of workers, and had access to one of the best infrastructure systems in Southeast Asia. During the 1980s, five industrial estates were developed in the island and a second FTZ was established in Seberang Perai, closer to the main harbor. The second FTZ provided additional space for companies producing white goods (such as large appliances) and electrical machinery and equipment.

Penang's success was also linked to the institutions that buttressed the physical infrastructure and the incentives of-

fered to firms in the FTZs. In particular, a highly streamlined administrative structure delivered results. The State Planning and Development Committee, chaired by the Chief Minister, provided strategic direction; the Penang Development Corporation (PDC) handled policy implementation and responded to feedback from firms in the FTZs; the Municipal Councils dealt with municipal issues; and the Penang Skill Development Center worked closely with firms to ensure that their crucial skill needs were fully addressed.

National Semiconductor was the first firm to commence assembly operations in Bayan Lepas (in 1971) and Advanced Micro Devices, Intel, Osram, Hewlett-Packard, Bosch, Hitachi, and Clarion followed over the next three years. Since then, over 500 electronics related firms have set up operations in Penang. Of these, more than 40 percent are leading multinational companies (MNCs) and the rest are Malaysian firms providing components, equipment, and services to the lead firms. As Malaysian costs have risen and the pool of skills has deepened, production has moved up the value chain. Low-skill assembly operations are being increasingly displaced by testing, design, and higher-order fabrication. In addition, Penang has attracted firms producing LED lighting and modules, photovoltaic cells and modules, and medical devices. Penang's continued ability to serve the changing electronics industry is a result of the skills, services, and infrastructure built up over the past few decades.

To avoid being too dependent upon manufacturing, the Penang state government developed a second engine of growth by encouraging tourism. Building on Penang's pre-war reputa-

tion as the leading holiday island and the Pearl of the Orient, tourism-related facilities developed rapidly. This included a string of self-contained seaside resort hotels, recreational centers like the Butterfly Farm, and shopping malls. Since 2010, Penang has received around 3 million visitors a year. The tourism sector has also diversified its offerings to remain competitive, following the emergence of other regional destinations. For example, Penang has moved up-market with boutique offerings such as a UNESCO World Heritage Site, featuring the largest conglomeration of pre-World War II buildings in Southeast Asia. Owing to its multiethnic heritage, Penang is also, according to the *New York Times*, the world's street-food capital (Sherwood and Williams 2009; Eckhardt 2010).

Penang enjoys a per capita GDP of approximately US$10,800 (Department of Statistics 2010), which is well above the average for Malaysia and higher even than Selangor. The state has enjoyed rapid growth over the past two decades, with a brief slowdown in 2009. Growth is driven by the manufacturing sector, which accounts for more than 40 percent of GDP and an almost equivalent share of employment. Moreover, by 2009, Penang was responsible for 39 percent of Malaysia's exports, up from 30 percent at the beginning of the decade. The continuing inflow of FDI, the large share of MNCs in total value added, diversification into new product groups with good long-term prospects, and the competitiveness and large share of manufacturing all augur well for future growth. Barring unforeseen developments, Penang should be able to maintain growth momentum and possibly climb the value chain as technological capacity increases.

Dealing with the Negative Externalities

From 1971 to 1990, Penang (like other major states in Malaysia) industrialized rapidly, thus providing job opportunities and increased living standards to citizens. Neighboring states, such as Kedah and Perak, benefited from the spillover from Penang, especially with the completion of major infrastructure projects such as the Penang Bridge in 1986, and consequently the North South Highway in 1993.

However, there are adverse effects of these progressive socioeconomic transformations that can be categorized into two main themes: (i) urban sprawl associated with increased population in urban areas, and (ii) environmental degradation.

The inefficient use of land and transportation routes associated with urban sprawl has led to increased road traffic and pollution in Penang State. A combination of rising house prices and the absence of tight zoning regulations have exacerbated the process of urban sprawl and its related problems.

Environmental degradation associated with rapid population increase is now at acute levels. The waters around Penang Island have some of the highest *E. coli* content in Malaysia, while the island's rivers have become increasingly polluted. The primary Sungai Pinang in Penang Island was declared a "dead river" in 1990. (Department of Environment 2010). Management of both industrial and household waste was poor, with little enforcement of regulations. Many of Penang's gardens and farms were lost to housing development projects beginning in the 1970s, and the trend remains unabated. The displaced agriculturalists have increased pressure on previous

unexploited areas. Highly polluting activities like pig farming and rubber processing did not always adhere to international waste management benchmarks. Encroachment by real estate development into water-catchment areas and green reserves became more frequent. The result was widespread environmental degradation, both on the island and the mainland.

The Penang state government introduced several policies and interventions from the mid-1980s onwards to respond to these challenges, notably in the construction industry, water management, waste management, and changing attitudes toward "green" living. In 1987, the Department of Environment (DOE) began developing a set of prescribed activities for industrial park development, including zoning. Detailed environmental impact assessments were carried out for industrial parks developed after 1987, including Batu Kawan and Bukit Minyak. For proposed projects within the industrial, park investors must clearly specify raw material inputs, manufacturing processes, effluents, and treatment of waste. The DOE then assesses the suitability of the proposed site in relation to zoning, neighboring industries, and buffer zones. The Penang Development Corporation (PDC), which manages all industrial land in the FTZ, only offers plots to investors with DOE approval as well as a number of related official agencies.

In the area of water management, Penang's Penang Water Supply Authority (Perbadanan Bekalan Air, PBA), is one of the most efficient in the region. Given the low water tariff (RM 0.31 per 1,000 liters), PBA has the lowest tariff rate in Malaysia. Penang has a consumption rate of 292 liters per person, only half as efficient as Singapore (153 liters per

person), and is well below the national average of 203 liters. As part of efforts to reduce water consumption, the authorities have introduced a water conservation surcharge since 2010.

In the area of waste management, the construction of a fully integrated waste disposal system has revitalized some of Penang's most polluted rivers. Indah Water Konsortium, a national waste management company, has built waste treatment plants in key areas throughout the state. In 2010, Sungai Pinang, one of seven most polluted rivers in Malaysia, was certified by the Department of Drainage & Irrigation as having improved to Class 3 (moderate level) after the local government built a waste discharge system at the River Road abattoir (Tan 2010). This is a direct result of waste treatment plants that process household wastewater before it is emptied in the rivers and the sea. Legislation has also been enacted to strictly manage waste material from real estate development, and international level standards in waste management have been applied to Penang's industrial parks. Hospital waste disposal systems also follow international benchmarks. The net result of these policies is that Penang was ranked 8th most livable city in Asia by the ECA International in 2010 (Chow 2010).

The promotion of "green living" in Penang was spearheaded by the Penang state government's recent "Cleaner, Greener Penang" initiative and the "No Plastic Bag" campaign (despite opposition from a strong plastic manufacturing lobby). The latter campaign introduced a fee for plastic bags and has been in constant operation since 2011. Rather than harming the plastic manufacturing subsector, the campaign has boosted production of biodegradable bags (Ling 2010). The result of

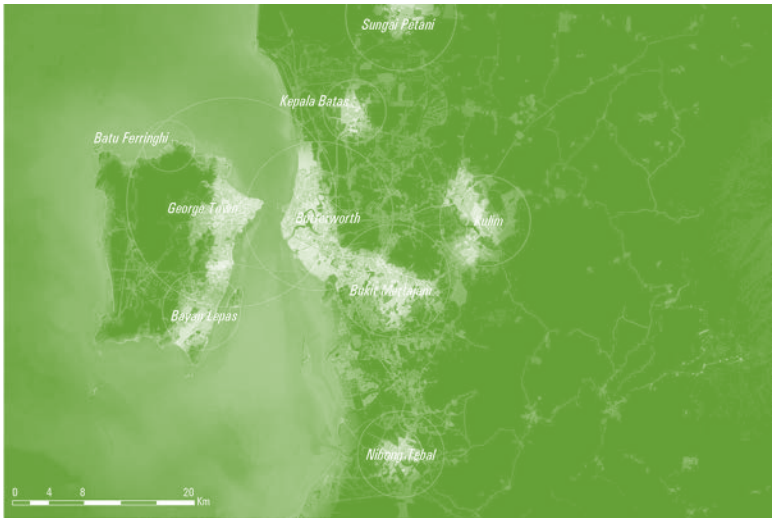
these interventions has been impressive. Penang has the highest rate of recycling in Malaysia and some of the best water resource management in Southeast Asia. Apart from government policies, Penang's civil society groups initiated the Sustainable Penang Initiative (SPI) in 1999. The SPI propagated a holistic approach and outcome-oriented strategies to achieve economic, environmental, cultural, and ecological sustainability. In 2000, the Penang state government incorporated SPI recommendations into the 2nd Penang Development Plan. In a review of the Plan in 2009, community groups highlighted that improvements had been achieved. Most notably, UNESCO listed George Town as a World Historical Site. Levels of recycling have increased but there is room for further improvement and need for stricter enforcement of regulation.

Green Urbanization

Without planned development and enforcement of regulations, Penang's livability will be affected by increased levels of urbanization, and urban sprawl, congestion, and environmental degradation would remain obstacles for sustainable growth. It was from this concern that the Penang Project was conceived. The following section describes some of the key recommendations made in the Penang Project. The aim is to help consolidate Penang's efforts towards dealing with the main challenges associated with urban sprawl and its environmental effects.

A favored approach to limiting sprawl (figure 1) is to develop strong internal connections between the existing industrial, commercial, and residential areas in suburban zones and in smaller towns. The George Town Conurbation Plan (Think

Figure 1. Urban Centers in Penang

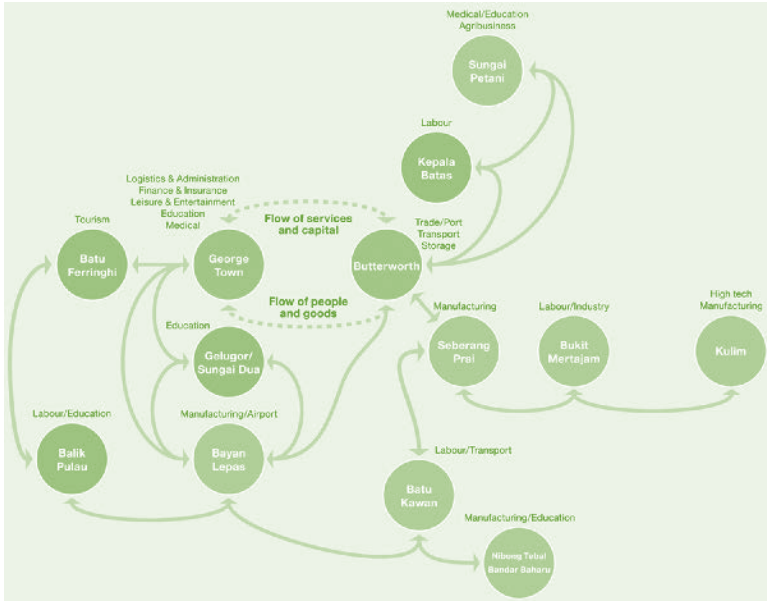


Source: Think City and Fundacion Metropoli 2012: 141.

City and Geografia 2010) is based on a network city model that utilizes polycentricity. The plan emphasizes transport-orientated development (TOD)—that is, projects that enhance a mixed-use urban form that is more resource efficient, reduces carbon emissions, and alleviates development pressures on natural ecosystems. The best model going forward is to create a new city core between George Town and Butterworth, and link it to a network of small but equally efficient urban settlements. This territorial approach to planning will revolutionize the way urbanization develops, and will link Penang with its hinterland and immediate region. The Plan identifies a number of nodes of specialization (see figure 2).

A second strand of the effort to green Penang is the Penang Project (Think City and Fundacion Metropoli 2012), which

Figure 2. The George Town Conurbation Urban Centers Network



Source: Think City and Geografia, 2010.

envisions opportunities for the city to serve as a transport/logistics hub for the southeast Asian growth triangle. The Penang Project begins by defining the new scale of planning that crosses municipal and state boundaries and attempts to give an accurate description of how the territory operates and serves its inhabitants. Urban morphology and population centers are analyzed in terms of geographic proximity, time, and distance.

Proyecto Cities also identifies "components of excellence" that intrinsically possess the highest potential for innovation and transformation of urban development. These components can be social, economic, environmental, and urban. The premise is that successful projects revealing competitive advantage

are based on the specific strengths and unique characteristics of the urban center. Successful urban transformations are rarely driven by projects that only address the deficits or limitations of a place. Instead, transformation depends on projects that build on the singularities and distinct urban profiles of cities and regions.

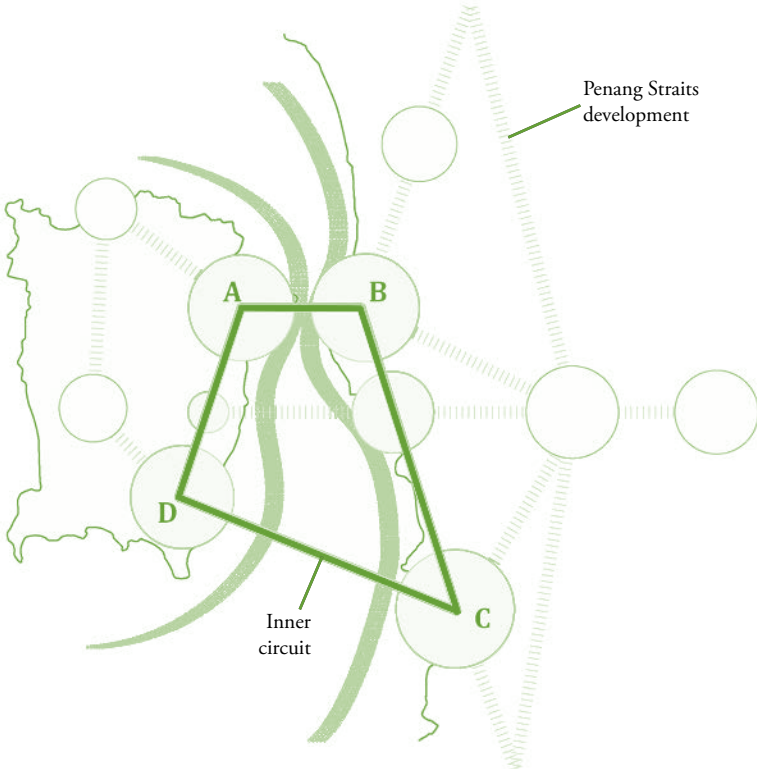
The strategic urban development that will facilitate Penang's transition toward a green economy is based on two types of programs: (i) building territorial connectors (using, for example, natural waterways such as the Penang Straits) and (ii) implementing key strategic projects that will spur the creation of a green tech supply chain.

For the territorial connectors, the strategic direction uses the Penang Straits (light gray connectors in figure 3) and creates an "eco-boulevard" on the island (dark gray lines in figure 3). This is a diverse network of connections that envelopes the coasts, linking new and existing hubs to new urban centers.

Five strategic projects have been identified to transform Penang into a "carbon neutral metropolis":

1. **Batu Kawan Eco City Project.** The proposed interventions include priority of public transport, high-quality and diverse public spaces, bioclimatic architecture design, eco-technology, complete water cycle management, sustainable urban waste management, modern digital infrastructure and urban grids, and an experimental laboratory for future habitation.
2. **Penang Innovation Park (the Bayan Lepas FTZ).** This is an infill development strategy (underutilized areas of 170 acres) with the aim of creating new public

Figure 3. Territorial Connectors: Towards a "Network City"



Source: Think City and Fundacion Metropoli 2012: 198.
Legend: Point A: George Town 21; Point B: Penang Grand Sentral-Butterworth; Point C: Batu Kawan Eco City; Point D: Penang Industrial Park (Bayan Lepas); Point D to A: Penang Eco-boulevard. Light green connectors: Penang Straits development. Dark green lines: inner circuit.

and residential spaces. By creating a new waterfront district, these spaces will accommodate new and innovative programs for transitioning the area from its manufacturing-based identity to new technologies.

3. **Penang Eco-boulevards.** These are specialized urban infrastructures, aligned with an important thoroughfare in the city to promote mobility, permeability, and sustainability.
4. **George Town 21.** The proposed interventions are designed as Batu Kawan initiatives. But they are situated in a brown-field development that is also a UNESCO world heritage site.
5. **Penang Grand Sentral.** This project leverages on the transport-oriented development scheme and creates a new waterfront for Butterworth.

These five projects address specific problems of alleviating environmental degradation, the creation of sustainable transportation systems, compact urban form development, and bioclimatic architecture to lessen energy consumption. However, the end users of these projects—the general public—will also have to participate in changing attitudes towards the green agenda in order for these projects to be sustainable.

Territorial Connectors and Strategic Projects: Creating Demand for Green Industries

Greening urban development requires more than just a technological commitment. It has deep economic, cultural, and political ramifications and nationwide implications. The involvement of the Prime Minister[1] in supporting green technology policy will create high-level action among government ministries, agencies, the private sector, and other key stakeholders

in the field of green growth.[2] The development of public-led infrastructure projects and the transformation of selected cities into green cities will create a continuous demand for the green technology sectors. The proposed project delivery system will have to be via public-private partnerships (PPP), in which the public sector leads the brief formative period in order to make sure that the green programs are adhered to by private actors. Rather than total privatization, PPP enables private sector entities to finance and develop infrastructure projects. Regulatory aspects of service provision remain under state control, including pricing of services provided by the infrastructure facility.

Green urban growth will affect industry in both Penang and neighboring provinces. The manufacturing clusters within the George Town Conurbation Areas are mainly Penang Industrial Parks, Kedah Industrial Park, and Perak Industrial Park. Incidentally, Penang Industrial Parks with Bayan Lepas and Prai clusters are involved in high technology and research and development activities and therefore these sites will be the frontrunners in embracing green technologies created by the Penang Project.

Conclusions

Due to the inherent physical nature of George Town as a historic city, port city, and more recently an industrial city, it has experienced urban sprawl and environmental degradation. However, by supporting green urban policies, existing urban areas can be improved and made more livable by creating appropriate infrastructure projects and cleaning up natural resources. These retrofitting greening efforts are best situated

within a new institutional framework that fosters new ideas and innovation. This framework is still in its infancy.

Apart from confronting the problems of the past, green urbanization efforts, such transport-orientated development, environmentally friendly transport systems, and green building construction will benefit the region positively. By creating a demand of green technology to be utilized in the creation of the built form and cities, this will induce the creation of a higher value-added supply chain and new green technologies companies into Penang and subsequently, Malaysia. These are all steps in the right direction to link urban growth, economies of agglomeration, and greening for a sustainable development initiative. At the same time, urban dwellers will need to change attitudes and reevaluate how their lifestyle can contribute to the success of such schemes. Greening urban growth will take time and resources, and will ultimately only be sustainable with the convergence of understanding and commitment among policy makers, funders, developers, manufacturers, and potential users.

Notes

1. Putrajaya, the administration capital of Malaysia, is being transformed into a green city under the prime minister's initiative.
2. The development and application of concepts, products, equipment, and systems in green technology is relatively new in Malaysia. Nevertheless, the Ministry of Energy, Green Technology, and Water has devised strategies and programs to promote green technology. These include a Green Technology Fund (which would operate under the concept of "polluter pays"); the creation of a National Green Technology Policy; and the establishment of the National Green Technology Council and Malaysia Green Technology Agency.

References

APDUG. 2011. "Greater Penang—Baseline Data Report." Unpublished consultancy report.

Chow, Tan Sin. 2010. "Penang's Capital is Eighth Most Liveable City in ASIA, on Par with KL and Bangkok." *The Star Online,* May 23. http://thestar.com.my/news/story.asp?file=/2010/5/23/nation/6322593&sec=nation.

Department of Statistics, Government of Malaysia, 2010. Gross Domestic Product Figures. Kuala Lumpur.

Eckhardt, Robyn. 2010. "In Malaysia, Tourists Are Lured by George Town's Colorful Past." *New York Times,* December 2. http://travel.nytimes.com/2010/12/05/travel/05georgetown-nextstop.html.

Ling, Gan Pei. 2010. "The Plastic Manace." *The Nut Graph,* July 20. http://www.thenutgraph.com/the-plastic-menace.

———. 2008. "Laporan Pemeriksaan Rancangan Struktur Malaysia, 2005–2006." Kuala Lumpur.

Tan, Ann. 2010. "Sungai Pinang Cleans Up Reputation as Dirtiest River." *The Star Online,* 10 November 16. http://thestar.com.my/metro/story.asp?file=/2010/11/16/north/7434105&sec=north.

Think City and Fundacion Metropoli. 2012. "The Penang Project: A Pilot Project for Eco-regional and Spatial Development Strategies in Malaysia." Joint project co-funded by the Performance Management and Delivery Unit (PEMANDU) of the Prime Minister's Department and Khazanah Nasional Berhad.

Think City and Geografia. 2010 "George Town Conurbation Spatial Strategy." Unpublished paper. http://www.thinkcity.com.my.

Sherwood, Seth, and Gilsela Williams. 2009. "The 44 Places To Go in 2009." *New York Times.* http://www.nytimes.com/interactive/2009/01/11/travel/20090111_DESTINATIONS.html

Continuing urbanization creates the necessity of reducing both local pollution and greenhouse gas emissions from cities. As yet there is no clear route to achieving this, but a number of cities are developing innovative strategies for green development. This monograph succinctly distills the experience of five such cities. Their experiences are insightful, and the monograph will be of great value to social scientists and to policy makers seeking to learn about how to make this crucial transition.

Tony Venables
Oxford University

A Voice for Starting Economic Growth

The greening of urban development is finally receiving increased attention. This is long overdue, as the globe's burgeoning urban population is using ever more resources and energy, which intensifies environmental pressures. If the demands on the biosphere's resources are not to exceed the limits of sustainability, major changes are needed in the design and growth of cities. Urban industrialization, transport, and energy use, and urban lifestyles more broadly, will need to change markedly and rapidly. The sustainable city of the future must be green. What such greening entails is becoming clearer from the initiatives of a few pioneers that have successfully begun to deal with green growth challenges. This publication captures the stories of five such cities. The authors examine how much greening cities can achieve within current technological and urban parameters, and what new strategies will be necessary. They also study the radical transformation required of cities that have not yet grasped the nettle of greening. Green urban development is imperative in order to respond to both the global carbon challenge and the need for economic growth.

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