The Zero Waste City:
Tokyo's Quest for a Sustainable Environment

By

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Abstract

This paper examines efforts to remake Tokyo, the world's largest megalopolis, into an ecologically sustainable city. The analysis is framed by two visions: a general model of eco-effectiveness derived from industrial ecology and an empirically grounded conception of a zero waste city rooted in the lean production practices of Japanese firms and extended beyond the firm to the city by government policies. We specifically focus on Tokyo Metropolitan Government (TMG) programs to reduce waste and especially greenhouse gases. We also examine how TMG's environmental efforts have been shaped by local politics and by the city's relations with the central state. Tokyo's environmental efforts are impressive but they still fall far short of ecological sustainability. The zero waste city is ultimately a political project and Japanese are still divided over how to prioritize and integrate economic growth and environmental quality goals. The eco-effective, zero-waste model envisions transforming the current trade off between economic development and environmental well being into a virtuous circle whereby environmental improvements can be achieved through new urban designs, technologies, products, jobs and economic growth. The divisions between advocates of growth and conservation are in fact blurring in Japan. But the Tokyo experience suggests that vibrant political leadership and vigorous government action will be required to accomplish this symbiosis.

1. Introduction

Human aspirations for economic development are clashing with nature's limits. Less developed countries desperately desire the wealth and consumption patterns prevalent in developed nations. Yet, industrial and urban development, as currently organized, cannot be sustained. The world's economic path is destroying the natural system upon which life depends. The wealthier and more economically developed a nation is, the higher its energy consumption and carbon dioxide (CO_2) emissions per capita (See Figure 1). As greenhouse gases warm the earth's atmosphere, the planet's glaciers, icecaps and sea ice are melting at the fastest rate in recorded history. During the coming decades, coral reefs will likely die at a quickening pace, marine life will disappear even more rapidly, hurricanes will become more violent, and more coastal areas will flood.

Mega-cities are both prime culprits and prime victims in the generation of greenhouse gases and environment degrading waste. Urban factories, construction sites, hospitals and households generate vast amounts of refuse. Heating and cooling systems for high rise offices, commercial buildings and apartment complexes consume huge quantities of fossil fuels. The motor vehicles clogging city streets expel enormous volumes of pollutants into the air. The world's major cities are at the same time highly vulnerable to global warming and environmental degradation. Thirteen of the world's fifteen largest cities are on coastal plains and at risk from rising sea levels and storm frequency generated by the earth's warming atmosphere (Nicholls 1995; Braile 2000). Big

city neighborhoods, particularly poor neighborhoods, manifest the highest rates of air pollution linked diseases, like asthma and lung cancer.

[Figure 1 About Here]

Both culprit and victim in degrading the environment, cities are also seedbeds for movements to protect nature and "green" the urbanization process (Beatley 2000; Moavenzadeh and Hanaki 2002; Portney 2003; Bullard 2007). When the Bruntland Commission drew attention to the clash between economic development and the natural environment two decades ago, it pinpointed cities as both contributors to the earth's crisis and potential initiators of a new, sustainable economic model, one that could meet the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development 1987:8).

Environmentalists have won many battles since the Bruntland Report, but they are losing the war. Time is running out. James Hansen, the renowned climate scientist, says the earth's climate nears, if it has not already passed, a tipping point beyond which devastating consequences will be unavoidable (Mckibben 2006). Lester Brown of the Worldwatch Institute says putting the global economy onto a sound environmental path requires restructuring on a scale and with a speed heretofore found only in national economic conversions from peace to war (2006).[1] The question facing governments, Brown warns, is whether they can respond quickly enough to prevent threats from becoming catastrophes.

The strong positive correlation between GDP and CO_2 per capita indicate two things. Less developed countries cannot follow the same economic path to affluence laid down by developed countries. And leadership in moving the global economy onto an environmentally sound path must come from the developed countries that bear primary responsibility for degrading the world's environment.[2]

This paper examines Tokyo policies to remake the world's largest megalopolis into an ecologically sustainable city.[3] The analysis is framed by two visions: a general model of eco-effectiveness derived from industrial ecology and an empirically grounded conception of a zero waste city rooted in the lean production practices of Japanese firms and extended beyond the firm to the city by government policies. We specifically focus on Tokyo Metropolitan Government (TMG) programs to reduce waste and especially greenhouse gases. We also examine how TMG's environmental efforts have been shaped by local politics and by the city's relations with the central state.

Tokyo's environmental efforts are impressive but they fall far short of ecological sustainability. The zero waste city is ultimately a political project and Japanese are still divided over how to prioritize and integrate economic growth and environmental quality goals. The eco-effective, zero-waste model envisions transforming the current trade off between economic development and environmental well being into a virtuous circle whereby environmental improvements can be achieved through new urban designs, technologies, products, jobs and economic growth. The divisions between advocates of growth and conservation are in fact blurring in Japan. But the Tokyo experience

suggests that vibrant political leadership and vigorous government action will be required to accomplish this symbiosis.

2. Eco-Effectiveness and the Zero Waste City

If world wide industrialization is both politically inevitable and environmentally impossible, then we need a new way of thinking that can eliminate the root causes of environmental damage while preserving the long run viability of industrialization. The challenge is to organize urban economic development so as to meet rising global demand without depleting the environment or undermining the quality of life. We examine two approaches to ecologically sustainable urban development: a more general eco-effectiveness model derived from industrial ecology, and a more specific conception of the "zero waste city," stemming from Japanese lean production practices.

Eco-effectiveness. Industrial ecology envisions an environmentally sustainable economy modeled on natural eco-systems (Frosch and Gallopoulos 1989). In a natural eco-system, organisms live by consuming each other's wastes, and the resulting "food web" optimizes the use of available energy and materials. An industrial system is structurally similar to a natural ecology in that the manufacturing of a product is also organized through a web of interacting activities that feed off of each other's material and energy outputs. Industrial ecology seeks to understand how the industrial web works, how it is regulated, how it interacts with the biosphere, and how it can be made compatible with the way natural ecosystems function (International Society for Industrial Ecology n.d.).

Industrial ecology's prescription for sustainable development is "eco-effectiveness." Eco-effectiveness boils down, in McDonough and Braungart's (2002: 104) catch phrase, to "waste equals food." Waste materials generated by manufacturing processes and by discarded end-of-life products become biodegradable inputs into natural processes or economically viable inputs into other industries. Industrial ecology eliminates harmful environmental effects by designing goods, services and systems from the very beginning to harmonize with nature, either through bio-degradability, or by recycling toxic materials in closed technical loops (McDonough and Braungart 2002: 104).[4]

Properly conceived, the best of human technology and culture could integrate buildings, neighborhoods and whole cities into their surrounding ecosystems in mutually enriching ways, McDonough and Braungart argue. Residential sites could safely co-exist alongside factories. Buildings could provide more energy than they consume. Factories could purify their effluents into drinking water. Transportation could improve the quality of life while delivering goods and services (McDonough and Braungart 2002: 87-91).

Taking nature as the model for urban industrial systems requires a reorientation in philosophical outlook, from conquering to cooperating with nature, and a reorientation in practice, from an extract and dump, "cradle to grave" production process, to a cyclical system, like the natural environment, that endlessly circulates and transforms materials "from cradle to cradle." A pollution-and-waste free world of abundance is within human reach, say McDonaugh and Braungart, but it requires parting company with the mass

production mindset underlying most industrial organization and city building. The mass production worldview is hostile to natural and cultural diversity but all sustainability is local and has to be connected to proximate materials, energy flows, customs, needs and tastes. Mass production imposes standardization, centralization and universal design on diverse local conditions through the brute use of energy, especially fossil fuels. Mass producers sacrifice quality for quantity and the future for short term pay offs.

The eco-effective city model is promising, even inspiring, in principle but it is dauntingly difficult to realize in practice (Frosch 1992). McDonough and Braungart offer a vision of an ecologically sustainable urban industrial system, possible guidelines for realizing that vision, and some strategic hands-on examples of success stories in industry and the urban built environment. But the mass production mind set, the short term profit calculus, the need for large R&D investments on eco-technologies and renewable energy sources, and the conflicting demands on city budgets make a wholesale transformation toward urban ecological sustainability a challenging goal, indeed.

The zero waste city. Japanese lean production, like industrial ecology, is devoted to eliminating waste.[5] Whereas industrial ecology's "waste equals food" maxim is modeled on nature, lean production's "zero waste" precept focuses on the multiple relationships that go into the making of a product: design, engineering, manufacturing, marketing, and distribution. Lean production attempts to integrate all links in the product cycle, from raw materials to finished commodity, through partnership relations among planners, designers, engineers,

plant operatives, suppliers, and distributors (Womack, Jones and Roos 1990). Close integration among links in the value chain and just-in-time processing favor spatial clustering of activities in production complexes. Finely tuned interrelations among parts enable swift system responses to changes in market demand (Fujita and Hill 2005).

Lean production is designed to uncover and eliminate waste in materials, energy, inventory, space, labor time and products. The aim is to permanently reduce costs and enhance profitability. Like industrial ecology, lean production emphasizes problem solving through changes in system design rather than through regulation at the "end of the pipe." Using inspection and repair to ameliorate defects in final products is a palliative that merely perpetuates the underlying problem. Lean producers seek instead to eliminate defects and waste permanently by altering product design, technologies and work processes.

Lean production is less a conceptual blueprint than a problem solving system that has evolved incrementally in a society scarce in habitable space and natural resources.[6] Lean producers shamelessly damaged the environment during Japan's high growth era (1950s-1970s). It took environmental protection movements in the 1960s and 1970s, rising energy costs during two oil crises in the 1970s, and government intervention through anti-pollution, energy conservation and recycling laws before Japanese firms seriously began to incorporate environmental costs into their lean production calculus and to develop technologies, work processes and products designed to conserve energy and eliminate harmful wastes.[7]

Today, Japan is one of the world's most efficient countries in the use of industrial energy. Japanese manufacturers lowered energy consumption per unit of output by 40 percent between 1973 and 2003 (Agency for Natural Resources and Energy 2005). France and Germany expend almost 50 percent more energy than Japan to produce the equivalent level of economic output. By the same measure, Britain's energy use is nearly double, the United States nearly triple, and China's almost eight times Japan's level (Brooks 2005). Japan also ranks near the bottom among developed countries in CO_2 emissions per capita and GDP ratio. In the OECD, only Sweden has lower CO_2 emissions to GDP ratio than Japan (Agency for Natural Resources and Energy 2005).

As of 2004, Japan constituted twenty percent of the world's firms achieving ISO 14001, an industrial standard for organizations seeking to minimize their harmful effects on the environment and continually improve their environmental performance [8], and Tokyo had the highest firm share (10%) among cities in the world (ISO 2005: 4).

Tokyo's industrial sector, mainly manufacturing and construction firms, lowered its energy consumption by 39 percent and its CO_2 emissions by 35 percent between 1990 and 2003 (see Table 1 and Figure 2). Industry accounted for only 9 percent of Tokyo's total energy consumption and CO_2 emissions in 2003, down from 17 percent in 1990. Industry's reduced share of Tokyo's energy and CO_2 output, relative to other sectors, is due partly to waste reducing lean production practices and partly to the fact that less manufacturing is taking place in Tokyo today. The city's more routinized factories have been moving to

surrounding regions and abroad while Tokyo functions as the center of coordination, control and innovation (Fujita and Hill 2005).[9]

As a result, Tokyo generates only 5 percent of the nation's CO_2 emissions despite 17 percent of Japan's GDP (TMG 2004a).

[Table 1 and Figure 2 About Here]

Tokyo Metropolitan government (TMG)[10] is incorporating lean production practices into its public policies to achieve a sustainable city. TMG plans and designs the process of eliminating waste, from the initial stage of waste production in household and industry sectors, to the waste collection stage, to intermediate and final stages of waste disposal. The metro government is working to reduce greenhouse gas emissions in industry, offices, commercial buildings, and households in the same way. To reach its environmental policy goals, TMG is advising businesses on the use of biodegradable and recyclable materials, promoting urban environmental industries, and running advertising campaigns encouraging Tokyoites to purchase waste free products.

TMG's vision of the zero waste city integrates industry, society and nature and urges changes in business practices, lifestyle and consumption patterns. TMG is putting itself forward as a leading example and urging like involvement from all Tokyoites.[11] The metro government has joined with industry associations, professional groups, NGOs, and city and ward offices to make and implement environmental policies more effectively.

3. Tokyo's Environmental Policy

Tokyo Metropolitan Government aspires to be a world leader on environmental issues. TMG's environmental policies are guided by the "2002 Tokyo Metropolitan Government Master Plan for the Environment" (TMG 2002). TMG officials made the metro wide blueprint in consultation with residents, businesses, and ward, city, town and village administrations (TMG 2005a). Global warming is the most urgent environmental policy issue facing the metro area, says TMG, and Tokyo's environmental plan is part of a central government coordinated effort to reach the goals set by the 1997 Kyoto Protocol: to reduce greenhouse gas emissions to six percent below the 1990 level by 2012.

Japan's Ministry of Environment (MOE) also subscribes to a "zero emission society" and advocates bringing the environment into all public policies. MOE envisions a "virtuous circle" between improvements in the environment and economic development as Japan becomes "a nation of environmental technology power" (MOE 2004). The Ministry finances R&D on alternative and renewable energy sources and low-pollution vehicles, and encourages recycling and energy savings with tax incentives, low-interest loans, and public-private partnership programs. MOE officials say they are confident that Japan can reach the Kyoto CO^2 emissions target by 2012, pointing to the energy conservation and world leadership in pollution control technology Japan has achieved over the past three decades through regulation.

But the Kyoto emissions benchmark is a daunting challenge. Japan was 8.3 percent over the 1990 level at the end of the 2004 fiscal year and must therefore reduce emissions 14 percent by 2012. Tokyo faces an even bigger

challenge. Ninety-seven percent of the city's greenhouse gases consist of CO_2. Despite one-third drop in CO_2 emissions in the industrial sector, the city's total CO_2 emissions grew 23 percent between 1990 and 2003. Rising energy consumption by households, offices, commercial establishments, and motor vehicles more than offset declining industrial emissions, raising the emissions reduction needed to reach the Kyoto target to 29 percent (TMG 2005b).[12]

In the face of these hurdles, both MOE and TMG renewed their commitment to the Kyoto Protocol in 2005. MOE mounted a campaign, called "Cool Biz", advocating changes in lifestyles and business practices (Ministry of the Environment 2005). TMG set out an action program that includes stronger regulations and monitoring, more guided design and planning, more vigorous green campaigns, deeper education, more targeted incentives, a wider regional approach with surrounding prefectures and cities, and stronger partnerships with the private sector and NGOs (TMG 2005b).

Tokyo is warming. Tokyo's average annual temperature has climbed 2.9°C during the last one hundred years (TMG 2004a).[13] The yearly number of days reaching 30°C and above has more than doubled over the past 40 years, from fourteen in 1963 to thirty-five in 2000. Heat islands, areas in the city experiencing 30°C and above temperatures for more than 30 days a year, were once limited to a few spots in the urban core; now they can be found throughout the central area.

Tokyo's warming results from hyper-intensive urbanization. As the nation's capitol, Tokyo is a magnet for government bureaus, corporate

headquarters, and producer service firms in finance, accounting, insurance, law and advertising, R&D labs, trading companies, department stores and hotels.[14] Metro Tokyo's population density, at 5,400 persons per square kilometer, is sixteen times the national average. Central Tokyo's population density, at 12,752 persons per square kilometer, is 38 times the national average. More cars travel more miles across Tokyo's streets than anywhere else in Japan.

TMG monitors CO_2 emissions through a climate observatory network (METROS) run jointly by the TMG Institute of Environmental Science and Tokyo Metropolitan University. TMG also monitors humidity at 100 sites in the city, and wind, air pressure, and rainfall at 20 locations. These observations suggest that Tokyo's warming is largely caused by office and household air conditioning, vehicle exhaust, and buildings made of concrete that emit heat at night after accumulating it during the day.

Business offices and commercial buildings are the biggest generators of Tokyo's greenhouse gases (See Table 1 and Figure 2). Tokyo's CO_2 emissions from business offices and commercial establishments are more than twice the national average and increased 57 percent between 1990 and 2003. The disappearance of open land and water surfaces diminish the city's natural cooling capabilities. Street pavements and building materials absorb solar heat during the day and emit the heat at night. High-rise offices and housing blocks prevent the circulation of cool sea breezes to the inner city. Air conditioning and business machines in densely packed offices add massive doses of CO_2 to the gases already pouring out of cars, trucks, buses and homes.

Combating global warming. TMG planners are creating green designs for cooling the city's atmosphere based upon environmentally sound construction that reduces the build up and emission of heat from the city's streets, rooftops and building walls. The city's green construction plan employs natural energies (solar, wind, ethanol, and biomass), biodegradable construction materials with a long life span, rain and waste water, and greenery in a building's immediate surroundings. The green plan is assessed at each stage of construction.[15] Neighborhoods participate in the evaluation (TMG 2005c).[16]

Firms constructing new buildings with floor space exceeding 10,000 square meters must submit a green design that meets TMG's building requirements.[17] TMG displays these designs on its web page to share information about new building technologies and enable measurement of policy outcomes.[18] City officials have partnered with construction firms, architects, design specialists, ward and local city offices to create environmental guidelines and maps for each neighborhood. TMG received 664 green building plans between 2002 and 2005 (TMG 2006).

The city requires green top roofing for new, privately constructed buildings of 1,000 square meters and above, and for public buildings larger than 250 square meters. TMG is also encouraging the city's public schools to install green roofing and walls. TMG provides loan subsidies to firms building green top roofing and research grants to support new green top technologies. The city awards prizes to the best builders of green roofing and publicizes the winners on its web page.[19] The number of green top building plans submitted to TMG rose

from 290 (52,428 square meters) in 2000 to 376 (128,479 square meters) in 2003 (TMG 2004b:40).[20]

TMG is providing leadership for the green plan through its own example. TMG's Institute for Environmental Science researches new materials and methods for paving roads that can dampen heat emissions. Water cooled pavements, for example, require materials that can absorb rainwater and release it when temperatures rise. The city is applying the new materials in construction projects in four downtown pilot districts.[21] TMG has also green roofed and green walled several of its own buildings, including city hospitals and the home of the city's elected assembly.

TMG began regulating CO_2 emissions in the commercial sector in 2004. Tokyo's commercial establishments—business offices, retail offices, department stores and hotels—contribute 35 percent of the city's CO_2 emissions. TMG turned to mandatory controls after a voluntary program to reduce commercial CO_2 emissions achieved only a 2 percent drop between 2001 and 2004. The city is closely monitoring CO_2 emissions at 855 commercial sites. The targeted firms amount to less than one percent of Tokyo's total but are collectively responsible for 30 percent of the commercial sector's CO_2 emissions. TMG's web page tracks firm progress in meeting the mandated targets.[22]

TMG's green design also applies to vehicle emissions. The concentration of moving vehicles in central Tokyo, particularly diesel trucks, slows traffic and pollutes the air. Average speed can slow to as low as 17.5 kilometers per hour during rush periods, half the national average. Tokyo has made considerable

progress in combating air pollution but diesel fuel generated nitrogen oxides and suspended particulate matter remain serious health hazards. Tokyo residents face twice the risk of dying from particulate matter caused lung cancer as the average Japanese (TMG 2002).

TMG has reached 93% of its nitrogen oxide reduction goal at its off freeway test sites but only 37 percent on its freeways. It has attained 40 percent of its particulate matter benchmark in the city as a whole but barely above zero on the freeways. Diesel vehicles are responsible for 52 percent of the particulate matter emissions and 80 percent of nitrogen oxide flowing into Tokyo's air. TMG began levying large fines and driving bans on diesel vehicles that didn't meet the city's emission standards in 2002. Prior to introducing these regulations, city researchers joined with private firms to study the feasibility of new engine designs to reduce diesel fuel emissions. By the time the regulations went into effect in 2002, the new emissions devices and cleaner gasoline were available on the market. By September 2003, 80 percent of the originally targeted vehicles had introduced the emission control equipment. Besides reducing the concentration of suspended particulate matter in the air, the vehicle emission regulation has created a new market for emission gas control devices.[23]

TMG researchers are also investigating alternative energy sources and energy recycling technologies. The metro government has placed solar energy generators at 16 different locations in its own Shinjuku building complex, at the city run Otsuka hospital, the Morigasaki Water Reclamation Center and in thirty-four other public places. TMG is currently undertaking Japan's largest solar

power plant at the Asaka Clean Water Center. The city is also experimenting with the use of biomass energy, drawn from waste burning and sewage heat, for cooling and heating facilities in seventy-four areas of the city.

The city has set up wind power generators along Tokyo Bay, jointly with a private company, J Wind Tokyo, to whom TMG has given land and property tax incentives.[24] Encouraged by the city's pilot project, and further motivated by the city's 2005 Environmental Security Law, Mitsubishi Heavy Industries has also built a wind power generation plant in Tokyo Bay which is now supplying electricity to Tokyo Electric Power Company. TMG's 2005 Environmental Security Law requires electric power companies to submit an energy plan to the city detailing their use of renewable energy sources and the magnitude of their CO_2 emissions (TMG 2005c). TMG now defines electricity as a "green purchase" and requires at least 5 percent of the electricity purchased by large public facilities to be derived from renewable sources.

Transport and household sectors are the second and third largest producers of greenhouse gases in Tokyo. Thirty percent of the city's CO_2 emissions come from motor vehicles, mostly from passenger cars. TMG has several strategies to reduce CO_2 emissions from automobiles, while at the same time lobbying the central government to levy stricter fuel efficiency standards on mid-to-large sized passenger cars. TMG has designated a "low pollution" category of automobiles, including electric, hybrid, fuel-celled, methanol and natural gas burning vehicles. TMG's own fleet of vehicles is largely made up of environmentally friendly cars. TMG requires firms owning more than 30 vehicles

for commercial and business purposes to have at least 5 percent of their fleet in the low pollution category. TMG has established several hydrogen gas stations and 44 natural gas stations in Tokyo and provides subsidized loans for natural gas fueled buses. At TMG's behest, public parking places now offer discounts for drivers of low pollution cars.

Twenty-five percent of Tokyo's CO_2 emissions come from households, mostly from home electrical appliances like air conditioners, refrigerators, televisions and lamps. To reduce CO_2 emissions in home electrical appliances, TMG is waging an energy saving education campaign with the city's consumers and on college campuses. The city has requested retail electric appliance stores to put energy saving labels on their merchandise and is encouraging consumers to buy energy saving products. TMG has put together a Committee on Energy Saving, consisting of consumer groups, industry associations and NGOs to design the energy saving labeling system.

Recycling in super eco-towns. Tokyo Metropolitan Government has long engaged in waste management and recycling. Local cities and wards in the metro area collect general waste and jointly perform intermediate and final stages in the recycling process. TMG is responsible for final disposal of general waste from the Tokyo's 23 wards and industrial waste from small businesses throughout the metropolitan area. The city separates toxic and nontoxic waste, extracts some useful materials, and converts burnt ash into slugs and eco-cement. Non-recyclable waste is dumped into landfills on Tokyo bay.

The volume of waste has steadily declined in Tokyo over the past 15 years while the volume for reuse has steadily grown.[25] Nonetheless, TMG has continued to dump large quantities of final waste into landfills.[26] The city's new "super eco-town" project aims at eliminating final waste entirely, a strategy equivalent to the "zero waste" approach practiced by lean production and the "waste equals food" approach advocated by industrial ecologists.[27] The super eco-town project is designed to eliminate industrial waste by disassembling discarded products into their original components and into raw materials that can be reused and transforming the remaining waste into energy (TMG 2005c). The project is also intended to stimulate new recycling technologies and promote the urban environmental industry.[28]

TMG's vision of a "zero waste city" lies behind the super eco-town effort. TMG came up with the original super eco-town idea and proposed the project to the central state. After considerable discussion and negotiations, the central government incorporated the super eco-town into a regional plan designed to transform localities in greater Tokyo into "zero waste sustainable cities." The super eco-town project now combines the efforts of Tokyo Metropolitan Government, some central government ministries and agencies, businesses and citizens groups and covers industrial waste from Tokyo's surrounding prefectures of Kanagawa, Chiba and Saitama (Prime Minister's Office 2005).[29]

TMG in partnership with private firms built two super eco-towns in 2002 offshore of Ota and Koto wards on land reclaimed from Tokyo bay. TMG provided the land and infrastructure while private firms built the facilities and are

recycling the waste. Follow up studies indicate that companies operating in Ota's super eco-town are eliminating between 90 and 100 percent of industrial, construction, computer and food wastes by turning them into new materials for reuse or into bio-energy. Koto's super eco-town includes the Environmental Safety Project Public Corporation, which processes PCB waste, and power companies that are recycling waste to generate electricity. All told, fifteen facilities were engaged in "waste equals food" operations in 2006.[30]

Tokyo's waste management system exemplifies Japanese style administrative guidance. TMG's 2000 Basic Law for a Recycling Society, legislated a few years earlier than Japan's national recycling laws, lays out clear waste treatment responsibilities for local governments, citizens and businesses. TMG is to support local wards and cities by guiding and coordinating the new regional recycling system. Tokyoites are to buy consumer products that generate less waste and must sort and dispose of their refuse in accord with a fat recycling handbook. Businesses are responsible for disposing their industrial waste and recycling their end-of-life products. The recycling laws are prodding companies to design and manufacture products that are easier to recycle and helping to catalyze a new urban recycling industry. As of 2005, nearly 800 firms had received TMG licenses to participate in the regional recycling system.[31]

To further regulate industrial waste, TMG enacted a 2005 law requiring Tokyo's large manufacturers, construction firms, hospitals, universities and research institutes to report to the city on their waste management practices, including their policies and organizational system to reduce waste, their selection

of waste disposal companies, their recycling rates, and how their recycled materials are being used.[32] Firms are required to display their environmental report on their company's web page. As of February 2006, TMG had listed 1,246 such reports on its own web page and had begun monitoring the progress of 900 establishments in meeting the law's guidelines.

The case of NEC. NEC is one such company and illustrates how major Tokyo firms are integrating ecology into their product development and communicating their activities via their web sites. NEC's information technology products run the gamut from semiconductors to telecommunication networks, PCs and mobile phones. The company's stated environmental goal is to "contribute to the creation of a recycling oriented society for sustainable development," not just by decreasing the ecological impact of its business activities but by "aggressively working to develop environmentally sound products." Consistent with the holistic, cradle to cradle outlook, NEC is seeking to "reduce environmental impact over the full product life cycle, from product design, to production, transport, use and disposal." [33]

NEC has established three environmental goals: prevent global warming by reducing CO_2 emissions, recycle resources, and reduce hazardous substances. At the product planning stage, the company sets specific environmental targets suited to each product's characteristics. To prevent global warming, NEC is working to minimize electricity and natural gas consumption at three points in the product life cycle: in the production process, during use by the consumer, and when the product is disposed. To recycle resources, NEC is

seeking to use recyclable and recycled materials over the entire life cycle of the product. To reduce the use of substances dangerous to human health and the eco-system, the company is "making a full fledged effort to understand all types of hazardous substances used and contained in the company's products and reduce them." The company has also instituted a "Green Purchasing" program that tracks hazardous substances in parts and gives priority to purchasing environmentally sound components.

At the product design stage, NEC is seeking innovations that reduce electricity consumption and extend battery life; that advance the use of recyclable materials; and that make it easier to dismantle products so parts can be reused. A product impacts the environment in many ways. To ensure that alleviating one environmental hazard doesn't end up increasing another, each impact must be tallied and related to all of the others. NEC has created a product design tool it calls 'Virtual Factory ECO" (VF-ECO) to assess the various environmental effects of a product. According to the company, “VF-ECO graphs out a lifecycle assessment based upon a product’s parts and design characteristics, its hazardous traits and its recyclability." Repeated simulations enable design improvements and judgments as to whether a new product meets environmental targets and can thus pass on to the production stage. NEC is now performing this assessment on all new products.

NEC has developed its own environmental product label, the "Eco Symbol." An NEC product carrying the Eco Symbol claims to be superior to its competitor products in environmental quality, including equivalent NEC products

that do not carry the Eco label. Twenty-one NEC products and 247 models carry the Eco symbol, including PCs, printers, electronics devices and telecommunications equipment.

NEC currently extracts over 10,000 parts from used products annually through its 3R system ("reduce, reuse, recycle"), including hard disks and LCD panels. The company reuses these parts in the maintenance of older model products. For parts that cannot be reused, the company recycles materials, such as copper, steel and glass, and retrieves heat emitted during incineration to improve product recycling efficiency.[34] The company feeds back information gained at the time of recycling to the product design and development division to help reduce the amount of resources designed into a product and to make longer lasting products.

4. Tokyo's Environmental Politics

Japanese culture stresses the symbiosis between human beings and nature. But human motivations are not of one piece, and aspirations for material prosperity clash with aspirations for harmony with the natural environment. Not long ago, Japan was shamelessly polluting and Tokyo was one of the nation's worst offenders. But Tokyo has moved beyond its worst ecological moments and is improving its relationship with nature. The remaking of Tokyo's environment is a political process that reaches back to the high tide of Japan's environmental movements in the 1960s and 1970s.[35]

Grassroots demands for a better Tokyo environment emerged during Japan's high growth era (1950s-1970s) in response to environmental

deterioration caused by state led industrialization. Tokyoites sought solutions for growth induced air and water pollution, population and traffic congestion, housing and school shortages. TMG, led by a conservative, pro-growth party at the time, failed to respond to citizens' demands. Coalescing into a political movement, Tokyoites elected an environmentally progressive Governor, Ryokichi Minobe. The Minobe administration circumvented the conservative majority in TMG's elected assembly by establishing a direct pipeline with Tokyo citizens through dialogues and town hall meetings. The city's public sector unions formed a communication bridge between top levels of the city administration and local neighborhood groups. Non-governmental organizations joined in TMG policy making.

The Minobe administration initiated more stringent environmental regulations and monitoring institutions in Tokyo than were currently in force nationally, including an air pollution control law, a Pollution Research Institute, and a Bureau of Pollution (now Bureau of Environment). Tokyo became a national precedent setter on environmental issues, establishing a leadership role that has continued to the present day. TMG's current policy efforts to reduce CO_2 emissions and improve Tokyo's air quality still reflect grassroots pressure. Community organizations continue to monitor air quality and temperature in their neighborhoods. It was neighborhood organizations, for example, that initiated the campaign to exclude diesel vehicles from Tokyo.

Tokyo voting patterns fluctuate, however, between pro-growth and quality of life trajectories. Voter preferences correlate with ups and downs in the city's

economy and corresponding alterations in state policies. When the economy goes well, Tokyo has tax revenues to support environmental programs, and quality of life politics comes to the forefront. When the economy slumps, Tokyo faces growing unemployment, TMG encounters fiscal barriers to the expansion of social programs, Tokyo voters desire development projects, and pro-growth politics come to the forefront.

Growing unemployment after two oil crises in the 1970's led Tokyoites to elect Governor Suzuki, a pro-growth conservative ex-bureaucrat with close ties to the central state. The Suzuki administration began a world city project along Tokyo bay in the early 1980s. TMG reclaimed land from the bay, built a teleport and convention center in partnership with private firms, and let out the rest of the real estate for private development. The Tokyo bay world city project created serious environmental problems. Reclaimed land blocked circulation of the sea and endangered natural species. Skyscrapers prevented the flow of sea breezes into the city aggravating Tokyo's warming problem.

After Japan's financial bubble burst in the early 1990s, land values plummeted, and corporations that had invested in TMG's world city project couldn't sustain their commitments. TMG ended up with huge debts and was forced to drastically scale down the project. Tax retrenchment made it difficult for TMG to fund environmental and welfare programs. At this point, Tokyoites voted in a populist, Governor Aoyama, who had campaigned on quality of life issues and against the world city project. Most recently, Tokyo voters have turned to Governor Ishihara, a former member of the conservative Liberal Democratic

Party, who advocates decentralizing power from central to local governments, and believes a virtuous circle is possible between environmental improvement and economic growth.

The Ishihara administration is currently facing grass roots pressure to halt TMG's Bay Loop Highway construction plan. Opponents claim that the Bay Loop Highway will generate more nitrogen oxide pollution and threaten the health of nearby residents. The super eco-towns are also causing anxieties among residents living near Tokyo bay. Households in the Koto ward where the PCB treatment facility is located worry about air quality and are pressuring TMG to impose more stringent safety regulations on the recycling operations (TMG Assembly 2005).

During his first election campaign in 1999, Governor Ishihara proposed "to change Japan by changing Tokyo." Ishihara's slogan reflects a tension between local and central power in Japan that has run throughout modern Japanese history. TMG officials govern within a centralized unitary state structure and are often at odds with their counterparts in the central government. Japan's strategically organized national state disperses functions to local governments while maintaining central control. Although Tokyo has a special status among local governments, TMG like other local governments exercises functions delegated to the city by national agencies, central bureaucrats fill important city government posts in rotation from the relevant ministries, and the city must conform to the regulations set by national ministries and bureaus.[36]

Although coordinated from the center, the structure of the Japanese state has many pluralistic elements. Center and localities exchange information to create common objectives and policies. The central government gives local officials discretionary powers to encourage their initiative, and then monitors the results (Muramatsu 1997a). Localities can initiate programs that may subsequently be incorporated into central state policies and they can secure concessions from the central government. Local officials must act in accord with their own electoral and political constraints and they have leverage with the central government because the state depends upon them to implement national policies (Muramatsu 1997b).

Ishihara's slogan also conveys a realistic understanding that Tokyo politics often prefigure Japan's national trajectory. In the past, progressive Tokyo governors, buoyed by grassroots quality of life movements, set an environmental policy agenda belatedly adopted by the central government. Today, that progressive environmental role has ironically passed to a Governor and political administration widely considered to be conservative and even right wing. This indicates some blurring of the distinction between pro-growth and environmental quality issues in Tokyo and of right and left political identities.

But divisions between pro-growth and quality of life forces persist as seen in the recent conflicts over Tokyo's proposed environmental tax. TMG wants to impose a tax on polluters to hasten reductions in greenhouse gas emissions but the central state is reluctant and divided. The Ministry of the Environment (MOE) and the Ministry of Finance (MOF) back TMG's environmental tax proposal. But

the Ministry of Economy, Trade and Industry (METI), which oversees the nation's major industrial concerns, is against it. Standing behind METI is Keidanren, the Japan Business Federation. Preferring voluntary environmental efforts, Keidanren vigorously opposes enactment of the tax (Keidanren 2004). Meanwhile, cities, community groups and the national labor federation (RENGO) side with TMG. So, the two opposing coalitions, pro-growth and quality of life, still characterize Tokyo's environmental politics, but the divisions between them have become more complex and fluid.[37]

6. Conclusion

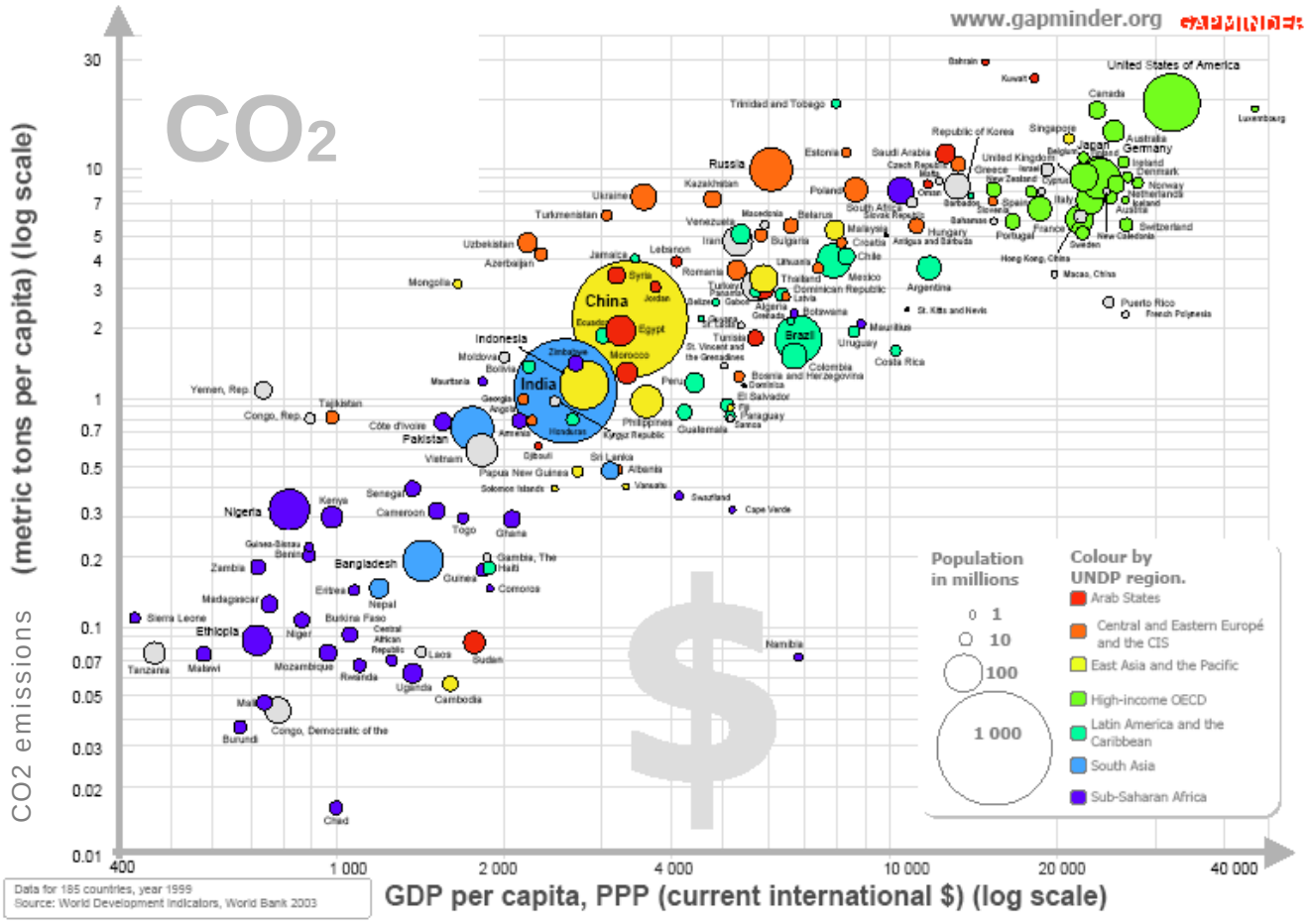
Hyper urbanization is warming the world's atmosphere and degrading the environment. Given the clash between urban development and the natural world, movement towards a "zero waste city" is imperative. The world's major cities must play a central role in achieving environmental sustainability. Tokyo is, by some measures, the world's largest megalopolis. Can Tokyo remake itself into an ecologically sustainable city? We have explored this question through an investigation of Tokyo's environmental issues, policies and politics. In particular, we have focused upon Tokyo Metropolitan Government's lean production based policy approach to eliminating waste and reducing the greenhouse gases responsible for global warming.

Achieving environmental sustainability is most fundamentally a political challenge. Tokyo is doing a lot but not yet enough to eliminate waste or reverse rising CO_2 emissions. The Japanese remain ambivalent and divided over how to balance economic growth and environmental quality goals. The zero waste, lean

production, industrial ecology vision promises to overcome this divide by connecting the solutions to environmental problems to new urban designs, technologies, sources of employment and economic growth, thus creating a virtuous circle between nature and the economy. Tokyo's super eco-towns that recycle waste, buildings made from biodegradable materials that dampen heat emissions, and alternative energies that power homes, offices and motor vehicles are all steps toward a zero waste city.

The divisions between developmentalists and conservationists are blurring in Japan. But time is running out. The scale and speed of restructuring is still far short of preventing today's threats to the environment from becoming tomorrow's catastrophes. The Tokyo experience suggests that putting the world's economy onto a sound environmental path will require local initiative, popular support, vibrant political leadership, public-private coalition building, an ability to stimulate and take advantage of technical innovations, intergovernmental cooperation and strong government action.

Figure 1: Correlations between GDP Per Capita and CO_2 Emissions Per Capita



Source: Gapminder.org

http://www.gapminder.org/downloads/handouts/worldenvironment-chart.html

Table 1: Energy Consumption and CO_2 Emissions by Sector in Tokyo: 1990-2003

Energy Consumption (Unit: PJ)*

	Total	Industry	Commercial**	Transport	Household
1990	738	128	182	256	172
1992	784	125	193	284	182
1994	799	113	210	291	185
1996	814	105	217	302	189
1998	841	102	233	314	192
2000	853	97	245	309	202
2001	837	88	244	305	200
2003	829	75	249	298	199
Percent changes between 1990 and 2003					
	14%	-39.1%	37.5%	16.6%	17.6%

*1J=10^{15}J

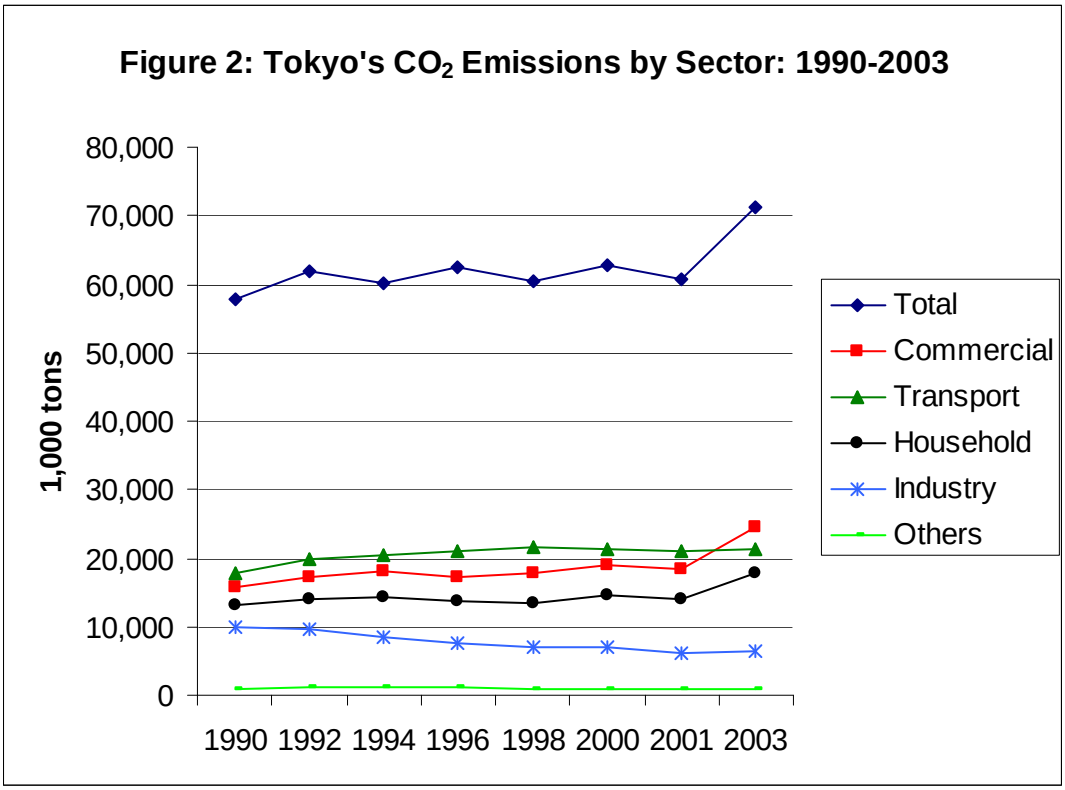
**Covers business offices, department stores, hotels, restaurants, etc.

CO_2 Emissions

(Unit: metric ton)

	Total	Industry	Commercial	Transport	Household	Others
1990	57.7	9.9	15.9	17.9	13.1	0.8
1992	61.9	9.6	17.1	19.9	14.1	1.2
1994	60.2	8.5	18.2	20.4	14.3	1.2
1996	62.6	7.5	17.2	20.9	13.6	1.2
1998	60.5	7.1	17.7	21.6	13.4	1.0
2000	62.7	6.9	19.0	21.4	14.5	1.0
2001	60.6	6.1	18.5	21.0	14.0	1.0
2003	71.3	6.4	24.5	21.1	17.8	1.0
Percent changes between 1990 and 2003						
	23.6%	-35.2%	57.3%	18.1%	35.8%	8.4%

Source: TMG Bureau of Environment, “2003 Greenhouse Gas Emissions in Tokyo.” October 11, 2005.



Source: Based on Table 1.

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Endnotes

[1] According to Lester Brown (2006), the Roosevelt administration's mobilization of the USA for entry into World War II in a matter of months "demonstrates that a country, and, indeed, the world can restructure the economy quickly if it is convinced of the need to do so."

[2] Developed countries were responsible for 59% of the world's CO_2 emissions and developing countries the rest in 2000. But CO_2 emissions from developing countries are projected to surpass those from developed countries around 2020-2030, and to reach about 6 times their present levels (and about the 3 times the amounts from the industrialized countries in 2100 (Yanase 2005).

[3] Tokyo's industry, population, higher education and commerce continue to decentralize to greater Tokyo and national capital region. The greater Tokyo area that covers Tokyo's three neighboring prefectures, Kanagawa, Saitama and Chiba adds 21 million more people to Tokyo's urban agglomeration (12 million people). And Tokyo stretches further yet, to form the national capital region, by encompassing four additional prefectures of Yamanashi, Gunma, Tochigi and Ibaraki. Tokyo's population reaches 42 million all together, one-third of the nation, and the world's largest metropolitan region.

[4] McDonough and Braungart argue that government regulation, by itself, is not a solution to environmental depletion. Regulation, like the mass production solution, is doing more with less, a method they label, "eco-efficiency." Reducing waste does not halt depletion, it only slows it down while continuing to transfer environmental costs elsewhere in the eco-system. End-of-the-pipe monitoring does not address the source of the problem, the basic design flaw. However, the authors appear to overlook the role of regulation in stimulating new eco-technologies, a process given greater currency in the Japanese zero waste model discussed below.

[5] Japanese lean production is modeled on the Toyota Production System, see (Womack, Jones and Roos 1990).

[6] Space concerns have enabled Japanese firms to develop compact and miniaturized technologies (Boulton 1995). Japan has only 4% of energy self-sufficiency rates. Even if nuclear energy is counted as domestic energy, Japan is dependent upon foreign imports for 80% of its energy.

[7] The Alternative Energy Development Law in 1980 established the New Energy Development Organization (NEDO) to promote alternative energy development. To replace oil dependence the law promoted nuclear power and other new energy sources that emitted less CO_2. Industry's dependence on oil fell to 49% from 77% between 1973 and 2001 (Agency for Natural Resources and Energy 2005). The 2003 revision of the Electricity Utility Law also promoted renewable energy and allows independent small providers to enter the electricity retailing business. This revision introduced a renewable portfolio standard (RPS) system.

The Energy Conservation Law sets energy efficiency standards on a broad range of products from automobiles to home and office appliances. The law establishes a "Top Runner Program" setting targets and timelines for energy saving improvements.

National Recycling Laws obligate manufacturing and construction companies to recycle their products and report on the results to the ward offices and cities in which they operate. The laws also encourage innovation in the design, development, and manufacture of recycled products.

[8] ISO stands for "industrial organization for standardization." ISO is a network among the national standards institutes in 146 countries. A central secretariat in Geneva, Switzerland, coordinates the system. The ISO goal is to reach international standards for products, services and industry sectors through consensus agreements among national delegations representing all concerned parties: suppliers, users, government regulators, consumers, etc. ISO 14001 is a certificate for environmental management systems. For further detail see Hhttp://www.iso.orgH; and Hhttp://www.iso14001.com

[9] The sudden upturn in CO_2 emissions between 2001 and 2003 is attributable to the temporary closure of nuclear power plants and the increased use of thermal electricity plants to compensate. Thermal electricity plants generate more CO_2 than nuclear plants. (CO_2 emissions from natural gas fired power plants are about 30% less than those from oil fired power plants, but still about 22 times higher than those from nuclear power plants.) Tokyo Electric Power Company (TEPCO) closed all 17 nuclear facilities in 2002 following a scandal over its cover-up of safety problems. TEPCO resumed all of its nuclear operations in 2005. CO_2 emissions are likely to fall commensurately. Furthermore, as TEPCO plans to increase its reliance on nuclear power plants from the current level of 30% to about 50 % by 2012 (TEPCO 2006), Tokyo's CO_2 emissions are expected to drastically come down. Yet, Tokyo's reliance on nuclear energy has

serious implications for future generations and environmental justices. No technology exists to dissolve nuclear waste today and future generations must live under radioactive threat from the underground, while residents near by TEPCO's nuclear reactors (all located outside Tokyo) must live under constant threats over potential nuclear leakages.

[10] The Tokyo Metropolitan Government encompasses 23 wards, 26 cities, and 13 towns and villages (as of 2006). The 23 wards that make up Tokyo's central city have political autonomy and an elected mayor but do not have the tax collecting power possessed by Tokyo's suburban cities, towns and villages. Ward budgets are allocated by the TMG. Wards and cities make their own policies according to their own specific environmental conditions, and they implement policies through their elected mayors and city councils. TMG's overall environment policy is a sum of these local policies. This paper sometimes addresses TMG as the city.

[11] For instance, every household must follow a thick recycle handbook when it puts trash bags out.

[12] As noted in footnote 7, the large increase in Tokyo's CO_2 emissions between 2001 and 2003 was due to the temporary closing of nuclear reactors and the substitution of thermal electricity. The nuclear facilities are now back in operation. Assuming emissions trends have returned to the trajectory prevailing during the 1990s, the emission reduction Tokyo needs to reach the Kyoto benchmark is probably closer to 10 percent.

[13] This rise in temperature is far beyond the 2.0°C many world climate scientists consider a tipping point beyond which global warming is unstoppable.

[14] 35.2% of Japan's 4,728 large corporations were in Tokyo in 2001 (TMG Bureau of Industrial and Labor Affairs 2005).

[15] TMG's Environment Bureau provides data on these project assessments on its web page. See Hhttp://www2.kankyo.metro.tokyo.jp/assessH.

[16] TMG adopted an environmental impact assessment system for large scale urban projects in 1981. Neighborhoods became involved then and have been participating ever since. The recently revised assessment system requires developers and public sectors of assessment at every stage of a project (TMG 2005c).

[17] TMG requires green plans only from the largest new buildings, 150 to 200 cases, less than one percent of new construction, but these buildings account for over one quarter of Tokyo's new floor space.

[18] See Hhttp://www2.kankyo.metro.tokyo.jp/building/list/2005/list_1.html

[19] Hhttp://www2.kankyo.metro.tokyo.jp/sizen/index.htm

[20] TMG's goal is to reach 1200 hectares of green top roofing by 2015.

[21] The model districts are in Marunouchi, Shiodome, Kojimachi, and Nishi-Shinjuku.

[22] Hhttp://www2.kankyo.metro.tokyo.jp/ondanka/seido/mokuji.htm

[23] The annual average concentration of suspended particulate matter (SPM) declined from 0.046 to 0.036 between 2002 and 2004 at 34 roadside measurement sites and from 0.035 to 0.030 at 47 non-roadside measurement locations (Takahashi 2004).

[24] This operation, called Tokyo Kazaguruma (Wind Wheels), generates 1,700 kilowatts of electricity, enough to support 800 households.

[25] Tokyo collected the volume of about 5 million tons of general waste, 10% of Japan's general waste collected by municipal governments, and 23.5 million tons of industrial waste, 6% of Japan's industrial waste in 2002 (TMG 2005c). Tokyo's collected volume of general waste declined by 18% between the peak year of 1989 and 2003. The final disposal volume as a percent of the volume collected was 10 percent in 2003, a decline of 59 percent since 1991 (TMG 2004a). That is, 90 percent of Tokyo's general waste is now reused. By contrast, the collected volume of industrial waste changed little between 1997 and 2002. But the volume reused increased by 24% and the final disposal volume declined by 47% during the same period. In 2002, the final disposal volume was 10 percent (TMG 2005d).

[26] Tokyo has been reclaiming land in Tokyo bay for over 150 years and using waste for the landfill since 1977. TMG is today reaching the limit in landfill.

[27] The super eco-town's regional approach also indicates that the city would treat 82% of Tokyo's final industrial waste disposal by itself. The city used to treat only 25% of final industrial waste disposal in the city border and ship the rest outside Tokyo, mostly to greater Tokyo.

[28] Super eco-towns are also a political response to pressures from Tokyo's wards and cities to end illegal abandonment of industrial waste in their vicinities.

[29] TMG proposed a "super eco-town vision for the greater Tokyo" in 2001 to the central government as a means to revitalize the metropolitan economy. Responding to TMG, the central state established "the Headquarters Office for Urban Renaissance Project" in the Prime Minister's Office. The headquarters

office set up a council called “Rebuilding the greater Tokyo region with a zero-waste city vision.” The headquarters office also set up a council in 2002 to coordinate similar efforts to create zero waste cities in the Kansai region that covers prefectures of Kyoto, Osaka, Hyogo, Shiga and Nara and cities of Kyoto, Osaka, Kobe, and Nara.

The Council consisted of the Prime Minister’s Office; the Ministry off Economy, Trade and Industry (METI); the Ministry of Agriculture; the Ministry of Land, Infrastructure and Transport; the Ministry of Environment; and the Ministry of General Affairs and Communication; the Prefectures of TMG, Saitama, Chiba, and Kanagawa; the cities of Yokohama, Kawasaki, Saitama, and Chiba; and the Japan Business Federation (Keidanren). The Prime Minister presided over the Council. (Prime Minister’s Office 2005).

Following the council‘s recommendation, TMG made a “Plan for Waste Disposal” in 2002, started building super eco-towns in two locations on its own reclaimed land in Tokyo Bay, and invited the private sector to join the project. (Hhttp://www2.kankyo.metro.tokyo.jp/recycle/superecotown/supereco_keii2.htmH)

[30] Industrial waste from greater Tokyo was expected to increase by 6.6% from 77 million tons in 2003 to 82 million tons by 2005, while final industrial waste disposal after recycles reuse and intermediate treatment was to decrease by 6% from 4 million to 3.8 million tons.

[31] TMG believes that eco-businesses will be born in the process of solving Tokyo’s peculiar environmental problems: industrial waste disposal, air pollution by diesel vehicles, local warming by office and commercial buildings, and soil pollution from mixed industry and housing areas.
And the city is promoting the entry of small and medium sized enterprises into the potentially growing eco-business industry. The Ministry of the Environment (MOE), and the Ministry of Economy, Trade and Industry (METI) project the eco-business market will grow to 47 to 70 trillion yen and employ 1.12 million by 2010. While MOE, METI and TMG are all intent on combining environment improvement with economic growth, the Ministries’ eco-business development policies focus mainly on technology development in big firms, private-public consortia, and public research institutes. TMG, on the other hand, focuses mainly on Tokyo’s small and medium sized businesses. TMG expects Tokyo will account for roughly 18 percent of Japan’s eco-business market and eco-employment by 2010 (TMG Bureau of Industrial and Labor Affairs 2004).

[32] The law applies to manufacturing firms with factories employing 300 or more workers and construction companies with capital over 300 million yen (approximately US$ 3 million).

[33] NEC. "Ecology and Technology: Environmental Activities at NEC." Hhttp://www.nec.co.jp/eco/en/profile/story/008/kan01.html

[34] In 1999, NEC collected 11,000 tons of used products, ranking at the top of the electronics industry, and achieved a 92 percent recycling efficiency rate, defined as the "weight ratio of substances that are reused, material re-cycled, and thermal recycled to the total weight of recovered used products." NEC has a 100% recycling efficiency rate today.

[35] Japan's environmental movements, see Steiner, Krauss and Flanagan 1980; Miyamoto 1989; and Broadbent 1998. Also see Shibata (2006) for the garbage war" in Tokyo.

[36] The central state also controls local taxation and borrowing. The national government collects roughly two-thirds of the nations' taxes and then reroutes half back to local governments. Much of the transferred revenue is earmarked for the duties local governments must perform as agents of the central state. Central matching grants, which require equivalent expenditures from localities, reflect national policies and are vehicles for the exercise of administrative guidance.

[37] For example, *Sustainbale Cities: Japanese Perspectives on Physical and Social Structures* (Tamagawa 2006) refers to divisions and tensions between professional urban planners and civil society as well as between social and technological solutions.