Fraunhofer

MorgenStadt
City of the Future

INNOVATION NETWORK

»MORGENSTADT: CITY INSIGHTS«

City Report

TOKYO

June 2013

MORGENSTADT: CITY INSIGHTS (M:CI)

Climate change, energy and resource scarcity, a growing world population and aging societies are some of the big challenges of the future. In particular, these challenges must be solved within cities, which are already home to more than 50% of the world's population. An ever growing number of cities are actively developing new and sustainable infrastructures and services, in order to safeguard and improve their citizens' quality of life.

New technologies make sustainable development of municipal infrastructure and the availability of adapted services possible. Renewable energies, energy-efficient buildings, electric vehicles and new mobility concepts, as well as flexible logistics and modern security systems are developing dynamically. New information and communications technologies are saturating and connecting all sectors and allow for the use of these technologies. The transformation of our existing cities and the development of new cities with the expectation of sustainability require a clear set of objectives, a long-term plan and the continual implementation of a plethora of projects addressing parts of the solution. Intelligent steering of the processes and active citizen participation in the conceptualization of solutions – that is to say, mature governance – are conditions for successful implementation.

Within the motto »Morgenstadt – City of the Future«, the Fraunhofer Organization focuses on the development of technological solutions for future-compatible, sustainable cities. Of the 60 Fraunhofer-Institutes which conduct applied research in different areas, 14 institutes are part of a network for the development of sustainable cities. The institutes contribute high quality competencies in their individual fields, and work together in an inter-disciplinary manner.

From May 2012 until October 2013, 12 Fraunhofer-Institutes conducted the project »Morgenstadt: City Insights« together with 30 industrial businesses and cities, with the goal of creating an inventory of good solutions for sustainable cities. Towards this end, a catalogue of inspiring cities world-wide was created and the following six cities were selected for in-depth study: Freiburg, Berlin, Copenhagen, New York, Singapore and Tokyo. A team of Fraunhofer researchers went to each of these cities, and through the use of interviews, discussions, and site visits they studied spear-heading projects and solution approaches. The goal was to find out how the example projects were initiated, conceptualized and implement, how successful they were/are, what success factors can be identified and what actors are involved. In addition, the goal was to determine under which conditions these solution approaches could be transferred to other cities.

Tokyo is by far the largest and most complex of the cities being researched, and was the last city a team of researchers visited. This report describes the results of the on-site research which took place in Tokyo in June 2013.

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City Report - Tokyo

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LIST OF ABBREVIATIONS

BAU	Business as Usual
BEE	Building Environment Efficiency
BEMS	Building Energy Management Systems
BOE	Bureau of Environment
BREEAM	Building Research Establishment Environmental Assessment Methodology
CASBEE	Comprehensive Assessment System for Building Environmental Efficiency
CEC	Coefficients of Energy Consumption
CEMS	Community Energy Management Systems
DfE	Design for Environment
CHP	Combined Heat and Power
DHC	District Heating and Cooling
DR	Demand Response
ECM	Eco-Model Cities Initiative
EDO	Efficient, Dynamic, Optimized
EIA	Environmental Impact Assessment
EMS	Energy Management System
EMTA	European Metropolitan Transport Authorities
ERR	Energy Reduction Ratio
ETC	Electronic Toll Collect
ETS	Electronic Toll System
ETS	Emissions Trading System
EV	Electric Vehicle
FAR	Floor Area Ratio/Regulation
FEMS	Factory EMS
FY	Fiscal Year
GB	Green Building
GBP	Green Building Program
GIS	Geographic Information System
HEMS	Home Energy Management Systems
IBEC	Institute for Building Environment and Energy Conservation
ICT	Information and Communication Technologies
IOC	International Olympic Committee
IPCC	Intergovernmental Panel on Climate Change
IR	Infrared
ITGS	Intelligent Traffic Guidance System
ITS	International Tracing System
ITS	Intelligent Transport Services
JaGBC	Japan Green Building Council
JFS	Japanese Society for Sustainability
JSBC	Japan Sustainable Building Consortium
LEED	Leadership in Energy & Environmental Design
LNG	Liquefied Natural Gas
LTE	Long-Term Evolution
MANTA	Metro Amusement Network Trinity App
METI	Ministry of Economy, Trade and Industry
MLIT	Ministry of Land, Infrastructure and Transport
MRV	Monitoring, Reporting and Verification
OBU	On-Board Unit
OEM	Original Equipment Manufacturer
PAL	Perimeter Annual Load
PFI	Private Finance Initiative
PIO	Plaza Industry Ota
REC	Renewable Energy Credits
RES	Renewable Energy Sources
RFID	Radio Frequency Identification
RW	Radio Wave
SOFC	Solid Oxide Fuel Cell
TCCI	Tokyo Chamber of Commerce and Industry
TEPCO	Tokyo Electric Power Company
TIACT	Tokyo International Air Cargo Terminal Ltd
TMA	Tokyo Metropolitan Area
TMG	Tokyo Metropolitan Government
TSE	Tokyo Stock Exchange
UCA	Urbanization Control Area
UPA	Urbanization Promotion Area
VERTIS	Vehicle, Road and Traffic Intelligence Society
VICS	Vehicle Information Communication System
YSCP	Yokohama Smart City projects

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1 GENERAL INFORMATION

1.1 »M:CI« – CITY RESEARCH IN TOKYO

The six cities studied within »m:ci« were chosen after a rigorous selection process. Several international rankings of sustainable cities were utilized and innovative projects and solution approaches were identified and analysed. This was the basis for selecting, together with the companies and cities involved in »m:ci«, the six cities which provided innovative and inspiring solutions in different technological sectors, located on different parts of the planet and demonstrating different climatic and other framework conditions.

Tokyo is internationally known as a highly efficient megacity representing the heart of advanced Japanese technology and striving to achieve sustainability and resilience. Many innovative technologies and solutions from several sectors have been rolled out and tested in Tokyo, such as the first urban cap-and-trade system, a highly-efficient mass transport system, a very dense housing environment resulting in cutting-edge solutions for decentralized logistics etc. Simultaneously, Tokyo is struggling with a super-aging society, and provides an example for European cities about how to deal with demographic challenges that will increase in the upcoming years. These facts formed the rationale for choosing Tokyo as a city to be studied in this project. Berlin, Copenhagen, New York, Singapore and Freiburg were the other cities analysed in the m:ci project.

All selected cities demonstrate interesting trail-blazing projects and solution approaches for improving sustainability. Each of the cities, however, had a different strong-point in relation to the sectors studied in »m:ci« , those being: energy, buildings, mobility, water, productions and logistics, security, information and communications technologies (ICT) and governance.

The six cities selected belong to the world-wide most inspiring cities with interesting and trail-blazing projects and solution approaches in the area of sustainability. However, this is not meant to suggest any judgment about the value of many other cities which also belong in this classification, but which were not studied.

1.2 OBJECTIVES

It is quite difficult to compare cities in terms of their sustainability and their projects designed to increase sustainability, since there is no uniform catalogue of criteria and because the framework conditions of each city are different. This brings up the question of whether it is even possible to learn from the experiences of individual cities.

»m:ci« works with the assumption that although a city with sustainability-oriented projects and approaches is reacting to specific problems, using resources locally available, and is implementing its project under local framework conditions, the main challenges addressed are, nevertheless, comparable in many cities world-wide and the projects are planned and implemented according to similar patterns. The objectives of »m:ci« are, therefore, to understand the activities within the individual cities, to identify the specific framework conditions present, and to recognize the patterns within the activities.

The »m:ci« research visits, thus, have the following objectives:

- Analyse the selected practice examples in relation to motivation, conception, planning, implementation success and the measurement of success
- Identify key drivers and framework conditions which have affected the projects and solution approaches either positively or negatively
- Analyse the network of actors, their roles within the studied projects and solution approaches
- Discuss the transferability of projects and solution approaches to dif-ferent cities

1.3 SECTORS STUDIED

Sustainability is a criterion which permeates all dimensions and aspects of a city and can therefore never be wholly captured. A research project on sustainability must, therefore, always concentrate on a specific area. Seven sectors which are strongly characterized by technological solutions were identified within the »m:ci« project, and the governance sector was included additionally, as it is also considered important for the successful conception, planning, and implementation of projects designed to increase sustainability. The following eight sectors are analysed within the project as a whole and include the following aspects:

Energy
Import, creation, distribution and use of electricity, heating/cooling, gas und fuel.

Buildings
Energy-efficiency, comfort, holistic balance of all building styles within a city, buildings and public space, resource efficiency and recyclability of materials used.

Mobility
Range of available mobility options, modal-split, energy use, area requirements, emissions, use of public space.

Water
Water supply and disposal, water quality, reliability of supply, rainwater drainage, energy use.

Production & Logistics
Production in the city, distribution of goods to stores and to consumers, induced traffic volume and emissions.

Security
Security of public spaces and in buildings against vandalism, crime rate, terrorist attacks, security in relation to natural disasters.

ICT – Information and Communications Technology
City administration data, electronic availability of city services, information options in public spaces, ICT-infrastructure, ICT applied for intelligent steering and user-friendly options in the areas of energy, mobility etc.

BIG – Business Innovation and Governance
Policy and administration structures as well as methods and concepts applied to determine objectives, conception, decision-making, planning and implementation of solution approaches and projects aimed at increasing sustainability in relation to the initiation, organization, steering and evaluation of processes and projects, active participation of citizens and all relevant city actors, city development and planning as regards its linkage with politics and administration.

1.4 RESEARCH APPROACH

The two-week research stay was conceptualized as follows:

City support	In advance, the TMG Bureau of Environment was informed about the research stay and asked to confirm the support of the administration. This was granted in a letter of support written by Mr. Teruyuki Ohno, Director General of the Bu-reau of Environment.
Indicators	Several indicators were identified for each sector, and the data associated with these indicators was studied in advance of the research stay.
Practice examples	Involved researchers identified interesting practice examples in their individual sectors, in advance, which were then studied during the visit. Data and information on the exam-ples was collected and analyzed.
Interviews	Relevant actors within each practice example were identi-fied, and interview appointments were made for within the research stay period. The interviews, typically 1.5h in duration, were conducted on the basis of a standardized guideline, which was adapted to each interview. The interviews were recorded, when permitted, and later analysed.
Viewings	The practice examples were, whenever possible, viewed/visited, in order to gain a personal impression.
Networking Dinner	During the research stay, the multipliers within the city were invited to attend a networking dinner at the Roppongi Hills Mori Tower - an evening event. The »m:ci« project and the researchers were introduced and several contacts were made and additional meetings arranged.
Morgenstadt Lab	During the ‘lab’ on the first Friday of the research stay, the researchers discussed – following a defined method – several hypotheses relating to the practice examples in Tokyo. The hypotheses had been developed by the researchers and were based on the interviews conducted within the first week. The discussions served to recognize the patterns inherent in the implementation of projects and solution approaches in Tokyo.

1.5 CITY TEAM TOKYO

The following Fraunhofer researchers conducted the study during the research stay:

Sector	Researcher
ICT	Thomas Vandieken *Fraunhofer IAO* *Institute for Industrial Engineering, Stuttgart*
Energy	Gerhard Stryi-Hipp *(City Team Leader)* *Fraunhofer ISE* *Institute for Solar Energy systems, Freiburg*
Buildings	Katrin Lenz and Christian Weichler *Fraunhofer IBP* *Institute for Building Physics, Stuttgart*

Mobility	Steffen Raiber and Carolin Capone *Fraunhofer IAO* *Institute for Industrial Engineering, Stuttgart*
Governance	Alanus von Radecki *Fraunhofer IAO* *Institute for Industrial Engineering, Stuttgart*
P & L	Marthe Knudsen, *Fraunhofer IML* *Institute for Material Flow and Logistics, Dortmund*

The organization of the research stay in Tokyo was supported by the German Chamber of Commerce and Industry in Japan, Marcus Shuermann and his team, and the Fraunhofer Representative in Japan, Dr. Lorenz Granrath.

2

2 TOKYO – AN OVERVIEW

Counting 36 Million inhabitants, the Greater Tokyo Area, Japan`s capital region (referred to as Shuto-ken), is renowned as the most populous urban agglomeration in the world. The core of Tokyo is made up of 23 Special wards (Tokubetsu-Ku or Tokyo Nijuusanku), which together occupy the area of what was originally the City of Tokyo before the merger with Tokyo Prefecture in 1943. The 23 Special Wards have a combined population of 9 Million, while the Metropolitan Prefecture (Tokyo-Bu – depicted in Figure 1) – hereafter reffered to as Tokyo – hosts roughly 13 million inhabitants (TMG 2011c).

The city is governed by the Tokyo Metropolitan Government (TMG). However, the wards remain largely autonomous and only major public administrative work, like water supply, sewage disposal and tax collection is carried out by TMG (TMG2013c).

Tokyo is situated in the south of the Kanto region, approximately in the centre of the Japanese archipelago. The city forms a long and narrow stretch of land, running about 90 kilometres from east to west and 25 kilometres north to south (The World Bank 2009).

While the 23 wards still represent the business and cultural centre, Tokyo has taken the shape of a poly-centric and transport-oriented city, where major sub-centres have formed along the central circle line (Yamanote Sen) as well as along private railway lines reaching out into the peripheral areas of the city (Okata, Murayama 2011).

Tokyo is susceptible to typhoons and has high seismic activity. While Typhoons rarely make landfall at Tokyo, they still cause considerable damage. Highly destructive earthquakes struck the capital in 1703, 1855 and 1923, the last of which took 105 000 lives (Stein et al 2006).

Figure 1: Metropolitan Prefecture of Tokyo (Tokyo Metropolitan Research Institute for Environmental Protection 2009)

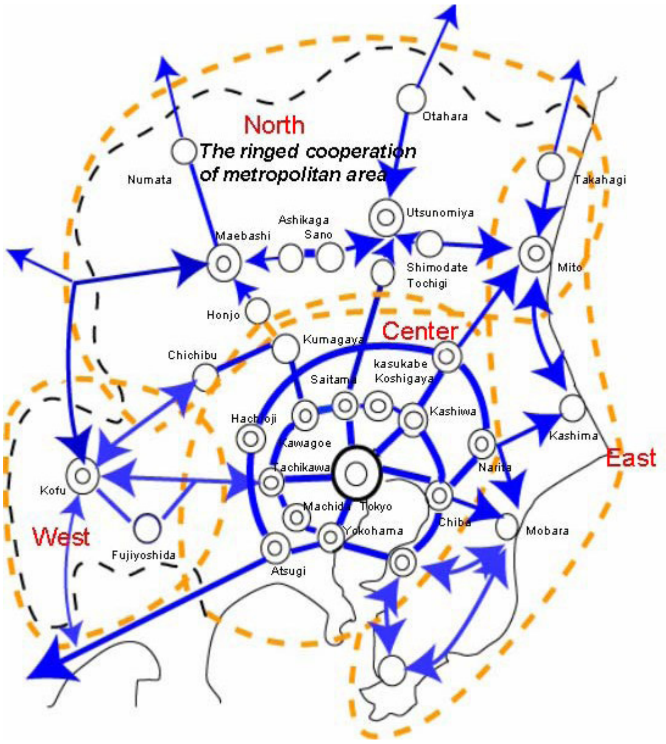


Figure 2: National regional development plans and multicentric development (Alpkokin n.y.)

Introducing a number of innovative sustainability measures in the past, Tokyo has evolved into an efficient, productive and sustainable mega-region (Tetsuo 2011). Still, Tokyo faces a number of environmental challenges, including: climate change, air pollution, and the decrease of greenery and water areas, affecting both, the attractiveness of the

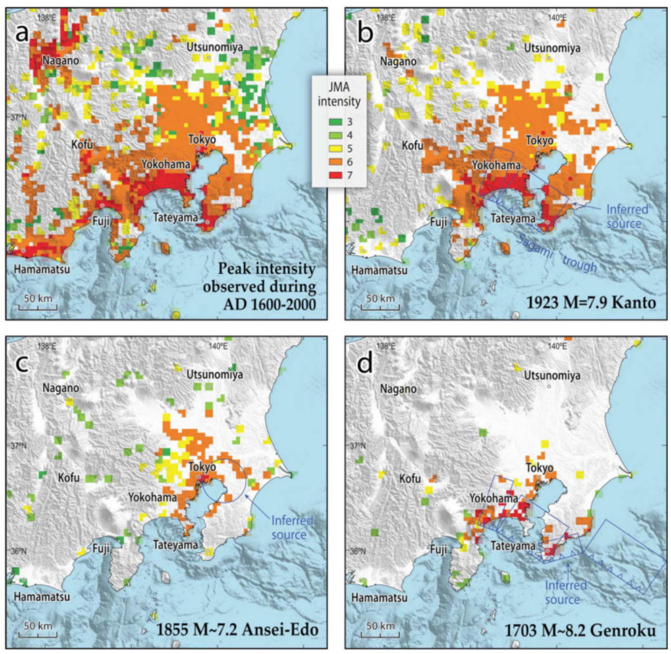


Figure 3: Overview over historic Tokyo Earthquakes (Stein et al. 2006)

Table 1: Facts about Tokyo

Indicator	Tokyo	Japan
Total population (Tokyo Metropolitan Prefecture)	13.28 million	127.34 million
Surface area	2,188 km²	377,960 km²
Population growth	0.36%	0.29%
Population density	6,029 (p/km²)	343,4 (p/km²)
Total GDP (nom.)	93.1 billlion Yen	479.8 billion Yen
Per capita GDP	3,907 million Yen	3,707 million Yen
Economic growth (p.a.)	1.7%	-0.2%
Per capita dept	1,31 million Yen	7,92 million Yen
Unemployment rate	5.7	4.3
PM10	24mg/m³	24mg/m³
Per capita CO_2 emissions	4.6 t CO_2/p	9.31 t CO_2/p

city as well as the severity of the Urban Heat Island Effect (Tokyo Metropolitan Research Institute for Environmental Protection 2009). The average temperature in Tokyo is 4°C higher than in the surroundings and has increased by 3°C over the last 100 years (Hara et al. n.y.). Given the already hot and humid summers due to geographical location, the Urban Heat Island Effect poses a major hazard to the health of the cities inhabitants (TMG 2007).

Located in a zone highly prone to earthquakes, the city of Tokyo has experienced several natural disasters throughout history, which has strongly influenced people's behaviours and attitudes and has also lead to technological innovation and individual solutions – for example in the building sector. There is no other city worldwide with a comparable number of quake-proof high-rise buildings. Figure 3 shows the intensity of some selected devastating earthquakes that have hit Tokyo throughout the past centuries.

2.1 HISTORICAL DEVELOPMENT

Tokyo's current structure has been substantially influenced by its history. From 1920 to 2007 the population of the Greater Tokyo Area has grown from 7.5 million to nearly 35 million inhabitants.

Major planning issues in the 20th century, therefore, were

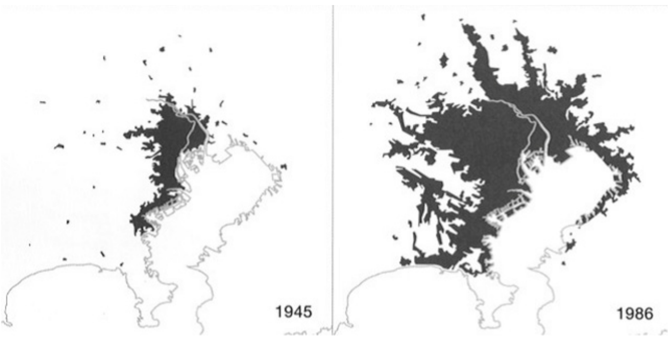


Figure 4: Tokyo in 1945 and 1986 (Okata, Murayama 2011)

rooted in the implications of this rapid growth in terms of infrastructure, environment and social well-being:

Suburbanization starts in 1920

With the opening of the first suburban railway lines and only weak zoning regulations in place, suburbanization began. The Great Kanto Earthquake of 1923, which destroyed about 300,000 houses, accelerated the suburbanization trend.

Private railway development starting in the 1920s

Enabled by national regulations, private railway companies begin developing housing estates and commercial areas along railway lines to finance railway construction.

Failure of the Greenbelt Plans 1930-1950

In order to control urban expansion, TMG introduced the Tokyo Regional Greenbelt Plan (1930), Green Belt Zoning, and the National Capital Regions Development Plan (1958), all of which aimed at the establishment of green belts around the city and the construction of new towns outside of Tokyo to accommodate the population overflow. However, the plans advisory character and "post-war liberalism", among other factors, hindered the effective implementation of these plans.

> Effect: Formation of a transport-integrated community (rail-based com-mutes making up 73% of the modal share (Okata, Murayama 2011) as urban expansion mainly followed the construction of (mostly private) railway lines until the introduction of the City Planning Law in 1968.

Immigration flood from rural areas

The post war baby boom generation began immigrating to Tokyo for access to education and jobs. To accommodate the flood of immigrants, dormitories and small wooden apartment houses with only minimum standards of technical and social infrastructure were built. This was possible due to the absence of strict planning regulation.

> Effect: Avoidance of informal settlements and provision of minimum standards such as water supply and elementary education for all citizens (known as the Civil Minimum).

1989 Tokyo Slim Campaign

Waste amounts started to increase in the bubble economy in the late 1980s and landfills for the 23 wards had reached their capacity. The Tokyo Slim Campaign implemented awareness raising measures and involved citizens in reducing and recycling waste. As a result, by the late 1990s, the amount of recycling in the 23 wards had risen to one million tons from the previous 300,000 tons.

> Today, Tokyo has one of the most thorough residential waste recycling systems in the world, awareness and cooperation in recycling has role model character.

No Diesel Campaign 1999

In order to fight air pollution by particulate matter, the No Diesel Campaign was initiated. In a dialogue with citizens it was finally decided to phase out diesel vehicles

> Effect: Phase out of 202,000 diesel vehicles in Tokyo, resulting in a measurable improvement in air quality.

New challenges: slow growth, ageing population and disaster resistance

Tokyo is no longer in a phase of rapid growth and is now characterized by a stagnation in population growth and an aging population. In the future, it will be a challenge to maintain a high quality of public transport. The Great East Japan Earthquake, as well as later earthquakes, has demonstrated the city's great vulnerability in terms of natural disasters. The Tokyo Vision 2020 represents a strategy to address these future issues (Nakayama, Hashimoto 2011).

2.2 POPULATION STRUCTURE, ECONOMY, EDUCATION AND SOCIAL ASPECTS

With a population density of 6,029 inhabitants/km² (and 14,422 inhabitants /km² in the 23 wards), Tokyo is the most

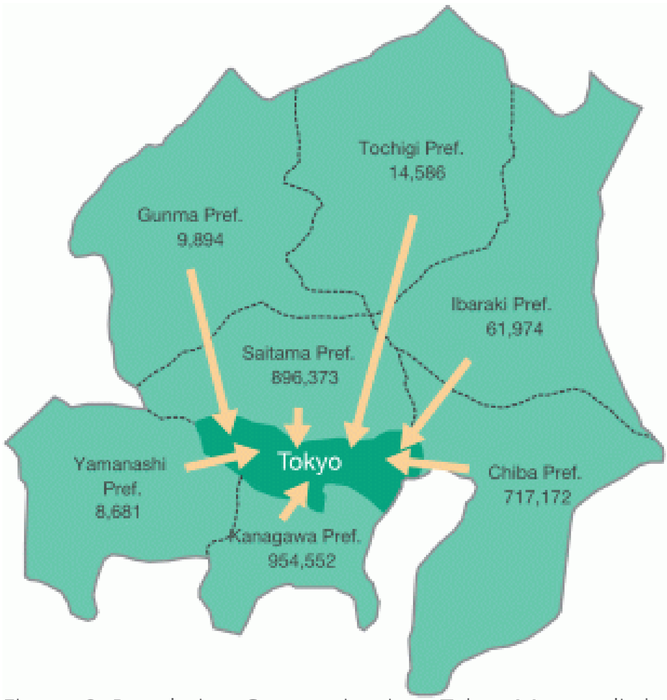


Figure 6: Population Commuting into Tokyo Metropolis by Prefecture (2005) (Tokyo Metropolitan Research Institute for Environmental Protection 2009)

densely populated prefecture in Japan. The population of central Tokyo increased continuously between the end of World War II and 1986, and then decreased between 1987 and 1996 due to sky-rocketing land value during the bubble economy. It is now recovering again since 1997. The foreign population, at 3%, is very low compared to other world capitals.

Due to considerable commuting for employment and schooling purposes, Tokyo's daytime population is 2.6 Million people higher than its night-time population.

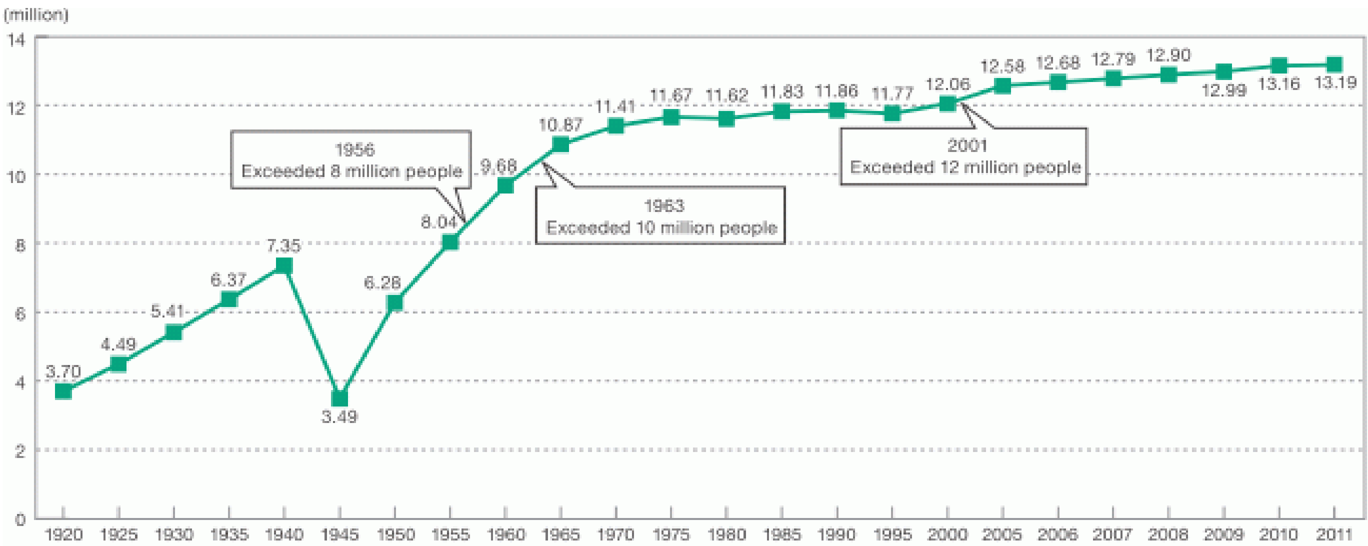


Figure 5: Trends in Population in Tokyo (Tokyo Metropolitan Research Institute for Environmental Protection 2009)

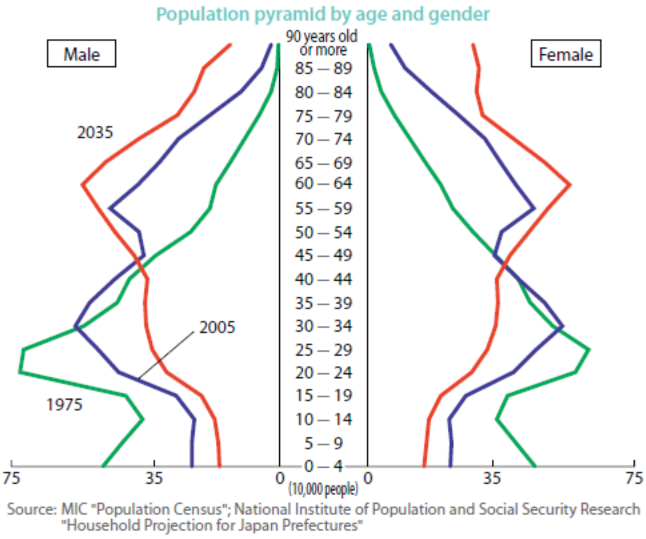


Figure 7: Population pyramid by age and gender

Approximately two thirds of Tokyo's inhabitants belong to the working-age population (15-65), while 11.4% are children and 20.4% belong to the group of aged persons (>65). The aged population is steadily increasing and in 1998 Tokyo surpassed the United Nations standard of 14% to count as an aged society. It will not be long until the city approaches the mark of a super-aged society (21%).

Elderly people were the most vulnerable group in the recent Great East Japan Earthquake. More than 90% of earthquake-related deaths affected individuals over the age of 65. Given the high likelihood of a strong earthquake in Tokyo in the foreseeable future, the city is faced with the challenge of reinforcing its emergency preparedness at multiple levels: rebuilding broken social relationships, reintegrating isolated older adults, and encouraging older adults' labour participation (Tsutsui et al. n.y.).

2.3 ECONOMY, EDUCATION AND SOCIAL WELFARE

The outbreak of the Korean War in 1950 aided Tokyo's economic recovery after the Second World War and led to a period of rapid economic growth in the 1960s. Growth was halted by the International Oil Crisis in 1973. However, the economy began to grow again with the emergence of the information society and increased global economic activity starting in the 1980s. Tokyo became world-renowned as a major international capital, boasting cutting-edge technology, culture, and fashion, as well as a high level of public safety (TMG 2011b). The Tokyo Metropolitan Area is home to Japans largest industrial area, located between Tokyo and Yokohama, and is responsible for the generation of two thirds of Japan's total production value. Still, roughly 80% of Tokyo's overall GDP is generated within the tertiary sector.

Beginning in 1986 Japan entered the so called Bubble Economy (Baburu Keiki), a phase of tremendous growth triggered by over-confidence and speculation over assets and stock prices. In 1991/1992 the burst of the speculation bubble caused massive losses in tax revenues and a critical state in metropolitan finances. Tokyo was, however, able to attenuate the financial crisis by means of two fiscal reconstruction programs (Tokyo Metropolitan Research Institute for Environmental Protection 2009).

Today, Tokyo is a global financial centre and the hub of Japans economic activity. It houses the Tokyo Stock Exchange (TSE), as well as the headquarters of several of the world´s largest investment banks and insurance companies. 51 out of the Fortune Global 500 companies are based in Tokyo. The total GDP is the highest worldwide, the per capita GDP amounts to 27,870 €. As a result of the financial crisis and the effects of the Great East Japan Earthquake, growth has

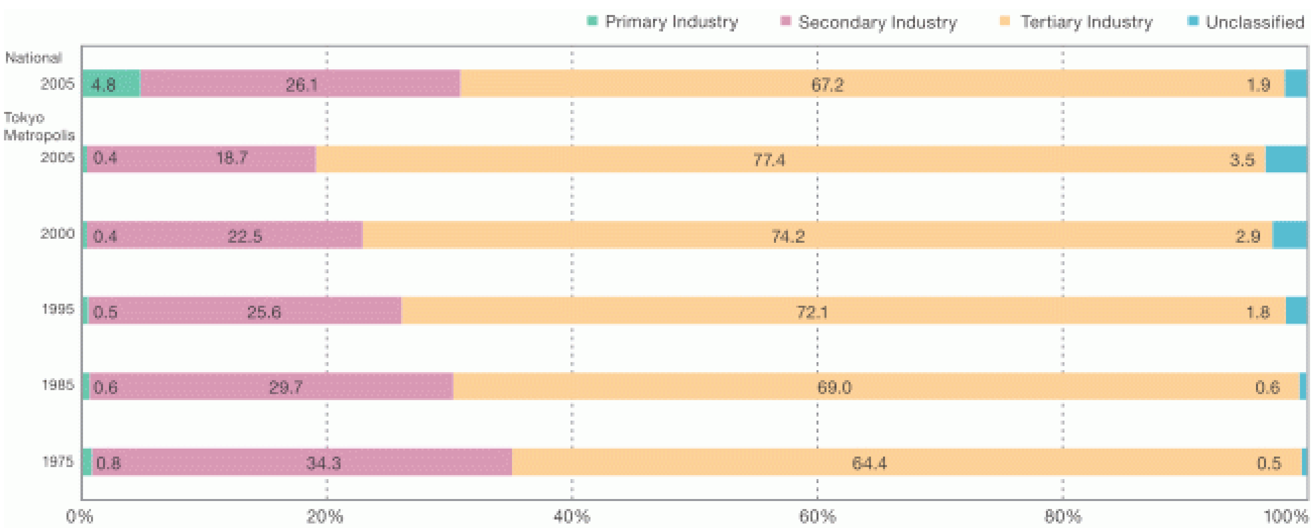


Figure 8: GDP Development by sector (TMG 2011b)

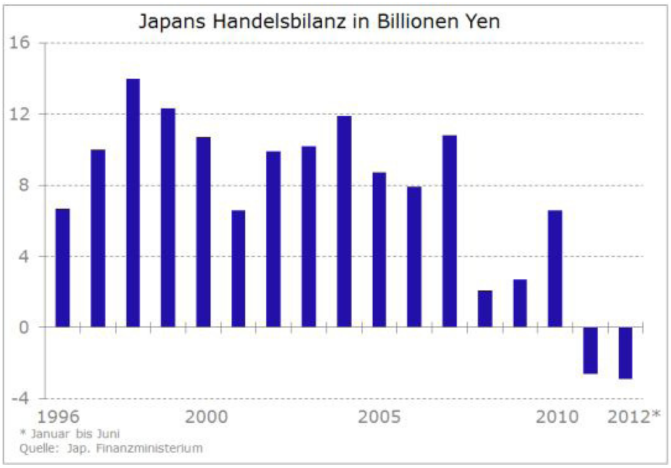


Figure 9: Japanese trade balance in billion Yen (Gellert 2012)

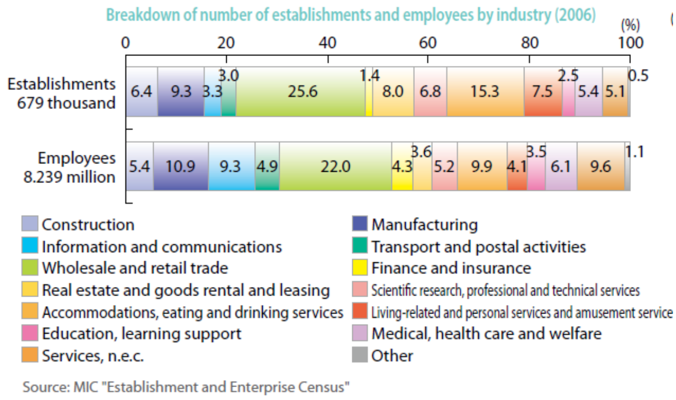


Figure 11: Breakdown of number of establishments and employees by industry (2006) (Tokyo Metropolitan Government 2011b)

been stagnant over the last years (Tokyo Metropolitan Research Institute for Environmental Protection 2009). The city has the highest living expenses worldwide (Siemens Green City Index 2011).

Roughly 70% of Tokyo's total metropolitan revenue is provided by taxes. The largest contribution of overall 16 taxes comes from the Fixed Assets Tax (27%). Roughly 1/4th of the expenses are personnel expenses, including salaries of the police and fire departments, schools, etc. Further 10% of expenses are construction costs to build social infrastructure such as roads and bridges, and facilities including schools and social welfare facilities.

More than 8.2 million people find work in Tokyo. The unemployment rate has been traditionally very low but rose up to 4.3% in 2013. In terms of employment, wholesale and retail trade, as well as food services are the most important industries.

With over 130 universities and colleges, Tokyo has the world's highest concentration of institutions of higher learning. One-third of Japan's university students are enrolled in Tokyo's schools, among which Tokyo University is the nation's most prestigious. There are a total of 943 research institutes. 5.2% of Tokyo's inhabitants are employed in science (TMG 2011b).

For decades, Japan considered itself a homogeneous middle-class society of economic equity and equal opportunity. Today Tokyo still has a diversified economy, a broad middle class social structure and a spatially integrated mix of occupational groups (Suzuki 2012). Recently however, Japan is struggling to come to terms with structural changes and a new self-image as a gap society (kakusa shakai) marked by increasing differentiation and new forms of social inequality (wealth, education, goals) (Pulvers 2012).

Economic stagnation and population aging are compounding extant problems in the labour market as well as in the already overstretched social security system.

2.4 GENERAL INTRODUCTION INTO ICT IN JAPAN AND TOKYO

Japan is one of the leading high-tech countries worldwide. The ICT sector in Japan has by far one of the most intense research and development activities by expenditures besides the life sciences (TMG 2011b). Nevertheless, the Japanese ICT industry faces some challenges such as the so-called »Galapagosization« phenomenon in which efforts to develop the latest technologies, products and services within the Japanese market have led to technolo-

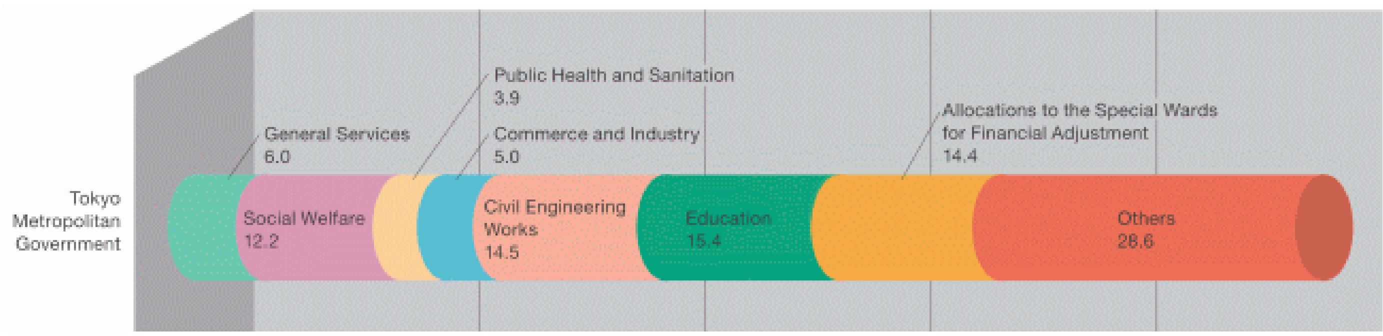


Figure 10: TMG Expenses (TMG 2011b)

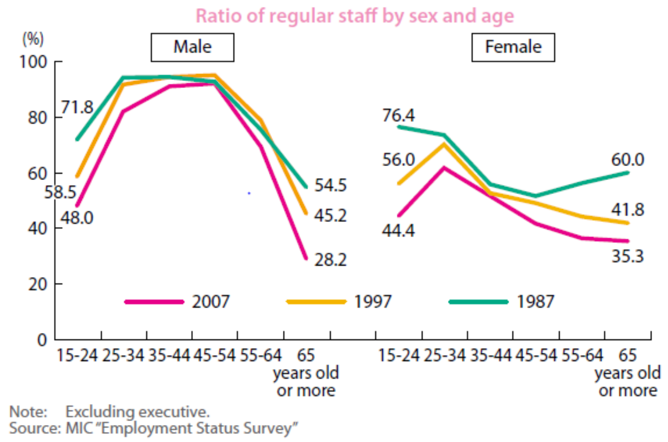


Figure 12: Ratio of regular staff by sex and age (TMG 2011b)

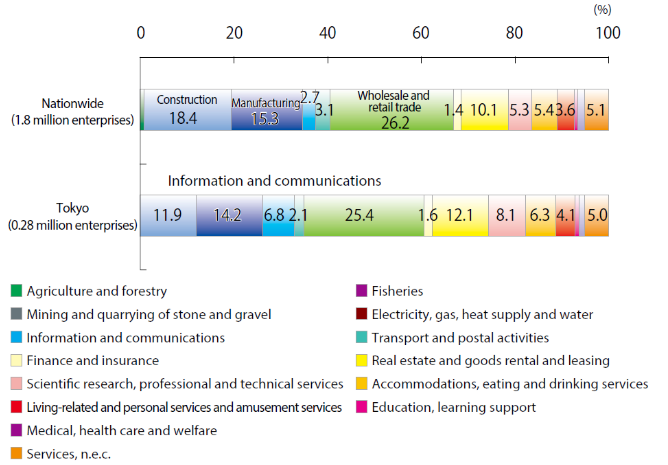


Figure 13: Breakdown of number of enterprises by industry (2009) (TMG 2012b)

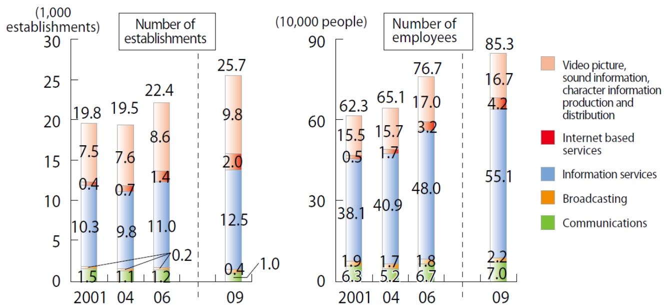


Figure 14: Number of establishments and employees in the ICT sector by medium groups in Tokyo (TMG 2012b)

gies, products and services that are unique to Japan (Takuo Imagawa 2009). Even with such an strong ICT sector Japan is only placed at number 18 in the United Nations e-government ranking for 2012 (United Nations 2012). The United Nations global survey of e-government presents a systematic assessment of the use and potential of information and communication technologies to transform the public sector by enhancing efficiency, effectiveness, transparency, accountability, access to public services and citizen participation in the 193 Member States of the United Nations, and at all levels of development.

However, ICT infrastructure in Japan is well provided and widely covered: 98.3% of households have access to the internet and 75 % of the population used it at least once in 2008. Especially the coverage rate is relatively high compared to other developed countries: for example, in Denmark only 82% of households have access to the internet, in Germany 75% have access and in Spain just 51% have internet access (Obi 2010). Nowadays, the number of cell phone subscriptions exceeds the total population in Japan with 109.43 subscriptions per 100 people in 2012. This number is even more impressive in the light of a new study about the different levels and types of impact that mobile technologies have on individuals, society and economy. The study revealed a statistically verifiable correlation between the level of mobile technology penetration in a society and important progress in the area of social development, political participation, education and gender equality. Also a positive effect of the increase of mobile phone subscriptions on GDP growth was shown for ten selected countries (Vodafone Institute for Society and Communications 2013).

Besides this, three of the world's ten largest ICT companies, based on revenue, are Japanese: Hitachi, Panasonic and Fujitsu. Two of them (Hitachi and Fujitsu) have their headquarters based in Tokyo. This demonstrates the importance of the ICT sector in Tokyo. Additionally, the importance of the sector can also be underlined by the breakdown of the number of enterprises related to information and communications in Tokyo, which is higher than the national percentage. This indicates a concentration of ICT companies in Tokyo (TMG 2012b).

Today, the number of establishments and employees in information and communications industries is on the rise, particularly in information services. The large number of establishments which are still young in years following their establishment points to the nature of this sector as representing relatively new growth industries. Sound information production and other information and communications industries generally have a high presence in Tokyo relative to national figures, with a concentrated presence of such industries observed in Tokyo (TMG 2012b).

2.5 ENERGY

2.5.1 The Japanese Energy System

Energy policy in Japan is mainly the responsibility of the national government, which is oriented on the long-term goals of energy security and CO_2-reduction. However, the Fukushima Daiichi nuclear disaster, with a meltdown of three of the six nuclear reactors due to the great earthquake and the following tsunami on 11 March 2011, affected the Japanese energy system and energy policy dramatically. Three main drivers within Japanese energy policy changed in importance as a result of the Fukushima accident:

- Climate change. In 2009, the Japanese Government set the goal to reduce climate emissions by 25% by 2020 versus 1990 levels. However, in November 2013 the government revised this goal to a 3.8% reduction by 2020 versus 2005 level, which amounts to a 3.1% increase from the 1990 level. The government argued that this is necessary since its nuclear power plants are not in operation (The Japan Times 2013).

- Import dependency and energy costs. About 93% of the energy consumed in Japan must be imported. After the Fukushima accident, cheap nuclear power was replaced by expensive fossil fuels – mainly liquefied natural gas (LNG) – and partly compensated by demand reduction. The share of nuclear power in electricity generation dropped from 29% in 2010 to about 2% in 2012 and 2013. Not only had the volume of imported LNG increased significantly, but so also had the price. Though the price for LNG in US$ remained quite stable in 2012 and 2013, the LNG price in Yen increased by 17% due to increased exchange rates. The costs of Japan's energy imports increased by 8 Trillion Yen (57 Bln €) to 58 Trillion Yen (410 Bln €) in 2013 and increased the annual trade gap to a record value of 11.5 Trillion Yen (82 Bln €) (Reuters 2014).

- Role of nuclear power. In 2013, only 2 of the 50 nuclear power plants were in operation. After the Fukushima accident, the governmental responsibilities for nuclear power were restructured and moved from the Ministry of Economy, Trade and Industry (METI) to the Ministry for Environment. In 2012, the Nuclear Regulation Authority (NRA) was founded. Today, the Japanese government aims to restart nuclear power plants as soon as possible after the proof of safety based on a new nuclear safety regulation adopted in 2013 (METI 2012).

Before 2011, energy policy in Japan was mainly driven by the goal to mitigate climate change and reduce greenhouse gas emissions. Since the nuclear accident in Fukushima, the most important drivers of energy policy are discussions on the future role of nuclear power and increasing energy costs. On one hand, a growing share of citizens is concerned about the risk of nuclear power and anti-nuclear movements have been founded in several prefectures. On the other hand, the Japanese economy is suffering as a result of the increasing cost of energy imports. In February 2014, Yoichi Masuzoe, a new governor of Tokyo, was elected. He agrees with government plans to restart Japan's nuclear reactors, while his two closest rivals campaigned on an anti-nuclear platform. The vote had been seen as a test of popular sentiment on nuclear power and showed that economic considerations are being taken very seriously (BBC News Asia 2014).

In order to understand energy policy in Japan and Tokyo, the specific characteristics and framework conditions of the Japanese energy system must be taken into account:

- High dependency on energy imports. Since Japan's fossil energy sources are very limited and renewable energy sources have thus far been barely utilized, the country imports about 93% of its primary energy demand. Japan is the world's largest liquefied natural gas importer, second largest coal importer, and third largest net oil importer.

- Electricity system consists of 10 regions with monopoles. Since 1951, the electricity system of Japan has been divided into 10 regions with one energy utility company in each region, as shown in Figure 15. As a result, the transmission line capacities between these regions are very low. Although the government began opening the electricity market in 1995, the effect has been very small until recently. In 2012, only 3.6% of the electricity was supplied by independent power producers. In 2013, the government adopted a fundamental reform of the electricity system.

- Two part electricity system. The electricity system of the eastern part of Japan, including Tokyo, runs with 50 Hz, while the western part runs with 60 Hz as shown in Figure 15. Since the capacity of the frequency coupling stations between the two parts is very limited with 1.2 GW in comparison to an expected peak demand of 75 GW (Eastern Japan, 50 Hz) and 96 GW (Western Japan, 60 Hz) in 2012, the possibilities to balance the two parts is very limited (METI 2012).

- Energy efficiency is already relatively high. After the oil crises in the 1970's, Japan pushed measures to increase energy efficiency. With a primary energy demand of 18.9 EJ (Exajoule) in 2012, the per head demand in 149 GJ (41.4 MWh) in Japan was 7% lower than the per head demand in Germany, which was at 160 GJ (44.4 MWh) (German Ministry for Economy 2013).

- Different views on the potential of renewable energies. Taking into account the available roof space, the on-shore as well as significant off-shore wind potential, together with biomass, geothermal and hydropower, the renewable energy potential is sufficient to cover 100% of Japan's energy demand. However, it is not easy to utilize this potential since there are a lot of high-rise-buildings and small buildings with small roofs in Japanese cities which limits the usage of solar energy and a large part in the centre of the Japanese island is covered by mountains. Additionally, intensive land use in the liveable areas of the country limits the use of on-shore wind power. There are areas with high renewable energy sources (RES) potential, such as the rural areas in Northern Japan (e.g. the Hokkaido prefecture), however, these are more than 1100 km away from the areas with high energy requirements in the centre of Japan (e.g. Tokyo and Kawasaki). To use this potential, the installation of new transmission lines must first occur. Therefore, the Japanese government regards the RES potential as rather limited, while other sources identify it as having a very high potential. For Tokyo, the solar potential is calculated as capable of meeting 5% of today's energy demand (which could be 10% if efficiency is doubled), therefore a major portion of renewable energy would have to be imported if Tokyo were to increase its share of renewable energy significantly (Wakeyama, Ehara 2011).

Key energy performance data from Germany, Japan, Berlin and Tokyo shows that Japan is about 7% more efficient than Germany in terms of primary energy demand as well as electricity demand per capita (see table 2). The total energy demand per capita is 13% higher in Berlin than in Tokyo. However, the electricity demand in Berlin, at 3500 kWh/a/cap, is significantly lower than in Tokyo with 6140 kWh/a/cap, which presumably reflects the small industrial production sector and high relevance of the service sector in Berlin.

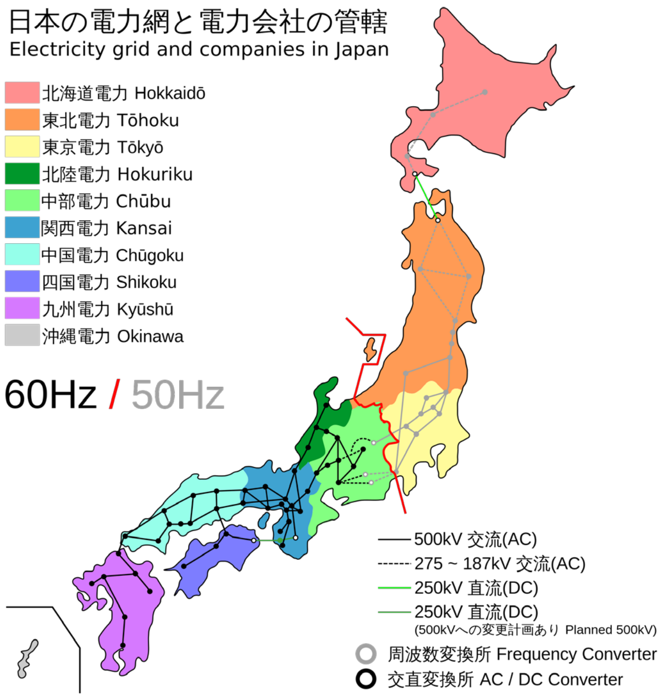


Figure 15: The 10 electricity monopole regions and the 50 Hz/60 Hz boarder and transmission lines as well as converters (Tada 2005)

2.5.2 Reform of the Electricity Sector

Until 1995, the 10 General Electric Utilities (GEU) had a complete monopoly within their regions. In 1995, METI somewhat opened the market to Independent Power Producers (IPP). It introduced the first competitive elements in the retail market in 2000, and established a wholesale power exchange in 2005. However, until now, electricity retail competition is only given for customers requiring above 50 kW. Beside the 10 GEUs there are several IPPs, wholesale electricity utilities, and power producers and suppliers on the market, however their share of the electricity retail market is only 3.6% (METI 2013b).

Due to the Fukushima accident, the weaknesses of the existing regional monopolies became obvious: lack of transmission capacity between the regions, no retail price competition, and low flexibility in changing the energy mix. Based on this experience, the Japanese government decided in April 2013 to conduct an electricity system reform in 3 steps. Step 1 is meant to be implemented by 2015 and includes the establishment of a new entity for securing power transmission nationwide. Step 2 will have been implemented by 2016 and includes the liberalization of electricity retail, securing generation capacity (by obligation to secure capacity, launch of capacity markets, and implementation of a power supply bidding system), and the foundation of an hour-ahead market. Step 3 is planned for implementation by 2018-2020 and includes unbundling of generation and transmission and abolition of price regulation (METI 2013b)

After the Fukushima accident, METI established the »Electricity Supply-Demand Verification Subcommittee«, which evaluates the severity of the power shortage in Japan. To assure sufficient power supply despite the fact that most

Table 2: A comparison of key energy performance data between Germany and Japan as well as Berlin and Tokyo

	Indicator	Unit	Germany	Japan	Berlin	Tokyo
1	Total energy demand	TWh /a	3,580	5,250	66.8	224.8
2	Total energy demand per capita	GWh /a/cap	44.5	41.4	19.3	17.1
3	Total electricity demand per capita	kWh /a/cap	8,360	7,848	3,500	6,140
4	Share of electricity demand generated by renewables	%	23%	6%	7.2%	1.3%
5	Average electricity price for private consumers	€ct /kWh	26.5	16.6	26.5	16.6
6	Renewable energy sources target on primary energy	Target	60% by 2050			20% by 2020
7	CO_2 -reduction target	Target	80-95% by 2050	4% by 2020	40% by 2020	25% by 2020
	Energy data of Price data of		2012 2013	2012 2013	2010 2013	2010 2011

of the nuclear power plants are not in operation, the committee requested power conservation measures. Without setting numerical targets, the government presented the expected reduction amount in power consumption in each electricity service area as guidelines for power conservation and promoted power conservation. For the 2013 summer period, the committee expected the electric power demand in Tokyo to be 10.5% lower than the summer power demand in 2010 and, based on this, a power capacity reserve margin of 6.7% (METI 2013a).

2.5.3 The Tokyo Metropolitan Government's Energy Policy

As early as 2000, Tokyo established the »Tokyo Metropolitan Environmental Security Ordinance« and began the development of several programs to increase energy efficiency and the use of renewable energy sources in the following years. Especially after the Fukushima accident, TMG enforced its activities in the energy sector to gain increased influence within the Tokyo energy system.

Several programs were established for the following sectors:

- **Large facilities:** The »Carbon Reduction Reporting Program« was established in 2002, followed by the »Cap and Trade Program« in 2010. The facilities must reduce their energy related CO_2 -emissions by energy efficiency measures or by using renewable energy sources.
- **New office and apartment buildings:** The »Green Building Program« was developed in 2003, »Green Labelling« was introduced in 2005 and mandatory energy efficiency performance standards in 2010.
- **Residential homes:** An energy efficiency labelling scheme for home appliances was established in 2005, subsidies have been provided to stimulate investments in solar energy systems since 2009, and an energy saving advisory program started in 2010.
- **Districts:** A »District Energy Planning System« was established in 2009 to promote the use of renewable energy, unused energy like waste heat and combined heat and power in district heating and cooling (DHC) plants. The Governor of Tokyo designates DHC districts.
- **Solar program:** A photovoltaic promotion project to provide house owners with information on PV systems and stimulate low-interest loans for financing of PV installations. Subsidies are given for solar hot water systems. In addition, small and midsize businesses receive a tax reduction if they install a solar system. For large buildings, a feasibility study on the installation of renewable energy equipment is required. The installation of a PV system is one criterion for receiving the Green Label for Condominiums.

In 2011, TMG described the »Tokyo Vision 2020« with one of eight goals being to »create a low-carbon society with a highly efficient, independent and distributed energy system«. Within this goal, the following specific energy-related measures are listed (TMG2012h):

- 1,000 MW capacity of natural gas-fired combined-cycle power plants,
- 500 MW cogeneration capacity in redevelopment projects,
- 900 MW photovoltaic capacity on detached houses, and
- 100 MW power generation capacities by waste combustion shall be installed.
- In addition leading projects for the realization of a smart city shall be conducted.

An important step in influencing the electricity sector was the creation of the constitution of the »Urban Energy Management Division« by the TMG Bureau of Environment in 2013, which aims to achieve following goals (TMG 2013a):

- Reformation of the Tokyo Electric Power Co., Inc (TEPCO)
- Promotion of electric power reform in Tokyo by increasing the share of independent power producers.
- Introduction of competition in the electricity sector by bidding the power purchase of 30 large TMG facilities (40 MW) and in future of all 300 TMG facilities (100 MW).
- Stimulation of the replacement of old power stations (17 GW) more than 35 years of age by new gas-fired power plants.
- Stimulation of investments in energy infrastructure by establishing funding structures.

2.6 MOBILITY

As suggested by the modal split [1] (see Figure 16), the backbone of Tokyo's transport system is the city's extensive rail and subway network: transit by rail accounts for up to 79% of all urban commutes. Reliability, frequency and service quality of the trains are superior to most systems in the world. The Tokyo Metropolitan Area (TMA)'s rail network consists of 121 lines with 650 stations operated by 30 companies, most of which are private. While the center is connected by a central circle line (Yamanote Sen), several radial lines connect the stations on the circle line with the suburbs. Subway lines mainly serve the city center; however, they are often operated through the private radial lines. The railway system will be described in detail in section 4.11).

Road traffic, on the other hand, is chronically congested in Tokyo and the average speed of traffic in the 23 central wards does not surpass 16.8 km/h (Tokyo International Air Cargo Terminal Ltd. 2013). In order to increase average tra-

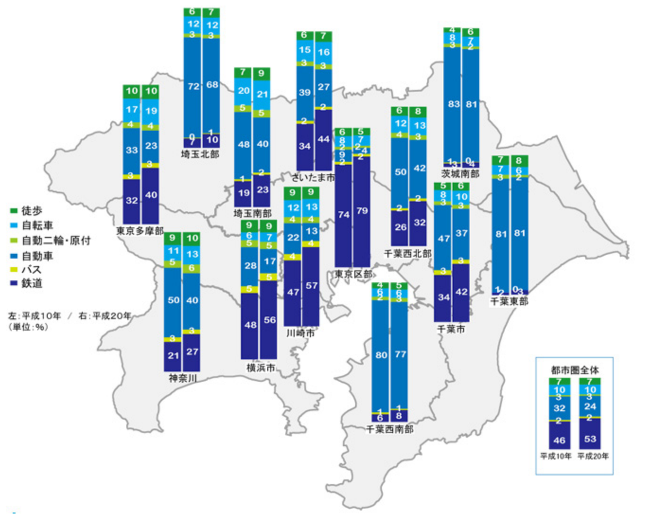


Figure 16: Modal Split in Commuting – 1998 and 2008 (Tokyo Transportation Planning Council 2008)

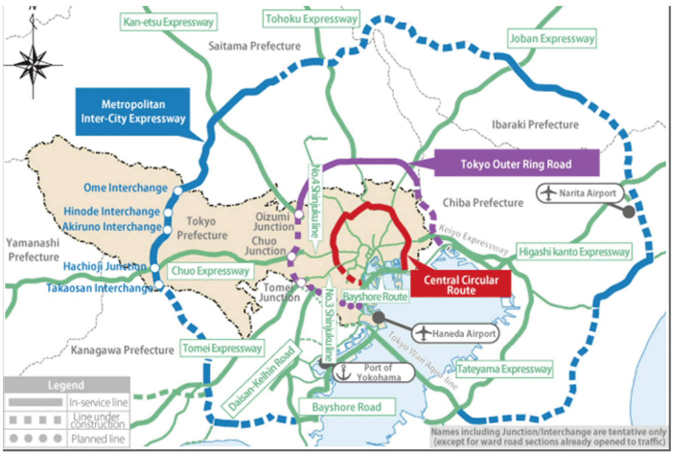


Figure 17: Tokyo's Three Loop Project (Tokyo International Air Cargo Terminal Ltd. 2013)

Figure 18: Distribution of cars by company in eastern Tokyo (Yokohama Smart City Project 2014)

1) The indicator "**modal split**" shows how traffic is spread on the different means of transport (road, rail and waterway) and indicates how eco-friendly an urban traffic system is. For example, a high share of road transport suggests high emissions and congestion; while a high share of rail transport is better in terms of sustainability

vel speeds and ease congestion and emission loads, the city has put various initiatives such as traffic light sequencing or the Vehicle Information Communication System (VICS) and the Electronic Toll System (ETC) in place.

The VICS, a traffic information and guidance system introduced in 1996, was the first and most successful system of its kind in terms of actual emissions reductions and increased travel speeds. Providing nationwide traffic information and routing via car navigation, it is now installed in more than 60% of all personal vehicles and has resulted in an increase of average travel speed by 1.9 km/h. A detailed description of the system is given in section 4.14.

The most significant congestion problems are found in the center of the city, were vehicle loads are four times higher than the national average (Tokyo International Air Cargo Terminal Ltd. 2013). To reduce congestion in the center, three loop roads: a central loop at a radius of 8-10 km from the center, a medium loop at 15 km radius, and an outer loop at 40-60 km radius have been constructed in addition to elevated and tolled radial expressways (compare Figure 17). For more details on the project refer to section 4.8.

In addition to congestion problems, the city has faced serious air pollution in the past. Measures in the transport sector addressing this problem include the ban of diesel vehicles as of 2003 by the TMG, as well as the promotion of environmentally-friendly vehicles and the introduction of car sharing services.

Japan is a forerunner in terms of market penetration of new generation vehicles. In 2012 there were roughly 3 million registered EVs and hybrids on Japanese streets, while Tokyo alone counts 4,850 EVs and 11,590 hybrids (CASBEE). The biggest challenge towards further market penetration in Tokyo is the current charging infrastructure, totaling 327 stations, which is insufficient (TMG 2008) as well as a lack of cooperation between suppliers. In November of 2013, the four biggest OEM have therefore agreed to provide additional funding to existing governmental subsidies in order to establish a national network of 12,000 charging stations overall and improve cooperation between charging networks (Bureau of Urban Development 2012).

By September 2013 there were 4,281 car sharing vehicles and 2,811 charging stations in Tokyo (Japan Smart City Portal 2014a), equaling 0.32 vehicles per 1,000 inhabitants. Operators are mainly car park chain owners and rent-a-car companies. Recently, smaller EV-based one-way systems have evolved, but are still in the demonstration phase of development.

A peculiarity of Japanese MIT are the so-called Kei Cars (Kei-Jidousha), a class of vehicles with limitations in engine size and length that were originally introduced by the government to promote motorization after WWII when people were not able to afford larger cars. Originally, these vehicles were exempt from the obligation to prove the availability of off-street parking space and benefitted from lower vehicle taxes. These benefits no longer apply. However, Kei Cars still enjoy high popularity in Japan, as they are easy to maneuver in narrow streets while at the same time being spacious on the inside thanks to their boxy shapes. Also, fuel consumption as well as initial costs are considerably lower than is the case for normal cars.

Tokyo also has a vivid cycling culture with modal shares for cycling reaching up to 19% in some regions of the TMA. Considering Tokyo's almost non-existent cycling infrastructure (8.7 km compared to 900 km in London and 1,500 km in New York City), the high cycling share might seem somewhat surprising. It results from the unique Japanese habit of mixing bicycles with pedestrians on sidewalks. The urban structure, with many narrow and winding streets further decreases traffic speeds and allows for cycling to be mixed with motorized transport in many areas. Nevertheless, improved infrastructure will create a safer environment for both cyclists and pedestrians and cyclist numbers are probable to further increase in the future.

As bicycles are the main means of transport to bridge the last mile between home and rail station, parking at station areas takes up extensive space. Japanese companies have therefore come up with innovative solutions for bicycle storage, buried 11 meters beneath the ground and storing up to 200 bicycles (see figure 19).

The TMA has two major gateways for air transportation: Narita International Airport and Haneda International Airport. With 60 million annual passengers, Haneda is an important hub for domestic air transport, while Narita is the main hub for international air transport. Narita is used by over 30 million passengers a year and ranks 13th in terms of international passenger numbers and 7th in terms of international cargo volume (TMG 2013b).

2.7 PRODUCTION AND LOGISTICS

In Tokyo, basic system conditions are continually changing due to the density of the metropolitan areas, new production and consumption patterns and demographic change. Customized products, e-commerce and a very high consciousness for service quality lead to more individual manufacturing and smaller quantities of goods resulting in higher delivery frequencies and atomization of shipments. Urban logistics is confronted with increasing traffic volumes, congested infrastructures and pollution.

Generally, the logistics system of a city enables the exchange of goods between businesses and ensures people's access to everyday goods and all kinds of services. Retail branches and home delivery services provide local supply functions that support urban life. Organizing urban logistics in a sustainable manner that is suitable for cities in the long term, above all, means that aspects such as CO_2 neutrality, energy efficiency and sustainability play key roles in planning, coordinating and operating urban materials and information flows. This involves not only the infrastructure, the means of transportation, the handling and storage of equipment, hub facilities and information technologies, but also the coordination of all these elements and actors in intelligent logistics networks.

The logistics sector plays an important role in Tokyo, as almost 40% of the entire traffic in the city is caused by freight traffic (Maeda 2012). Regarding the modal split, freight is transported almost exclusively by road, especially in the inner-city area. This is due, on the one hand, on the high density in Tokyo and, on the other hand, it is also a result of development measures for urban infrastructure. Tokyo's city-scape is constantly changing not only due to rapid growth and several historical catastrophes, but also because Japan's city planning is characterized by radical modernization of urban spaces.

Production in an urban environment offers advantages to companies such as the proximity to customers and market-

Figure 19: Conventional cycle parking and new bicycle parking in Tokyo (CoCreatr 2011)

places as well as to research and technology centers. Production plays an important role in local employment by providing jobs and opportunities for professional qualification especially in industrial wards like Ota-Ku in Tokyo. Short distances between living and working not only raise the employer's chances of recruitment but also simultaneously minimize commuter traffic. Nevertheless, in the past decades there has been a trend for manufacturing companies to relocate to areas outside of Tokyo. Although the figures for Tokyo show a relatively high share of manufacturing, the city's imports are higher than its exports. This proportion reversed for the first time in the last two years due to a slow decrease in goods production. Manufacturing is still an important economic sector, but the constantly growing imports of food products, particularly fish, now outweigh the exports. A challenge for Tokyo is to preserve businesses and industrial sites while attracting new businesses and establishing a balance between industry, trade and services.

The objective of the m:ci research in Tokyo was to gain deep insight into working concepts and existing solutions for sustainable urban production and logistics systems as well as successful means of implementation through analyzing the following practice examples:

- Yamato Parcel Delivery Service is an example of an innovative delivery concept for urban areas. It shows that the combination of a dense network of delivery hubs together with the utilization of alternative low emission vehicles form one important element of a sustainable urban logistics system. Inner-city distribution can be carried out by small electric vehicles and handcarts in a city-compatible and sustainable manner.

- The Ota-City urban production practice example in Tokyo is focused on a cluster strategy which is based on the accumulation of manufacturing companies. It is a cooperative effort between small and medium-sized enterprises (SME), mainly from the engineering and metalworking industries, which are highly specialized in different manufacturing fields. Through their collaborative approach and spatial proximity they are able to jointly process orders and benefit from the division of labor in the network.

- Tokyo is pursuing large-scale reconstruction of its road system and local infrastructure in the Three Loop Roads project, which will result in significant changes to the city's existing structure.

- The new road system includes special routes designated for freight traffic and an optimized connection especially to the newly established and sustainable Tokyo International Air Cargo Terminal.

2.8 INTRODUCTION TO THE BUILDING SECTOR IN JAPAN AND TOKYO

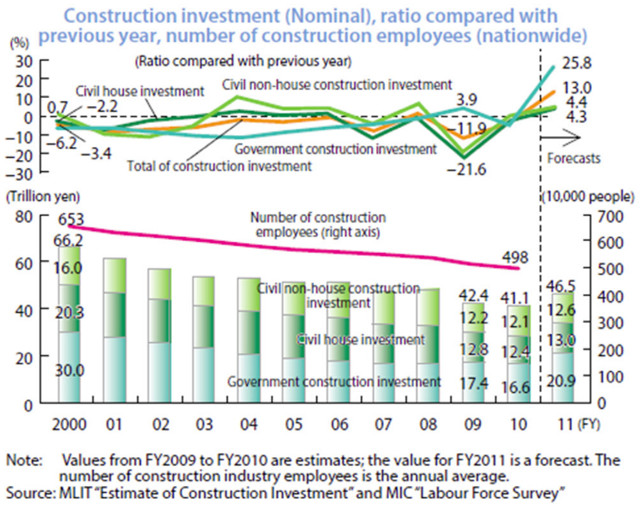
As of 2009, the construction and real estate sectors in Tokyo accounted for approximately 24% of the city's total enterprises – having a share of about 28% on nationwide construction enterprises in Japan. Their contribution on Tokyo's gross nominal metropolitan production was reported as approximately 4,7 Trillion Yen (decrease by 10% for construction[2]) and 11,2 Trillion Yen (growth by 18% for real estate) in 2009.

In general, nationwide investment in construction has been on a decline in the past, down to 41.1 Trillion Yen in 2010. However, it is expected to increase in the future due to nationwide earthquake disasters and necessity for reconstruction. Main investments are estimated for governmental construction. Civil and non-civil construction is expected to show growth rates of about 4 (see figure 20).

Land price development for residential and commercial areas in Tokyo shows a slight decrease since 2010. Nevertheless, commercial areas bring a four- to five-fold higher price per 1m² than residential areas.

Twelve different zoning types for residential, commercial and industrial use are distinguished within the City Planning Law; examples include: exclusively low-story or medium-story residential districts, neighbourhood or quasi commercial districts and exclusively industrial districts. Apart from building use, building coverage ratio, floor area ratio, shade restriction, building height and design or green space ratio are specified for buildings constructed within these zones. District plans, as upper level instruments for urban/city planning, promote the detailed and comprehensive development of districts with specific characteristics in order to improve the urban environment. Main regulations are set for the location of public facilities, buildings to be constructed (as of above) and the preservation of green areas, etc. Urban development projects (above district planning projects) are concerned with land readjustment, urban redevelopment and new residential area development. Urban development projects, often initiated by private bodies, also serve for the development of infrastructure as parts of the profit induced by such projects is re-allocated. Centralized city planning principles have changed in the last ten years towards concepts for decentralized planning, as prefectures and municipalities are normally the decision-making bodies. The procedure for city planning may also include public hearings and explanations in case of important decision-making, such as area division. In any case, public review and feedback by citizens is possible before enacting. Japan is currently experiencing a "machizukuri boom" (see also chapter 2.9) with increased involvement of local resi-

2) Compared to fiscal year 1999.



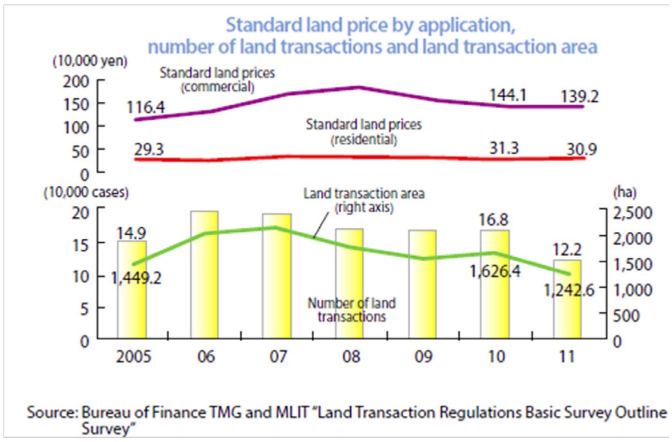


Figure 20: Nationwide construction investments (left); land transactions and landprice development (right) (TMG 2012b)

dents in urban planning projects which therefore benefit from greater public support (Lenz 2013).

Tokyo centre area[3] is characterized by close developments for construction whereas open development dominates great areas in the outer wards of the Tokyo Metropolitan area. As of 2011, the majority of buildings in all wards[4] of Tokyo are buildings with less than four storeys, representing approximately 90% of all buildings. Buildings with more than four storeys have a share of 10%, whereas only 8% of these are buildings with ten or more storeys (TMG 1957 - 2011).

As of 2008, approximately 46% of all dwellings were privately owned whereas 54% were rental units. The share of rented dwellings from public or governmental bodies was 15%. 85% of all rented dwellings were rented from private bodies. Main building types for residential housing are apartment houses, making up 74% of dwellings and detached houses comprising the remaining 24% (TMG 1957 - 2011). The average living space consumed per person in residential buildings is about 26 square meters (Schaefer, Hosoya n.y.).

In general, the main building construction types can be split into two categories: wooden and non-wooden buildings. For non-wooden buildings, building construction is characterized by reinforced concrete, steel frame construction, light gauge steel or others.

50% of the energy consumption and respective CO_2 emission within Tokyo in 2005 were created by the construction sector, namely the commercial (36.4%) and the residential sector (26.2%). Nowadays, these sectors are the targets of various programs for sustainable building development. For the commercial sector, main contributors have been stated with office buildings. Building energy supply (e.g. for heating and cooling) is dominated by electricity whereas in private households approximately 50% of energy is used for heating purposes and 35% for general power supply (e.g. lighting).

New building and construction rates within the last ten years ranging from 1 to 3% of overall ground floor area (Tokyo Metropolitan Government Bureau of Environment 2012). Due to the high vulnerability to natural disasters, low past building quality and very short building service lives (around 25 years)[6] refurbishment has not played a role in the past. It is expected to become more important in the future due to higher building standards targeted at green and environmentally-conscious buildings, resulting in additional costs for implementing respective measures and technologies (The Real Estate Companies Association of Japan 2013).

Sustainable construction and building regulation in Tokyo is focussed on low carbon development and emission re-

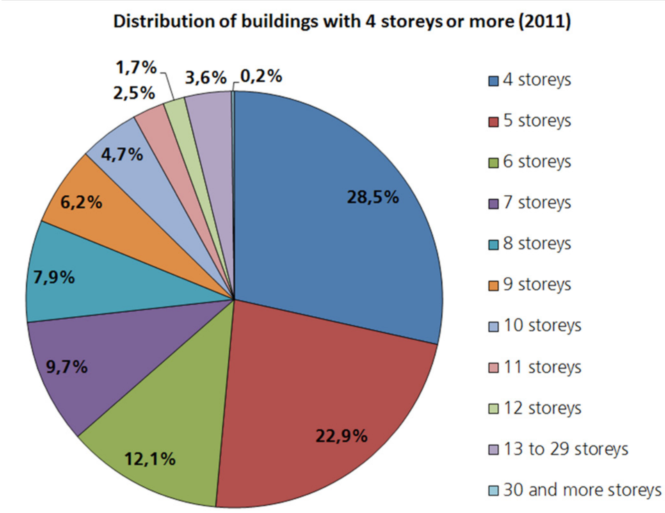


Figure 21: Distribution of buildings with 4 storeys and more as of 2011 (TMG 1957 - 2011)

3) Costal inner-city radius of about 6-8 km covering wards such as Shinjuku, Minato, Bunkyo, Sumida, Koto.
4) Beginning at wards such as Shibuya, Meguro, Toshima, Edogawa, Arakawa.

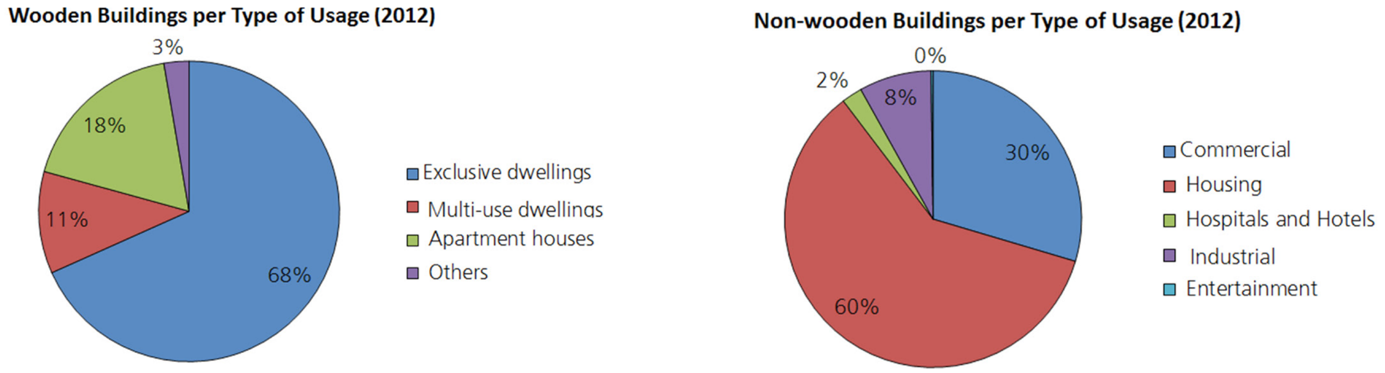


Figure 22: Wooden and non-wooden buildings per type of usage as of 2012 (TMG1957 - 2011)

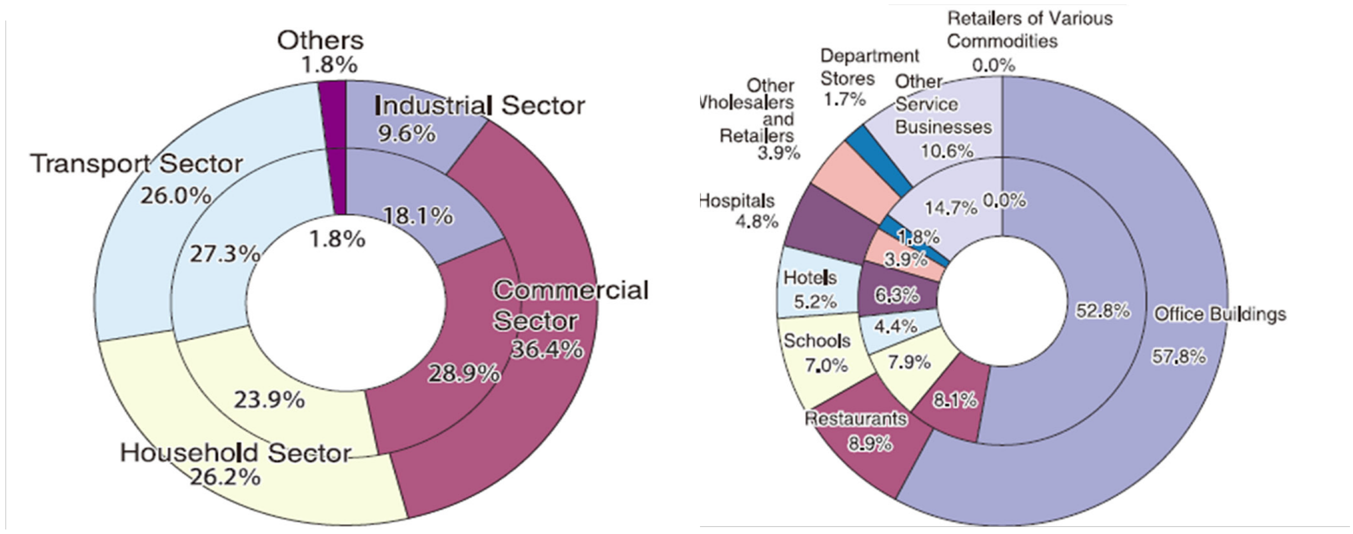


Figure 23: Increase and composition ratio of CO_2 emissions per sector (left side); increase and composition ratio of CO_2 emission by building use in commercial sector[5] (Tokyo Metropolitan Government Bureau of Environment 2008)

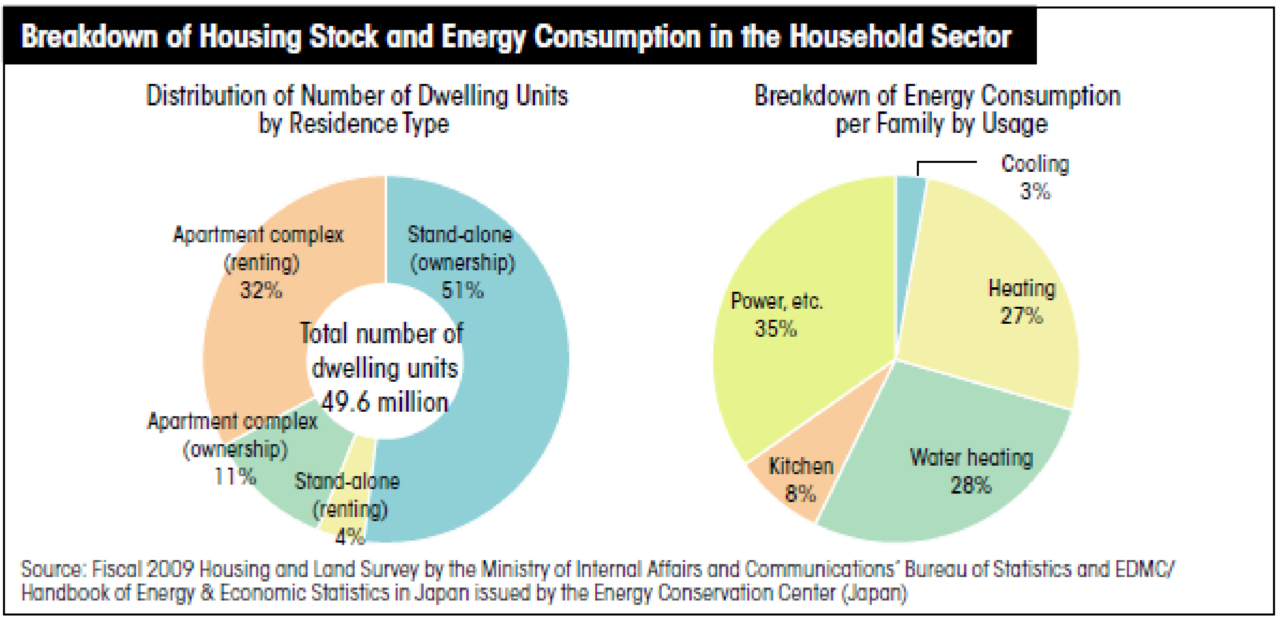


Figure 24: Breakdown of energy consumption in the housing sector (Smart 2020 2008)

5) Inner circle representing fiscal year 1990; outer circle representing fiscal year 2005.

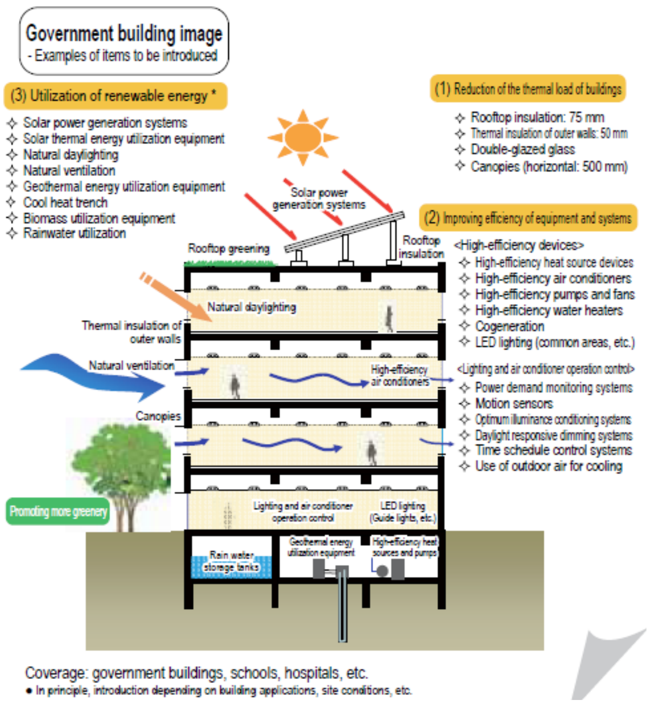


Figure 25: Examples of energy-efficiency measures as regulated in the „Energy Performance Specifications" for public buildings (TMG 2011a)

ductions, providing a comfortable indoor and outdoor built environment as well as disaster resilience. These topics are closely related to the Tokyo Metropolitan Environmental Master Plan and Tokyo Vision 2020, leading to the promotion of (Tokyo Metropolitan Government Bureau of Environment 2008,TMG 2012h):

- Global warming measures for the commercial and residential sector (e.g. via the Cap-and-Trade Program);
- Renewable energy and cogeneration for diversifying energy sources for building supply via "roof rental business/programs", subsidies for household power generation;
- Urban Development Measures via the Green Building Program or the guidelines on heat island measures;
- Smart Energy cities and Smart Grids with necessity for advanced metering infrastructure (BEMS[7] ,HEMS[8]) or customer-side systems (e.g. energy management systems, energy storage and distribution systems) as well as linking e-mobility and building construction;
- Increased energy efficiency in buildings and large scale development projects, promoting respective certificates as well as district heating/cooling;
- The development of zero-energy and environmentally-conscious buildings.

6) E.g. as of 2010: 71% of all office buildings in Tokyo with a floor area of 5.000 m² or more, have a building age under thirty years Freedman, Yasunari 2011.
7) Building energy management systems
8) Household energy management systems

2.9 TOKYO'S GOVERNANCE SYSTEM

The special ward system in Tokyo (Tokubetsu-ku) is a unique form of local governance in Japan. There are basically two forms of local government in Japan: prefectures and the municipalities that make up the prefectures. Both are local public entities of equal status and cooperate in local administration according to their share of duties. Prefectures are in charge of the broader regional administration, municipalities are local public entities that have a strong and direct relationship with local citizens and are responsible for handling the everyday lives affairs of citizens. Japan is made up of 47 prefectures, 786 cities (including cities), 754 towns, and 184 villages. Tokyo is not a city, but a prefecture. In contrast to conventional Japanese municipalities, Tokyo has therefore two special kinds of governmental institutions that have been established for specific objectives relating to local government: the Tokyo Metropolitan Government and the Ward governments.

The largest share of Tokyo consists of 23 of these special public entities – the wards. The entire Tokyo Region is called Shutoken, meaning "National Capital Region", and is comprised of the four prefectures Chiba, Saitama, Kanagawa, and Tokyo. The Tokyo Prefecture consists of the Tama area and the Ward area with 23 "ku", or wards that are, in principle, subject to the same regulations that apply to cities but actually come under a special system designed to meet the needs of a large metropolis. These 23 wards are collectively considered to be the heart of urban Tokyo.
The density and de-facto inter-wovenness of the Tokyo wards and the greater metropolitan area has led to a unique administrative system that differs from the typical relationship between municipalities and prefectures. Tokyo Metropolitan Government is a regional government encompassing the 23 special wards, 26 cities, 5 towns and 8 villages. Specifically, in the 23 wards, the metropolitan government takes on some of the administrative responsibilities of a city, such as water supply and sewerage services, and fire-fighting in order to ensure the provision of uniform, efficient services, while the wards have the autonomy to independently handle affairs close to the lives of the residents such as welfare, education, and housing. To finance the joint public services it provides to the 23 wards, the metropolitan government levies some of the taxes that would normally be levied by city governments, and also makes transfer payments to wards that cannot finance their own local administration.

In the year 2000, a larger reform of the Metropolitan Government System of Tokyo became effective, granting more autonomy to the wards (such as the responsibility for urban planning and waste management) and establishing them as basic local public entities.

2.9.1 Political Decision-Making Bodies and City Administration

On the two levels (prefecture and ward) there are numerous institutions in Tokyo that are collaborating to administer and manage the affairs of this complex city. At the prefecture level, the Governor, the Tokyo Metropolitan Assembly and the Tokyo Metropolitan Government share powers. At the Municipal level, there are ward assemblies, chief executive officers and municipal offices that are responsible for the management of local affairs.

Prefecture and ward institutions come together in a Metropolitan Ward Council in order to deal with cross-cutting issues. Figure 26 gives an overview over the most important decision making bodies and administrative institutions of Tokyo:
The **Tokyo Metropolitan Assembly** is the main decision making body of the Tokyo Metropolitan Region. It consists of 127 assembly members chosen through elections by the metropolitan citizens on a four years basis. The Metropolitan Assembly

> *"[…] has the authority to, among other things, enact, amend, and repeal metropolitan ordinances, approve the budget and certify its settlement, and elect members of the Election Administration Commission and other such bodies. In addition, the consent of the Assembly must be sought for important appointments, nominations, and other designations made by the Governor such as those of a Vice Governor or administrative commission member. Representing the people of Tokyo, the Assembly also has the powers to investigate and inspect all aspects of the metropolitan government." (TMG 2012)*

At present, the Metropolitan Assembly is comprised of eight parties with the liberal-democratic party providing the largest share of assembly-representatives.

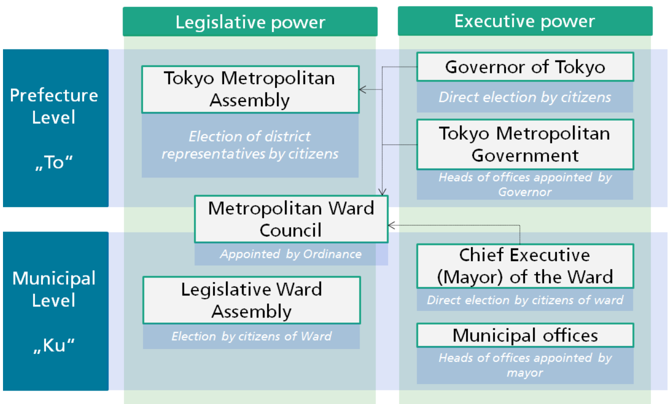


Figure 26: Governing institutions in Tokyo (own figure)

The **Governor of Tokyo** is simultaneously head of the Metropolitan Government and the main executive power within the city. He takes part in the sessions of the Metropolitan Assembly and has an important voice there. The Governor of Tokyo has a considerable amount of power, since he is in the position to:

- allocate and approve the budget of the TMG (Over 92 billion € in 2014)
- appoint the heads of the TMG offices
- lead the way in general political affairs and ordinances

Governor **Shintario Ishihara** was the most prominent and effective Governor of Tokyo within the last two decades. He came into power in 1999 and was re-elected four times until he resigned in 2012. Under his government important steps towards sustainable urban development in Tokyo were taken. Many of the best practices listed in this report were developed under his lead (Green Building Program, Cap-and-Trade system, Tokyo Vision 2020, etc.). At the same time, his style was disputed heavily and criticized having for strong tendencies towards nationalistic and right wing policies.

Naoki Inose, the Governor that replaced Ishihara resigned in December 2013 and in February 2014 Japan's former Health Minister **Yoichi Masuzoe** was elected as the new Governor of Tokyo (Sieg 2014).

A **Metropolitan Ward Council** is responsible for the communication and coordination between the Metropolitan Government and the wards. It is made up of a total of 16 members, representing an equal number of representatives from the Tokyo Metropolitan Government (including the Governor) and the wards. According to the Local Autonomy Law (Article 282-2-2) the Governor of Tokyo must first hear the opinions of the Council, when an ordinance relating to financial adjustment between the Metropolitan Government and the Special Wards is to be enacted (Ohsugi 2011).

The **Tokyo Metropolitan Government (TMG)** is the executive body, representing the prefecture of Tokyo and comparable to a city administration in other larger cities around

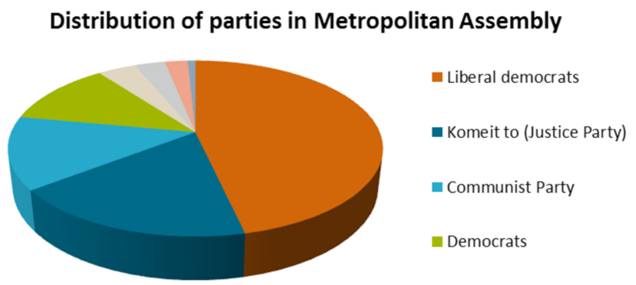


Figure 27: Distribution of parties in Metropolitan Assembly (Tokyo Metropolitan Assembly 2014)

Figure 28: Shintaro Ishihara, former actor and author who has been governor of Tokyo since 1999, (TMG)

the world. Although there are ongoing negotiations between the ward governments and the TMG about the duties and affairs that fall into the realm of the wards, at the present time, the metropolitan affairs handled by TMG as determined by law are as follows:

- Affairs relating to urban planning decisions (Town Planning Law)
- Affairs relating to the installation and management of the water supply (Water Supply Law)
- Affairs relating to the installation and management of sewers (Sewerage Service Law)
- Affairs relating to protection from and the prevention of the spread of infectious diseases (Act on Prevention of Infectious Diseases and Medical Care for Patients Suffering Infectious Diseases)
- Affairs relating to fire-fighting (Fire Defence Organization Law)

On top of these affairs that directly affect ward policies and strategic measures, there are numerous affairs on the prefecture level that TMG is also in charge of; these include environmental policies and measures, management of Tokyo Metropolitan Hospitals, promotion of SME's, construction and management of metropolitan roads and bridges, port Management, management of public enterprises in Tokyo (subway lines, bus lines, waterworks, sewerage), establishment and management of public schools, management of the Metropolitan Police Department etc.[9]

Figure 29: Yoichi Masuzoe, (BOE 2010)

As of April 1, 2012 there is more than 165,000 staff members listed as employed by the TMG. (Breakdown: Governor's bureaus, 24,096; administrative commissions and the Assembly, 1,005; public enterprises, 13,188; police/fire fighting, 64,221; school staff, 62,973) (TMG 2012).

Unlike other prefectures in Japan, the TMG has an extraordinarily strong position with regards to financial autonomy from the national level. Some revenues normally collected by municipalities (resident tax, fixed asset tax, property tax) are collected by TMG, accounting for 40% of the TMG's own source of revenues. 55% of these adjustment taxes are transferred back to the wards via a special system of financial readjustment in order to ensure a uniform level of services across the 23 Wards (Vogel n.y.). Figure 31 gives an overview of the Local Allocation Tax System between the Metropolitan Government and the wards. In addition to the adjustment taxes there are 13 other kinds of taxes (such as corporate taxes) that are collected by the TMG. All taxes account for almost 70% of the revenues generated by the Metropolitan Government.

2.10 CITY PLANNING, POLICIES AND LEGAL CONDITIONS

Tokyo is characterized by its patchwork structure. Modern shopping districts, characterized by wide streets, skyscrapers and pedestrian walkways, lie side by side with traditional neighbourhoods featuring a maze of narrow lanes of small lots with a mixture of apartment and single-family houses and miniature gardens. Streets in these neighbourhoods are not seldom used as an extension of the living-room or additional storage capacity for small businesses. This patchwork structure is reflected in two different planning approaches: *Toshikeikaku* (urban planning), government planning focussing on overall physical structure and layout, and *Machizukuri* (community-building), concerned with small-scale urban design that is triggered by community organization and participation of local residents.

Toshikeikaku – urban planning

The *National Land Use Planning Act* divides the land into five categories: urban area, agricultural area, forest area, natural parks and natural conservation area, each area being governed by a particular law. The areas partly overlap, resulting in 73% urban area, 56% agricultural area, 33% forest area and 19% natural park area in the Greater Metropolitan Area of Tokyo (Okata, Murayama 2011). Land use in urban areas of Tokyo is controlled by the City Planning Law. To control urban sprawl, the area is roughly

9) For a full list of TMG affairs please see (Yokohama Smart City Project 2009).

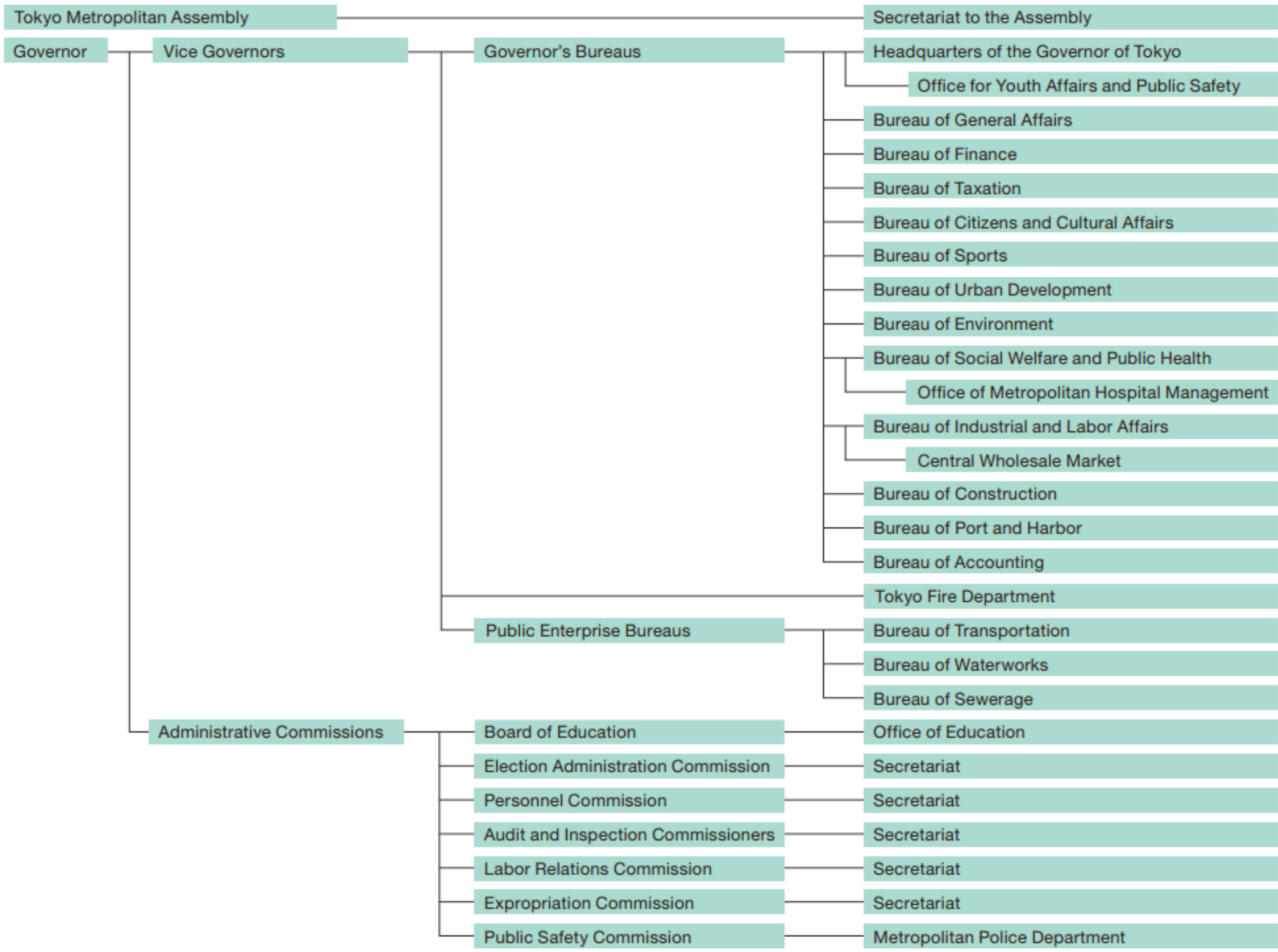


Figure 30: Organizational chart of the TMG (as of April 1, 2012) (TMG 2012)

Category	FY 2010 (¥ million)	Ratio (%)
Metropolitan Taxes	4,190,132	67.9
2 Corporate Taxes thereof	1,246,033	20.2
Local Transfer Tax	178,264	2.9
Special Local Government Grants	16,458	0.3
Local Allocation Tax	—	—
Sub-total (General Fiscal Resources)	4,384,854	71.1
Special Grants for Traffic Safety Measures	3,854	0.1
Charges and Obligatory Share of Expenses	58,661	1.0
Charges	115,558	1.9
Fees	25,758	0.4
National Treasury Disbursements	452,847	7.3
Subsidies to Municipalities where National Facilities Are Located	24	0.0
Revenue from Property	63,038	1.0
Contributions	7,813	0.1
Funds Transferred	248,950	4.0
Funds Carried Forward	107,883	1.7
Various other revenues	349,207	5.7
Metropolitan bonds	352,254	5.7
Total	6,170,701	100.0

Figure 31: Details of the TMG's revenue (TMG 2012)

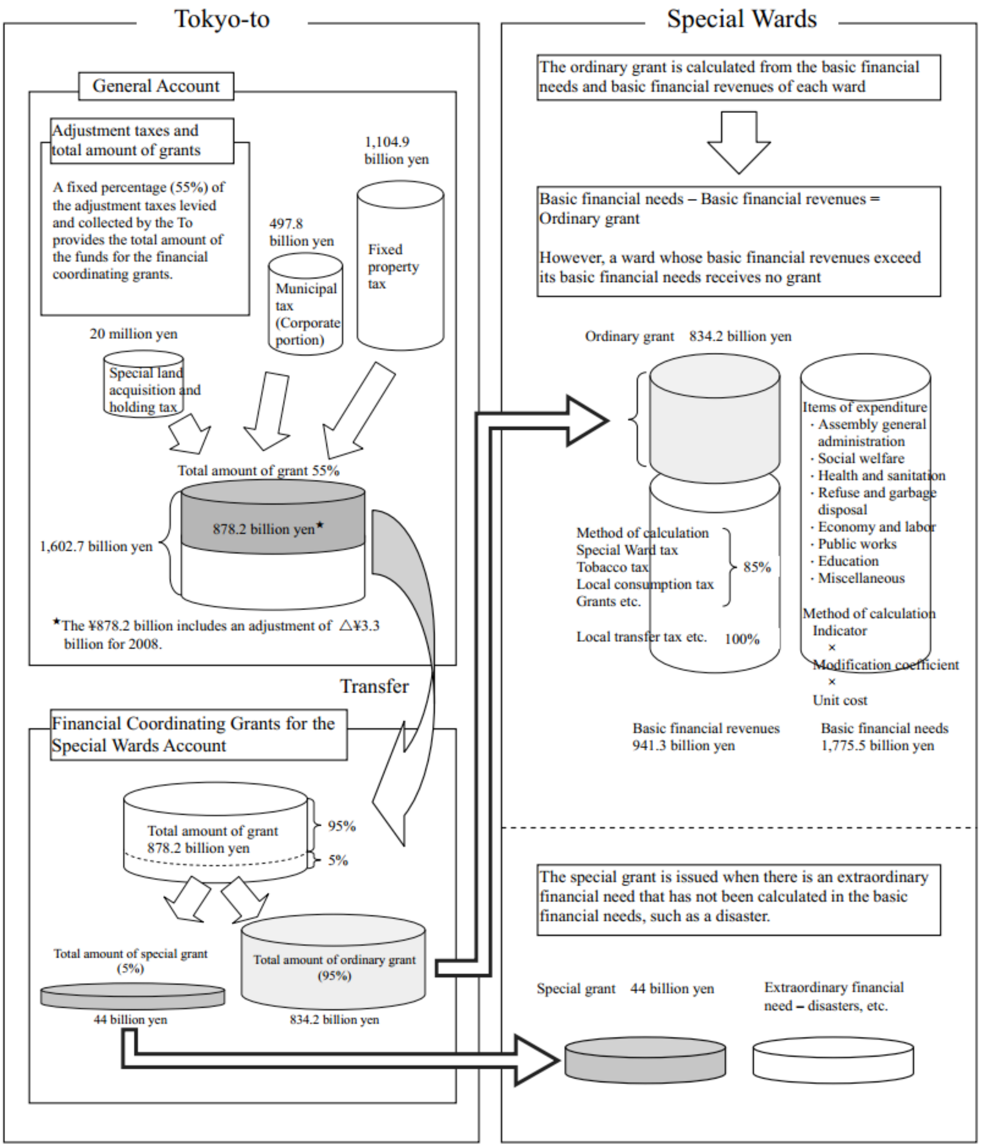


Figure 32: Basic mechanism of the Financial Adjustment System between the Metropolitan Government (Tokyo-to) and its Special Wards (Ohsugi 2011)

divided into Urbanization Promotion Areas (UPA) and Urbanization Control Areas (UCA).

The City Planning Scheme primarily consists of a vision, two master plans and three development policies plus individual city plans that are formulated on an optional basis, e.g. when a development project is planned in the area.

The *City Planning Vision* is the overarching document for urban planning; it defines future goals and policies and suggests measures by which to reach these. The current vision was formulated in 2001 and revised in 2009. For the Greater Tokyo Metropolitan Area it foresees a circular megalopolis structure in combination with a concept of compact cities at the local level with essential urban functions concentrated around train stations.

The Tokyo Prefecture Area (23 wards and Tama region) is divided into five zones according to its characteristics and future envisioned role in the Greater Tokyo Area. Future challenges, as well as strategies to overcome these, are outlined for each zone.

The vision sets five goals for urban development in Tokyo and defines seven basic strategies for reaching these goals:

Goals	Strategies
• Maintenance and further development of urban vitality • Coexistence with the environment • Creation of a high quality living-environment • Exhibition and further development of Tokyo´s unique urban culture • Cooperation with and integration of stakeholders (residents, corporations, NGOs, etc.)	• Improve the regional transportation infrastructure • Establish centres that increase economic vitality • Transition towards a low-carbon city • Form networks of water and greenery • Create attractive urban spaces • Improve living environment • Create a highly safe, disaster-resistant city

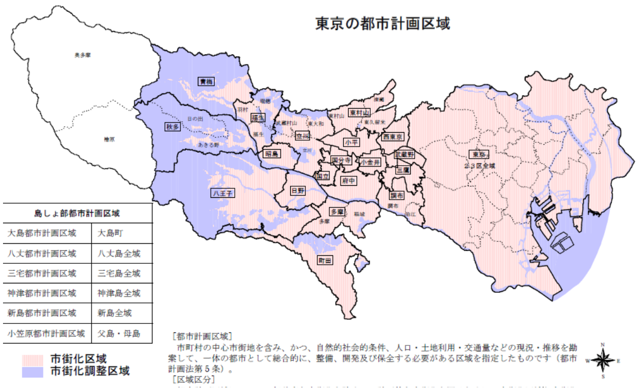


Figure 33: Urbanization Promotion Areas and Urbanization Control Areas in Tokyo (Legend: pink: UPA/ blue: UCA/ white: forest area/natural park area) (Bureau of Urban Development 2011)

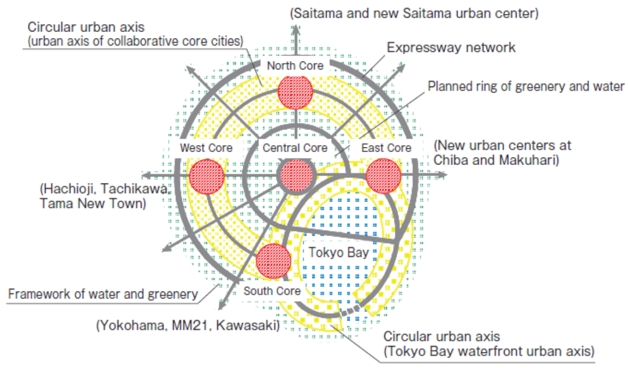


Figure 35: Circular megalopolis structure of Greater Tokyo BOE 2003)

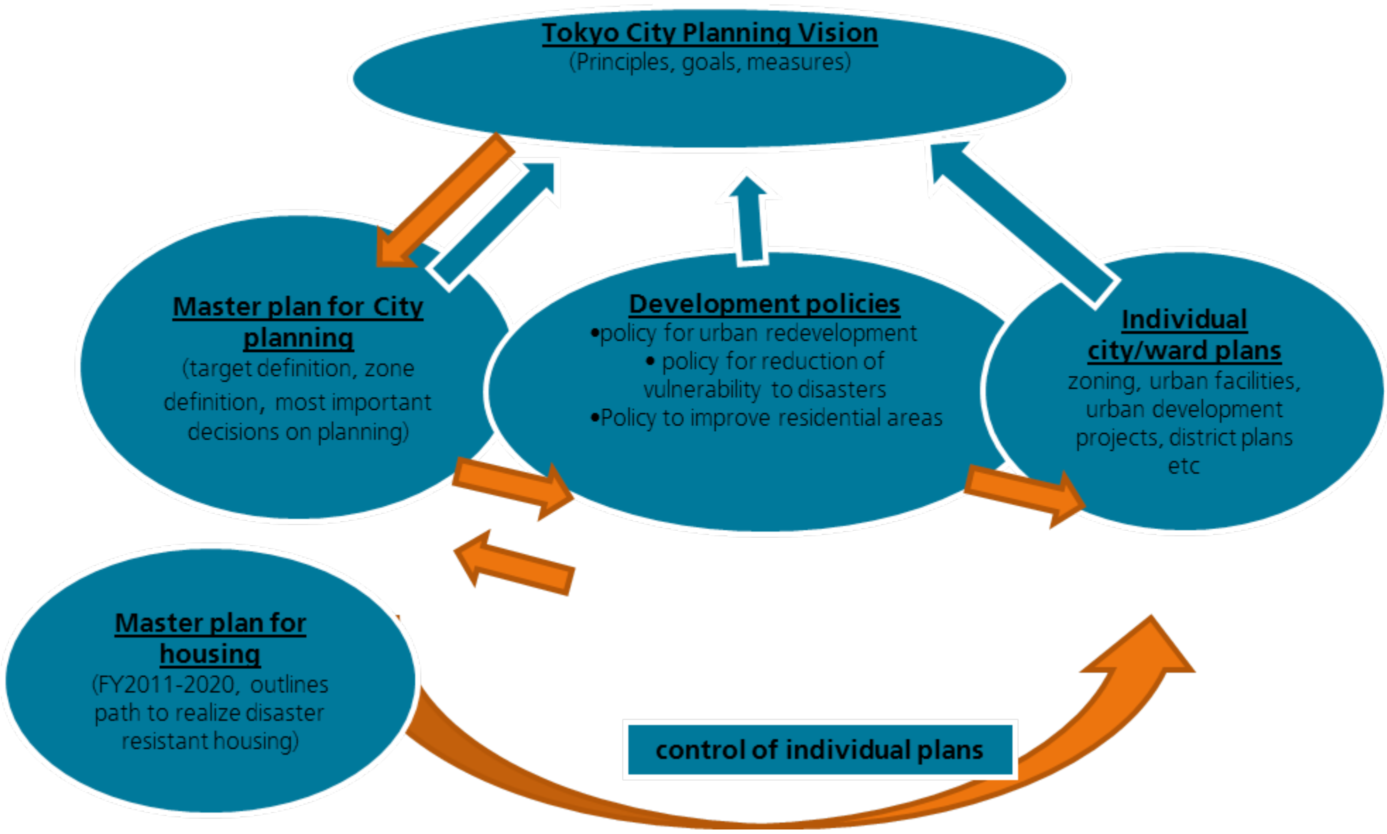


Figure 34: Tokyo City Planning Scheme (m:ci, based on Bureau of Urban Development 2011)

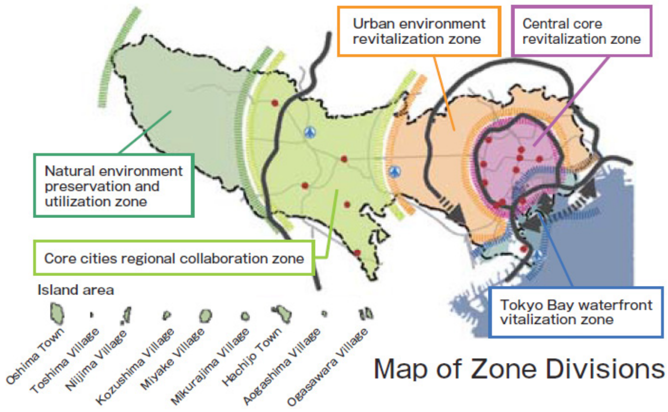


Figure 36: Map of Zone Divisions (BOE 2003)

The Master plan lays out a path towards reaching the goals defined in the vision and suggests a number of specific measures and projects, including the creation of parks, air corridors or bridge structures for trains to avoid fragmentation. Since the 50rd revision of the *Urban Renewal Law* and the *Land Readjustment Law* in 2002 and 2005 respectively, private companies are allowed to draft and implement urban development projects after approval by the city government.

For success monitoring, some specific goals are formulated in the Master Plan:

Individual City Plans generally include items that are subject to *City Planning Law* or the *Building Standard Law* (building height, land uses, design, plans for new small streets and parks etc.) The plans must adhere to the city master plan and the three development policies and must be approved by the local government. Figure 38 shows the city plan for the 23 wards of Tokyo.

Machizukuri – community building

In addition to top-down city planning, a secondary bottom-up approach, the so-called *Machizukuri* has evolved in Japan since the 1960s. Originally a protest movement by residents who opposed specific aspects of centralized planning (e.g. the building of high-rises in residential neighbourhoods), the concept evolved to represent a diverse range of local development projects relating to improving the local environment and the liveability of neighbourhoods (Hein 2008). The main characteristic of the Machizukuri concept is the active role played by local citizens in planning and management of the projects, resulting in strong communal bonds and raising the power of citizens to influence urban policy. Machizukuri projects are supported financially and organizational by the establishment of ordinances and funds on a local level (Woodend 2013). In general, Machizukuri projects are concerned with small scale development. Some examples include:

- Redevelopment of traditional shopping streets (Shotengai);
- Decreasing vulnerability to disasters by lowering density and replacing wooden building constructions;
- Implementation of pocket parks;
- Measures to increase accessibility of infrastructure for people with a disability;
- Social measures for the integration of senior citizens.

- **Increase of traffic speed to 30 km/h by 2025 (21 km/h in 2000)**
- **Decrease of congestion on trains to 150% in peak hours by 2025 (2000: 180%)**
- **Doubling of green area by 2015**
- **Maintaining green share of 80% in Tama region until 2025**
- **Increasing share of disaster proof buildings to 95% by 2015**
- **Creating a fire protection belt in the Tama region**

Figure 37: Specific goals 2015/2025 formulated in the Master plan, source: (TMG 2008)

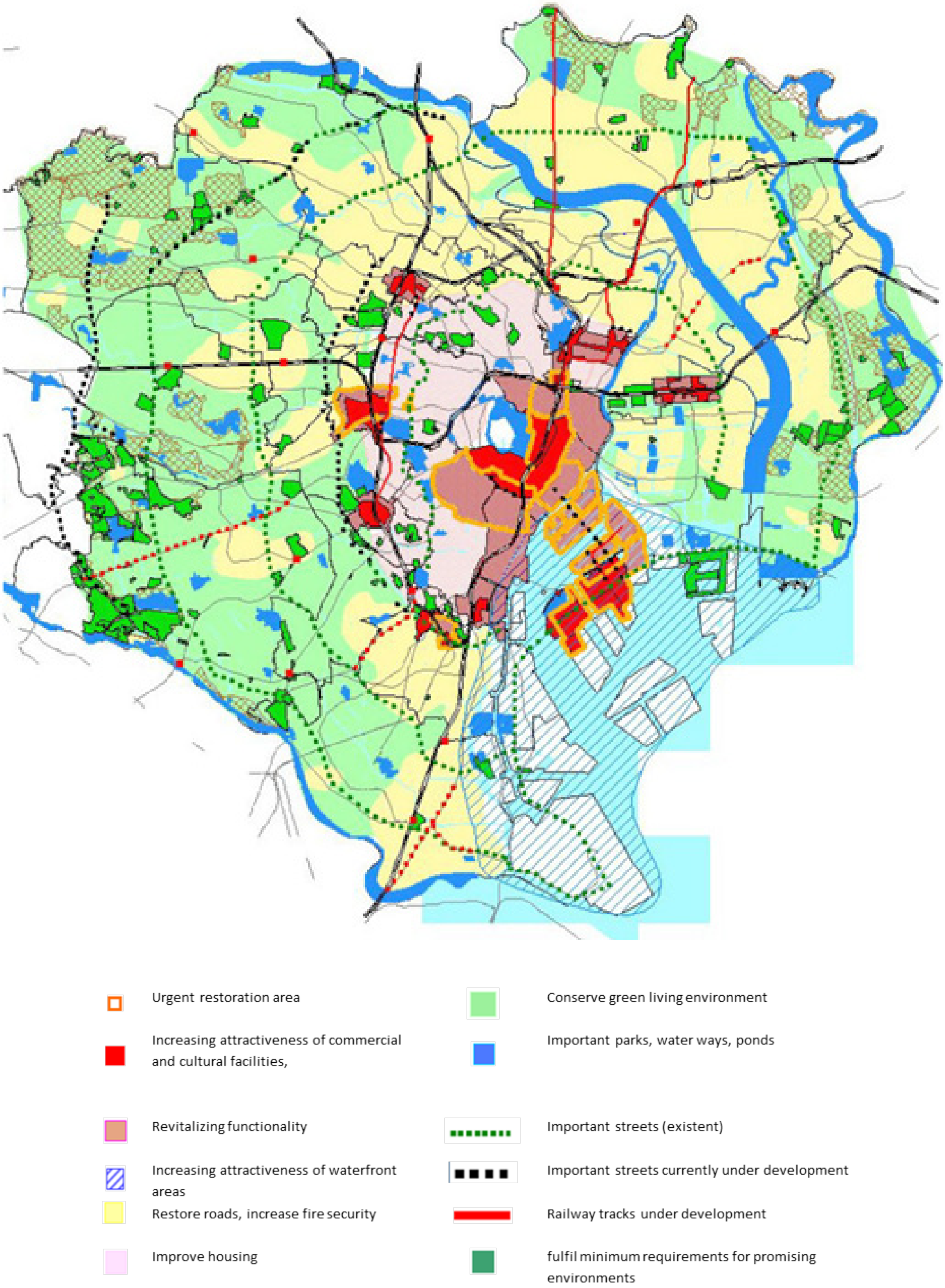


Figure 38: City Development Plan for the 23 Special Wards (Bureau of Urban Development 2011)

3

3 CLIMATE CHANGE STRATEGY & TOKYO VISION 2020

There have been several events in Tokyo's recent history that are directly related to the citizen's struggle for an environmentally healthy and liveable city. One important period was the Tokyo war on waste in 1971, another one was the methyl mercury-induced Minamata disease around 1995 that began shaping people's awareness and affected policies and regulations. However, Tokyo's quest for sustainability really began in the year 2000, when the TMG enacted the "Tokyo Metropolitan Environmental Security Ordinance". Prior to this milestone there were two events that helped individuals with a sustainability-focus come into positions of influence: the election of governor Ishihara in 1999 and the assignment of Teruyuki Ohno to the environmental administration of TMG in 1998.

Teruyuki Ohno had been working for the TMG since 1979, accumulating experience from the Bureau of Sewerage, the Bureau of Port and Harbour, the Bureau of Urban Development, and the Bureau of Policy and Information. Under the newly elected Governor Ishihara, he was in charge of planning and implementation of the TMG's campaign "Say No to Diesel Vehicles", which enjoyed great success at the beginning of the 21st Century (BOE 2008). This campaign was directed at the health of citizens and created a lot of awareness for the necessity of environmental policies and sustainability in Tokyo. Until today, this campaign is present in the mind of the people, with many citizens in Tokyo and several of the interview partners referring to the moment that Governor Ishihara showed a plastic bottle with soot from diesel vehicles in front of the Tokyo Metropolitan Assembly, making everyone realize the extent to which the air is polluted in Tokyo. One could say this image marks the collective initial moment of beginning the move towards environmental protection and sustainability in Tokyo.

The "Tokyo Metropolitan Environmental Security Ordinance" was a ground-breaking regulation in Japan, since it mentioned "global warming" and an upcoming climate crisis for the first time and at the same time required large businesses to report their greenhouse gas emissions to the TMG (TMG 2002). Moreover, the Environmental Security Ordinance became the origin of a broad scope of TMG programs, regulations and incentives – all aimed at making Tokyo more sustainable and liveable.

The main approach towards shaping sustainability that was chosen by Tokyo's administration is a combination of **market mechanisms** and **regulations**. The idea is to transition Tokyo's markets in such a way that financial assets are channelled into green investments. The self-organizing forces of the economy are supported in order to shift investments towards low-emission technologies and create, for example, green real-estate markets through certification programs and the introduction of renewable energies. Usually, TMG runs a moderate carrot-and-stick policy, with large carrots and small sticks for industrial actors.

Today, four key policies shape Tokyo's path towards sustainability:

a) The Environmental Master Plan
b) The Green Building Program
c) The Tokyo Climate Change Strategy with the Cap-and-Trade System
d) The Tokyo Vision 2020

Framing Sustainability in Tokyo:
There are several definitions of sustainability in Tokyo. We would like to point out two different formulations on what sustainability means for people in Tokyo. In its Environmental Master Plan, the TMG states:

> *"A city exists in conditions where there is a secure and stable subsistence foundation of all living beings; an "environmental vessel" so to speak. In the same way, an urban environment should be maintained at a level where the lives and health of those living there are not jeopardized by pollution. Moreover, to be sustainable not only environmentally but also socially and economically, a city needs to be capable of providing comfort so that people enjoy high quality urban life."* (BOE 2008)

Also, the Japanese Society for Sustainability (JFS) defines sustainability by referring to Environment, Society and Economy. In 2005, the following definition was shaped:

> *„After thoroughly examining definitions that served as benchmarks in the past, JFS defined the word „sustainability" as follows: acts by humankind that respect the diversity of all creatures, and result in the passing on of life, nature, livelihoods and culture to future generations within the carrying capacity of the natural environment, and the establishment of mutual connections with the purpose of building better societies and seeking the greatest happiness of the greatest number across both time and space."* (Tada 2005)

After the Great East Japanese Earthquake in 2011 the importance of resilience as a part of the Japanese definition of sustainability grew significantly. JFS states today: *„Our challenge is to consider not only sustainability and future generations on our planet, but also how to make our livelihoods and communities more resilient today."* (Calimente 2009).

Simultaneously, TMG has heavily shifted priorities towards resilience and safety after 2011, as explained in chapter 3.3 on the Tokyo Vision 2020.

3.1 THE ENVIRONMENTAL MASTER PLAN

Tokyo's first Environmental Master Plan was enacted in 2002. It contained the early basis of the Green Building Program and several goals towards a green and environmentally-friendly Tokyo. Global events, a shift in the mindset of Tokyo's citizens and the growing awareness of increasing risks through climate change lead to a revision and the enactment of a new TMG Environmental Master plan in 2008. According to TMG interviewees and several reviewed documents, such as the Tokyo Climate Change Strategy (Suzuki 2012) and the environmental Master plan (BOE 2008), the following discussions had an impact on Tokyo's understanding of sustainability:

The awareness of climate change as a real threat rose dramatically throughout Japan with the IPCC Fourth Assessment Report on Climate Change in 2007 (Pachauri, Reisinger 2007). At the same time local effects increased in Tokyo:

- The **urban heat island** effect lead to a shift in temperatures of 2-3 °C degrees within Tokyo, resulting in increased summer temperatures and an increase of tropical nights (BOE 2005b). Although measures to combat the Tokyo heat island effect were put into place by TMG (BOE 2005), the macro-structure of the city continued to be dominated by new high-rise buildings preventing the off-shore wind flow from cooling the city centre, which contributed to an aggravation of the Tokyo heat island effect. [10]

- A drastic **increase in torrential rainfalls** throughout Tokyo lead to increased overload of the storm water capabilities of the Tokyo sewerage system and made citizens aware of a changing local climate. Between 1990 and 2005, the amount of locations in Tokyo recording an hourly rainfall of more than 50 millimetres rose by 500%.

„On September 4, 2005, a torrential downpour of more than 100 millimetres per hour inundated the western part of Tokyo's Ward area. More

10) For a good summary on the urban heat island effect in Tokyo see Edahiro 2008.

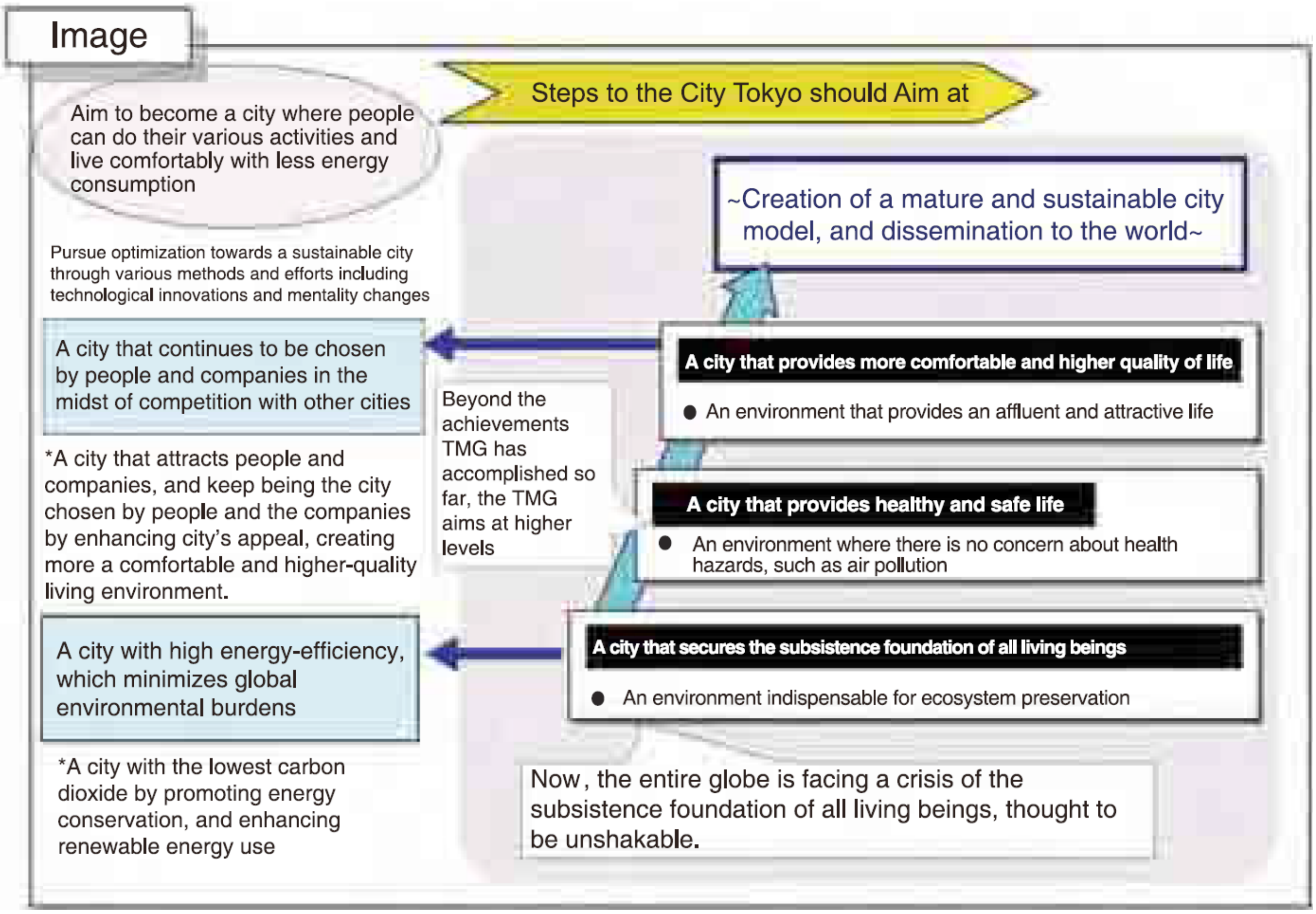


Figure 39: Goal setting in TMG Environmental Master plan (TMG 2012a)

than 5000 households suffered flood damage, the subway system and expressway interchanges were temporarily closed, and urban functions and the lives of citizens were seriously affected. Given the ongoing trend to effectively use urban space by building subways and underground shopping complexes as well as an increase in the number of owners building homes with basement/semi-basement rooms or parking spaces, measures to protect against such intense rainfalls became a topic of rapid interest" (Sugai 2008)

- The strong **dependence** of the entire Tokyo Metropolitan Area **on resources and food** from outside the city and outside the country leads to increased vulnerability of Tokyo in case of geological changes at the macro-level. 44% of the 30 tons of resources used by every Japanese person each year must be imported from abroad (Panel for New 3Rs Strategy 2009). If climate conditions in Japan change to a certain extent or commodity prices for oversea products rise unexpectedly, Tokyo citizens will face severe challenges in meeting their resource needs. At the same time, GHG emissions from resource processing and consumption sum up to 1.34 billion tons of CO_2 per year (Ibid.).

- Existing **environmental pollution** (mainly air pollution) and the growing **competition between cities** to attract a highly skilled workforce and investments by companies resulted in an increased perception of the need for a green image and a high-quality urban environment.

With the revised Environmental Master plan from 2008, the Tokyo Metropolitan Government intended to address these challenges in an integrated manner by formulating ambitious meta-goals and delineating coherent strategies and measures for each sub-sector. The three meta-goals set in the environmental master plan are:

a) Securing the subsistence foundations of humans and other living organisms
b) Ensuring a healthy and safe living environment
c) Creation of a more comfortable and high-quality urban environment.

Goal a) heavily draws on the content and targets of the Tokyo Climate Change Strategy enacted in 2007 (see chapter 3.2). Ten basic areas of impact are addressed in order to achieve the Tokyo climate change goal for 2020:

- Cap-and-trade Program;
- Mandatory reporting program for SME and households;
- Energy efficiency labels for appliances;
- Green labelling of condominiums;
- Expansion of renewable energy use;
- Green Building Program;
- CO_2 reductions in urban developments by district energy planning;
- Education, information and leadership by TMG;
- Measures towards sustainable transport;
- Measures for promoting resource conservation as well as reuse and recycling.

Goal b) focuses on environmental pollution in Tokyo. Measures are directed at air pollution (e.g. emission controls for new vehicles), chemical contamination of soil, groundwater and water (e.g. IC-tag tracing of chemical waste and waste monitoring system) and at noise from air and land travel.
Larger urban development projects need to undergo an Environmental Impact Assessment (EIA). In 2002, the TMG enacted a revised regulation on the EIA, which is a mandatory component of a variety of development projects. The threshold for being asked to deliver an EIA thus is comparably high. For complexes with less than 1.500 houses, landfill sites with less than 15 ha or new petroleum pipes with less than 15 km it is not mandatory to prepare an EIA. (BOE 2005a)

Goal c) is being pursued with a variety of measures addressing the increase of green spaces, measures for redeveloping the water cycles and direct measures against the heat island effect.

3.2 THE TOKYO CLIMATE CHANGE STRATEGY

„In the absence of a national strategy on climate change mitigation, the Tokyo Metropolitan Government has advanced the world's highest-level strategies and has taken the lead in Japan's climate change mitigation measures. It may be noted that the Tokyo Climate Change Strategy is far more ambitious in its objectives and scope than Japan's commitment under the Kyoto Protocol. "
(The World Bank 2009)

With 53.6 million tons of CO_2 emitted in 2009, Tokyo ranges between Switzerland and Bulgaria on rank 29 of the most highly emitting regions in the world. With its per capita emissions at 4.4t CO_2 per year, Tokyo has a comparably low CO_2 output. Nevertheless, there is a need to tackle GHG emissions on the city scale - especially with respect to the building sector.

As shown in Figure 38, the building sector accounts for over 70% of all emissions in Tokyo, showing a steady proportional increase in the share of overall emissions since 1990, although overall emissions peaked in 2007 and have been declining since then.

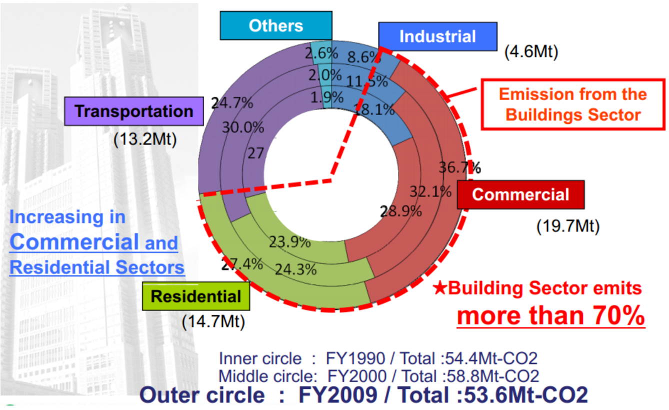


Figure 40: Tokyo CO_2 emissions by sector (Tokyo Metropolitan Government 2012e)

One important step in Tokyo's climate change strategy was a binding target for CO_2 emissions-reductions on a city level. In December 2006, the TMG committed itself to reduce city emissions by 25% in comparison to the year 2000.

The reduction target, however, was not equally distributed to each sector, but rather focused on addressing the most pressing problems and collecting low hanging fruits in terms of enacting and implementing measures to reduce greenhouse gas emissions within the city. Table 3 shows a comparison of the Business As Usual Scenario of the TMG with the targets set for each sector. Since industry is expected to emit 8% more by 2020 than under a BAU scenario, the largest shares of emissions-reductions must be carried by the commercial and the household sectors.

Table 3: emissions reduction targets and BAU in 1,000 tons CO_2

	BAU for 2020	Comparison to 2000	Target for 2020	Comparison to 2000	Comparison Target /BAU
Industrial Sector	501	-26%	554,2	-19%	8%
Commercial Sector	2356	25%	1757,7	-7%	-32%
Household Sector	1542	8%	1146,4	-20%	-28%
Transport Sector	1290	-27%	1059,6	-40%	-13%
Total	5689	-1%	4517,9	-22%	

Source: BOE 2008

The TMG adopted a rather progressive climate change target as a result of the growing awareness of citizens and politicians about climate change as a real threat. However, it was also the perceived future economic opportunities that would distinguish a low-carbon city from cities which do not invest in sustainability, which motivated the move in this direction:

> *"A shift towards a low-energy model in terms of Tokyo's corporate activities and urban design is essential for further growth…"* (TMG 2010c)

The aim of the climate change strategy adopted in 2007 was to define and implement policies and measures in the corporate sector, the household sector, the energy sector and urban planning, etc. In order to strategically address the main emitters, and turn Tokyo into a low carbon society, the TMG assigned a bundle of measures which are based on two principles:

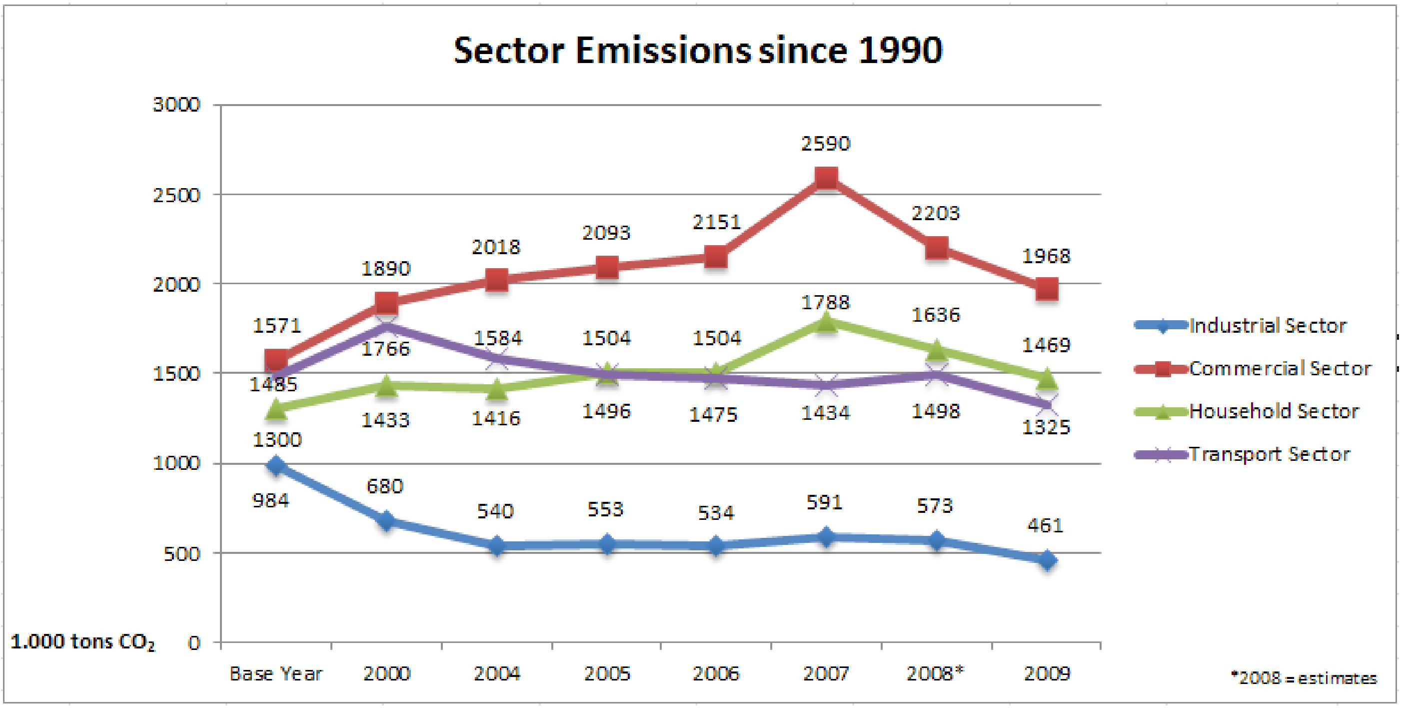


Figure 41: Sector emissions since 1990 (Calimente 2012)

Initiative I: promote private enterprises' efforts to achieve CO_2 reductions

- Cap-and-Trade System: big business
- Environmental Collateralize Bond Obligation (CBO) : small business
- Environmental Investment and Loan options
- Green power purchasing program

Initiative II: reduction in households – light and fuel expenses

- Incandescent lamps elimination campaign
- Passive energy (light, heat & wind)
- Energy saving performance of houses
- Renewable energy & energy saving equipment certification system

Initiative III: reduction in urban development

- District energy planning
- High energy conservation specifications for buildings applied to TMG facilities
- Energy conservation performance program for large new buildings (incl. certification scheme)
- Effective utilisation of energy and use of renewable energy in local areas

Initiative IV: vehicle traffic

- Fuel efficient vehicles and widespread diffusion of hybrid cars
- Green vehicle fuel **conducive ??**
- Voluntary activities : Eco-drive campaign
- Traffic volume measures through public transport system

Initiative V: TMG mechanisms to support activities in respective sectors.

- Emission Trading System
- Program to encourage and support small business and household energy saving efforts
- Study on energy conservation tax incentives

Figure 42: Strategic initiatives as a part of the Tokyo Climate Change Strategy (The World Bank 2009)

1) **reducing energy consumption** by implementing **energy conservation measures** and using passive energy, and

2) **strive to use renewable energies** and **unutilized energies** in a positive manner. The following box presents a brief description of the policy package for Tokyo.

These initiatives, however, do not correspond to similarly structured policies, making it difficult to understand how policies and measures interact, and which measure belongs to which policy or program. Often, the same program and measures are listed under different policies (e.g. the environmental master plan contains many aspects of the climate change strategy and the green building program shares many measures with the climate change strategy). Figure 43 gives an overview of the programs, policies and measures towards climate change mitigation and sustainability being addressed since the year 2000.

Actors and Strategies

The TMG's Bureau of Environment (BOE), in coordination with other bureaus, is responsible for the planning and administration of environmental issues in Tokyo, including the development of climate change strategies, plans and programs as well as the preparation of emission inventories. However, the TMG is not able to roll out and implement projects at its will within the municipalities and wards in Tokyo. Thus, the TMG channels the backflow of money to the wards by means of a funding strategy. The TMG covers 100% of the costs of climate-related projects in the 23 wards which have a pioneering character and a multiplier effect. Through this strategy, the TMG has been able to initiate 36 climate-change projects at the ward level, some of which are highly innovative in character.

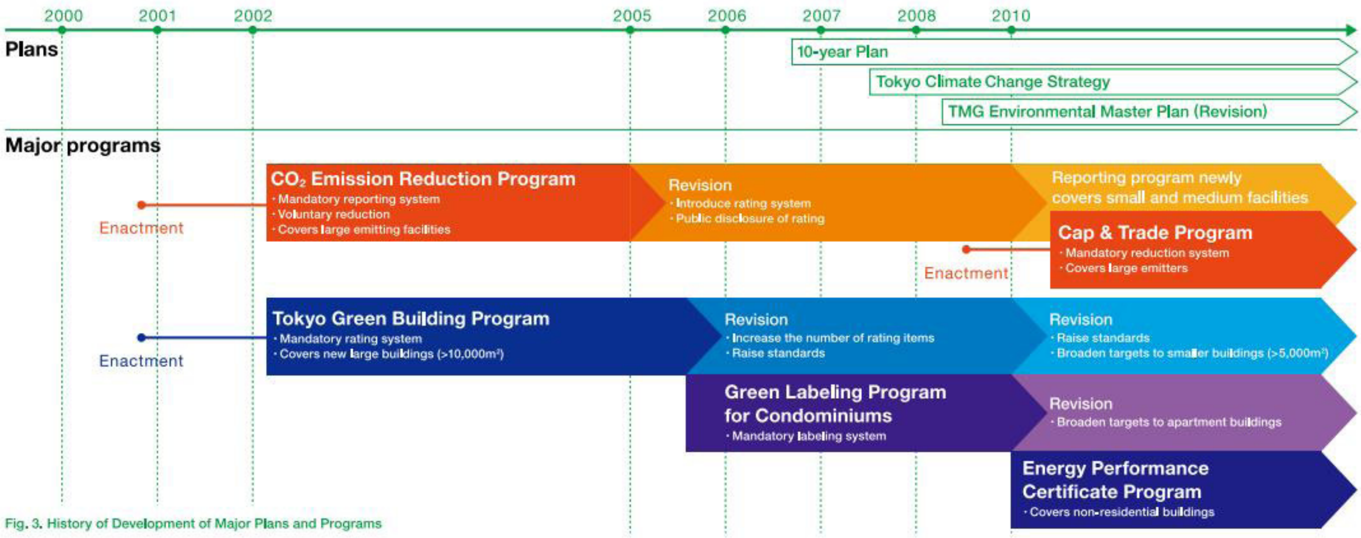


Figure 43: Policies and Programs on Climate Change and Sustainability since 2000 (TMG 2012g)

- Minato Ward, for example, has issued guidelines for a CO_2 **sequestration certification system** for commercial building tenants, aiming to increase the amount of CO_2 sequestered in the ward through the use of wood and to contribute to increased uptake of CO_2 by forests managed in Japan. Within this system, tenant businesses that use domestic forest products which are verified as legal or supplied under a sustainable forestry agreement for an interior/furniture makeover before moving in or during renovation, are eligible to obtain a certificate for CO_2 sequestration from the ward. The amount of CO_2 sequestered is calculated based on the amount of such timber used (JFS 2014).

- A second example comes from Toshima Ward, where the municipality grants subsidies to small and medium businesses (annual energy consumption of <1500 kl oil equivalent) under the "Metropolitan Small and Medium Credit Utilization Promotion Scheme "to install **energy-saving facilities** (Sojitz Corporation 2011)

In addition, the BOE emphasizes a participatory approach in the planning and implementation stages, arguing that active participation of all the stakeholders in Tokyo is essential when addressing environmental problems. In the planning stages, the BOE collects the opinions of communities, industries, municipalities, NGOs, scholars, research institutes and energy suppliers through public opinion surveys, internet based monitoring questionnaires on BOE's administration, surveys of the municipality and stakeholder meetings on an irregular basis, and reflects them in its strategies, plans and programs. In this, TMG uses a two-pronged-approach: the TMG forms the outline of actions through an Environmental Advisory Committee while it simultaneously consults with other stakeholders to gather input and gain their acceptance. It was in such meetings that the TMG learned it had to discriminate between what it can compromise on and what it definitely needs to defend strongly in its proposal (The World Bank 2010).

Measuring Success

Overall, GHG emissions in Tokyo were reduced by 7% between 2000 (57.7 million tons) and 2009 (53.6 million tons). In order to lead actions by example, the TMG has officially announced to reduce GHG emissions from its own facilities every year since 2000, which – according to the TMG – has been achieved.

Table 4: Emissions in Tokyo

Emissions (t-CO2 equivalent)

2004 (FY 2004) (base year)	2005 (FY 2005)	2006 (FY 2006)	2007 (FY 2007)	2008 (FY 2008)	Growth rate (%)	
					The base year	Year-on-year
2,276,434	2,200,622	2,142,108	2,087,319	2,084,847	-8.4%	-0.1%

Source: Cervero 1999

On the city level, no figures are available for the years after 2009. Most TMG facilities are covered by the cap-and-trade system, which started in 2010 and, thus, figures are available on a compiled level.

Facilities which are part of the cap-and-trade system have managed to reduce GHG emissions by 23% with reference to the base line. 13% of this reduction was realized in the year 2010, and an additional 10% was realized in 2011. Unfortunately, there are currently no newer figures available for the cap-and-trade system.

Emissions reductions from buildings under the cap-and-trade system contributed to a further reduction of 7.4% of CO_2 emissions at the city level between 2008 and 2011, contributing the largest share to achieving the goals of Tokyo's climate change strategy. Given all other emitting sources have not changed since 2009, **overall emissions reductions amounted to 14% in the year 2011** in comparison to 2000, indicating that Tokyo has managed to achieve more than half of its goal for 2020 in the first six years after formulating the goal in 2007.

3.3 TOKYO VISION 2020

A vision of re-branding Tokyo in the world's view stood at the forefront of Tokyo's new development plans. Attracting the Olympic Games to Tokyo was identified as strategic leverage for Tokyo's self-reform and therefore this aim was pursued with rigour and strength since 2006, resulting in the International Olympic Committee's (IOC) decision in 2013 that the 2020 games will be held in Tokyo.

Tokyo's Big Change was the name of Tokyo's first large-scale master plan. It was released in the year 2007 – and since the TMG had hoped to already host the 2016 Olympic Games – it was a 10-year plan and painted a vision of Tokyo in 2016. Tokyo's big change built upon eight meta-goals for the city:

1. Restore Tokyo's beauty as a city of water and greenery;
2. Transform Tokyo through the three loop roads;
3. Transition Tokyo to become the city with the lo-

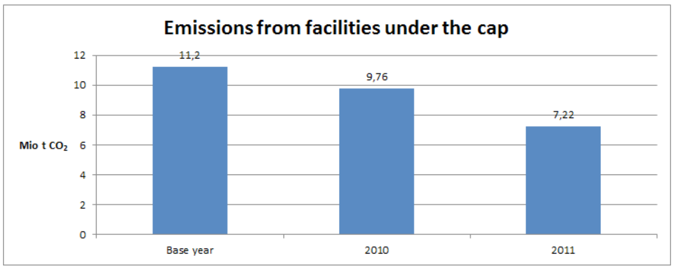


Figure 44: Emissions from facilities under the cap (Environmental Leader 2013; TMG 2013)

west environmental load in the world;
4. Strengthen Tokyo's disaster preparedness to enhance credibility;
5. Create the world's first urban model for a super-aging society;
6. Make Tokyo more prominent in terms of culture, tourism, universal design and industry;
7. Create a society where motivated individuals can pursue their ambitions;
8. Promote sport to provide dreams to children;

In order to realize this plan, the TMG established a government-wide system for promoting the plan by utilizing the Tokyo Olympics Reserve Fund, establishing Tokyo's own Fund for Promotion of Measures Against Climate Change etc. Important policies such as the Climate Change Strategy, the second Environmental Master Plan and Tokyo Vision 2020 were directly influenced by Tokyo's Big Change.

Between 2007 and 2011, three external events heavily impacted upon Tokyo and changed some of the former preconditions:

- On March 11, 2011 Japan was hit by the devastating **Sendai Earthquake**, resulting in the meltdown of the Fukushima nuclear reactor. Tokyo suffered from severe consequences with electricity cuts, several people injured and buildings damaged.
- In 2008, the full **economic crisis** hit Japan, leading to a decline of exports of nearly 50% and to the loss of thousands of jobs (Tanaka 2009).
- In 2009, the Olympic Games in 2016 were assigned to **Rio de Janeiro** – not to Tokyo.

In response to these developments, and as affirmation of its will to win the Olympic Games 2020, the TMG developed the Tokyo Vision 2020 – a similar 10-year master plan aiming at transforming Tokyo around the core topics of resilience, climate & energy and liability.

Vision 2020 builds upon the goals set out in Tokyo's Big Change, but it clearly reacts to the experienced challenges by shifting the priorities towards disaster management, transformation of the energy system and stimulating economic development. The Tokyo Vision 2020 is operationalized into action programs of three-year periods. The 2012 Action Program lays out three-year goals, total program budget, and annual plans for 2012 to 2014. The program contains 22 measures and 370 projects (of which 84 are new, and 87 revised). The total budget for the program is approx. 2.2 trillion yen, (15.5 billion €) and the program budget for fiscal 2012 is approx. 750 billion yen (5.3 billion €) (2012 Action Program for Tokyo Vision 2020 - TMG 2012).

Figure 45 gives an overview of the strategic goals and measures of Tokyo Vision 2020. Following this, Table 4 indicates strategic measures and projects that will be addressed under vision 2020, including the budget that has been allocated to each policy. The budget for the measures sums up to 32.3 billion € - a figure that will be distributed to many projects to be carried out over several years.

An analysis of financial resources allocated to each of the above named goals, gives a good impression of the priorities set by TMG for the development of Tokyo within the time-span 2012 – 2020.

Clearly, the main focus of Vision 2020 lies on two priority areas:

a) Prepare for natural disasters
b) Stimulate economic growth

Today, Tokyo is already the most-prepared city for the event of natural catastrophes. Nevertheless, Tokyo needs to improve and enhance its built environment so that the city that can cope with disasters and external shocks like earthquakes, floods, storm water and an increase in temperature. 35% of all resources allocated to Vision 2020 aim at creating a more resilient city.

As is the case in virtually all cities, economic growth is the backbone of Tokyo's ability to react to external pressures and finance strategic measures for enhancing resiliency, providing important social services – such as child care – and investing in clean technologies and a low-carbon society. Thus, stimulating economic growth by attracting foreign investments and providing the infrastructure for a highly efficient and dynamic urban economy is seen as a very important aim of the TMG. In addition, the TMG addresses the human resource base of Tokyo's economy. Shrinking birth-rates and a lack of women in employment are macro trends that are reflected in the socio-economic indicators of the city (see chapter 2), bearing the risk of economic downturn and a loss of Tokyo's strength as a metropolis. Addressing these issues effectively will help Tokyo stabilize its population and at the same time stimulate economic growth through a higher share of employed women. Goal 4, goal 5 and goal 6 address the socio-economic future of Tokyo and - taken together - account for 49% of all funds allocated to Vision 2020.

Investing into creating markets for clean technologies, green buildings, sustainable mobility and a green urban environment utilizes 16% of all funds within vision 2020. Although this appears a small share in comparison with other priorities, Tokyo is promoting some of the most innovative urban development projects and emissions reduction strategies on the globe. The green buildings program and the

The Eight Goals of Tokyo Vision 2020

1. Achieve a sophisticated disaster-resistant city and demonstrate Tokyo's safety to the world
Complete seismic retrofitting of buildings alongside emergency transport roads / Accelerate seismic retrofitting using Tokyo's unique system of displaying a mark of seismic resistance / Finish construction of major city planned roads in districts with close-set wooden houses at high-risk (7,000 ha) / Establish Disaster-Management Neighborhood Units / Enact ordinances concerning stranded people / etc.

2. Create a low-carbon society with a highly efficient, independent and distributed energy system
Build high-efficiency natural gas-fired power plants with a 1-million kW capacity / Introduce 500,000 kW of power through co-generation systems / Introduce 900,000 kW of photovoltaic power to detached homes / Leading projects for realization of a smart city / etc.

3. Restore Tokyo to a beautiful city surrounded by water and greenery
Create 1,000 ha of new greenery and double roadside trees to 1 million trees by 2016 / Newly develop 433 ha of city parks / Renewal of 50,000 large trees along emergency transport roads / Building a network of water and greenery / Development of the Sumidagawa Renaissance project leveraging the Tokyo Sky Tree / etc.

4. Connect land, air, and sea to raise Tokyo's international competitiveness
Complete 92% of the three loop roads (completion of the Tokyo Outer Loop Road) / Nearly complete backbone trunk roads such as ward ring roads, Tama north-south roads, etc. / Expand daytime international slots at Haneda Airport / Establish the Keihin ports position as Asia's hub port / etc.

5. Put Tokyo on a new track to growth by raising industrial power and the allure of the city
Attract foreign companies to Tokyo using the comprehensive special zone system and establish Tokyo's position as the site for Asian headquarters / Cultivate industries with growth potential and promote the use of the high technologies of SMEs / etc.

6. Build and show the world an urban model for a society with a low birthrate and aging population
Create child daycare services to accommodate 70,000 more children / Establish Tokyo's unique senior job center / Build networks to look after senior citizens in all municipalities of Tokyo / Increase the employment of disabled persons by 30,000 / Increase NICU beds to 320 by the end of FY 2014 / etc.

7. Raise globally competent individuals by creating a society where anyone can strive for high goals
Propose concrete reform from the broad perspectives of the Educational Renaissance: Tokyo Round Table Conference / Support study abroad by a total of 10,000 young people under the project, "Let Your Child Experience the World" / Provide detailed support for the employment of young people and non-full time workers / etc.

8. Create a society where everyone can enjoy sports and provide children with dreams
Bring the 2020 Olympic and Paralympic Games to Tokyo / Develop sports clusters in Jingu, Komazawa, and Musashino-no-Mori districts, and the waterfront area / Hold a parade of international sports events / Create the Tokyo Athletes Cycle / etc.

The 12 Key Projects Supporting Tokyo Vision 2020

- Initiatives to be strategically implemented over the next 10 years to achieve the eight goals are positioned as the 12 key projects
- Each project has a specific vision of Tokyo in 2020 and outlines policy implementation

2012 Action Program for Tokyo Vision 2020

Three-year action plans are formulated for steady and expeditious implementation of policies to achieve Tokyo Vision 2020

Plan period: FY 2012 – FY 2014 Scale: 22 measures, 370 projects

Project costs: Three years approx. 2.2 trillion yen; FY 2012 approx. 750 billion yen

Figure 45: Goals of Tokyo Vision 2020 (Chorus 2012)

Table 5: Vision 2020 - strategic measures and actions for the next years

Action Program 2013		budget over 3 years in billion JPY	Specific action and measures
Goal 1 - Sophisticated disaster-resistant city			
Policy 1	Build a city that is highly quake-resilient by focusing on earthquake measures.	1,037 billion JPY 7.32 billion €	Finish seismic retrofitting of public elementary and middle schools, the core hospitals for disaster response as well as metropolitan buildings deemed important from a disaster management perspective. Seismic retrofitting of pipes supplying water to important facilities. Seismic retrofitting of bridges and emergency transport routes, etc. (finish 410 of the 413 bridges within this project period.)
	In the districts with close-set wooden houses (districts designated for development under the earthquake resilient city development plan), major city-planned roads have been totally completed, and there is ZERO possibility of destruction of urban districts from the spread of fires.	10 years project	Accelerate construction of major city-planned roads that would form firebreak belts (28 roads, total of 26km). Non-flammable regions compose 70% of a given area in the said districts (12 areas).
Policy2	Aim to minimize damages and achieve early recovery of urban functions through maximum leverage of the strengths of self-help and mutual assistance.	388.4 billion JPY 2.74 billion €	1,600 Helicopter signatures on hospitals and large apartment units. Certify Tokyo disaster-Management Neighbourhood Units (36 units in 2012) and support their activities by sending specialists etc. Install emergency generator in the park to use as an emergency activity base in the event of a disaster.
Policy3	Strengthen measures to deal with urban disasters such as torrential rainfall occurring as a result of climate change.	185.8 billion JPY 1.31 billion €	Advance the development of infrastructure capable of dealing with intensive rainfall surpassing 75mm per hour (2013 goal). Tama region (upper stream area) 65mm/h. (In 2010, the goal was 50mm/h for both areas). Appoint 4,000 additional landslide disaster areas; implement measures of safety and evacuation centres. Additional 40 km of heat-insulating and water-retaining pavement in the central care area.
Goal 2 - Low Carbon Society			
Policy4	Disseminate new energy policies from Tokyo with the aim of striking a balance between economic growth and environmental preservation.	64 billion JPY 0.45 billion €	Build capacity for producing 1 million kW natural gas generated electricity. Establish a public-private infrastructure fund to support small scale (10,000~30,000kw) electric companies and stabilize distribution.
Policy5	Become the world's most eco-friendly, low carbon city	225.2 billion JPY 1.59 billion €	Encourage use of hybrid trucks. Set up a total of 20 bicycle lanes. Reduce CO_2 by the cap. 27,000 next-generation cars in the city. Subsidy for installing BEMS on small and medium sized buildings.
policy6	Create a world-leading, clean urban environment.	261 billion JPY 1.84 billion €	

Goal 3 - Water and Greenery			
policy7	Pass on to future generations a Tokyo with a rich natural environment connected via a network of greenery	135.9 billion JPY 0.96 billion €	300 school grounds covered by green.
policy8	Create bustling vibrant waterfront spaces that attract people	8 billion JPY 0.06 billion €	Bring about the creation of townscapes where building facades face the waterfront; illuminate bridges and buildings along riverbanks.
policy9	Increase Tokyo's value by creating cityscapes befitting a national capital	55.9 billion JPY 0.39 billion €	Remove utility poles with a focus on those along emergency transport routes, double the removal of utility poles(length approx.600km) in the TAMA and neighbouring wards areas
Goal 4 - Improve international competitiveness			
policy10	Install a land, sea, and air transportation network capable of winning in the global arena	677.5 billion JPY 4.78 billion €	85% completion of the rings roads. 94% completion on the rings roads in the ward area and 84% of Tama north-south roads. Illuminate level rail crossings in 27 locations. Increase arrival and departure slots at Haneda Airport to 447,000/year and at Narita Airport to 300,000/year.
policy11	Advance the development of „hubs" in the city centre and other areas, and transform Tokyo into a city with an even higher level of functionality.	164.1 billion JPY 1.16 billion €	Attract more than 500 foreign companies (Asian Headquarters in Tokyo project).
Goal 5 - Increase industrial power			
Policy 12	Cultivate industries with growth potential	66 billion JPY 0.47 billion €	
Policy 13	Establish the Port of Keihin's position as Asia's hub port	488 billion JPY 3.44 billion €	
Goal 6 - super aging society			
Policy14	Overcome the issue of declining birth rates by having society as a whole support families and raising children	646 billion JPY 4.56 billion €	Establish and expand child care facilities to care for more than 24,000 children.
Policy15	Build a social system that can respond to the various needs of senior citizens	80 billion JPY 0.56 billion €	Create 10,000 Tokyo-model care houses for the elderly by the year 2016.
Policy16	Realize a society that provides a living environment for everyone by supporting the lives of people with disabilities within the community	24.8 billion JPY 0.18 billion €	Build group homes for a total of 7,000 people. Increase employment of people with disabilities by approx. 30,000.
Policy17	Create a society where people can live healthy lives and receive high quality healthcare throughout their lives	58.8 billion JPY 0.42 billion €	Increase Neonatal Intensive Care Unit (NICU) capacity up to a total of 320 beds.
Policy18	Create a city where visitors and residents can spend a reassuring and comfortable time.	9 billion JPY 0.06 billion €	Complete barrier-free renovations in communities centring on train stations and hospital routes (total 327km).
	Total spendings	**4,575.4 billion JPY** **32.3 billion €**	

Source: TMG 2012d; Investment figures translated from Japanese version.

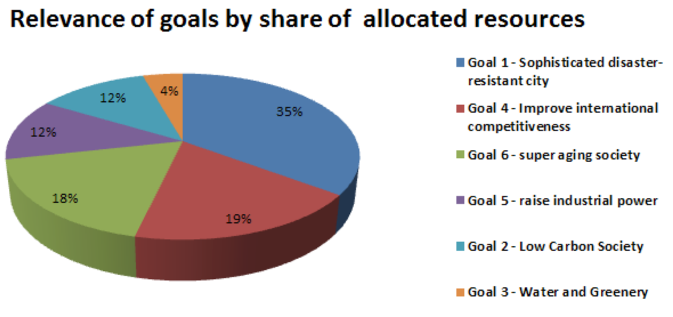


Figure 46: Strategic priorities of TMG [11] (own illustration)

cap-and-trade program are evaluated in more detail in the best practices examples in chapter 4. Here, we would like to highlight the **Umi No Mori** project as one large project in Tokyo that aims at improving the urban ecosystem by connecting green spaces in Tokyo in a green belt throughout the major parts of the city.

By creating a large green area and a forest in the middle of an artificial island created by waste, Tokyo planners are aiming to generate a natural air conditioner for Tokyo.

> *"The central goal is to plant 1,000 hectares (2,471 acres) of new green space in the city this decade. The plantings will be a mix of new parks, rooftop gardens, and trees planted on public lands such as beside railway tracks."* (Curtis, Renne 2009)

Tokyo Vision 2020 has been developed as a high priority project for Tokyo's Governor Ishihara. It is both a political statement and a strategic project for the city. It combines important measures that are lead and managed by different sections of the TMG in a comprehensive plan. The responsible unit for defining and outlining the Tokyo Vision 2020 is the Planning and Coordination Section at the Headquarters of the Governor of Tokyo.

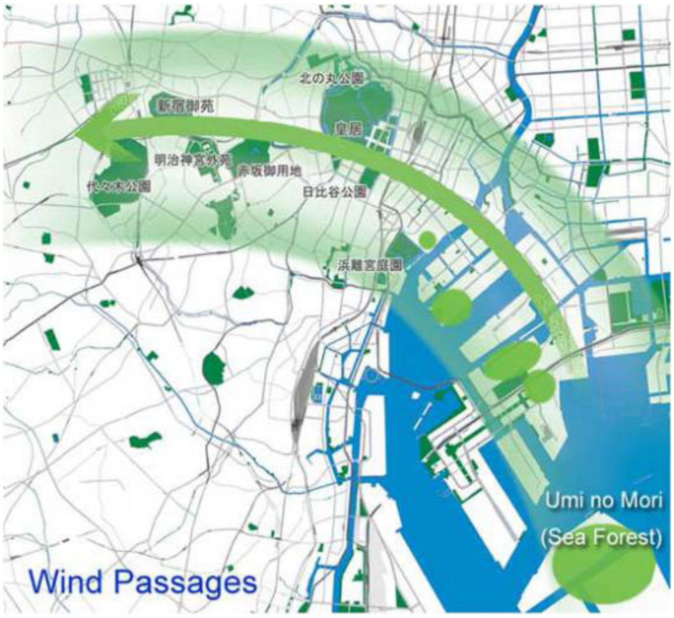


Figure 47: Wind passages (Paul Chorus 2009)

11) Spendings for goal 7 and goal 8 sum up to 580 Million € and thus only represent 2% of the money allocated under Vision 2020 (Tokyo Metropolitan Government).

4

4 SELECTED BEST PRACTICES TOKYO

This chapter shows selected best practices from Tokyo in the sectors governance, energy, mobility, production & logistics, buildings and ICT. All best practices aim at contributing to a more sustainable, energy efficient and well-functioning Tokyo.

4.1 CAP AND TRADE SYSTEM

The cap-and-trade system in Tokyo is the first functioning urban emissions trading system in the world. Unlike existing emissions trading systems on national or provincial levels, the TMG Emissions Trading System (ETS) tackles emissions of greenhouse gases downstream on the consumption side. ETS aim at solving the problem of hidden environmental costs of technologies that rely on fossil fuel consumption by putting a price on carbon emissions. Governmental bodies fix an absolute cap on emissions (maximum amount of emissions allowed) and let the emitting entities trade their emission rights (credits). The aim is to achieve optimum allocation of resources by market mechanisms while also supporting the reduction of GHG emissions. Most ETS tackle emissions at the source; e.g.: in Europe, large coal-fired power plants and industrial emitters are requested to purchase emission credits. By addressing large consumers of energy on the city level, the TMG ETS points towards the potentials of ETS for enhancing energy efficiency and the reduction of energy use and thus represents an innovative system for including the private sector actively in the process of reducing emissions in cities.

4.1.1 Origin and Objectives

The idea for an urban emissions trading system originated with the staff of the planning division within the TMG's Bureau of Environment in 2002. The TMG first launched a project for »Creating an Emission Trading Market« in 2002. It started by discussing the possible emission trading designs with stakeholders. In a series of internet workshops held with emissions auditing corporations, private companies, and financial institutions, discussions covered (i) methods of calculating emissions, (ii) methods of categorizing emissions, and (iii) trading methodologies. Simultaneously, the TMG set up an advisory board consisting of experts and researchers in this area and, over time, developed a proposal for an emission trading scheme.

Under the lead of Director General Teruyuki Ohno it took the Bureau of Environment six years from when the idea for a Tokyo ETS was first conceived until it was approved by the Metropolitan Assembly in 2008. In the first years, the Bureau of Environment did not have sufficient legal power to oblige facilities to reduce emissions; therefore, the Bureau developed a voluntary reduction plan starting in 2002. At the core of this program was a mandatory reporting system: from April 2002 onwards, around 1,000 large facilities (300 factories, 700 buildings) with an annual energy consumption of 1,500 kiloliters of crude oil equivalent or more were required to report their GHG emissions annually to the TMG (Rudolph, Kawakatsu 2012). While emission reductions were voluntary, the reports had to include energy consumption data broken down by months and energy sources. An emissions factor was applied to the energy from the electrical grid.

Also, facilities had to prepare a 3 year CO_2 Emissions Management Plan that was made available to the public after one revision by the TMG and the facility owner. The TMG rated all emissions reduction activities of the corresponding

2000: Ordinance Amendment for Mandatory Emissions Reporting	
Emissions Trading System (ETS) Planning **2002: Deliberations Begin**	**2002-2004: Phase I of Voluntary System** • Emissions reporting • Voluntary emissions reduction setting • Three-year emissions reduction plan
June 2007: Launch of Tokyo Climate Change Strategy **June 2008: Ordinance Amendment for ETS Implementation**	**2005-2009: Phase 2 of Voluntary System** Public announcements and evaluations of reduction plans begin
2010: April 1, Start of ETS	

Figure 48: Ordinance amendment for mandatory emissions reporting (The World Bank 2010)

facilities on a scale from C (TMG proposed measures not implemented) to A (all measures implemented) and certified the facilities with higher grades (A* and AA), if reduction targets were set. Since all ratings were made public, 98% of all facilities achieved A-ratings by the end of 2006 (Rudolph, Kawakatsu 2012).

Throughout various sessions – mainly held publicly – between the TMG, private sector representatives and members of the environmental advisory group, progress was made in convincing stakeholders of the necessity for an ETS with a mandatory cap. In June of 2007, the Tokyo Climate Change Strategy was implemented to pave the way for the ETS. In 2008, the Metropolitan Assembly passed an ordinance that incorporated the implementation of the ETS into the "Tokyo Metropolitan Environmental Security Ordinance".

Following approval of the scheme, a considerable amount of work was required to prepare for the scheme's implementation. The Emission Reduction Section of the Urban and Global Environment Division is responsible for organizing the scheme and preparing guidance to the roughly 1,340 facilities involved.

4.1.2 Organisation / Structure / Measures

As laid out in chapter 3, the commercial sector and the housing sector account for the highest share of CO_2 emissions produced within Tokyo; as a consequence, the Tokyo ETS targeted CO_2 emissions from the end-use of energy in large buildings and factories. All facilities that consume energy of more than 1,500 kilolitre crude oil equivalent per year are included in the system and must contribute to a mandatory cap of CO_2 emissions, which is reduced by period.

In total, the program includes around 1,392 facilities (TMG 2013) and all major skyscrapers and central government buildings are part of the scheme, including the Prime Minister's residence, the Diet Building and major ministries as well as parts of the Imperial Palace (Rudolph, Kawakatsu 2012).

The program encompasses roughly 13 million t. of energy-related CO_2 representing a share of 40% of all CO_2 emissions from the commercial and industrial sector in Tokyo and a share of 20% of Tokyo's total CO_2 emissions.

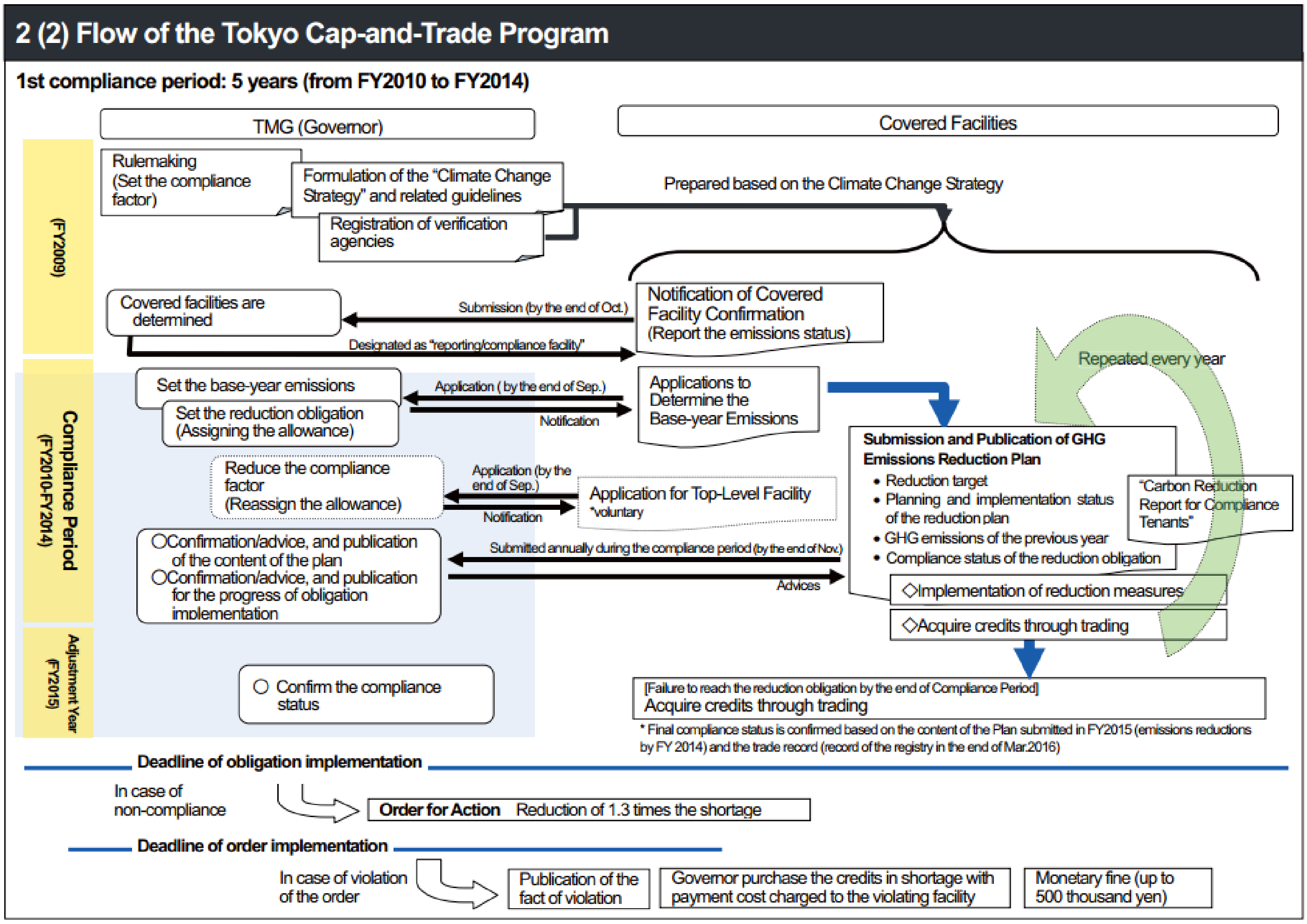


Figure 49: Cap-and-trade flow chart (Tokyo Metropolitan Environmental Security Ordinance 2012)

The cap refers to two different trading periods:

- > Period 1 (2010- 2014): Target reduction = 6% below base year emissions.
- > Period 2 (2015 – 2019): target reduction = 17% below base year emissions.

The general function of the cap-and-trade system is organized as follows:

a) The Bureau of Environment allocates the emission credits to the building owners – based upon their calculated baseline emissions and the mandatory cap.

b) At the end of the year, the emitting facilities must prove that they either stayed within the emission limits or, if not, have purchased extra credits that equal or exceed their emissions exceeding the cap.

The emissions factor attributed to the electricity used in the facilities which are part of the ETS refers to Tokyo exclusive power supplier: TEPCO. It applies the following formula:

CO_2 emissions =
electricity usage (kWh) x 0.463 kg CO_2/KWh [12]

Figure 49 provides an overview of the formal cap-and-trade process, which links facility owners and government bodies in several information flow steps. With respect to overall organization, three essential design criteria are essential for the success of the Tokyo cap-and-trade program:

a) The allocation of credits
b) Trading of credits
c) Monitoring, Reporting and Verification (MRV)

These program components are discussed in the following sections.

Allocation of Credits

In the TMG ETS, the distribution of emissions rights is based on "grandfathering" – meaning that they are granted to the facilities for free at the beginning of each compliance period. Certificates are not handed out to the facilities. Rather, a formula is applied for calculating the amount of access credits available to every facility for trading on an annual basis. Base year emissions are calculated as the average energy consumption of three executive years between 2002 and 2007, whereas the participants were able to pick the exact period.

"In terms of individual allocation of emission rights to facilities, in fact, the TMG ETS allocates annual reduction obligations at the beginning of each compliance period following the formula:

Reduction Obligation =
BY x CF x year of the compliance period

With: BY = average emissions of three consecutive base years between 2002 and 2007

CF = Compliance factor (Phase 1: 6% for factories, 8% for buildings)

However, basically, from this calculation the amount of total emission rights granted to facilities for specified compliance period can be calculated in the following way:

Compliance Period allocation = (BY – (BY x CF)) x 5"

TMG did not exclude the possibility of introducing auctioning as allocation mechanism for the period after 2019. All emissions allowances (or a certain share) would have to be bought by facilities under the cap in annual auctions, generating revenue for the TMG through the ETS.

Trading of credits

Trading of emissions is allowed between facilities participating in the TMG ETS. Facilities are allowed to trade excess credits that result from emission reductions beyond the annual reduction obligations. However, trading is only allowed on a bilateral basis and takes place in a rather opaque way. TMG lists all facilities and their annual emissions and the actual reductions on its Information Disclosure Website and informs participants upon request about available access emissions certificates. The TMG brings together supply and demand. Pricing is then negotiated directly between the owner of the excess credits and the owner of a facility that needs extra credits for covering its surplus emissions. The members of the BOE state that they usually do not ask for the price agreed upon by the trading parties. However, according to Yuko Nishida, member of the BOE, a control sample by the TMG showed prices around 100 US$ per emissions certificate (1t CO_2).

The TMG ETS also includes offset credits from three different sources:

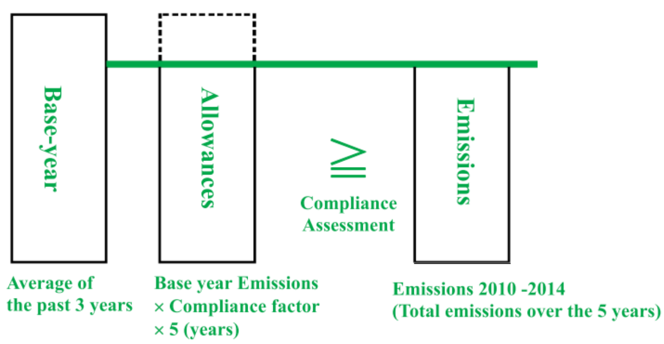


Figure 50: Allocation scheme for emissions in compliance period (BOE; TMG 2010)

12) Emission factor for the year 2012 (TEPCO 10/11/2013)

a) Emission Reduction Credits from energy savings in small or medium sized facilities in Tokyo which are not participants in the ETS.

b) Renewable Energy Credits (REC) from electricity production by renewable energies in Tokyo. REC's count 1.5 times the value of regular credits, since TMG considers them to have a specifically positive effect on the low carbon market.

c) Emission Reduction Credits from outside Tokyo. The TMG only accepts credits from facilities that are regulated under the TMG ETS conditions. Thus, foreign offset credits cannot be applied in Tokyo.

At the end of a period, each facility under cap must prove by means of its energy bills that its emissions either correspond to or exceed the reduction requirements set by the ETS or it needs to prove the purchase of a corresponding amount of credits from the ETS.

Monitoring, Reporting, Verification (MRV)
Standardized reporting and a clear monitoring system (by the TMG and authorized and trained auditors) lie at the heart of the cap-and-trade system. Figure 51 shows the reporting requirements for facilities that are included in the ETS. TMG places a strategic focus on involving public opinion and thus the achievements and failures in emissions reductions of the facilities are published on a TMG website. There is a list of companies that do not achieve a reduction in their emissions. Additionally, the names of facility owners who do not comply with purchasing extra credits for offsetting excess emissions are made public.

Facilities that do not comply with the regulations of the TMG ETS must pay up to 500,000 JPY as penalty and cover up to 1.3 times the amount of excess emissions by a deadline determined by the Governor. These penalties may apply if:

- The CO_2 emissions of a facility exceed the allowed amount of emissions for the facility and no or insufficient extra credits are handed in to the TMG
- Reports are not submitted or do not contain sufficient information.

4.1.3 Financing & Business Models

The TMG ETS is publicly financed. Money invested by the TMG into the cap-and-trade system comes from the taxes raised by the Metropolitan Government. The costs of organizing and running the ETS system amount to approximately 2.5 million € per year. There is a possibility that the TMG might introduce auctioning as a distribution method for emissions allowances after 2019, generating revenues for TMG out of the ETS, however, this has not yet been decided on.

Together with the green building program (see section 4.2), the TMG ETS aims at creating a green real estate market. It has been designed to attract investments into energy conservation and renewable energy in buildings, the development of renewable energy sources and technology improvements. Value creation for building owners under the ETS

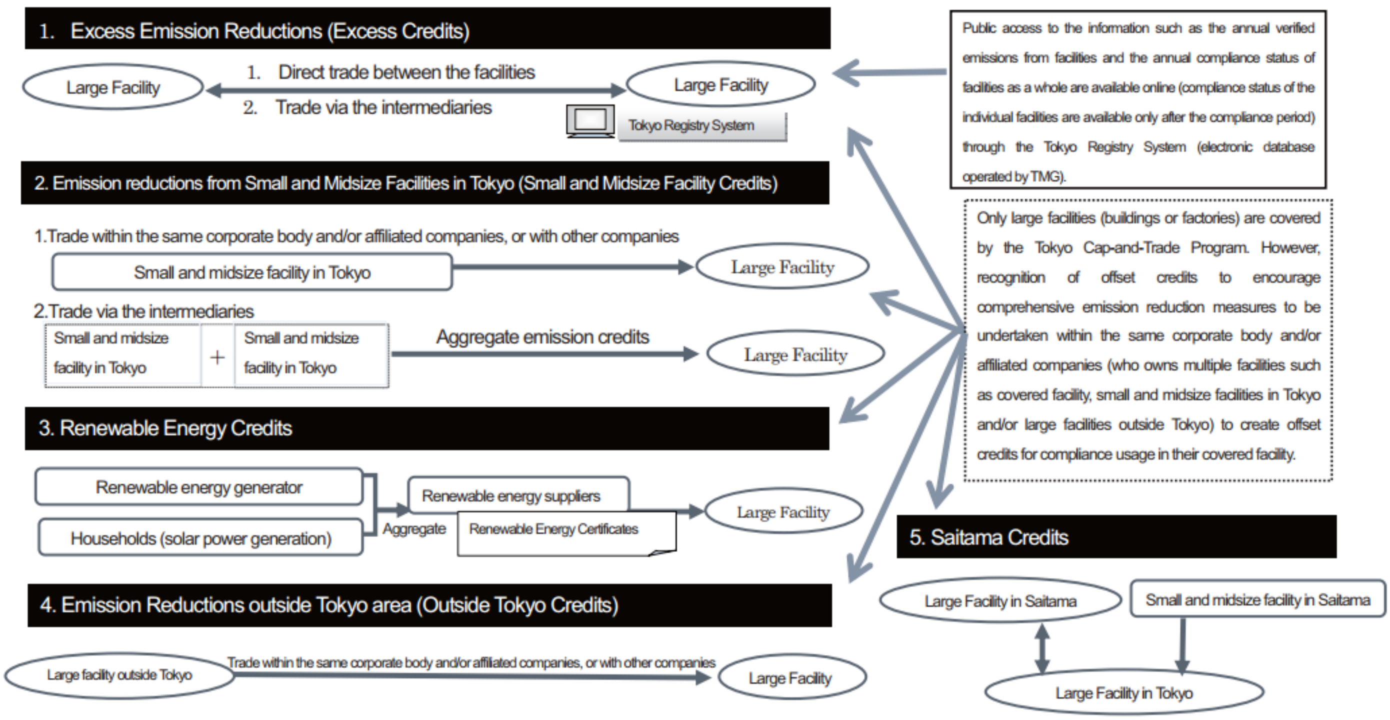


Figure 51: Overview of emissions trading in Tokyo (Tokyo Metropolitan Environmental Security Ordinance 2012, p. 19)

may exceed investments into energy efficient technologies and renewable energies. At the same time, market values for conventional buildings are starting to dwindle since all political efforts are pointing towards green buildings and low carbon technologies.

By creating a market for low carbon buildings, the TMG has effectively linked its governance potential and the creativity of the private sector.

4.1.4 Main Actor and Supporting Stakeholders

The driving force behind the establishment of the TMG ETS was certainly the TMG Bureau of Environment under the lead of Teruyuki Ohno. Highly skilled staff members were able to analyse existing ETS systems from around the world and apply this knowledge in designing a system that would work for Tokyo. In addition to the BOE, other important stakeholders were responsible for the functioning of the TMG ETS:

- Governor Ishihara: he supported the system and helped gain support within the Metropolitan Assembly, leading to the enactment in 2008.
- The Tokyo Chamber of Commerce and Industry (TCCI) and the Japanese Federation of Economic Organisations (FEO or Keidanren) were the main opponents to the TMG ETS at an early design stage. Both were included in a process of consensus building, leading to additional measures for small and medium sized businesses and to the eventual support of the ETS by both the TCCI and the FEO.
- An environmental advisory council served as an expert panel and underlined the necessity for an ETS in Tokyo.
- The media and the public were addressed actively by the TMG and were also included into the decision-making process.

4.1.5 Obstacles and Challenges

The main challenge when introducing the TMG ETS was to find a way to counteract the opposition from strong business associations. By building upon a mandatory reporting scheme, TMG was able to refer to an existing database and had access to the necessary arguments for a cap-and-trade system, when the opposition needed to be tackled. Nishida gives a great overview of the discussions and arguments exchanged during this process between business groups and the TMG (Yuko Nishida; Ying Hua 2013).

Thus far, the TMG ETS has succeeded in reducing GHG emissions from large emitters in Tokyo. However, some obstacles and challenges must still be overcome.

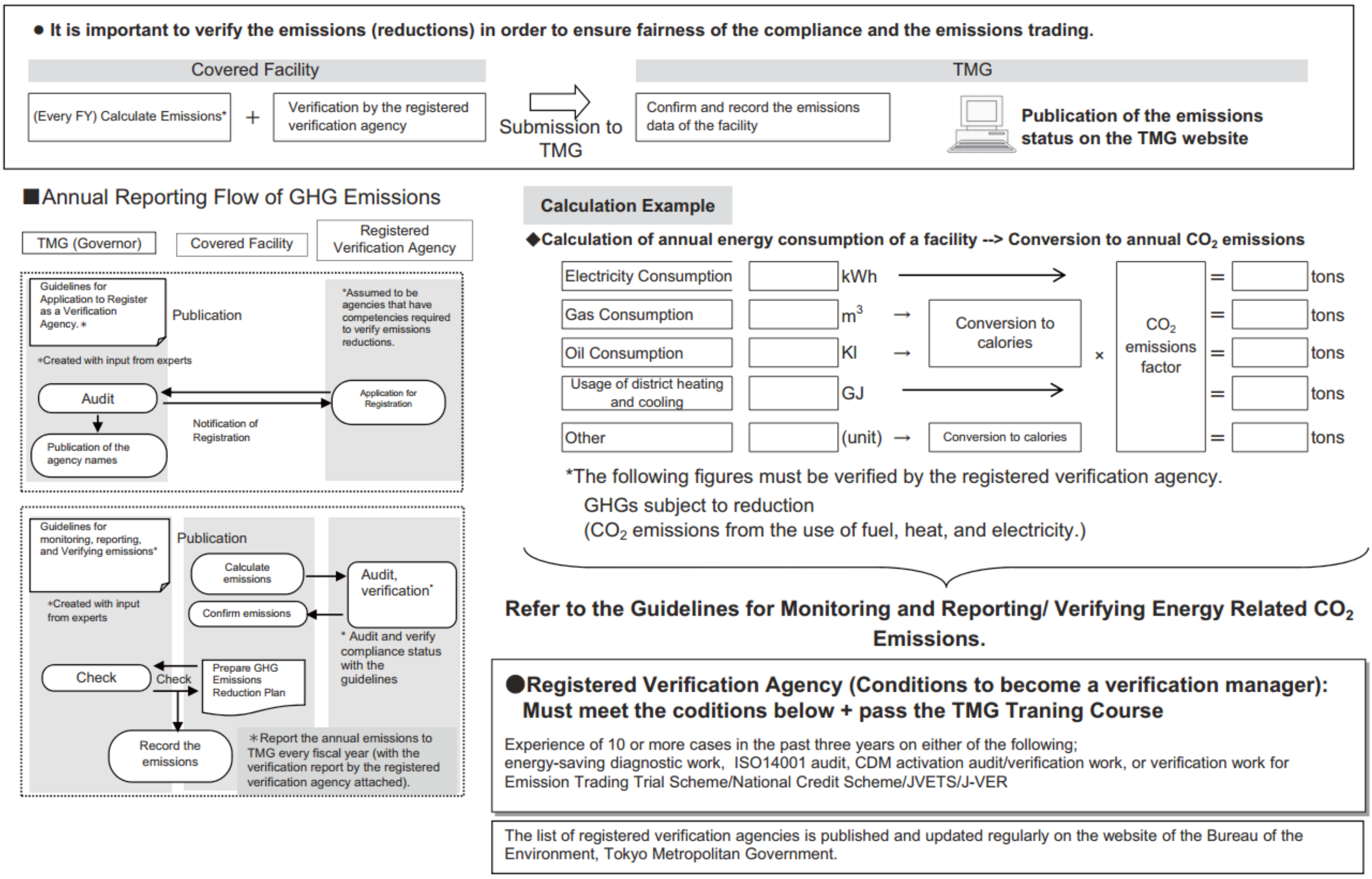


Figure 52: MRV process of the TMG ETS (TMG 2012f)

The reduction goals for the second period (2015 – 2019) have already been achieved by the majority of the facilities. In order to maintain a functioning cap-and-trade system, the target needs to be adjusted and the cap needs to be tightened.

An opaque trading system leads to situations, where owners of several buildings in Tokyo invest all emissions reduction efforts into one building, offsetting the emissions of the other buildings without having to refer to market prices of CO_2. These non-market shifts of emissions can only exist because trading is done on a bilateral basis.

4.1.6 Impact Factors

Mandatory cap: a mandatory scheme was necessary to create a fair environment for investments. A first voluntary scheme was inefficient and could not create longer-term investments for emissions reductions.

Effective cap-setting and allowance allocation: both the cap and the reduction target must be strict enough to achieve the emissions reductions goal of the city. However, it also needs to be feasible for facilities to achieve. An evaluation of the effectiveness and scope of the cap can only occur after the ETS has been functioning for some time. This leads to a dilemma, where powerful business stakeholders can impact on the design of the cap with arguments. In Tokyo, the cap has obviously been set too high (not very ambitious), resulting in an early overachievement after only the second year. However, this may also be seen as a strategy of the TMG, where it first creates the system and is then able to adjust the details later.

Simplicity: a simple design helps stakeholders manage the ETS. The Tokyo program targets only energy-based CO_2 as GHGs and clear data sources exist for CO_2 inventory calculation. Moreover, inclusion in the scheme is simply decided by the amount of energy use (1,500 kl crude oil equivalent).

Blame and Shame: fines for non-compliance are extremely low. The highest penalty is 500,000 JPY (3500€) which corresponds to 35t CO_2 (BOE 2010). A typical building under the ETS emits 8,300 – 8,700 tons of CO_2 annually, thus, making it easier to pay fines than to conduct investments in clean technologies that exceed the amount of 3,500€. Nevertheless, facility owners have invested in solutions that exceed this amount by far. The main reason for this is the TMG's "blame and shame strategy", as the government publishes all GHG emissions reports on its website and points out those facility owners that do not comply with the system.

Early data collection and standardized reporting: by introducing an early reporting system in 2002, TMG had all the necessary information on a good design for the ETS.

A voluntary system as a first step: Through this program, the Bureau of Environment deployed its staff to help the facilities implement the voluntary plan. It was here that the BOE staff obtained information concerning private sector ways of thinking and decision making, institutional makeup, rules, and constraints. TMG also made use of the accumulated data and experiences to develop the ETS.

Table 6: Overview of facilities emissions reduction after first year

Usage of Facilities	Number of Covered Facilities	Base Year Emissions (t-CO2)	Emissions in FY2010 (t-CO2)	Emission Reduction Rate (%)	Reference: Average Base Year Emissions per Facility (t-CO2)
Commercial Sector	970	8,302,326	7,418,087	11%	8,559
Office	509	4,176,696	3,656,371	12%	8,206
Information Communication Center	32	375,389	373,260	1%	11,731
Broadcasting Station	5	96,099	90,204	6%	19,220
Commercial Facility	172	1,216,026	1,095,963	10%	7,070
Accommodation	41	475,318	437,529	8%	11,593
Educational Facility	57	470,686	447,350	5%	8,258
Medical Facility	64	542,639	503,563	7%	8,479
Cultural Facility	24	149,427	130,595	13%	6,226
Distribution Center	20	145,864	129,129	11%	7,293
Heat Supplier	46	654,182	554,123	15%	14,221
Industrial Sector	189	2,906,270	2,345,869	19%	15,377
Factory	134	2,253,308	1,756,379	22%	16,816
Waterworks/Sewerage	39	481,658	455,639	5%	12,350
Waste Management	16	171,304	133,851	22%	10,707
Total	1,159	11,208,596	9,763,956	13%	9,671

Source: The World Bank 2010

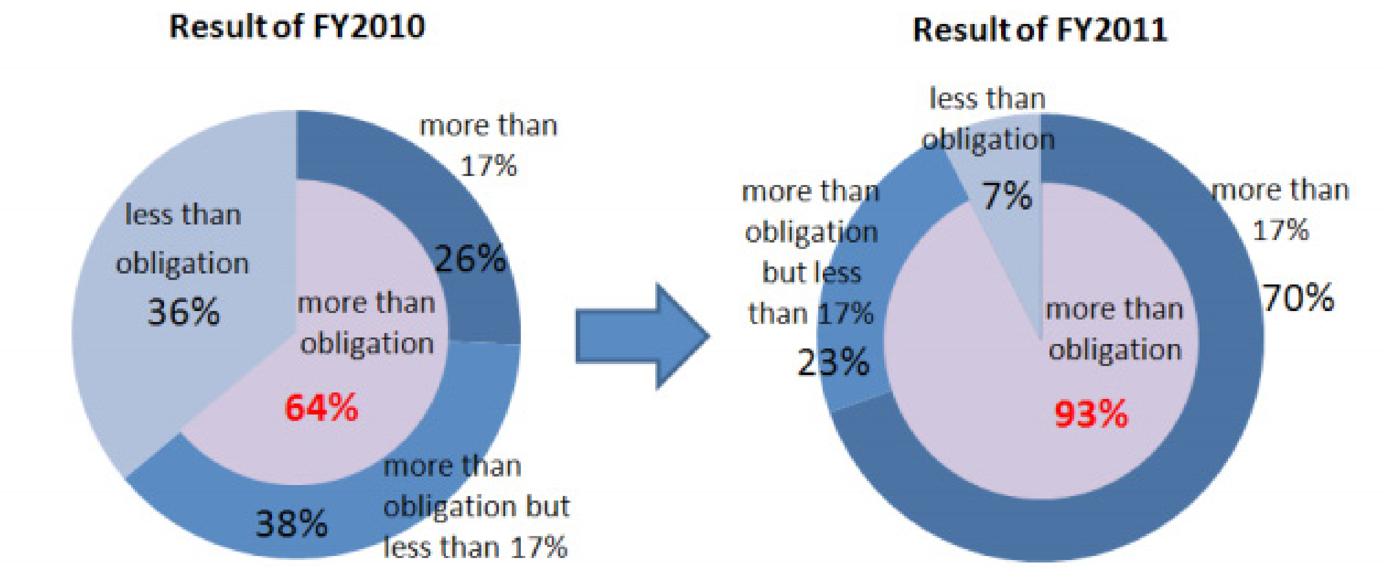


Figure 53: Emissions reductions within the first two years of the TMG ETS (TMG 2013)

4.1.7 Achievements and Success Criteria

The main success criterion of the TMG ETS is the amount of CO_2 emissions that are produced by the facilities covered under the cap-and-trade system.

An analysis of the achievements of the cap-and-trade system leads to the conclusion that the TMG ETS is functioning and has led to significant emissions reduction within the building sector:

In total, emissions reductions were far bigger than the intended reductions for the first phase. While TMG had set the goal for a 6% reduction in the first compliance period (2010 – 2014), overall emissions reductions already added up to 13% with respect to the base year emissions after the first year. Table 5 gives an overview over the reduction achievements of different types of facilities:

Of the 1,173 reporting facilities in the first year, 59% achieved reductions beyond their actual targets, while 41% were not in compliance. 22% achieved reductions of even more than 17%, which is the reduction target for the second compliance period (2015-2019). After the second year (2011), 23% of emissions reductions were already achieved by the facilities that are listed under the TMG ETS, with 70% of all facilities already achieving the emissions reduction target for the second period.

Table 7: Tokyo's ETS compared to an ideally sustainable ETS as discussed by Rudolph

	Sustainable ETS	TMG ETS
Coverage and Bindingness		
pollutants	all GHG; if selective, then most important	CO_2 from combustion, electricity use, 20% of total CO_2
emitters	all; if selective, then biggest polluters	1,300 facilities; 80% buildings, 20% factories
upstream vs. downstream	upstream; if downstream, then comprehensive	downstream
bindingness	mandatory	mandatory
opt-in, opt-out	yes, no	no
Cap		
target and total amount of emissions	top-down, scarce, target-oriented, fair[12]	-6% by 2014 (base 2002-2007), -17% by 2019; base-year by emitters
dynamics	devaluation of cap or allowances[13]	two-step decreasing cap
absolute volume vs. intensity target	absolute volume target	absolute volume
Initial Allocation, Validity		
free of charge vs. for purchase	full auctioning	grandfathering (allocation of reduction obligations instead of allowances)
revenue use	per capita dividend, adaptation measures[14]	no revenues
banking and borrowing	banking, no borrowing	unlimited banking, no borrowing
offsets	limited (amount, quality), below cap	3 kinds of ambitious offsets, partly limited
new entrants	auctioning; if free, reserve from the cap	grandfathering from reserve below the cap
shutdowns	no new allowances, return of allowances	no allowances after drop-out
Trading System		
compliance period	short; if long, then annual reconciliation	2 phases of five years (2010-2014, 2015-2019); annual monitoring
marketplace	established markets	bilateral trading of excess credits
market interventions	none	possible if price surge
Monitoring and Penalties		
MRV	IT-based, continuous, reliable	externally verified facility reports and registries
penalties	>allowance price + compensation	penalty up to 500,000 ¥; 1.3 times compensation, "name and shame"

Source: Rudolph, Kawakatsu 2012

4.1.8 Sustainability

There is extensive literature about the contribution of ETS to sustainable development through the reduction of GHG emissions and the incentivation of clean technologies and investment into energy efficiency and renewable energies. The basic idea behind an ETS is to have positive economic effects while reducing the ecological impact of a fossil fuel dependent society. Rudolph et. al. have analysed the sustainability of the ETS and feature design recommendations for an economically efficient, ecologically effective and socially just ETS (Rudolph et al. 2011). A comparison of these recommendations with the existing features of the TMG ETS shows that Tokyo has already implemented many aspects of a sustainable ETS, but that there is also room for improvement with respect to

> Extending the scope to other sectors and gases
> Tightening the cap
> Phasing in auctions for emission allowances
> Allowing trading of all allowances and institutionalizing an allowance market

Based on these principles, it can be stated that the TMG ETS contributes to enhancing Tokyo's sustainability by: successfully forcing the biggest polluters to contribute significantly to reducing the GHG emissions of the city, including emissions reductions from SME's into the offset trading process and using market mechanisms for optimal allocation of reduction measures.

4.1.9 Transferability of the Practice Example

An urban ETS, such as the one in Tokyo, can be implemented in other cities around the world – however, it takes time and political will to develop, implement and maintain an ETS within a city or an urban region. The TMG example shows that some main factors must be taken into consideration when transferring the Tokyo example to other cities:

- The city (or region) must be large enough to entail a significant amount of major CO_2 emitters who can be addressed with a cap-and-trade system.
- A standardized calculation of emissions and a sound database are the main success factors that must be considered. The introduction of an ETS, thus, needs to follow a phase of data collection on emissions from the targeted facilities or emitters.
- A comprehensive and ongoing public discourse must be an integral part of the development and implementation process.
- Independent third party verifiers must be in place in order to certify emissions reductions and to guarantee independent oversight of the process.

4.2 TOKYO GREEN BUILDING PROGRAM (ENERGY-EFFICIENCY AND BUILDING REGULATION FOR THE ENVIRONMENT)

4.2.1 Origin and Objectives

The legal starting point of Tokyo's Green Building Program (GBP) was the introduction of the Tokyo Metropolitan Environmental Security Ordinance in 2000, which prioritized environmental topics such as limitation of energy resource consumption, air pollution and prevention of global warming for the health and safety of Tokyo's' citizens.

In parallel to a carbon reduction reporting program (a pioneer of the current cap-and-trade-system) for existing buildings, the Green Building Program was established and targeted the environmental performance of new buildings with a floor area over 10,000 m². Since 2002, the program has been continuously strengthened and improved and today it also includes the expansion of existing large-scale buildings and new buildings with a floor area starting at 5,000 m² (Figure 54).

With its rating and reporting scheme, the program now stipulates the development of environmentally-conscious buildings in Tokyo, aiming to create a real estate market of highly valued green, energy and resource efficient and environmentally-friendly buildings. Through practical implementation of specific environmental measures in the building sector, the program directly supports the goals of the Tokyo Climate Change Strategy and the Tokyo Environmental Master Plan.

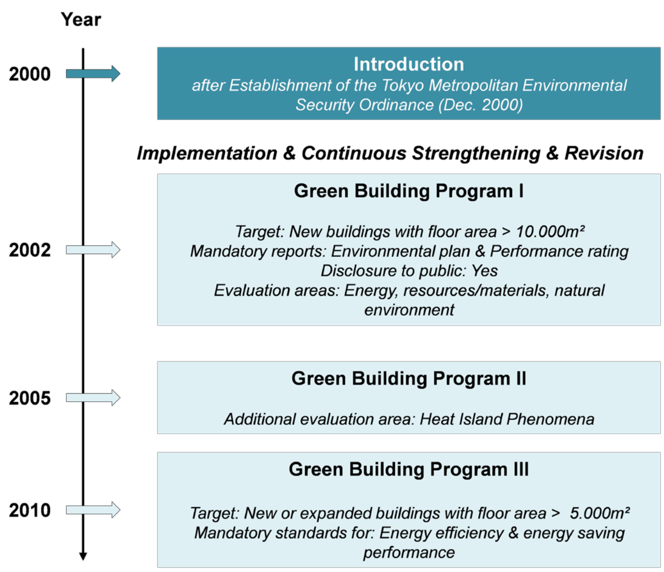


Figure 54: Development of Tokyo's Green Building Program (TMG 2010d)

4.2.2 Organization / Structure / Measures

Organized by the BOE, the program is characterized by four features, as follows (TMG 2010b):

Submission of a green building plan (indicating measures to be taken) and self-assessment of the building's environmental performance by building owner (based on Green Building Guidelines provided by TMG) before building permit and mandatory for buildings with floor area over 5.000 m²,

- Encouragement for building owners to engage in voluntarily measures (e.g. for buildings with floor area between 2,000 m² and 5,000 m²);
- Publication of green building plan on governmental TMG website as well as guidance or recommendation for improvement,
- Confirmation of compliance with Green Building Guidelines after completion of construction as well as on-spot inspections for verification.

All building owners (both public and private) as well as all building types are subject to the program.

With the program's latest revision in 2010, the focus of the program was broadened to include energy-efficiency and energy savings, renewable energy and climate mitigation. The green building plan submitted includes environmental items to be assessed such as (TMG 2010b):

- Rationalization of energy use via reduction in building heat load, use of renewable energy, energy saving system, district energy saving, and effective building operation systems.
- Preservation of the natural environment via water cycles, greenery or biodiversity,
- Appropriate use of resources and materials via eco-materials, exclusion of fluorocarbons, extension of building life, or water conservation.
- Mitigation of heat-island phenomena via reduction of artificial exhaust heat from building equipment, improvement of site and building covering, consideration of the wind environment.

Furthermore, the program inter-relates with other existing programs by also basing the assessment of the environmental building's performance on:

- Energy performance certificates (for non-residential buildings) based on energy performance specifications (such as thermal building performance) and minimum energy standards,
- Energy saving plans with energy saving measures, and
- Feasibility and implementation studies on the introduction of renewable energy equipment (such as solar energy, ground-source heat or biomass).

4.2.3 Financing / Business models

Based on Tokyo's environmental policies and programs which drive demand and investment towards a green economy, the Green Building Program is focused solely on (future) market mechanisms by delivering – with its labelling scheme – environmental building information to stakeholders (user, investors etc.) or requesting that innovative building measures to be taken. Future market mechanism addressed by or resulting from the program may include (TMG 2012g):

- Higher economic valuation of green buildings through labelling and therefore higher achievable rents, leasing rates or sale prices,
- New business models for renewable energy projects or energy-efficiency derived from environmental building measures taken, or
- Increasing investments in green buildings and green technology.

Furthermore, the program itself has led to additional programs such as the:

- Green Labelling Program for Condominiums (2005) and Apartments (2008) with mandatory display of "Environmental Performance Label" in sales and rental advertising, or the
- Energy Performance Certificate Program (2010) for non-residential buildings with mandatory presentation of the certificate for every transaction (sales) or lease.

4.2.4 Main Actors and Supporting Stakeholders

The TMG BOE is the main actor for both the introduction and current organization of the program. A participatory approach was chosen, involving different stakeholders and representatives of industry, experts, NGOs and citizens (TMG 2010c).

4.2.5 Obstacles and Challenges

Specific barriers and past challenges in terms of the acceptance of the Green Building Program have not been recorded. Previous and early intense discussions in the year 2000 on the introduction of a CO_2 emission reporting program made way for the agreement on this complementary program coping in an easier way with standards for energy efficient and environmentally-conscious buildings (ICLEI 2012).

4.2.6 Impact Factors

Factors influencing the introduction of the program and its revisions have been (Nishida 2013; ICLEI 2012):

- Tokyo's existing policies/programs (e.g. the Tokyo Metropolitan Environmental Security Ordinance) which indicate future targets, such Tokyo's target to reduce 20% of the energy consumed and 25% of the greenhouse gases emitted by 2020 (compared to the year 2000) and how to link these with legally-binding requirements for the building sector (e.g. the need for performance assessment in energy use rationalization).
- The large contribution (almost 66%) of the residential and commercial building sector to Tokyo's total energy consumption (figure 55) and therefore major sources of CO_2 emissions.
- The high share of existing buildings (approx. 94%) in the total building stock (figure 56).
- Buildings with an average lifespan of 30 years and the significant influence of building design on the operation phase as well as the building's impact on the (natural) environment.
- The perception that existing Japanese national energy-efficiency standards for buildings were not effectively implemented in Tokyo and not tailored to Tokyo's unique regional characteristics.

4.2.7 Achievements and Success Criteria

Currently, the program already includes 1,300 buildings and approximately 40% of all newly built buildings in Tokyo. Two-thirds of these buildings exceed the national thermal performance criteria for insulation. Furthermore, a decrease in the number of lower and an increase in the number of higher energy-efficiency performance buildings (both for residential and non-residential use) can be seen. The energy efficiency performance pf buildings is measured with the following values (TMG 2011d; ICLEI 2012; TMG 2010c):

- ERR: Energy Reduction Ratio, as the rate of reduction for energy used by the technical equipment system and as a measure for the energy saving performance, based on Coefficients of Energy Consumption (CEC); [13]
  CEC: Indicating the relation between actual energy consumption in [MJ/a] and standard energy consumption [MJ/a]; introduction of energy saving measures reduces actual energy consumption and improves energy-efficiency.
- PAL: Perimeter Annual Load, as a performance measure for the thermal insulation of the building envelope by calculating an annual thermal load factor [MJ/m²*a];
- PAL reduction rate: Indicating the relation between existing building PAL value and a defined standard PAL value13 (e.g. for office buildings 300 MJ/(m²*a); the higher the rate of reduction, the more effectively the building is insulated.
- The perception that existing Japanese national energy-efficiency standards for buildings were

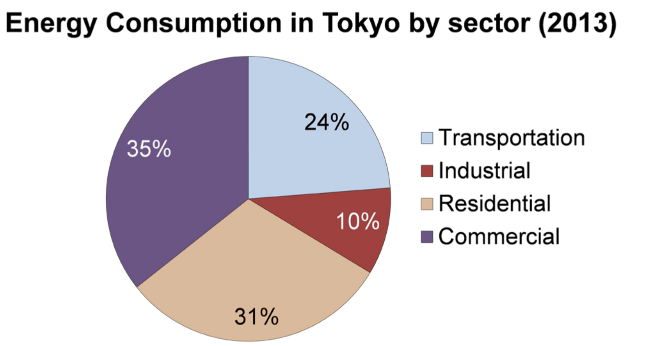


Figure 55: Energy consumption in Tokyo (own illustration)

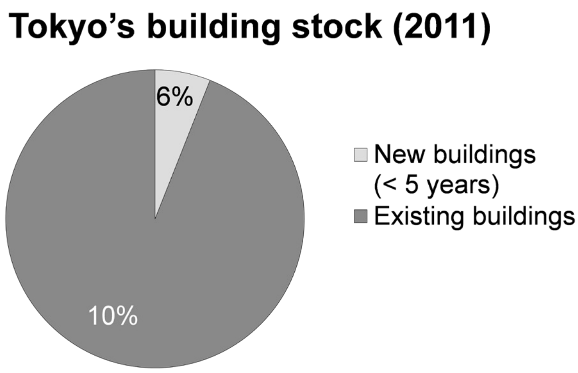


Figure 56: Tokyo's building stock (own illustration)

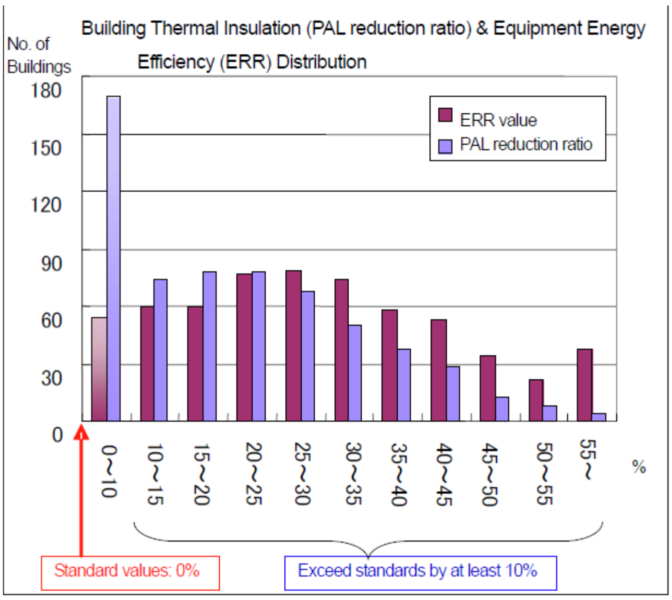


Figure 57: Building performance in the Green Building Program - number of buildings exceeding the standard ERR values and standard PAL reduction ratio (based on 608 non-residential buildings from April 2002 to July 2009) (TMG 2010c)

13) Standard values for PAL and CEC available based on "The Act on the Rational Use of Energy" for following commercial building types: hotel, hospital, retail, office, school, restaurants (Huang 2007).

not effectively implemented in Tokyo and not tailored to Tokyo's unique regional characteristics.

4.2.8 Sustainability

Tokyo's Green Building Program is influencing sustainability in the building sector in various ways. Obviously, the requirement for using renewable energy, meeting specific energy standards and improving the building operation system by introducing energy saving measures contribute to improve environmental sustainability through saving fossil energy resources, preventing environmental pollution or reducing CO_2 emissions, amongst others. In this way, the program directly interrelates with the cap-and-trade-program leading to existing buildings with lower emission potentials. On the other hand, the Green Building Program covers both the planning and implementation stage in building design and therefore sets the course for future environmental building projects.

From an economic perspective, the program is expected to result in new market and business models or technologies for environmentally-conscious building design, thereby contributing to the development of a green economy in Tokyo.

From a policy perspective, the introduction and constant revision of the program has resulted in the development of other related programs like the TMG ETS supporting and complementing the program itself.

4.2.9 Transferability

In general, replication of the Green Building Program is possible by adapting the labelling system and evaluation criteria to specific regional circumstances (e.g. climatic conditions) and environmental goals. In 2009, 21 local Japanese governments (approx. one-third) had already introduced similar programs with varying degrees of strictness and different rules for enforcement. A combination of market-oriented voluntary measures and legally-binding obligations is considered a pre-requisite for successful implementation.

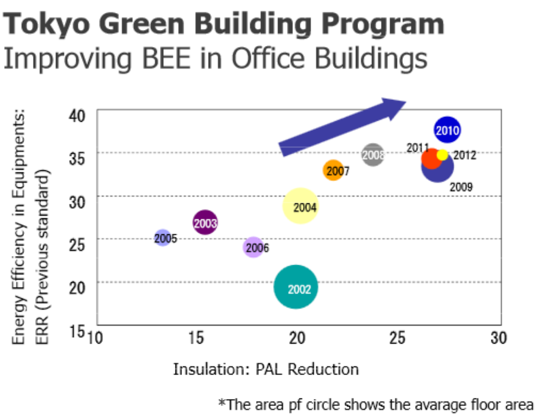


Figure 57: Improved building energy efficiency within the Green Building Program (Nishida 2013)

4.3 SHINJUKU DISTRICT HEATING AND COOLING CENTRE

4.3.1 Origin and Objectives

Urban districts with a high density of (high rise) buildings are characterized by high energy requirements and a limited ability to generate energy on site (e.g. due to limited roof and façade area for generating solar energy). However, at the same time, dense urban districts allow high efficiency rates by using combined heat and power generation units and distributing thermal energy via grids with low losses due to short distances. If cooling is also desired, trigeneration with generating electricity, heat and cold is an attractive technology with overall efficiency rates up to 85%.

In Japan, combined heat and power (CHP) deployment has continuously increased from about 0.8 GW installed CHP capacity in 1987 to about 9.5 GW in 2008. Since then, capacity development has stagnated and provides only about 3% of the country's electricity production (Toura 2013). This stagnation is a result of the adverse evolution of energy prices and a shift of policy focus towards residential micro CHP (Tokyu Corporation 2005).

The government aims to expand Area Energy Networks, representing a combination of traditional small scale district heating and cooling networks linked to existing distributed heat resources. These networks are included in Japan's Kyoto Protocol Target Achievement Plan and are incentivized through low interest loans and subsidies.

Following the construction of the first district heating and cooling system in 1970 at the Senri Chuo Area in Osaka, the Shinjuku district (which began DHC in 1971) was one of Japan's first DHC developments and is now with the largest DHC scheme in Japan with 2.2 million m2 floor heated/cooled area (Tokyu Corporation 2005). The Shinjuku DHC plant represents the beginning of the long-term growth of DHC systems based on the heat supply business act from 1972, which allowed independent companies to obtain a license for heat and electricity generation and supply heat and electricity in a very cost effective way.

4.3.2 Organisation / Structure / Measures

From 1971 to 1991, chilled water and steam were supplied to Shinjuku West New Town area. In 1991, when the DHC Plant was fully shifted to its present location, the Tokyo Metropolitan Government Office moved to their new building in the Shinjuku district, which is supplied by the Shinjuku DHC system. The plant was completed in 1995.

With a cooling capacity of 208 MW and a heating capacity of 173 MW, the centre serves more than 15 skyscrapers in the Shinjuku ward of Tokyo. Natural gas is used as the primary energy source for the trigeneration of electricity, heat and cold. Two gas turbines, producing electricity with a combined capacity of 8.5 MW, two absorption and three turbo chillers produce 4°C chilled water (return 12°C) with a capacity of 59,000 RT (refrigeration ton). The very efficient generation of electricity, as well as hot and cold water, with natural gas leads to low CO_2 emissions. In addition, a system to reduce the NOX emissions of the gas turbines is in place and low-NOX boilers were installed. The system was built and operated by the private company Energy Advance. This demonstrates that the private sector plays an important role in Tokyo for implementing highly efficient solutions in the energy sector.

4.3.3 Financing & Business Models

Advanced Energy Co,Ltd., a daughter company of the Tokyo Gas Co., Ltd., invested in the Shinjuku DHC plant. The plant was built and is operated by Shinryo Corporation.
Based on the heat supply business act established in 1972, all heat suppliers operating a facility with a capacity of 21 GJ (5.83 MWh) or more are considered a public utility and must apply for a license from the ministry of Economy, Trade and Industry and obtain approval for rates and supply conditions (Tokyu Corporation 2012).

4.3.4 Main Actor and Supporting Stakeholders

The DHC system is owned by Energy Advance Co., Ltd, one of the Tokyo Gas Group companies. The combined heat, cooling and power facilities are located in the technical centre below the Tokyo Gas tower.

Since 1970, Shinryo Corporation has been developing and operating DHC plants in Japan and other Asian countries. It operates 66 DHC areas in Tokyo and an additional 35 DHC areas in other Japanese cities. Other DHC areas have been implemented by Shinryo Corp. in Dubai, Thailand, Macau, Malaysia and Singapore.

4.3.5 Obstacles and Challenges

Until around 2005, CHP was a success story in Japan, based largely on its ability to significantly reduce energy costs for industrial and commercial users. Since then, energy prices have developed in such a way as to erode these benefits. The key barrier to the wider deployment of commercial CHP has been the adverse trend in energy prices (fuel prices rising relative to electricity prices), which has significantly reduced the economic incentive for energy users to invest. Since only low prices are paid for the electricity generated by the CHP system and sold to the utility, most Japanese CHP plants generate heat and power for their own consumption only, although larger benefits could be achieved if they could supply heat and power to other users or the network.

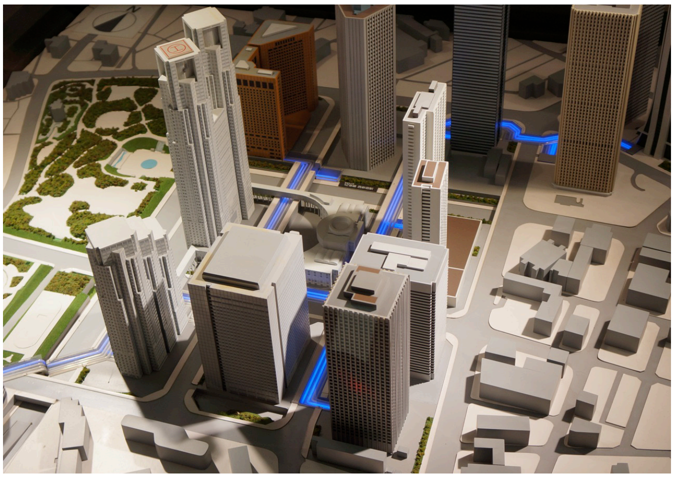


Figure 59: Model of the Shinjuku DHC plant with most of the 15 skyscrapers connected to the network (twin towers on the left: TMG building, blue lines: cooling network) (m:ci 2013)

Figure 60: Control room of the Shinjuku DHC plant (m:ci 2013)

The relatively high capital costs associated with DHC infrastructure development represent the main challenge to building heating and cooling grids. The current approach, which targets smaller heating networks, for example the stand alone energy network project at Roppongi Hills (which supplies about one third of the business area of the Shinjuku DHC system), provides one mechanism for overcoming this barrier. Opportunities for using CHP and waste heat from several sources – for example, from garbage or waste treatment station biogas – are also being explored in cities (Tokyu Corporation 2005).

4.3.6 Impact Factors

The following list represents the main impact factors for DHC systems:

- Transparent and stable gas and electricity prices;
- Greenhouse gas credits or feed-in tariffs for electricity generated by CHP plants, which is then fed into the grid;

- R&D programs and technological developments, particularly to increase efficiency and competitiveness of fuel cell micro CHP; and
- Development programs for heat networks in cities.

4.3.7 Achievements and Success Criteria

The Shinjuku DHC plant is the largest DHC plant in Japan and generates 33 GWh electricity and 225 TJ heat annually. Engaging building developers and companies in striving towards energy efficient and cost effective solutions for heating, cooling and electricity supply for their buildings is a criterion for success. An attractive political framework is a prerequisite and must provide the ability for businesses to act as independent power producers able to sell electricity to the grid at an acceptable price.

4.3.8 Transferability of the Practice Example

Energy efficiency district heating and cooling systems are very attractive for all city regions with high building densities and high heating and cooling requirements. The DHC technology is available from international companies in varying sizes; the challenges are mainly related to financing and regulations. As a rule, DHC systems can be transferred to all cities with high density areas and strong heating and cooling requirements if the business case can be made, which depends mainly on the political framework.

High initial investments are necessary in order to develop a DHC network and, therefore, long-term contracts to refinance the investment are required. In new areas, building owners can be sometimes be obliged by the building area purchase contract to be connected to and buy heating and cooling from the network. In existing districts, usually neither the utility nor the city administration are able to oblige building owners to connect to the network and the DHC investor carries the risk. Energy generation is very efficient in a DHC plant, however, the deductions on the network often make a DHC system profitable only if the electricity price is subsidized (e.g. with a fixed bonus for every kWh fed into the grid, as is the case in Germany).

4.4 PROMOTION OF RENEWABLE ENERGY SOURCES

4.4.1 Origin and Objectives

In addition to energy efficiency measures, the shift from fossil energy sources to renewable energy sources (RES) is required in order to achieve the goals of the »Tokyo Climate Change Strategy« from 2007. The TMG aims »to increase the percentage of renewable energy use to about 20% of Tokyo's energy consumption by 2020«. The sub goal »to create solar energy equal to one million kW by 2016« was also stated the by TMG (TMG 2010c). As a starting point, a conference of experts was organized and three goals for the deployment of PV were defined. Firstly, installation costs would be reduced, secondly, the public understanding of PV would be increased, and thirdly, the product performance would be enhanced (BOE 2012).

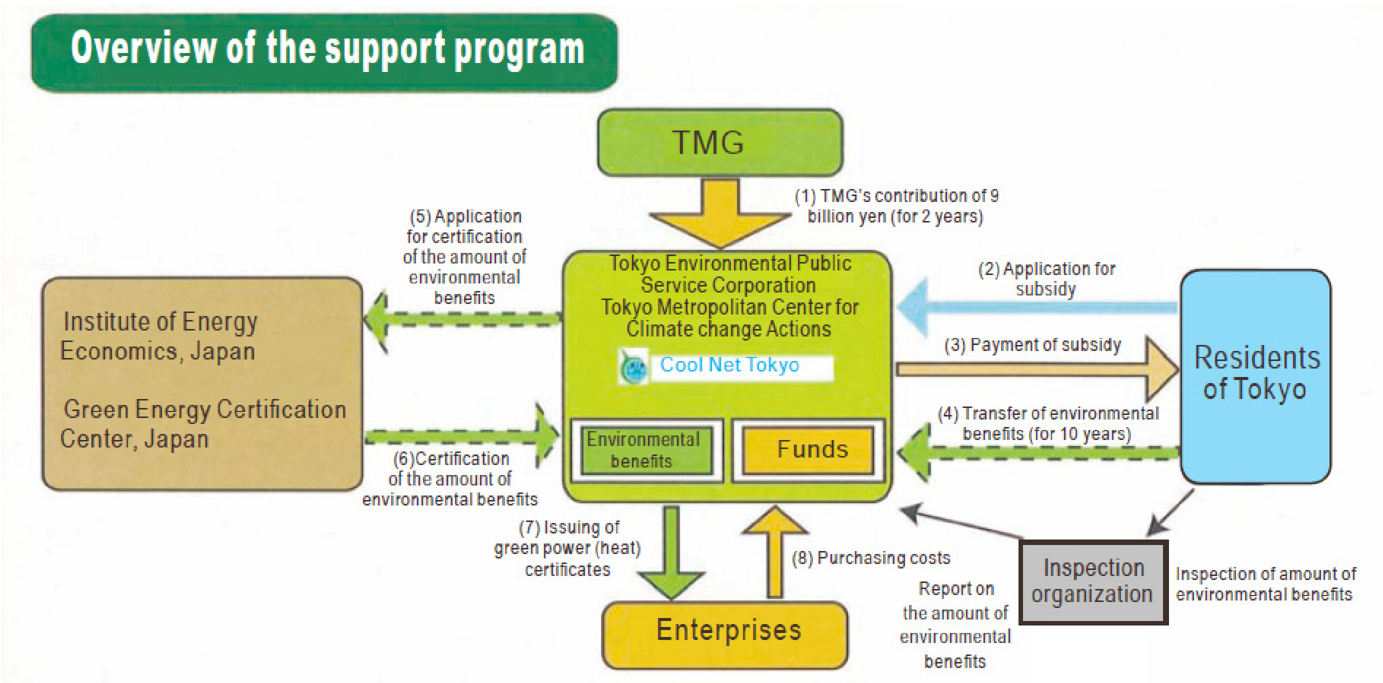


Figure 61: Structure of the solar energy subsidy program which turns environmental benefits of solar systems invested by Tokyo residents into green power certificates (Tokyo Metropolitan Government 2010a)

4.4.2 Organisation / Structure / Measures

The TMG uses various different programs to promote the use of RES:

- The Tokyo Cap-and-Trade Program rewards the use of RES for large facilities;
- the Tokyo Green Building Program has made the use of solar energy one of the rated criteria for achieving certificate (for large buildings also);
- in the residential sector, TMG supports the installation of PV and solar thermal systems with tax incentives and subsidies;
- the TMG established cooperations with other regions with high RES potential to encourage the import of RES from these regions to Tokyo city; and
- the TMG has drawn up guidelines for its own facilities, which make the introduction of renewable energy equipment a high-priority.

4.4.2.1 Project to Promote the Use of Solar Energy

On behalf of the TMG, the Tokyo Metropolitan Center for Climate Change Actions (called »Cool Net Tokyo«) started the »Project for Promoting Solar Energy Utilization Appliance for Residential Use« in 2009, with the aim of installing solar energy systems in 40,000 households within two years. To initiate the installations, PV systems received a subsidy of 100,000 Yen (€710) per kW and solar water heater between 9,000 and 33,000 Yen (€65 - €235) per m2 collector area.

To receive the subsidy, the residential investors must transfer the environmental benefits (reduction of CO_2-emissions) to Cool Net Tokyo, which turns them into Green Energy Certificates through certification by third party organizations and then sells them to enterprises (see Figure 61) (TMG 2010a).

In addition to subsidies for solar systems, from 2011 onwards, the TMG supported »household power creation equipment« as a response to the Fukushima accident. The TMG called for securing »urban electric power made in Tokyo« and subsidized the installation of gas co-generation systems (fuel cells), which are often installed in combination with a photovoltaic system.

In 2012, the national government started a feed-in-tariff scheme for solar electricity, which further pushed the deployment of photovoltaic systems in Tokyo. The TMG has since discontinued the subsidies for photovoltaic systems, but continues to support this development (e.g. by matching roof owners with renters in the so-called "roof rental business") (BOE 2012).

To promote solar energy, Tokyo held 35 Solar Energy Trade Shows with the exhibition of solar-powered equipment in liaison with wards and municipalities in 2009. In addition, the »Solar Energy Unitization and Promotion Forum« was created, by which natural gas contractors promote initiatives to advance solar power resulting in the development of new business models (TMG 2010c).

In contrast to photovoltaic, only little progress has been achieved in the field of solar thermal energy for heating purposes. Therefore, in 2011, the TMG started a program for solar thermal systems, focusing especially on newly built condominiums and single family homes. To increase public awareness and understanding of solar thermal systems, and thus reduce the use of electricity for heating purposes, a public campaign called »Heat from Heat« was conducted.

4.4.2.2 Cooperation Among Regions on Renewable Energy

The RES potential in Tokyo city is very limited in comparison to the city's high energy requirements. Therefore, the TMG signed an agreement with the Aomori, Hokkaido and Tohoku prefectures in the northern part of Japan regarding the use of their high RES potential. In 2009, TMG and the government of Aomori Prefecture in the Tohoku Region signed an interregional cooperation agreement to promote renewable energy. In 2010, TMG signed further agreements with the prefectures of Hokkaido, Aomori, Iwate, Akita, and Yamagata to create a structure for cooperation on renewable energy among these six regions. The prefectures will supply »Live Green Electricity« from wind power plants to large commercial buildings in Tokyo city under the cap-and-trade system. Thus, the TMG has promoted the participation of »Green PPS« contractors in the electricity market (PPS = power producers and suppliers). In return, this shall revitalize the economy of participating prefectures and create employment opportunities (TMG 2010c).

Main actors and supporting stakeholders

The Climate Change policy is driven by the TMG's Bureau of Environment., The Tokyo Metropolitan Center for Clima-

Figure 62: Photovoltaic system on a typical Japanese house (CoCreatr 2011)

te Change Actions (Cool Net Tokyo) was founded to operate it (e.g. manage the green certificates).

In Japan, public-private-partnership have had a long history. For solar promotion programs, experts from research and industry were invited in 2008, to identify measures necessary to achieve the TMG targets. Owner of buildings from residential homes to large buildings, are incentivized to use RES by way of the different promotional programs.

4.4.3 Obstacles and Challenges

There are several challenges to promoting the use of RES in Tokyo:

- The general awareness of RES was very limited in Japan until the Fukushima accident.
- Japan is divided into 10 electricity regions, and each region's electricity supply is monopolized by one main utility. In Tokyo, TEPCO is by far the biggest electricity supplier and only about 5% of electricity is supplied by independent power producers (e.g. generated by combined heat and power plants). After the Fukushima accident, the TMG rolled out initiatives aimed at increasing the competition in Tokyo's electricity sector. In 2013, the national government decided to reform the electricity market. To be able to more strongly influence the energy sector in Tokyo, the TMG must build up new administrative structures and know-how.
- The potential of using RES is rather limited in the Tokyo due to the high density of buildings and people and, related to this, limited roof and façade areas to generate solar energy (however, only a very small share of this potential has been used thus far). Therefore, cooperation with other regions is necessary.
- The average lifespan of a building, at 25–30 years, is rather short in Tokyo. This leads, on one hand, to low investments in building construction (also, because of the very expensive nature of construction property). On the other hand, it is a barrier to installing solar systems on existing buildings, as the remaining lifespan of these buildings is often than the new solar system being installed.
- Tokyo is a strong earthquake region, which leads to special requirements for the installation of RES systems – these increase the costs of installation.

4.4.4 Impact Factors

Originally, climate change policy was the main driver for the deployment of RES in Japan. However, the »Great East Japan Earthquake« in Tohoku on 11 March 2011 and the nuclear power station accident in Fukushima changed the situation fundamentally. Due to experiencing blackouts and the shortage of electricity in Tokyo, a process of rethinking the energy supply system began. Today, the main impact factors on the RES policy of Tokyo are as follows:

- Ensuring energy supply, also in the case of a blackout, is the main driver behind investments. Thus, the installation of fuel cells and batteries is growing strongly and is often combined with a photovoltaic system. The main goal of the investment is not to generate renewable energy, but to have a secure supply of energy.

- Since 2012, investments in photovoltaic systems is profitable due to feed-in tariffs on the national level. Therefore, the demand for photovoltaic systems is also growing steadily as a financially attractive investment option. In the past, photovoltaic systems were sold mainly to new buildings. Therefore, new market structures must be established to facilitate approaching the owners of existing buildings as well.

4.4.5 Achievements and Success Criteria

Based on the TMG's policy, the deployment of photovoltaic systems has shown very good results since 2007. The installations in the fiscal years (FY) 2011 and 2012 are shown in Table 8. On the 30th of March, 2012 (end of FY2012) 260 MW PV capacity had been installed in Tokyo. Therefore, there is no doubt that the TMG's target of 900 MW PV capacity installed by 2020 will be achieved (TMG 2013b).

Since the introduction of the feed-in tariff in July 2012, the installations of photovoltaic systems have increased strongly in Japan – from 1.4 GW in FY2012 to 3.8 GW in FY2013. The TMG was one of the promoters of the feed-in tariff, which was set at 42 Yen per kWh in 2012 and reduced to 37.8 Yen per kWh in April of 2013.

Success factors in the field of photovoltaic include its continuous promotion since 2007 and the combination of subsidies, tax reductions, awareness campaigns and the stimulation of new business models. In addition, solar energy was included in other programs and initiatives, such as the green building program, and the various initiatives launched were adapted to different target groups.

Table 8: Installed PV capacity in Tokyo (FY from 1 April to 30 March)

	Total installed by end of FY2010	New installed in FY2011	New installed in FY2012	Total installed by end of FY2012
Households	109 MW	38 MW	81 MW	229 MW
Others	20 MW	2 MW	9 MW	31 MW
Total	130 MW	40 MW	90 MW	260 MW

Source: TMG 2013b

In contrast to the success seen in the photovoltaic sector, the effects of the TMG policy on the solar thermal sector are still rather small. In FY2011 and FY2012, subsidies were provided for 22 solar thermal systems supplying 2,216 households in Tokyo (TMG 2013b).

4.4.6 Transferability of the Practice Example

All instruments established in Tokyo and used for the promotion of RES (awareness raising, subsidies, tax reduction, supporting the development of new business models, stakeholder dialogue and cooperation with other regions) can be transferred to other cities.

4.5 YOKOHAMA SMART CITY PROJECT

4.5.1 Origin and Objectives

In four locations around Japan (the City of Yokohama, Toyota City, Keihanna Science City in the Kyoto Prefecture, and the City of Kitakyushu) the national government is supporting smart grid and smart city concepts and technologies. Yokohama is a southwesterly neighbour of Tokyo in the Kanagawa prefecture, which can be reached by train in half an hour from Tokyo. Since the Yokohama Smart City project is a national Smart City test bed closed to Tokyo, it was visited as a best practice example.

Operational experiments in these cities are being conducted from 2010 to 2014 to explore technical, social and economical aspects. The project aims to make power use visible, control home electronics, hot water systems and other devices, explore demand response concepts, link electric vehicles with homes, and optimize the design of energy storage systems, EV charging systems, and transport systems. Furthermore, a Community Energy Management Systems (CEMS) will be developed to optimize the energy supply and demand of the community. The Japan Smart City Platform not only aspires to test and develop new technologies and business models, but also to support the export of Japanese smart grid and smart city technologies to other countries (Japan Smart City Portal 2014b).

4.5.2 Organisation / Structure / Measures

The Yokohama Smart City project (YSCP) was initiated by the City of Yokohama and involves 32 institutions and companies.

A YSCP master plan was developed with the following eight initiatives (YSCP 2009):

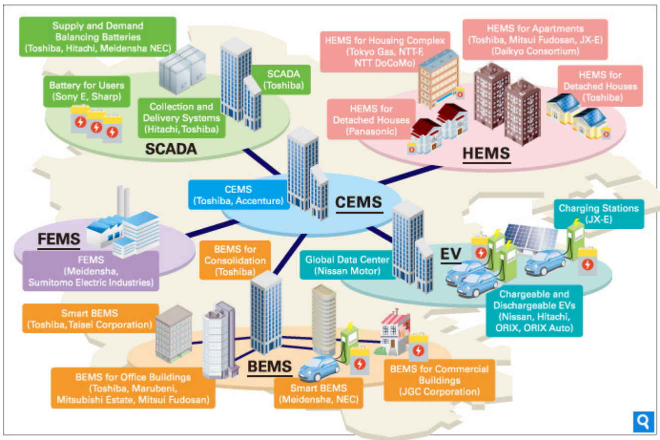


Figure 63: Structure and elements of the Yokohama Smart City Project (YSCP) including the companies participating in the different projects (City of Yokohama 2014)

Figure 64: Pictures of the Kankan Kyo prototype house in the Yokohama Smart City Project with a photovoltaic roof (top left), an electric verhicle being charged in the building (top right) and a living room with a control screen for the Home Energy Management Systems (HEMS), which can be used as a TV as well (Sekisui House)

1. introduction of large quantities of renewable energy sources including 27 MW photovoltaic capacity;
2. installation of Home Energy Management Systems (HEMS) in 4,000 detached houses with the aim of reducing 20% of CO_2 emissions;
3. installation of Commercial Building EMS (BEMS) in 1.6 million m2 building area with the aim to reduce 20% CO_2 emissions;
4. installation of Community EMS (CEMS) in 3 areas of Yokohama;
5. conduct large-scale verification of demand response (DR) and the relationship between the utility grid and EMS;
6. test of next-generation transport concepts with 2,000 EV including charging and discharging facilities;

7. lifestyle changes amongst the citizens; and
8. Optimized governance structures for smart cities.

In addition, Factory EMS (FEMS) were implemented to optimize the control of factory operations. The different initiatives are shown in figure 65.

4.5.2.1 The Smart House Prototype Kankan Kyo

As an example of a YSCP project, a smart house prototype is presented in the following. In Japan, most of the residential homes are prefabricated houses. One of the largest house manufacturer is the Sekisui House Group, which built 45,300 houses in 2012, of which 11,462 (25%) are sold with a photovoltaic system and 7,765 (17%) with a fuel cell.

Sekisui House used the YSCP to present and test the »Kankan Kyo« prototype house, which was built in 2010. Since August 2011, this house has been offered on the market under the name »Green First HYBRID« and about 400 houses had already been sold by the beginning of 2013.

The well-insulated house includes a 2.3 kWp roof-integrated photovoltaic system (roof tile solar modules), a fuel cell and a battery with 8.96 kWh capacity (called 'reserve cell'). A Nissan leaf electric vehicle is part of the Kankan Kyo house, and is powered by the building's electrical system. The electrical system can be disconnected from the grid and will then provide electricity to the residents solely through the photovoltaic system, the fuel cell or the battery.

A so called »Ene-Farm« fuel cell is used, which is produced by Panasonic in cooperation with other Japanese companies and has been commercially available in Japan since 2009. By the end of 2012, about 21,000 Ene-Farm fuel cells for detached houses had been sold in Japan. The national government subsidizes fuel cells with 450,000 Yen (3,200€), which is about 25% of the investment cost. In 2013, the investment costs of the Ene-Farm fuel cell were reduced from 2.8 to 2.0 million Yen (14,200€). It provides 200 – 750 W of electrical power and heat for hot water. It's overall efficiency reaches 95%. Two fuel cell technologies are available under the scheme, PEMFC and the SOFC; currently, the split is around 80% PEMFC and 20% SOFC. Panasonic has announced that the Ene-Farm fuel cell will also be available for condominiums from 2014 on (Carter 2013; Panasonic 2013A; Panasonic 2013B).

The Kankan kyo building's energy system is controlled by HEMS. It can be operated through the large screen in the living room or a screen at the building entrance, but also allows for remote control through mobile devices. Lighting is controlled by »human sensors« which detects the presence of residents and illuminance sensors, floor heating is controlled by human and temperature sensors. The house also includes an air purification system and is built with a seismic vibration absorption system, which is designed to reduce the deformation of the building by earthquakes by about 50%. The electric vehicle charging station is integrated in the HEMS. If the PV system generates more electricity than needed in the building, the solar electricity is fed into the grid and sold to the utility.

In the future, the plan is to also integrate solar heating systems, to use the electric vehicle as a battery, to improve the passive design by controlling technology for insolation and the monitoring technology for sensing the indoor and outdoor environment. The network technology shall be further improved by optimizing the interfaces between the residents and the house as well as between the IT platform and the town (Sekisui House 2012; Sekisui House 2013A).

4.5.2.2 Yokohoma Green Valley

In order to improve the energy use efficiency within a community, it is necessary to optimize energy consumption not only within private residences and offices, but also in factories that use vast quantities of energy. Therefore, the YSCP focuses not only on residential, business and public areas but also on industrial and factory areas. Yokohama Green Valley, which is a part of the YSCP, is a project to promote the reduction of CO_2 emissions and achieve economic vitalization by developing an environmental industry. Kanazawa Ward the model area which includes 87,000 households has all elements of Yokohama (including residential estates, industrial estates, public facilities, nature and sea) in a compact area.

Pursuing one of the YSCP´s main objectives – the development of the environment and the energy industry – Yokohama carries out the following measures in Yokohama Green Valley:

- Support for technologies and products that contribute to the environment;
- Granting of subsidies for manufactures who develop technologies and products that contribute to the transition to a low-carbon society;
- Promotion of energy-saving measures in manufacturing processes;
- Promotion of approaches to mitigate global warming in new business fields.

In addition to the measures mentioned above EMS will be introduced in the participating urban districts, such as the Yokohama Green Valley. Thereby FEMS are favorable for controlling factory operations and promoting energy saving measures in manufacturing processes (TMG 2012c).

Toshiba is responsible for the introduction of the EMS in Yokohama Smart City. Until now, the main activities have been the introduction of CEMS, HEMS and BEMS. Nevertheless, in the future, FEMS will also be used for optimal

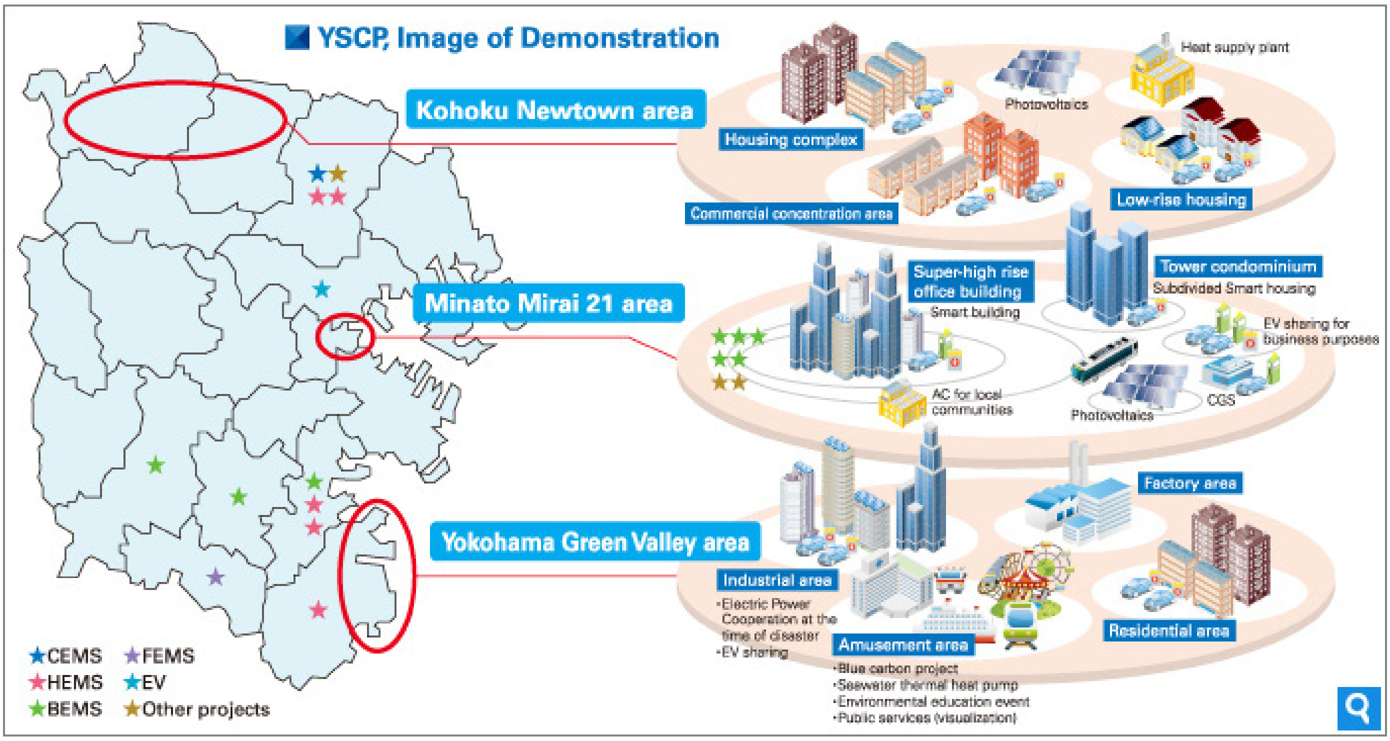


Figure 65: Yokohama Smart City Project (YSCP 2011)

production. The most important objectives and benefits to be gained through the introduction of FEMS include (Yokohama Green Valley 2013; HOSOYA& IEDA 2004):

- Management and control over both energy supply and demand at manufacturing sites;
- Optimization of energy usage across the entire plant to reduce costs and cut CO_2 emissions;
- Prediction of the level of power generation from renewable energy sources such as wind and photovoltaic power generation;
- Reduction of the cost of energy purchases;
- Maintenance of the security of supply by coordinating generation with the planned and the actual operation of the plant;
- Visualization of energy usage and calculation of per-unit usage to achieve energy savings by optimizing the planned operation of the utility plant in collaboration with production plants.

All efforts should lead to decreasing greenhouse gas emissions over 25% by 2020 and over 80% by 2050 (compared to 1990 levels) (TMG 2012i).

4.5.3 Main Actors and Financing

The YSCP is managed by the Yokohama city administration. A steering committee and a board of governors was implemented to steer the project. Working groups were established for the individual initiatives. In total, 32 institutions and companies are involved and named as follows: Tokyo Institute of Technology, Urban Renaissance Agency, MM42 Kaihatsu TMK, Yokohama Smart Community, Accenture, NTT docomo, NTT Facilities, ORIX, Sharp, JX Nippon, Simitomo Electric Industries, Sekisui House, Sony energy devices, Daikyo Astage, Taisei, Tokyo Gas, Tepco, Toshiba, Nissan, JGC, NEC, Nomura Real Estate, Panasonic, Hitachi, Misawa Homew, Mitsui, Mitsubishi, and Meidensha. The list shows that many major Japanese companies are involved, which elevates the YSCP to the status of being the national smart city test bed. YSCP is scientifically supported by the Toyko Institute of Technology and the Urban Renaissance Agency In total, the YSCP costs are calculated at 74 billion Yen (530 million €). The project is financed by participating companies and institutions and subsidized by the Japanese government.

4.5.4 Transferability of the Practice Example

In general, all the YSCP initiatives can be implemented in other cities as well. However, the project is driven by the national competition on Smart City projects and receives significant national subsidies. This attracted the participation of large companies who contributed with significant resources of their own. Without this national initiative it would be difficult to bring together so many relevant actors.

4.6 MOBILE SPATIAL STATISTICS

4.6.1 Introduction

Nowadays, Japan has more mobile subscriptions than inhabitants, and the trend is increasing. Intelligent mobile devices, such as smartphones, are becoming increasingly common and important as platforms for the creation, consumption and transaction of real-life activities. In dense city areas like Tokyo, mobile phone operators already face performance issues caused by intense network use. In order to take appropriate measures to solve these issues, the operators must analyse mobile network performance data. Together, the wide distribution of mobile phones and the network performance analysis can be used in a broad range of contexts (e. g. to estimate actual population statistics). Thus, Mobile Spatial Statistics is a way in which mobile phone data can be used to contribute to the establishment of more resilient cities and to improve urban planning.

4.6.2 History and Objectives

The number of users of mobile cellular networks has increased rapidly in recent years. In 2011 the Wireless Broadband Alliance forecasts the global mobile data traffic to nearly triple in only two years from 2012 to 2014 (Wireless Broadband Aaliance 2011). The load of the networks varies in different areas and times, exceeding network capacity occasionally. This is a major challenge for mobile phone operators especially in dense areas like Tokyo. To optimize performance, analysis of network performance data is crucial (Rissanen 2003). For that reason, it is not surprising that NTT DOCOMO, Japan's leading mobile operator with over 58 million domestic customers, has been working on this topic for years. NTT DOCOMO noticed that this technology

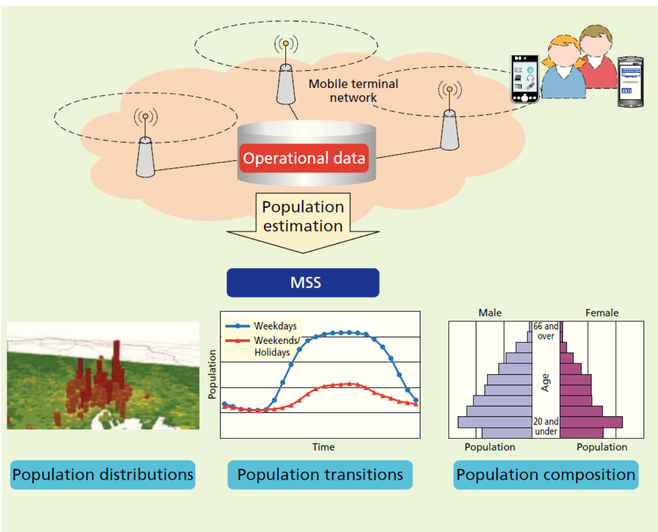


Figure 1 Overview of MSS

Figure 66: Overview of Mobile Spatial Statistics (Okajima et al. 2013)

must not only be used for efficient operation, but can also estimate actual population statistics.

Typically, population statistics are based on the people's usual residence. Since people are usually at their residence during the night, it can be expected that the residential population captures the actual population during night-time. However, many inhabitants commute from their residence during the day, which results in changes to the distribution of the population. These changes are not reflected in residential population data, but in actual population statistics, which is a term for the actual population remaining in a given area. As people move these statistics change from one minute to the next. Mobile phones, since they are carried with the individuals, allow ascertaining these statistics from operational data taken from the mobile terminal network. This is why these statistics are called *Mobile Spatial Statistics* (Okajima et al. 2013).

Dr. Terada, one of the senior research engineers says "we wanted to optimize society". Thus, in the fall of 2010, NTT DOCOMO conducted a joint research project with the University of Tokyo which involved utilizing *Mobile Spatial Statistics* for efficient urban planning. Another research project with Kogakuin University studied how these statistics could support disaster-prevention planning. In particular the latter project became very relevant after the Tohoku earthquake and tsunami in March 2011 caused large numbers of people to become stranded in the Tokyo metropolitan area. This underlines the necessity of accurate population statistics for the Tokyo Metropolitan Government, and other municipal authorities, in order to ensure effective prevention measures (e. g. number and location of shelters, placement of emergency equipment) are conducted.

From the viewpoint of official statistics, *Mobile Spatial Statistics* are less accurate; however, they are valuable because they can grasp the trend of population change on an hourly basis, which official statistics cannot deliver. For that reason, the National Statistics Centre Japan and NTT DOCOMO decided to undertake a research project for small area statistics. The goal is to assess the quality of Mobile Spatial Statistics compared to official statistics and explore the usability of *Mobile Spatial Statistics*. In the end, statistics-users such as municipalities should benefit from improved small area statistics.

4.6.3 Project Implementation and Next Steps

At the invitation of NTT DOCOMO, the University of Tokyo and the Kogakuin University joined the research project. While NTT DOCOMO financed the project, the research partners analysed the potential of this type of technology in their fields of research (urban planning and disaster prevention planning). The outcome was used as the theoretical framework for the development of Mobile Spatial Statistics. Additionally, several municipal authorities (e.g. Tokyo, Kashiwa City, Chiba, Saitama) were involved as end-users. As participants in the case studies they had access to the research results and the opportunity to internally discuss the usability of *Mobile Spatial Statistics* with regard to their duties. Several projects got stuck at a case study level, even when local governments were deemed suitable for utilizing *Mobile Spatial Statistics* in a city context. One reason for this might be that up to this time the persons in charge do not feel comfortable relying on a new technology. However, some prefectures and cities will continue with or start utilizing *Mobile Spatial Statistics*.

To address this concern and increase the number of users, an important next step is to extend the database. For the study, which was attempting to estimate the number of stranded people in Tokyo's metropolitan area in the event of an earthquake, data was only gathered over a period of one week in December 2010 (see Figure). For more precise estimations, data must be collected over at least one year, including all seasons. This is only feasible if the data collection process becomes fully automated.

Another important step for NTT DOCOMO is the development of a variety of business models for Mobile Spatial Statistics. One possible application could be a frequency analysis of pedestrians, which might be useful for shop owners or transport operators. In this way, NTT DOCOMO can continue with the development and improvement of the underlying technology and thereby provide helpful services to municipal authorities.

4.6.4 Challenges

NTT DOCOMO and its partners had to address several challenges in order to make *Mobile Spatial Statistics* a reality. The first challenge was whether population statistics of sufficient precision could be calculated from massive data ("Big Data") with realistic processing times and costs, or not. Even with large-scale processing infrastructure (Ishida et al. 2013) the data output still takes approximately one

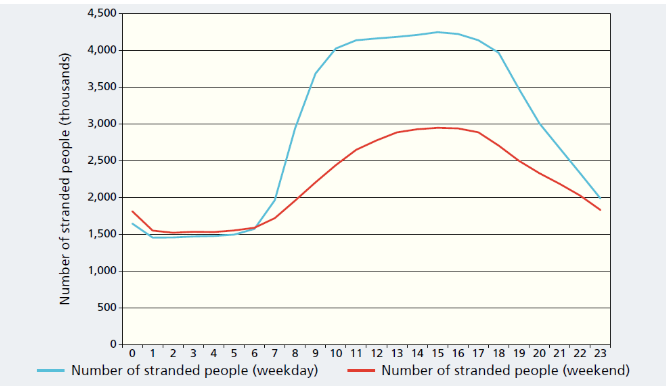


Figure 67: Number of stranded people across the whole of Tokyo, broken down by time of disaster occurrence (Suzuki et al. 2013)

week. Biases and 'noise' in the raw data must be considered and the results must be calibrated. Several computational models are necessary for dealing with specific analytical challenges (e.g. bypassing cars in a cluster).

The second challenge was related to inventing applications. Since NTT DOCOMO had no expertise in the area of utilizing statistical information, the exchange with research partners was crucial. The experts in urban planning and disaster prevention planning developed methods of utilizing population statistics in their areas of research. Together with municipalities, realistic community challenges were identified that could be addressed with *Mobile Spatial Statistics*. In addition to these applications in the public sector, business models for the private sector are under development.

The third challenge was related to obtaining social census. Even when population statistics are only statistical values and do not include any personal information, they are based on individual movement data from mobile customers. Therefore, the preservation of user privacy is essential and must be a sincere priority. NTT DOCOMO implemented a technical solution on the basis of guidelines prepared by Prof. Horibe of Hitotsubashi University which assembled the basic elements necessary for the protection of privacy when creating and providing *Mobile Spatial Statistics*, considering both legal and social aspects.

The fourth challenge is adoption by municipalities. Even though a couple of municipalities participated in the studies, it still takes great effort to convince decision makers to use *Mobile Spatial Statistics* for city planning tasks in work day life. This might be due to the fact that, especially in crucial and long-term decision making processes, risk aversion is common. Success stories and early adopters are vital to overcoming this issue and proving the reliability of population statistics.

Assuming that *Mobile Spatial Statistics* will become popular as a support to urban planning in the near future, discussions about open data will arise. As described by Dr. Terada, this would be a challenge. Generally, all data used for the public good is supposed to be open. In this way, the data can be used for the benefit of society. On the other hand, open data can be misused and could be a risk to existing business models. The challenge will be to balance the rising demand for openness and the incentives for innovation in the area of population statistics.

4.6.5 Impact Factors

The story of *Mobile Spatial Statistics* shows the importance of strong local networks between private companies and research institutions. Because NTT DOCOMO had no internal competences on how to utilize population statistics for urban planning, they cooperated with local universities and sponsored research activities. Since the project was led by the NTT DOCOMO research laboratories, there was no primary need to develop business models.

The joint research focused on serving municipalities. These, in turn, supported the activities by providing use-cases and platforms to present the results. All in all, this is an example of how high-tech companies can trigger and finance the development of a new technology which can be used for the public good and supports local governments on their journey towards a more sustainable city.

Two main aspects make it difficult to judge the success of *Mobile Spatial Statistics* at this point. Firstly, *Mobile Spatial Statistics* is more a tool-set than a single solution for one specific problem. Or, how Mr. Murase, Managing Director of NTT DOCOMO research laboratories, puts it

> *"The greatest value of mobile spatial statistics lies not in specific solutions, but in allowing general-purpose population statistics to be used regularly by ICT. […] this new information infrastructure will contribute greatly to the sophistication and development of society from here on and become essential"*
> (Murase 2013).

Secondly, most implementations are use-cases and not relevant to everyday work life.

However, even with these constraints, one can see how *Mobile Spatial Statistics* facilitates the trend towards a more evidence-based urban government. For example, according to "Damage Estimation of an Inland Earthquake Directly Below Tokyo" (published May 2006), approximately 4.48 million people in metropolitan Tokyo will be stranded when an earthquake occurs. Furthermore, according to a fact-finding study announced by 'The Council for Measures for Persons Stranded by an Earthquake Directly Below Tokyo' in November 2011, the number of people in Tokyo stranded by the Great East Japan Earthquake on March 11, 2011, was 3.52 million. The estimations based on *Mobile Spatial Statistics* predict 4.25 million stranded people in Tokyo for a disaster occurring at 3 pm on a weekday (Suzuki et al. 2013) [14].

This shows that there is an interest as well as a need for detailed information by the Tokyo Metropolitan Government and other responsible authorities in order for them to take effective measures towards ensuring disaster prevention. Additionally, *Mobile Spatial Statistics* provides differentiated information regarding the numbers of stranded people (e.g. based on time of disaster occurrence, age group, gender, or origin). This allows more reliable planning and more precise measures.

14) The differences in the numbers will not be discussed here.

4.6.6 Sustainability

Urban development requires knowledge of population statistics. This means that *Mobile Spatial Statistics* can influence various fields of urban planning with regard to sustainability (Odawara, Kawakami 2013). For example, understanding population movements can help to improve traffic. The residents main travel routes can be identified and matched with existing infrastructure and available public transportation (buses, subways, trams, etc.). In a next step, bottlenecks and/or missing connections can be identified and considered during traffic planning.

Additionally, the real land-use by residents during daytime and night-time can be observed. This allows for more efficient urban administration and better alignment of urban development policies. The evaluation of parks and green spaces is another possible application. Population statistics allows for the analysis of the way such spaces are used and the results can be used for the reorganization of parks. Finally, as described above, disaster prevention can also benefit from *Mobile Spatial Statistic* and thus improve city resilience. Besides these few examples, many other applications are possible (Blondel et al. 2013).

4.6.7 Transferability

The general idea is transferable to any other city worldwide since cell phones are spread around the globe (and their prevalence is increasing) as is an interest in analysing the resulting data. However, the necessary technology is both complex and expensive. Because only telecommunication carriers have access to cell phone data, it is necessary for interested municipalities to cooperate with them. Complicating factors include legal concerns and problems related to the analysis of individual phone data, even when the data is aggregated to statistical numbers without personal information. This could be a show-stopper in some countries. In addition to this, different urban environments might require different applications of *Mobile Spatial Statistic* to address local needs.

4.7 TOKYO INTERNATIONAL AIR CARGO TERMINAL

With the Tokyo Vision 2020 objectives of bolstering land, sea and air transport, the Tokyo Metropolitan Government is focusing on turning Haneda Airport into a hub airport by linking it with other major Asian cities. In line with the expansion of the Tokyo International Airport, Mitsui Group, Japan´s biggest trading company, began operating the Tokyo International Air Cargo Terminal (TIACT) located in Haneda's international cargo area in October of 2010. The TIACT site covers an area of 170,000 m² and has a total floor area of 80,000 m². Taking advantage of its convenient location near the Tokyo Metropolitan Area, TIACT aims to provide nonstop 24-hour-a-day logistics services for international air cargo as a hub that most efficiently connects both Japan to the world and the metropolitan area to local regions in Japan (TMG 2009).

4.7.1 Objectives

TIACT aims to apply their knowledge and innovations to become an „EDO (Efficient, Dynamic, Optimized) Air Cargo Terminal," that contributes to the improvement of Japan's international competitiveness (MITSUI & CO. Ltd. 2013).

The TIACT's objective is to ensure stable transportation of cargo by fully utilizing the advantages of the metropolitan airport. It has easy access to the metropolitan area and major locations in the surrounding area. TIACT is aiming to improve its service for the convenience of their customers by, for example, avoiding traffic congestions and increasing the speed of pick-ups and deliveries. They are also determined to improve distribution quality by adapting their standard operating procedures as well as their logistics structure to meet their customer's requirements. This includes a 'perishables handling area' and a special storage space for drugs and medical supplies.

In addition, with its ecological facilities and the latest information system, TIACT embodies the concept of an innovative air cargo terminal and contributes to the sustainable development of Tokyo´s logistics network.

Figure 68: The TIACT Terminal (TMG)

4.7.2 Procedure, Measures and Project Implementation

After more than 30 years of absence, during which time cargo was transferred through Narita, international flight operation started at TIACT in 2010 with the inauguration of the fourth runway, known as the "D Runway." Today, TIACT is equipped with four runways. Within a few years, TIACT will expand its capacity by increasing available timeslots. In 2013, the volume of international cargo handled in one month at TIACT adds up to 10,000 tons.

In addition to reducing CO_2 emissions and fuel consumption through efficient logistics-techniques and short distances to the center of Tokyo, the TIACT facilities themselves are designed to be eco-friendly. Most of the roofs of International Cargo Buildings No. 1 and No. 2, which are the main facilities of the terminal, are covered with photovoltaic power generation modules (MITSUI & CO., LTD. 2013).

Rainwater and recycled water are also actively utilized at TIACT. Both sewage and greywater are processed by an advanced water treatment system within the terminal and utilized for miscellaneous uses (e.g., flushing toilets), contributing to a significant reduction of waste water. Rainwater that falls on the massive roof and the site of the terminal is also saved in tanks and utilized.

Furthermore, the truck-staging area of the terminal is equipped with power supply stands to avoid idling during standby times. These stands supply power to parked trucks so that their frozen or refrigerated cargo is protected even when idling is stopped, helping to reduce CO_2 emissions and fuel consumption.

A truck guidance system provides smooth traffic guidance and is linked to the access control. At both the entry and exit gates an automatic authentication system using radio frequency identification (RFID) has been implemented, which prevents vehicle congestion in the areas around the gates.

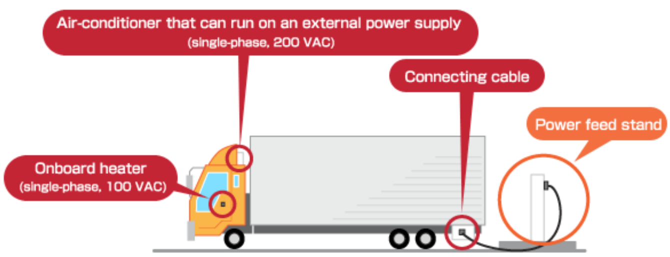


Figure 69: Power supply for trucks (TMG)

4.7.3 Financing of the Project

The TIACT's financing is based on the Private Finance Initiative (PFI). The PFI is a way of utilizing funds, management capabilities, and technical capabilities from the private sector to build, maintain, and operate public facilities. The TIACT is operated by Mitsui which holds 100% of the TIACT shares.

4.7.4 Actors

Constrained conditions for commercial flights in Tokyo prompted the TMG to lobby the national government for the expansion and internationalization of Haneda Airport. To promote this project, the TMG cooperated in a variety of ways. This included providing the central government with interest-free loans from the fiscal year 2004, to be used for the construction of a new runway, a measure going beyond the conventional responsibility of a local government. The 2,500m long runway is linked to the rest of the airport by a connecting taxiway.

In 2005, the TMG put out a tender for the construction of a passenger and international air cargo terminal. Mitsui trading company was awarded the tender in 2006, which included both the construction and operation of the terminal. Mitsui has been operating the TIACT since 2010 and has a 30 year lease contract with the TMG. For the operation of the terminal, the TMG made some restrictions concerning the traffic and security at the airport. However, apart from that, the TMG does not have any influence on the operation of TIACT.

4.7.5 Barriers and Challenges, Key Drivers and Framework Conditions

The consequences of the world economy crisis pose one of the biggest challenges for the TIACT, making it impossible to utilize TIACTS´s available capacities completely. Previous estimated transshipments - especially shipments to other Asian countries – do not meet the volumes expected. Haneda Airport was planned as a supplement to Narita Airport because Narita had reached its maximum capacity. However, as loading volumes decreased, most distribution companies still use Narita exclusively because it is their main air cargo terminal and they have their logistics facilities there and not in Haneda. Although TIACT offers transfers to Narita it is still more comfortable for companies to transport to Narita than to Haneda. Haneda has the ability to transfer a maximum of 500,000t per year. Until June 2013, however, Haneda Airport only transferred a yearly average of 150,000t. The national government has been making efforts to spur demand; for example, the landing charge for international cargo flights arriving between midnight and the early morning hours was discounted by 50% in April of 2011.

Mitsui's objective of developing TIACT is to develop it into an international hub airport is still stunted in growth due to the low level of support by the japanese government. Nevertheless one of the key drivers that push the development of TIACT is the Tokyo Vision 2020. The TMG´s objective is to realize Haneda´s expansion and to establish international flights to 16 global destinations, such as Paris and Los Angeles. Furthermore, the three loop roads project influences the development of the TIACT by providing a better connection to the central loop road and Tokyo´s outer loop road.

4.7.6 Achievements and Success Criteria

TIACT is directly connected to the international passenger Terminal Haneda. If passenger flights are not fully booked and there is still free capacity in the belly, those capacities are used for air cargo transportation. For TIACT as well as for the passenger carriers it is beneficial due to optimized degree of capacity utilization. As TIACT competes with Narita airport the fact that night flights are allowed compared to Narita airport is an important advantage for TIACT. Night flights give the carriers more flexibility in their supply chain and in some cases fastens the transportation. Moreover, the TIACT is located in central Tokyo whereas it takes at least a one-hour-drive to get from Narita to central Tokyo. Although a one hour might not seem like much, it will be a success criterion for the TIACT, especially once the three loop roads project has been finalized.

4.7.7 The TIACT and Sustainability

The TIACT contributes in many respects to sustainable logistic processes in Tokyo. One of the most important aspects is the location of Haneda compared to Narita. Haneda is located directly in the center of Tokyo so that distribution processes within the city are shorter than from Narita.

Shorter distances cause less traffic in general and therefore lead to a reduction in CO_2 emissions. Considering the economic aspect of sustainability, the TIACT supports new possibilities for more direct distribution to the prefecture Ota-City, which is located directly at the TIACT and characterized by its industrial enterprises. The TIACT also influences the resilience of Tokyo. Before the TIACT was in operation, Narita was the only international air cargo terminal in Tokyo. The dependence on one airport is very risky in case of, for example, an earthquake. Haneda offers an alternative route for transporting goods to Tokyo if Narita should no longer be available. The fact that the TIACT is directly connected to the passenger airport makes it possible to usilize un-used capacities on passenger flights. If capacities are used at a higher capacity utilization rate, the total number of flights will decrease which will in turn lower the overall emission of CO_2.

The second most important aspect considering sustainability is related to the logistics facilities themselves. As described, the TIACT uses solar energy. 28,000 m² of photovoltaic modules generate a capacity of around 2,000 kW and supply approximately 10% (or 2 million kWh a year) of the total power needs of the terminal. Through the use of rainwater, approximately 70% of the water for miscellaneous uses within the terminal is supplied, which provides several other benefits including a reduction in the load on the municipal sewage system. The shared use of passenger flights with cargo transportation contributes to higher efficiency which leads to economically sustainable development.

4.7.8 Transferability of the TIACT Concept

The transferability of the TIACT concept depends strongly on various conditions within the city, as one of the main advantages of the TIACT is its location. In terms of the logistics facilities, all measures are adoptable by any terminal. Furthermore, cooperation between the passenger and cargo terminals is possible if they are directly connected.

4.8 THREE LOOP ROADS PROJECT

Tokyo Vision 2020 contains the objective of transforming Tokyo into a city which can be presented to the world proudly, as an urban model for the 21st century. One of the eight main goals is to bolster the land, air transport network in order to raise Tokyo´s international competiveness and to accelerate the flow of people and goods by completing the three loop roads project.

The three loop roads project was planned in the 1970´s and consists of a network of three ring roads ((1) Metropolitan Expressway Central Loop Route, (2) Tokyo Outer Loop Road (Gaikan) and (3) National Capital Region Central Loop Road (Ken-o-do)) and nine radial roads. Since then, radial expressways like Kanetsu have been constructed, but the construction of the ring roads has been lagging behind. As a result, traffic that wouldn´t necessarily need to enter the urban center is concentrated on the inner circular route, which results in chronic traffic congestion (see following picture) (BOE 2010).

4.8.1 Creation and Objectives

The three loop roads project focuses strongly on reducing traffic congestion and effectively utilizing the Tokyo Megalopolis Region's potential to enhance Tokyo's international competitiveness.

The alleviation of traffic congestion induces a reduction of travel time (e. g. increasing vehicular traveling speeds from 18.8 km/h to approximately 25 km/h during rush hours), an increase of distribution efficiency and a reduction of distribution costs by approx. 10%.

The decrease in traffic congestion is based on the following four aspects (TMG 2010c):

- The inflow of through-traffic to different city sections is controlled,
- Traffic from suburbs to the city center areas will disperse,
- A direct move between peripheral areas will be possible
- Detours can be accomplished quickly, even if caused by disasters or accidents.

By achieving shorter driving times and lower operating costs, the construction of the three loop roads is anticipated to have large economic impacts. This will also strengthen collaborative activities with the neighboring cities and contribute to the sharing of functions throughout the Tokyo Metropolitan Region. Thus, it will greatly benefit the revitalization of urban functions in Tokyo and the area surrounding Tokyo. In addition to the alleviation of traffic congestion, the development of a wide-area logistics network covering the land, air, and sea will be achieved by improving connections between seaport/airport (such as Haneda airport) and inland areas. Initiatives to update the functions of distribution hubs in the ward area and to boost distribution functions in the Tama area, based on development of the National Capital Region Central Loop Road (Ken-odo), will be engaged in.

4.8.2 Procedure, Measures and Project Implementation

The following chart shows the three main loop roads and their implementation level in the year 2013.

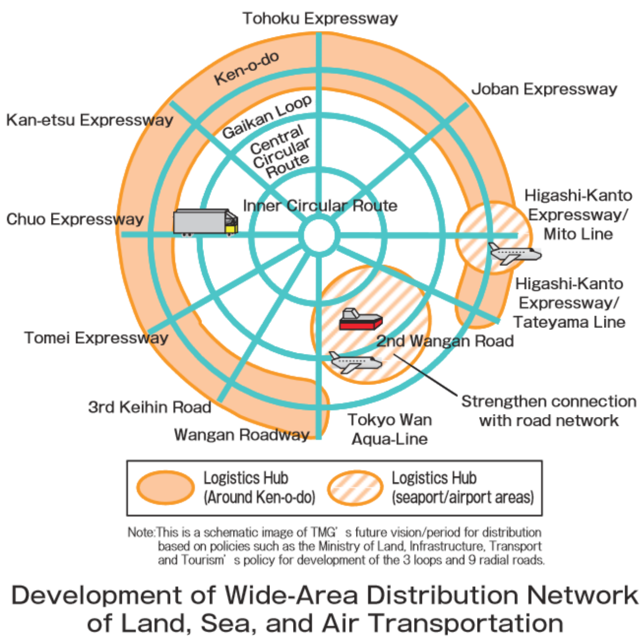


Figure 70: Three loop roads in Tokyo (BOE 2010)

Tokyo Metropolitan Expressway Central Loop Route
The inner circle of the three loops is approximately 47 km long and links areas within an 8 to 10 km radius from the center of Tokyo. The section between No.5 Ikebukuro Route and No.4 Shinjuku Route was completed in December 2007, the section between No.4 and No.3 Shibuya routes was completed in March 2010 and the section between No.3 and Wangann routes is scheduled to open by the end of the 2014 fiscal year, completing the entire loop route with the construction of the Shinagawa tunnel (TMG 2010c). The Shinagawa tunnel will be 9 km long and will connect Haneda airport with Shinjuku (Dr. Atsushi Katatani). The connection between the Shuto Expressway with the Central Circular Route is a new construction that was completed in 2010 in Meguro near Shibuya. It connects roads spanning a high difference of 80 meters. The Meguro Sky Park is an exceptional feature that was created on top of the Shuto Expressway at Ohashi Junction. The 400 meter long and 16-24 meter wide park actually follows the shape of the highway junction, giving it its unique loop appearance. The difference in elevation is 24 meters and its highest point is 35 meters above street level. The sky park was always part of the project and the junction was built with both walls and a roof as a noise-reduction measure (Torres 2013).

Tokyo Outer Loop Road (Gaikan)
The Tokyo Outer Loop Road is a circular road that is approximately 85 km long, connecting areas at a 15-km range from the urban center. In 2013, a section of about 34 km, between the Oizumi Junction and the Misato Minami interchange, served as a highway for cars only, allowing no freight traffic.

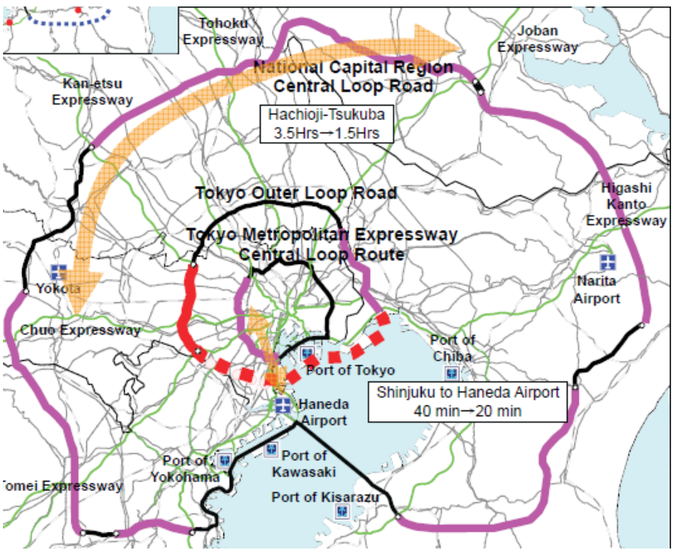


Figure 71: The three loop roads in Tokyo (TMG 2010c): black line = completed; pink line = to be completed by 2016; red line = to be completed in or after 2016; red dashed line = concept under study; green line = expressway

National Capital Region Central Loop Road (Ken-o-do):
This route is approximately 300 km long and extends across Tokyo and its four surrounding prefectures at a 40-60 km radius from the city center. The completion of this loop is scheduled for 2016. The Ken-o-do is being constructed in order to make the region more attractive as a place for industry and logistic enterprises to settle down (BOE 2010).

The project's roads can be classified into four different categories by using article three of the Road Act. 0.7% are considered national motor roads, 4.5% are state roads, 10.7% are prefecture roads and 84.1% are municipal roads.

4.8.3 Financing of the Three Loop Roads project

The financing of the three loop roads project is driven strongly by the central government's lobby. The government has provided the project with concentrated investment from tax revenues and established a new scheme for expressway tolls. The new toll scheme contains discounts when transferring to expressways operated by different companies (e.g. Metropolitan Expressway and Chuo Expressway). The possibility of regional injection of revenues from tolls in the greater Tokyo area is an aspect of the new tool scheme that is currently being examined.

In general, the way an individual road is financed depends on the specific section of road in question. The outer loop road, for example, is 80% government financed, although 60% of the monetary support is provided by the national government and only 20% by the local government. 50% of the Shinagawa tunnel is financed by the municipal government and 50% by a private enterprise called the capital freeway organization.

4.8.4 Actors
The main actors involved in the extension of the three loop roads project change depending on which section of the road is being discussed. As the National Capital Region Central Loop Road is a project which also affects surroundings cities, the Ministry of Land, Infrastructure and Transport is responsible for the administration of the project. Furthermore, the Ministry of Land, Infrastructure and Transport, together with the TMG's Bureau of Urban Development, are jointly leading the construction of the Gaikan road. Private companies, such as Nexco [15], operate the highways in Tokyo.

4.8.5 Barriers and Challenges

Road construction always has a large impact on urban development. In July 1966, city planning decided upon the construction of the Gaikan loop road. However, there was fierce opposition from local residents and the local government. The Minister of Construction responded in October 1970: "The plan should not be enforced until the time in which the conditions for communication with local residents and local government organizations have been completed". As a consequence, the construction of the loop road was halted. In April 2001, 30 years later, a new plan was established. The projected underground structure was officially announced (this meant a change in plans from an elevated roadway structure to an underground roadway structure). In April 2007, the third national development Arterial Expressway Construction Council approved the basic plan, and the project was able to start in May 2009.

4.8.6 Impact Factors

To ensure the integration of civil society into the planning process, a regional issue review meeting was implemented. A total of 26 regional issue meetings have been held in seven wards along the Gaikan since January 2008. The purpose of the meeting was to incorporate local residents' opinions and ideas for sorting out various regional issues, such as measures to preserve the environment and local town revitalization, and to discuss corresponding policies. To summarize the opinions expressed, the meetings were held in a workshop style where groups of around ten residents discussed the issues and presented their opinions to the entire audience.

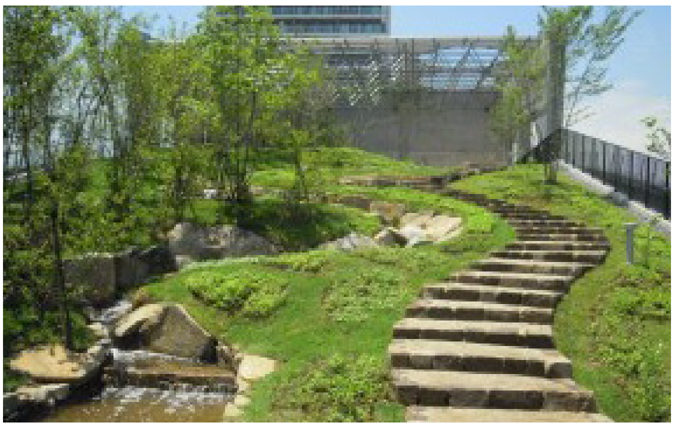


Figure 72: Ohasi junction (Torres 2013)

4.8.7 Achievements and Success Criteria

For Japan, the cooperation between private operators and public institutions like the TMG is a success during the development of the street network. All streets are operated privately, so that costs for maintenance and service are covered by the operator. A new scheme for expressway tolls was introduced.

The scheme will help promote the use of loop roads (preferential fees to serve as incentive).

Through the synergy achieved by the development of land, sea and air transport infrastructure, international competitiveness of the entire capital region will be strengthened. The intermodality includes a better connectivity between the Haneda airport, the Kethin Port in the south and the Narita Airport in the west of the city. There is still no data available, but the objective is, for example, a reduction in the amount of time it takes to travel from Shinjuku to Haneda airport from 40 to 20 min (TMG 2010c).

4.8.8 The Three Loop Roads Project and Sustainability

The project is based on both individual and cargo traffic within the city. Without the expansion of the streets, Tokyo

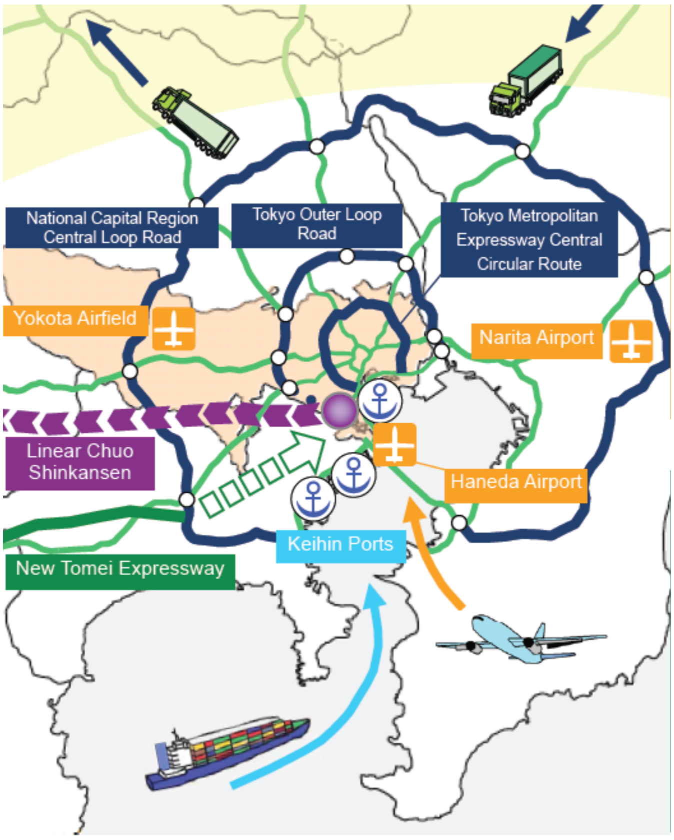


Figure 73: Intermodality in Tokyo (TMG 2010c)

15) Tokyo Transportation Planning Council 2008

would one day suffer a collapse. Considering the ecological aspects of sustainability, travel times and distances will be reduced and traffic congestion will be avoided as a result of this project. Tokyo's objective is to reduce CO_2 emissions by 2 to 3 million tons per year, which amounts to 3-4% of Tokyo's total yearly.

Furthermore, Tokyo's economic situation depends on the three loop roads project. Industrial enterprises and logistic facilitations will be better connected to both the center and the airport. Thus, distribution processes can be realized in a more efficient manner and infrastructural conditions will facilitate the settlement of new enterprises.

Furthermore emergency transports will be secured and disaster- preparedness of the Greater Tokyo Area will be strengthened.

All in all, the effects of the project will boost Tokyo's collaborative activities with neighboring cities in the future and increase its international competitiveness.

Despite the positive impacts on economy, the environmental compatibility of street and tunnel construction must always be critically examined and evaluated.

4.8.9 Transferability of the Practice Example

Road construction always means large impacts on city development. Possible consequences include the movement of buildings/whole districts and effects on the interfaces with nature. For each city, it is necessary to decide individually whether it is possible to construct a ring road, taking aspects such as land availability – or the feasibility to move buildings – into consideration.

There are various comparable examples, such as in Beijing, where the construction of 30 routes with 6 ring roads was completed in 2009.

4.9 YAMATO KURONEKO- "TA-Q-BIN", A DOOR-TO-DOOR PARCEL DELIVERY SERVICE

4.9.1 Introduction

Yamato Transport Co., Ltd. was established in 1919 and is the leading Japanese home delivery company on the market. To improve convenience for the customers, and to add value to its services, Yamato continues to do business with an emphasis on a "customer first" policy. With this mindset, Yamato has developed new services in the industry and has created new demands in the market, including the invention of „TA-Q-BIN" a door-to-door Parcel Delivery Service. In 2011, this new service handled more than 1.4 billion parcels.

The Yamato Group consists of Yamato Holdings Co. Ltd., 45 subsidiaries and 7 affiliated companies. It is primarily involved in six business segments: Delivery, BIZ-Logistics, Home Convenience, e-Business, Financial and Truck Maintenance, and services incidental to these activities. The delivery business, operated mainly by the Yamato Transport Co. Ltd., provides small parcel delivery services to the general public and corporations.

The delivery business made 80% of the share on sales and had a share of 42.3% in the Japanese market, in 2012. Concentrating primarily on the optimization of operation in the "last mile" of delivery, in order to make the distribution process easier and more sustainable for the customer, Yamato has introduced various innovative measures (Yamato Holdings 2012a).

4.9.2 Objectives

In their 2012 annual report, Makoto Kigawa, the Representative Director, President and Executive Officer of Yamato Holdings Co. Ltd said

> *"The Yamato Group's management philosophy is to help enrich our society by enhancing the social infrastructure of TA-Q-BIN networks, creating more convenient services for comfortable lifestyles and developing an innovative logistics system. This philosophy also aims to generate sustained growth and maximize corporate value while balancing growth potential, financial soundness and operating efficiency"* (Yamato Holdings 2012a)

For Tokyo, Yamato intends to improve the efficiency of parcel collection and delivery in the downtown and in overcrowded residential areas. Various measures are explained in the next chapter. All measures were introduced to reduce CO_2 emissions and other air pollutants in order to make the company's service friendly for both citizens and the city.

4.9.3 Procedure, Measures and Project Implementation

Yamato tries to be deeply rooted in the local community in order to reduce the distances in the last mile of delivery and to be as close as possible to the customer. The following chart shows the numbers of pick-up and delivery stations in Japan. Yamato is not only working together with convenience stores but also with Japanese Railway Stations, fire

Figure74: brand logo (Yamato Holdings 2012a)

and police stations and metro carriers. The average access time to a delivery station is between 4 and 30 min (Yamato Transport 2013).

Yamato is engaged in a wide range of initiatives aimed at reducing carbon emissions during pickup and delivery, which include the deployment of electric vehicles and the use of streetcars.

Yamato has also continued to actively introduce low-emission vehicles. They added 327 hybrid vehicles and 1,341 low-emission vehicles to their fleet in 2012. As a result, the accumulative total of low-emission vehicles at Yamato Transport is now 14,908, or 34.2% of their entire fleet (Yamato Transport Tokyo).

Opening more depots within the city reduces the delivery area assigned to each sales driver. This change not only enables drivers to provide more detailed services to each customer, but also helps to dampen increases in the number of vehicles required to keep pace with increased parcel volume.

Yamato Transport is promoting the development of these depots, which enable the pickup and delivery of parcels without the use of motor vehicles (see picture above), apart from the occasional mini-vehicle, in mainly urban districts and densely populated residential areas.

The company opened approximately 1,000 depots in 2012. Although the areas offering vehicle-free collection and delivery services are limited, the company had 971 depots as of the end of March 2010, after opening 13 new depots in the 2009 fiscal year.

For areas that are not covered by these depots, the company is trying to reduce the use of vehicles as much as possible by adopting appropriate methods for parcel collection and delivery, based on the following delivery-area sizes (Yamato Transport 2013):

- For areas within a 400 meter radius of a depot, carriages and electrically-powered bicycles with rear carts are used.
- For areas within a 400 to 800 meter radius, mini vehicles are used.
- For larger areas outside an 800 meter radius, low-emission vehicles travel along set routes, and parcels are collected and delivered using carriages. In Tokyo, mainly hand-carts and electrically-powered bicycles with rear carts are used.

While optimizing the distribution process, Yamato Transport developed –and in March 2010 started deploying – the See-T Navi, which is a proprietary telematics system encouraging safe and environmentally friendly driving. This system, which records an extensive array of driving performance data, enables Yamato Transport sales drivers to self-inspect their driving performance and make improvements. The data from this system can also be used to individually instruct sales drivers, and has functioned as a strong support for safe driving habits.

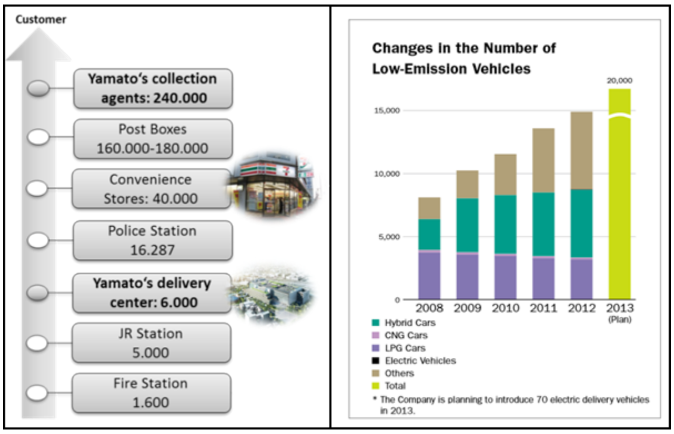


Figure 75: Yamato pick up stations and low-emission vehicles (Yamato Holdings 2012b)

Figure 76: Hand-carts for the last-mile distribution (Yamato Holdings 2012a)

In March 2012, 25,814 delivery vehicles at Yamato Transport's 69 main centers throughout Japan were equipped with the See-T Navi system (Yamato Holdings 2012a). Furthermore, it is possible for Yamato customers to select the time zone in which they would like their parcel to be delivered without any additional charge. For Yamato the purpose is to reduce the number of re-deliveries while at the same time providing the customer with the comfort of knowing when the parcel will be delivered. Currently, sales drivers are required to re-deliver twice a day for seven days. If the parcel has not been deliverable within one week, it will be sent back (Yamato Transport 2013).

4.9.4 Financing of the Project

Yamato is a 100% private enterprise, so all measures are financed by the company itself. Therefore, profitable efficiency plays an important role when introducing any measure to optimize customer service.

4.9.5 Actors

For „TA-Q-BIN", the door-to-door Parcel Delivery Service, Yamato has been cooperating with various enterprises to be as close to the customer as possible. The most important cooperation partners, besides convenience stores, are police stations and post offices.

4.9.6 Barriers and Challenges, Key Drivers and Framework Conditions

Japanese culture is characterized by a strong consciousness for high-quality service. Next-day delivery services and same-day delivery services are expected by the population, but are leading to a disproportional logistical effort. Tokyo is characterized by being an extremely densely populated area, which makes, on the one hand, the distribution process more efficient but, on the other hand, results in major traffic congestion in the center of Tokyo. Traffic congestion not only leads to longer transportation times but also to delays, which is especially undesirable if a customer has been provided with a delivery time-slot. As many areas within the center of Tokyo have parking prohibitions, Yamato had had to introduce alternative transportation mediums to straddle the last mile of delivery. That is one of the main reasons for not using traditional vehicles such as trucks, but rather e-bikes and hand-carts. Since e-bikes are used for delivery, one challenge faced by Yamato is the bike transport network. In Tokyo, the railway transport network is well-developed. However, it is still not comfortable to use bikes in the city center. Mostly, bikes must be ridden on regular roads or on pedestrian walkways. Thus, Yamato Transport Global Warming Prevention Targets from 2003, which call for a 30% reduction in $C0_2$ emissions per parcel, still promote the utilization of electric vehicles and hand-carts (Yamato Holdings 2012a). As Yamato is a private enterprise, its most important challenge is to reach a balance between cost-orientation and ecological-orientation.

4.9.7 Achievements and Success Criteria

For a delivery service company it is important to be located as near to the customer as possible. Yamato´s approach, to cooperate with, for example, convenience stores reduces logistic costs. Simultaneously, it increases customer service as the customers can pick up their parcels at local convenience store whenever they want. As Tokyo is very densely populated, distances between deliveries are shorter than in a rural area, which means that during a given period of time more deliveries can be realized. The customer-oriented service is strengthened by personal contact to sales driver. When using Yamato, delivery times can be determined with the sales driver by mobile phone, flexibly, twice a day. Since it is not necessary to have a driver's license in order to operate an e-bike or hand-cart, is easier and cheaper for Yamato to find employees who can work as drivers using these delivery methods. From a logistical point of view, Yamato tries to improve the distribution process through early consolidation, starting in the city center. Furthermore, the transportation of parcels to depots within the city center is achieved during the night.

4.9.8 Yamato and Sustainability

For a private company like Yamato, it is essential to successfully compete against other delivery services. Therefore, the economic pillar of sustainability overshadows both the ecological and social perspectives. Following its customer-oriented philosophy Yamato´s first objective is to achieve a high level of service which contains a one-day delivery or even a same-day delivery. Shorter lead times lead to higher logistical efforts, which are – among other things – characterized by lower usage of consolidation potential with the consequence of under-utilized transportation vehicle capacities. Yamato attempts to counteract this problem by offering a choice of delivery time-slots to the customer. The choice of transportation medium is an important leverage point for increasing the ecological sustainability a delivery service. The use of low-emission vehicles, e-bikes and hand-carts has had a direct impact by reducing CO_2 emissions. This, in combination with a reduction in traffic and the concomitant noises through using alternative transportation vehicles, make Yamato´s distribution processes more city-friendly. In terms of resilience, manual solutions such as hand-carts can adapt to changing demands better than can distribution by truck. Additionally, the fixed costs are lower as well.

4.9.9 Transferability of the Practice Example

The choice of a delivery services' transportation medium depends to a large extent on the density of the population in a city. If parcel delivery services aspire to use hand-carts or bikes without engines, it is necessary to calculate the average distances for a distribution route. Electric vehicles are also beginning to be introduced in other cities. As a first step, charging stations must be installed first. Most cases show that without any subsidiaries it is very difficult to introduce the essential infrastructure.

4.10 OTA-CITY: AN EXAMPLE FOR URBAN PRODUCTION

Ota-City is one of the 23 special wards of Tokyo and is characterized by SMEs in which 82% of companies have nine or fewer employees. The engineering and metal-working industry accounts for over 80% of the factories within Ota-City limits. Ota-City´s predominant characteristic is the accumulation of factories centered in mixed residential and industrial areas. The number of factories has decreased from over 9,000 in 1983 to about 5,000 in 2008, because of the hollowing out of industry as a result of relocation to the countryside and the shift of manufacturing to foreign countries. However, the companies are still highly specialized in the engineering and metalworking industry. Small businesses make up the majority of the enterprises in Ota-City. One reason that small businesses are able to continue to prosper is that their proprietors live and work in the same place, or live very close to their workplaces. They also each have their own specialized techniques and skills and have accumulated the experience and techniques necessary to accomplish manufacturing that cannot be done following design instructions alone. They also rely on formal and informal networks in the area when they receive requests they cannot complete by themselves. The Ota-City administration has introduced various measures in order to support local SMEs. The objectives of the measures, the success factors and their transferability will be discussed in the following sub-chapters (Ota City Industrial Promotion Center).

4.10.1 Creation and Objectives

Due to the decrease in the number of factories, the accumulation of factories in densely populated areas and the highly specialized small enterprises present, one of the most important objectives for Ota-City is the maintenance of an industrial zone while building a town where residents and industry are able to exist together in harmony. Therefore, Ota-City has defined the following objectives as key for the development of the Ota-City industry:

- to secure and educate personnel,
- to develop new products and technologies,
- to protect intellectual property against infringement,
- to promote business and establish facilities that foster relationships between industry and academia and forge new relationships between business,
- to assist in maintaining factory sites and operating-environments in the city,
- and to ward off potential conflicts resulting from the mixed residential and industrial environment through the development guidelines.

The Ota-City 10 year Basic Plan consists of five main topics, as follows:

1. Support for Maintaining and Expanding the Accumulation of Industry

Ota-City aims to maintain and strengthen the accumulation of manufacturing by, on the one hand, funding part of the

Figure 77: Location Ota-City (Google 2014A; Google 2014B)

expanses for firms and start-up enterprises that wish to do business in the city and, on the other hand, by building and managing factory apartments.

2. Support for Reforming Technology and Management
Assistance programs and contests for new product and technique development are being offered in order to encourage Ota-City's companies to shift to product development business models. The Business Support Program is a consultation service which was founded for helping Ota-City companies to solve their management problems. Ota-City is also offering general consulting on intellectual property with the aim of establishing, protecting and making use of intellectual property for businesses that possess it as a management resource.

3. Expanding business and Venturing into the global Market
Ota-City offers individual business support, such as consultation about receiving and placing orders, organizes independent exhibitions such as the Ota Industry Fairs, and provides support for domestic and international trade shows in order to expand business for Ota-City's SMEs.

4. Securing and Educating a Manufacturing Workforce
Ota-City needs to educate and produce leaders in the manufacturing industry. Ota-City is making an effort to boost interest in manufacturing amongst elementary and junior high school students and to cooperate with local educational institutions to educate a manufacturing workforce. Ota-City also facilitates matches between companies and both elementary and junior high schools in order to increase the number of young people working in the manufacturing industry.

5. Environmental-friendly Manufacturing
Ota-City supports companies as they continue to introduce energy conservation and new energy technology and encourages development of ecological technology that makes use of the technological power of Ota-City's companies (Ota City Industrial Promotion Center).

Ota-City is taking advantage of benefits resulting from other projects such as the introduction of international flights to Haneda and the three loop roads infrastructure development project (see also chapter 4.8).

4.10.2 Procedure, Measures and Project Implementation

Traditional urban planning recommends that industrial and residential environments are kept separate. However, a look at SMEs in Ota-City reveals that living very close to the workplace is the norm.

In 1985, the first **Factory Apartments** (Omori Minami Factory Apartments) were constructed. This multi-level, integrated industrial-residential building features 10 separate ownership-type factories on the first floor and public housing on the second to the eighth floors. The building was constructed in various creative ways so as to prevent infiltration of noises and vibration from machining factories. It functions as though completely separate residential and industrial spaces had been built. At the same time, the site was used intensively in order to decrease costs associated with the high price of land and the employees of factories were given preference for the housing to realize the idea of living near the workplace. There have been almost no pollution problems between the factories and residences since factory operations began. This factory-apartment shared-use model, which was aimed in particular at enterprises with 20 or fewer employees, was one advancement program for SMEs and provided them with substantial financial support.

Subsequently, Ota-City constructed two more factory apartment complexes (NHK News 2003). Land values in 1985 were very high in the urban district of Ota-City and owning a factory was difficult for small-scale enterprises. However, appreciation of land values that followed made it even more challenging for small-scale enterprises that lacked financial power to purchase factories, and maintaining operations with full ownership became increasingly difficult. Ota-City then planned and implemented construction of **factory apartments for lease** in order to meet the need of improving the manufacturing environment for small- scale enterprises. The first one built was the Shimomaruko Temporary Factory. It was constructed in response to the demand for reconstruction factories as temporary work sites for lease that could spur production over a set period of time. Various rental factory apartments had been constructed by 2008, with different purposes. These included improving the operating environment for fundamental technology industries and for research and development for companies pushing into new fields, promoting the creation of new, unique enterprises and industrial locations for advanced technology and generating new business. Techno Wing is one of the most important Factory apartments and focuses on the co-existence between maintaining an industry and residential environment. Furthermore, construction of condominium-style housing complexes on lots left vacant by factories that have moved or went out of business is still on the rise.

Plaza Industry Ota (PiO) was established in February 1996 as an industrial support facility for SMEs. All kinds of advice are available at Plaza Industry, from management and patents to loan facilitation, receiving and placing orders, and international business. In addition, the facility houses a technological development assistance center that supports companies' research and development and a convention area that businesses can use for exhibitions, symposiums, and all kinds of meetings (Ota City Industrial Promotion Center).

4.10.3 Financing of the Ota-City Project

One of the main benefits of the measures supported by Ota-City is the development of a strong network between SMEs, research centers, schools and the city.
Nevertheless, Ota-City conducts measures which must be financed (e. g. the Factory for leasing project is financed by rental fees, which are paid by SMEs that use the factory apartments provided). Ota-City also subsidizes measures such as the support center for start-up businesses.

4.10.4 Actors

In order to successfully carry out all measure in Ota-City, various actors have been contributing their time and expertise.

The city administration leads and organizes the initiatives. The main profiteers are the SMEs by being able to use, for example, the factory apartments provided. However, research departments also benefit enormously due to cooperation with the SMEs. Furthermore, the schools are able to cooperate with both with SMEs and the research departments to improve education and make it more practice-oriented.

4.10.5 Barriers and Challenges, Key Drivers and Framework Conditions

The Ota-Cities development is linked directly to the economic cycle. In 1973, the oil crisis began and small and medium-sized factories began reflecting on their business structures, which often depended on contracts from one company. They then narrowed their business strategies to specific manufacturing fields and organized a system which was conducive to receiving jobs from several companies, in order to reduce risks. They ventured into specialized fields with little competition and made use of the high concentration of factories in the area. They were able to produce quality products and completed parts with high added value through their associations with other specialized companies in the regional networks.

The bubble economy in the early 1990s resulted in an economic manufacturing depression, resulting in deflationary tendencies and financial institution breakdown. Manufacturing companies shifted toward other Asian countries. In the year 2000, the hollowing-out of domestic industry was becoming serious and there were changes in global industrial structure and the progression of IT. This resulted in the shrinking of order volumes due to a switch to overseas procurement of materials. The components of domestic orders decreased due to the rapid progression of funda-

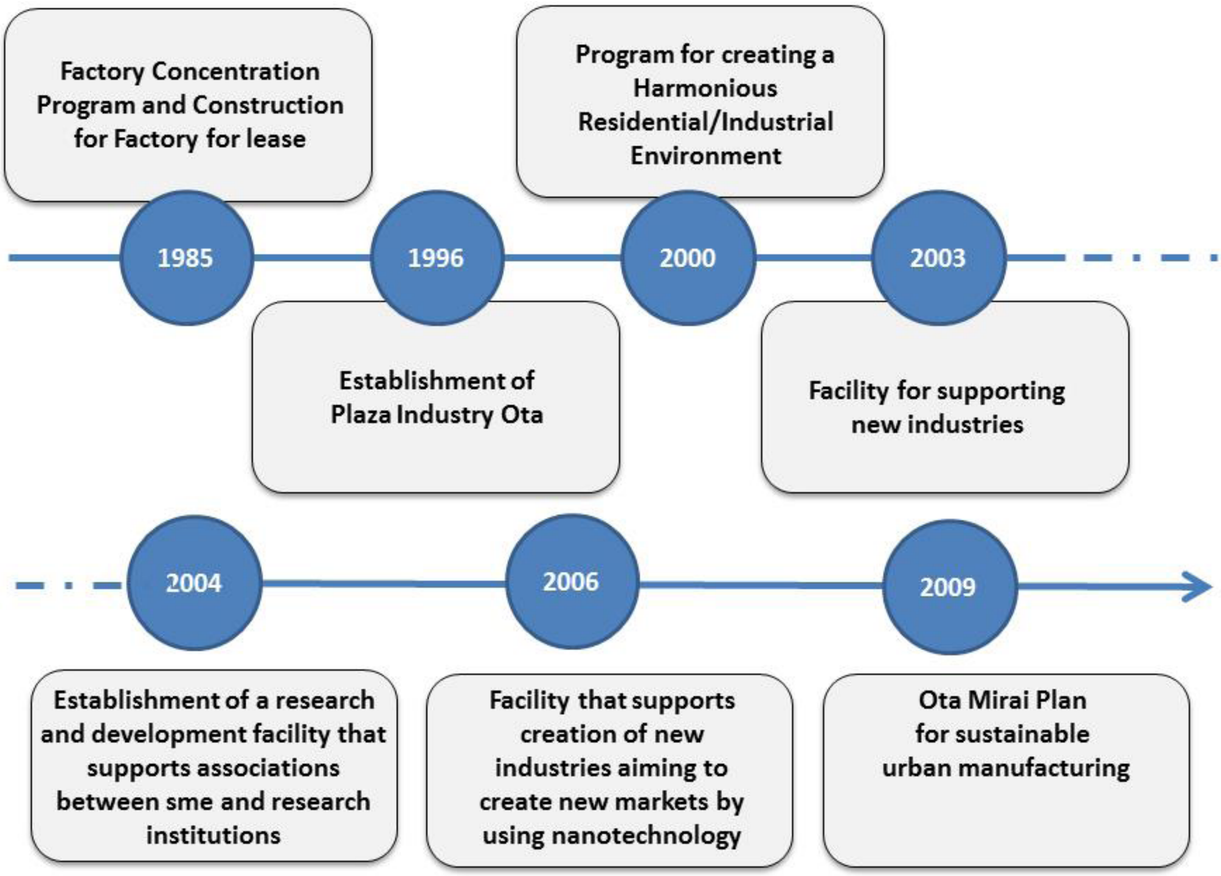


Figure 78: Success factors Ota-City (Ota City Industrial Promotion Organization 2007)

Table 9: Ota-City and sustainability

Social	**Ecological**	**Economic**	**Resilience**
Work-life balance realized by proximity to workspace	Consolidation of delivery and distribution processes; Reduction of freight traffic	Maintenance and expansion of the accumulation of industry	fluctuating order loads can be cushioned by the network
Education for people working in the manufacturing industry	Less commuter traffic	Support for R+D centers and start-ups	Ensuring the best utilization of the factories through factory sharing
Low rental fees for factory apartments make it possible to maintain own manufacturing	Harmony between industrial and residential area through factory apartments.	Support for reforming technology and management	
	Factory apartments are constructed so as to prevent infiltration of noises and vibrations		

mental technology of foreign companies. However, not all manufacturing was able to move overseas; various SMEs concentrated on a new shop-floor production system with division of labor between nations where Japan handled low-volume, special-order items and other countries manufactured products for which techniques unique to Japan were not necessary.

Suffering under the global economic crisis in 2009, the Japanese Cabinet decided upon a plan for new growth in order to achieve a "shining Japan." The plan calls for the creation of new demand through "Green Innovation" and "Life Innovation." The plan looks to solve unavoidable environmental, energy, health care and welfare problems related to citizens' lives and could be a path which would allow Ota-City to make high-tech contributions toward reviving the regional industry. Simultaneously, Japan is deepening its co-existence with a developing Asia. Ota-City has continued to have direct industrial exchange with ASEAN and China and has connections with foreign organizations; it has built a system which can support the development of its businesses. Since 2010, Ota-City has been able to use the international terminal at Haneda Airport as an opportunity to strengthen its relationships with the rest of Asia.

4.10.6 Achievements and Success Criteria

The success of Ota-City´s initiatives is, amongst other things, based on its location. Ota-City is the southern doorstep of Tokyo and operates as a critical junction between roads, rails and airways. Ota-City stands out on a national scale as a superior industrial area due to its location as a transportation hub. Due to its high density and the accumulation of high specialized factories in Ota-City, the mixed-usage of industrial and residential area is unavoidable. However, it can also be interpreted as a success criterion.

The most important milestones for the success of the Ota Cities industry are summarized in the following chart. All steps were initiated in order to maintain industry in Ota-City, to make Ota-City attractive for R&D centers and to make a harmonious residential life possible in an industrial environment.

4.10.7 Ota-City and Sustainability

Ota-City´s initiatives contribute to the sustainable development of the region in various ways. The table below shows in which aspects the initiatives influence the four pillars of sustainability.

4.10.8 Transferability of the Practice Example

The transferability of the initiatives depends on several factors. The high density of factories makes it is possible to build a network of enterprises. It is also favourable if there are enterprises present which are high specialized in different kinds of technologies, so that they can work on an order collaboratively. Considering the factory concentration program and the mixed use of industrial and residential buildings, laws and cultural aspects must also be considered.

4.11 RAIL NETWORK DEVELOPMENT

4.11.1 What Makes Tokyo a Rail City?

Roughly 32 million people live in the TMA, making it one of the largest metropolitan regions of the world. Of these, 15.5 million use the train every day for their daily commute. To put the size of this into perspective, the entire German rail network – considered one of the busiest in Europe – is used by only 6 million commuters per day (Hitachi Ltd. 2013).

The greater commuting area of Tokyo has a radius of 50 km. All of the people living within this radius can be considered to be within easy commuting distance to the center of Tokyo (Ohno 2012c). Figure shows the extensive network of 2,600 km of commuter rails, subways, monorails and trams, counting a total of 121 lines and 650 stations within the TMA. [16]

While station density is especially high in the city center, rail-integrated structures have formed outside of the circle line (Yamanote Sen), where urban development and rail development have been carried out by private actors in an integrated manner. In contrast to most European cities where the station is built close to the center, in Tokyo, the station itself forms the center, as it is the place where most entertainment facilities, department stores and restaurants are concentrated. The rail-integrated neighborhoods are characterized by pedestrian- and bicycle-friendly high-density, mixed-use developments. The mixed-use nucleus is typically surrounded by residential areas, spreading out in a radius of 800m around the station.

Tokyo's rail network is considered one of the most punctual, clean and safe networks in the world. Trains run in intervals of 2-3 minutes during rush hours, while roads are congested and subject to high tolls and parking fees. All of the above factors make rail the preferred option for urban transit in Tokyo, resulting in an internationally unmatched high rail share in the urban modal split.

However, railway transit in Tokyo is not just a convenient means of transport. It has evolved to form an integral part of the urban culture. As a matter of fact, addresses and directions are typically described by referring to station names rather than the names of streets and quarters, and housing exposés feature the walking minutes towards the next station. There are also a number of widely known games involving station names and lines and it is common when meeting new people to ask what line they live on.

Tokyo's railway network is operated by 30 companies, most of which are private. While in most countries in the world subsidies are provided for train operation, the Tokyo system runs without governmental support and manages to provide a very high level of coverage, frequency and service quality.

4.11.2 History

<u>1903/04: Establishment of a tram system by three private companies</u>
The tram system was established by three private companies in 1903/1904, which merged into one and was then purchased by the TMG in **1911**. With a length of 210 km, the system was the largest in the world; however, it could not keep up with steeply increasing demand during the 1920s and faced financial difficulties caused by very large repair costs after the Great Kanto Earthquake in **1923**, which led to the abolishment of the tram network.

<u>1906: Railway Nationalization Act</u>
In 1906, the Railway Nationalization Act was passed and private railway companies were no longer allowed to build lines within the central circle line. As a result, sub centers in Tokyo have formed on the circle line, as these made up the transfer hubs from private radial lines to inner-city subway lines. Since all of the private lines terminated on the circular Yamanote Line, passengers were forced to transfer to public lines at stations such as Shinjuku, Shibuya, etc.

The population increased dramatically in the 1920s and the private development of radial lines gained momentum. The **Great Kanto Earthquake in 1923** destroyed 300,000 houses in Tokyo, which further accelerated the suburbanization trend, as people desired to move to the safer Musashino hills in the western suburbs.

<u>1906: Construction of the Yamanote circle line</u>
The construction of the circle line was started in the same year, following a new master plan, which intended to increase functionality of urban lines by separating the tracks for long-distance passenger trains, freight trains and urban passenger trains. The planners had studied examples of London, Paris and Berlin and finally modelled the Yamanote line after the example of Berlin, connecting the trunk line stations and the urban network by a rapid transit system rather than integrating all the terminals in one station. The Yamanote circle line was completed in 1925.

<u>1920: First Master Plan for subway development and renewed private actors involvement</u>
A Master Plan for a subway network totaling 80 km in length was adopted with the aim of completing the inter-urban rapid transit system by way of an inner-city high-speed subway network. While this was actually a public responsibility,

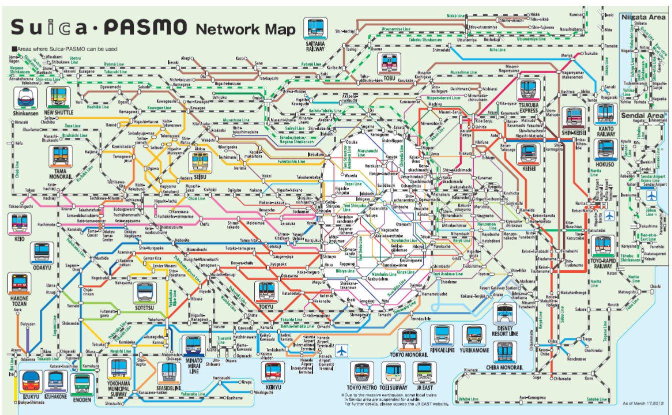


Figure 79: Map of Tokyo`s railway network (Tada 2005)

16) For comparison, Berlin has a total network length of 550 km and 326 stations

the TMG faced constraints in procuring funds, causing construction delays. Eventually, private companies were given exceptional permission to build the subway lines. The construction of the first subway line started in 1927 and the first line (today's Ginza line), with a total length of 14.3 km, was completed in 1934. The two companies involved constructed and ran the businesses with no public assistance.

<u>1938 Land Transport Business Coordination Law</u>

The Land Transport Business Coordination Law laid the foundation for the fact that, today; each private railway operator has his or her own geographical area of operation and therefore has a certain monopolistic power on the given line. The law recommended consolidating all private railways in the southwest into one entity named Tokyo Kyuko Electric Railway (nicknamed Big Tokyu) and all companies in the northwest into the current Seibu Railway Company (Aoki et al., 2000). In 1948, the Big Tokyu was broken up to create the current Keio, Odakyu and Tokyu Corporations (Hitachi, Ltd 2013).

<u>After 1945: Japanese urban private railways featuring diversified business management</u>

Since the private railway operators were bound to less profitable routes outside the densely populated city center, they had to think of innovative means to provide for steady passenger flow and sufficient revenue. Most significant among the different businesses of interest to the private railway operators were department-store operations and residential land developments. In addition, schools, universities, sport stadiums or amusement parks were built along the lines.

<u>1960s-1990s: Population growth phase</u>

Between **1965** and **1985** the Japanese population grew from 99 million to 121 million people, leading to a massive population drift to the suburbs of the TMA. With a population growth of 9 million people within 20 years, residential settlements sprawled along the public and private radial lines, while in-between areas were left relatively undeveloped. During the population growth phase, rail development was based mainly on adding capacity. The commuting radius gradually grew to more than 50km during this time.

<u>1964: Tokyo Olympic Games and through-services</u>

New subway lines were constructed in the **1950s** and early **1960s** with the aim of serving the Tokyo Olympic Games, to be held in **1964**. In order to decrease congestion, subway trains, from this point of time onwards, were permitted to be operated through to the existing suburban private railways and JR lines, eliminating the necessity to transfer on the Yamanote loop. As subway construction requires very large capital investment that cannot be achieved by fare revenues alone, government subsidies were introduced in **1962**. As a result, the total subway network length reached 100km by **1968** and 200km by **1986**.

Figure 80: Sub center formation along the Yamanote line (Hitachi Ltd. 2013)

Figure 81: geographical segmentation of private railway companies (Hitachi Ltd. 2013)

Table 10: International comparison of the modal share of various types of transit [17]

	Tokyo 23 Wards	Berlin	Taipei	Rome	NYC	London
Rail	48	26	14	20	12	12
Bus	3		18		10	15
Private	12	32	46	59	33	40

Source: Based on NHK News 2003

17) Based on the number of journeys by main mode of transport. It includes all modes for all purposes

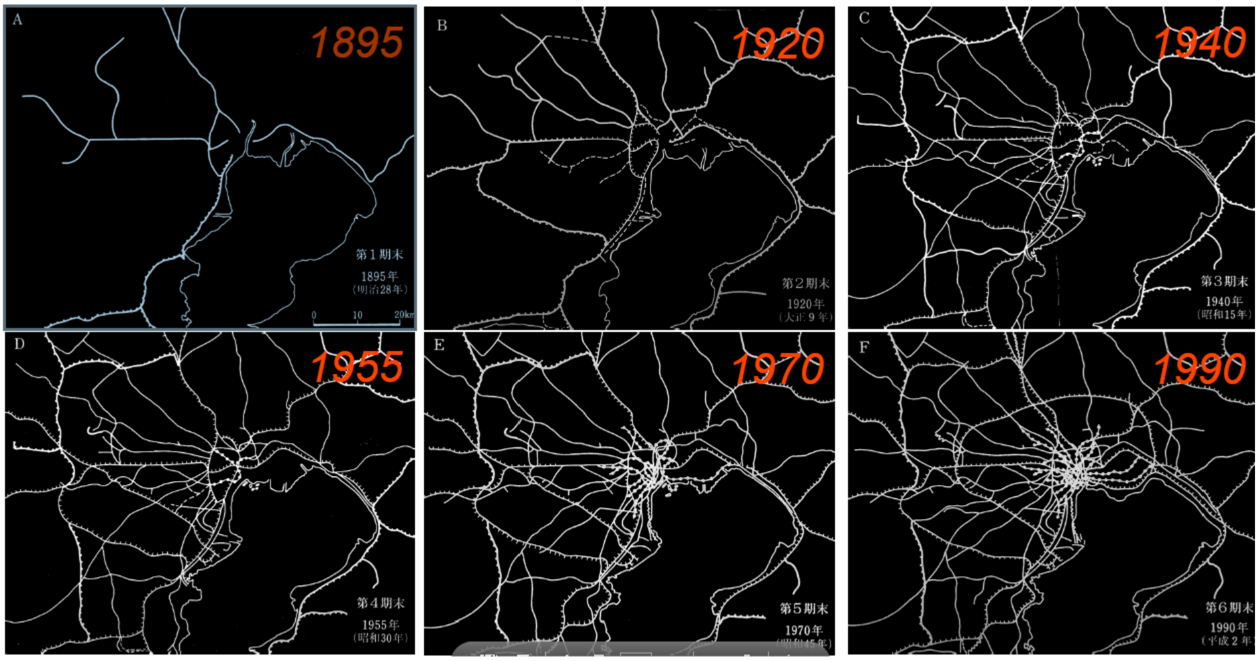


Figure 82: Development of the rail network during the population growth phase (Daily Cargo 2012)

1990s – Today: Population stagnation phase

The most recent master plan was drafted in the year 2000. Since population growth had started to stagnate in the 1990s, and is anticipated to further slowdown in the mid- and long term future, the new master plan no longer focused on quantitative growth, but rather on qualitative improvements (e.g. measures to decrease in-vehicle congestion, measures to improve connection to the airports and measures to decrease vulnerability to disasters).

4.11.3 Actors

There are two key actors in integrated rail development: the TMG and the private railway operators. In addition, the Ministry of Land, Infrastructure and Transport (MLIT) is involved by providing the overall legal framework for land use planning as shown in figure 83:

Ministry of Land, Infrastructure and Transport (MLIT)

This ministry is responsible for granting licenses to railway companies. Once a license is granted, the duration is unspecified and the railway companies are not subject to competitive bidding. The only competition railway companies are faced with is the competition for customers that live within the catchment of more than one line with different providers (which is often the case).

Tokyo Metropolitan Government (TMG)

The TMG uses planning and financial instruments to facilitate desired land use developments. Although lines are proposed and developed by private actors and the master plans do not have a binding character, the TMG has considerable power in directing private investments (e.g. subsidies are bound to provisions specified in the plan). A major planning instrument is the Floor Area Ratio (FAR). Station areas are usually assigned higher FAR values than surrounding areas, allowing higher building volumes and thus potentially higher profits for real estate developers. Also, station areas are typically zoned as 'commercial districts', which further incentivizes private investment as few rules regarding land use are applied to this zoning type. Next to higher density development at station areas, the TMG also aims to make stations functionally differentiated. For example, the main stations around the Yamanote line have each been assigned a different functional profile, such as 'electric town', 'young fashion town' etc. In order to achieve such differentiation, the TMG uses temporary real estate tax exemptions for companies with a fitting profile (Hitachi Ltd. 2013).

Transport Policy Council

Rail network development is planned according to master plans that are drafted in intervals of 15 years and contain all new planned lines and improvements for the next 15 years. Suggestions for developments are mainly submitted by the private actors in cooperation with the TMG, however, in theory they can also be made by citizens or political actors. The suggestions are checked by the national government (MLIT) under support of the Transport Policy Committee, an advisory body within the MLIT, which consists of academics, private operator representatives and government officials. The committee discusses proposed developments during the period of one year and drafts the master plan. After the developments have been authorized in the master plan, the private operators submit their formal construction plans. The latest plan for Tokyo was formulated in the year 2000 and contains all railway developments/improvements until 2015.

Hironori Kato
Member of Railway
Planning Committee under MLIT

„There is almost no government intervention. A master plan is drafted every 15 years but has no statutory power. Still, it poses high guidance to private developers as financial incentives (for investment costs) are coupled to it. By doing so, the government has some influencing power, and can direct investments into a certain direction as for example the building of bridge structures to avoid the separation of communities."

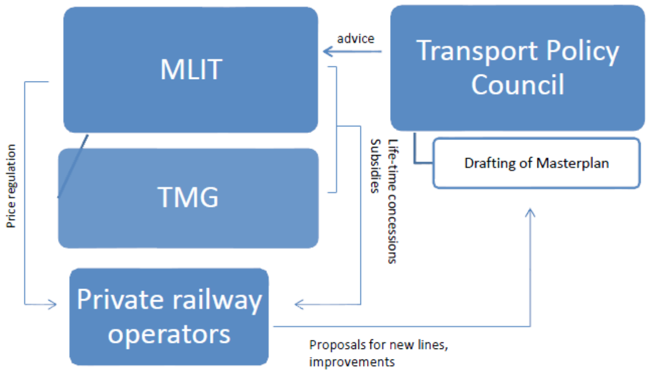


Figure 83: Actors involved in urban and railway planning (Own illustration)

Table 11: Network length and passenger volume by company

	Network length			Passenger kilometers	
	km	Stations	% (total km)	Millions	%
JR East	1106,1	103	42,4	80,058	43,7
Tokyo Metro	195,1	172	7,5	18,518	14,6
Toei Metro	131,2	105	5	6,131	6,4
Odakyu Electric Railway	120,5	23	4,6	11,084	5,7
Tokyu Corporation	104,9	75	4	10,202	6,4
Keisei Electric Railway	102,4	19	3,9	3,583	2,5
Keihin Electric Express Railway (Keikyu)	87	20	3,3	6,223	3,7
Keio Electric Railway	84,7	66	3,3	7,471	3,9
Sagami Railway	35,9	26	1,4	2,586	1,4
Tobu Railway	463,3	28	17,8	12,389	7
Seibu Railway	176,6	71	6,8	8,753	4,7

Source: JSCP 2014

Private railway operators
There are a total of 30 private operators; including eight major operators (refer to 10). The role of these private railway operators in the development process is rather prominent as the local government limits itself to providing some technical standards and guidance. The railway companies usually own considerable amounts of land along the railway lines, making them rather independent in the decision to utilize this land for constructing houses, universities, offices, department stores, sport facilities or amusement parks. Developments along the line are planned cautiously as revenues from additional businesses are crucial to the profitability of the railway service. The business concepts and development approaches of the private railway operators will be discussed in detail in section 4.11.

Individuals
Individuals have some degree of power, as private railway companies compete for customers and are dependent on their reputation.

4.11.4 Success Factors

Tokyo's success in railway development and operation is driven by a number of governmental policies which enable private sector involvement, guide private investments to benefit society as a whole, incentivize public transport usage and discourage private car use. In addition, the attractive railway system is a product of competition between private actors, resulting in high quality service. Last but not least, it was found that customer cooperation is crucial for the functioning of the system:

Governmental policies

Market-oriented planning instruments:
The TMG facilitates land development by private railway operators through the use of market-oriented planning and financial instruments. By doing so, the government has considerable influence in directing development investments by private actors. However, it then leaves subsequent decisions to the market.

Flexible zoning at station areas:
Station areas are usually zoned as 'Commercial Districts', which is the most flexible zone in terms of eligible building types, building density and allowable building height.

Floor-Area Regulation (FAR) Instrument:
In order to attract private investments, station areas are generally assigned higher floor-area values than surrounding areas. The additional FAR-transfer instrument allows one to transfer height entitlements to neighboring properties. As tracks are part of the system, rail operators and developments along the lines are further favored by this policy.

Incentivizing the development of sub-centers with diverse

functional profiles:
The government grants temporal tax breaks for companies with specific profiles (fashion, electronic goods, etc.) in order to develop sub centers with diversified profiles that complement one another rather than compete with one another, which further assists in stabilizing traffic flows.

High private sector involvement in planning:
Urban plans and railway developments are drafted on the initiative of private actors, allowing for comprehensive and coherent planning and implementation.

Unlimited permits for rail operators:
Life-time licenses for railway operation are granted by the government which allows railway operators to develop long-term strategies for their railway territories.

Operators are allowed to own and manage their infrastructure:
In contrast to Europe, where network management and rail operation is managed separately, railway operators in Tokyo usually own the infrastructure that makes up their specific lines, which further encourages them to engage in long-term planning.

Fare regulation and no-subsidies policy:
As ticket prices are controlled by the government and no subsidies are provided for operation, operators are forced to look for other options to increase profits. This has led to additional activities such as real estate development and retail businesses along the line in order to exploit synergies between individual businesses and increase profit margins. For example, business activities are aligned carefully along railway lines in order to generate bi-directional passenger flows.

Incentives for commuting by public transport:
The government provides a tax free commuting allowance. While a tax free allowance is also provided for commuting by car, this is considerably lower than for rail transit.

Negative incentives to discourage commuting by car:
Taxes on car ownership are high in Tokyo and in order to register a vehicle, owners must prove that they own an off-street parking space. Also intra- and inter-urban highways, as well as parking lots, are operated by private actors, thus considerably adding to the cost of vehicle ownership.

High quality and service/customer orientation

High reliability
Trains and buses in Tokyo are extremely punctual and frequent while average road traffic speeds do not go beyond 23 km/h. Thus, public transport is the more favorable option, especially for commuters.

Ekinaka
Many stations in Tokyo feature a collection of high quality shopping facilities, cafés and restaurants, referred to as Ekinaka. Without exiting the ticket gates (and therefore without additional cost), commuters can make the most out of their waiting time. As different stations are used by different kinds of customers, specialized ekinaka facilities have formed, including, for example, daycare centers in areas with many young families or golf shooting ranges and fitness clubs at stations with a high proportion of business clientele.

Ticket vending machines
As a response to high passenger flow, vending machines are very fast and user-friendly. Several coins and bills can be inserted at the same time; tickets are given out instantly. In the case of difficulties, assistants are available.

Suica und Pasmo
Suica and Pasmo are IC card electronic money systems, which are accepted by all means of public transport plus a great variety of Ekinaka and surrounding stores and vending machines. For more details see section 4.13.

Osaifu-Keitai
The term Osaifu Keitai, literally means „Wallet phone", and refers to a cellphone with an integrated IC card which can replace the Suica and Pasmo passes. Functions include electronic money, identity card, loyalty card and credit cards.

Lavatories and mirrors
Every station is equipped with restrooms free of charge. At many stations, mirrors are installed on platforms as a service to commuters.

Signage: Guiding Systems
A number of well-designed signposts inform transit-users about station facilities and transfer possibilities. Additional transfer signposts point out the carriage number closest to the exit which leads to the train the customer wishes to transfer to.

Exact stopping points
Trains are not only punctual, they are also extremely accurate in terms of stopping position, enabling queuing and easy boarding, which is accessible to disabled customers as well.

Air-conditioning
Tokyo has hot and humid summers and winters can get quite cold. As a matter of fact, virtually all trains are equipped with air conditioning and seat heating. For customers sensitive to the cold, many operators provide carriages with lower air
conditioning settings.

Silence
Unlike other subways, e.g. the London Subway, Tokyo´s trains are very silent. Not only from a technical point of view, but also in terms of customer behavior, it is conside-

red bad manners to eat and drink on the train and to talk on the phone. While, in general, phones should be put in silent mode, posters advice customers to shut the phone off completely near priority seats.

Women Only Carriages
Women-only carriages have been introduced to combat lewd conduct, particularly groping (Chikan), in crowded trains. Women-only carriages are operated at peak hours and are indicated on the platform floor to ease boarding on crowded platforms.

Internet Connection
Most trains and subways provide a high speed wireless LAN connection within trains and on platforms, allowing commuters to utilize their commuting time in crowded trains for reading the news, studying vocabulary or reading cell phone novels, which became popular in the early 1990s.

Eki-Stamp: Station Stamp Collecting
Almost every train and subway station has their own specific stamp, featuring a picture of a local attraction or feature. People enjoy station stamp collecting, as the stamps provide attractive and affordable memories. Also, it is seen as a challenge to collect all of the available stamps, and national stamp ralleys are organized every year.

Customer Cooperation

Queuing
Customers are disciplined when it comes to queuing, or lining up, on train platforms. Customers wishing to board a train stand at the sides, waiting for exiting customers to get off the train. However, this has not always been the case, and is a result of heavy campaigning by train and bus companies.

Transportation of goods
It is very rare to spot customers with bulky items, such as suitcases, boxes or bicycles on trains and subways in Tokyo. While transporting bicycles is forbidden, many passengers refrain from carrying suitcases in order to avoid inconveniences. This considerate behavior is facilitated by the existence of affordable suitcase delivery services.

Gaman
The Japanese concept of 'Gaman' can be translated roughly into 'patience and endurance' by means of self-discipline and putting aside selfish thoughts in favor of consideration for others. As a matter of fact, passengers do not, in genera, complain about overcrowded trains, but rather stand and wait patiently inside trains and in front of escalators.

Meiwaku
Meiwaku is a similar concept of Japanese cultural identity, referring to a sense of not wanting to inconvenience others. For example, people wear masks when they have

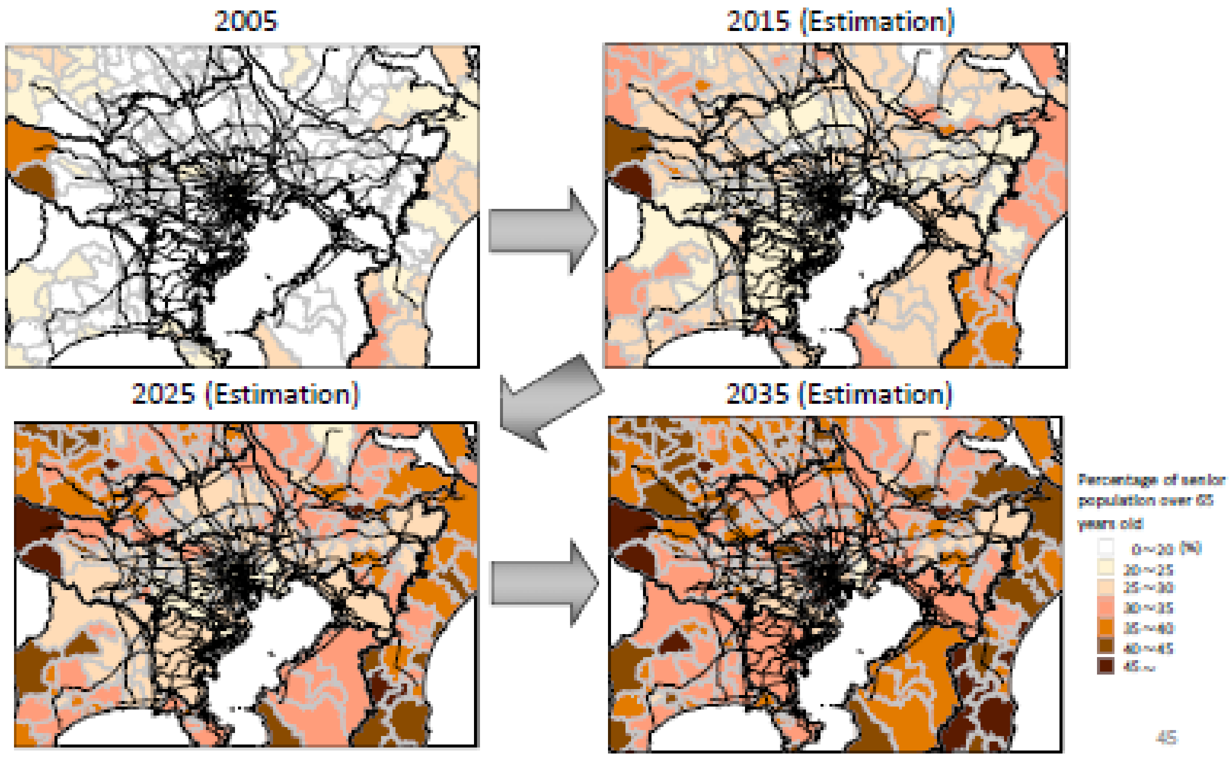


Figure 84: Aging of the TMA´s population (Daily Cargo 2012)

caught a cold in order not to infect others on crowded trains. Transit-users also speak quietly and refrain from talking on the phone. Meiwaku can also be thought of as the reason behind not transporting goods on trains.

4.11.5 Current Challenges

Aging population and changes in travelling patterns
Long-term estimations predict that Tokyo's population will age dramatically within the next 20 years. Rapid aging poses a major challenge for the rail network. As most revenues are generated by commuters, private rail operators will face problems with a decline in the working population. An aging population will likely also have an impact on land use patterns. While many people in the 1970s used to buy single detached houses in the suburbs, younger generations tend to prefer high-rise apartments in the city center. With fares based on distance (and fixed by the government), shorter distances will decrease revenues for private operators and less well-used lines may become economically unfeasible. Abandoning lines will not be easy for operators as they are dependent on keeping up a good reputation. However, 'opportunities', such as earthquakes, might be used in the future to rationalize abandoning a line when it is no longer economically feasible.

<u>In-vehicle and station congestion</u>
In-vehicle and station congestion began increasing in the early 1960s. As a result of most office and business functions being concentrated in the city center, and a recent trend towards moving back into the central districts, in-vehicle occupancy can be up to 200% at some stations during peak hours.

High congestion rates also lead to delays, which has far-reaching effects as many subways are connected directly to the suburban railways. In order to manage this problem, Tokyo has put a number of congestion reduction initiatives in place. The government is also thinking about the introduction of a subsidy scheme to increase platform capacity.

<u>Accessibility of airports</u>
Another challenge is improving the connection between airports and high-speed rail stations, especially in consideration of the efforts to further strengthen global ties. Although Haneda and Narita airport are operated around the clock, there are currently no trains available between 1:00am and 5:00am.

<u>Strengthening earthquake resilience</u>
In light of the fact that a major earthquake is predicted for the Tokyo region, strengthening earthquake resistance in physical terms will be crucial in the near future. In addition to decreasing the vulnerability of the technical system, a second challenge addresses the management of transportation demand after the occurrence of an earthquake. The Government is currently simulating possible destruction scenarios.

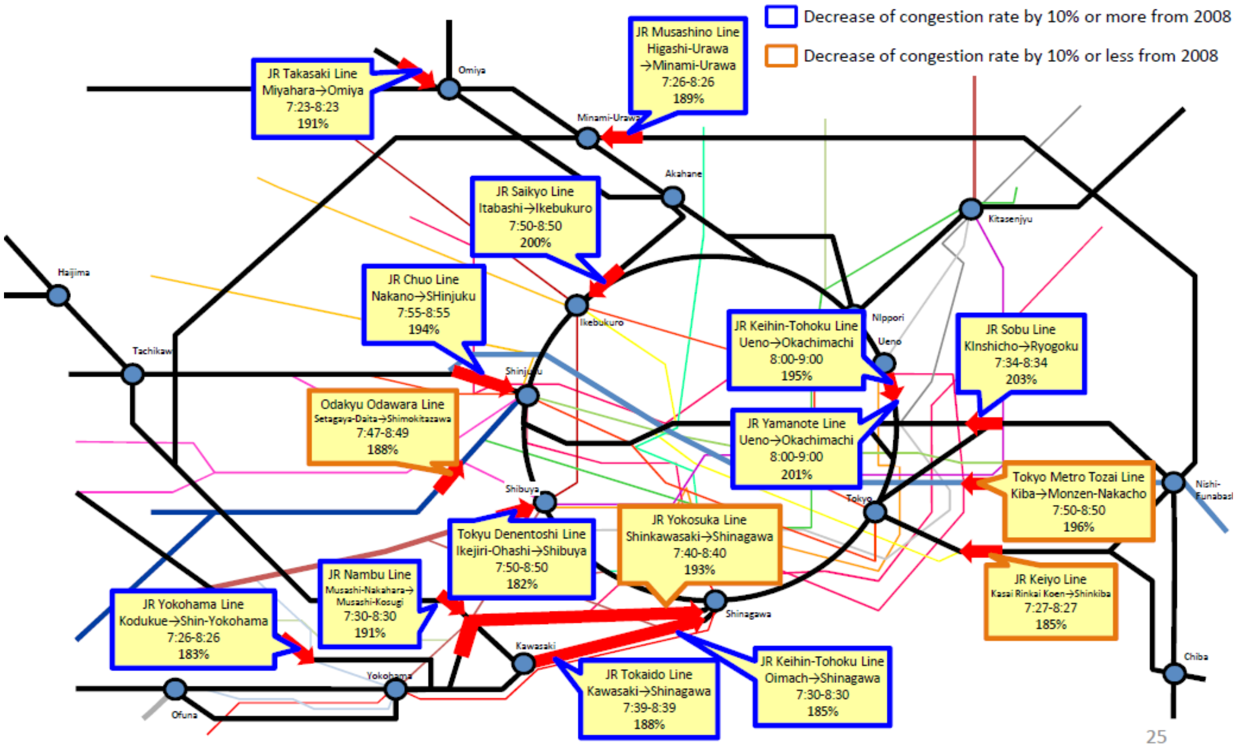


Figure 85: In-vehicle congestion on selected lines (Daily Cargo 2012)

4.12 TOKYU CORPORATION – RAIL INTEGRATED COMMUNITIES

4.12.1 Introduction

This chapter delves more deeply into the general information about rail development provided in the previous chapter. This section is based on the Tokyu Corporation as a best practice example.

The Tokyu Group began as the Meguro-Kamata Railway Company in 1922. Today the group is Japan´s largest rail-based conglomerate (Cervero 1999) with a total of 235 companies and eight other incorporated bodies, headed by the Tokyu Corporation and employing 21,172 people (of which 4,188 work directly for the railway).

The Tokyu Corporation is one of 16 major private railway operators in Japan and is considered one of the most successful companies in integrating rail and real estate development. It is also one of the first companies to complete master-planned urban development around its railway lines, particularly at its station areas. Today, urban development – underpinned by transportation services – is still the cornerstone of Tokyu´s business, alhtough its business portfolio has spanned the field of real estate, lifestyle services, hotels and resorts, business support services and many other activities. (Tokyu Corporation 2012)

The Tokyu network comprises a total of eight rail lines extending 104.9km. Furthermore, Tokyu operates several bus routes which act as feeders for its railway network and enhance user convenience via, for example, direct airport services and overnight express buses. Overall passengers volumes are growing almost every year and stood at 1.08949 billion in the 2013 fiscal year (Tokyu Corporation 2013b).

The area along the Tokyu lines, which is defined by Tokyu as 17 cities and wards where Tokyu Lines are operated, stretches over 490 km^2, which is equivalent to half the size of Berlin, and is inhabited by 5.09 million people – equivalent to 1.5 times the population of Berlin.

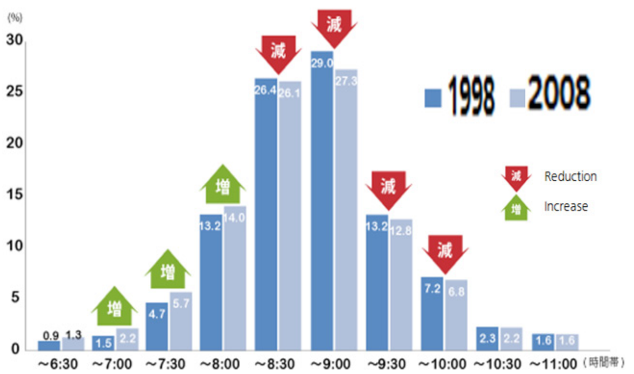


Figure 86: Reduction of In-Vehicle Congestion during peak hours in Tokyo Prefecture (Tokyo Transportation Planning Council 2008)

4.12.2 Development / Objectives

As mentioned in the introduction, the Tokyu Group has a broad business portfolio ranging from urban/real estate development to lifestyle services such as cultural and sports facilities. However, Tokyu's basic strategy is based on three major pillars of action: a Transportation Business, a Real Estate Business and a Life Service Business. Each pillar provides a certain contribution to the company's overall growth strategy. While the Transportation Business creates a stable cash flow the Real Estate Business is the main driver for profit growth. The Life Service Business is intended to enhance the value of rail service areas in coordination with both the Transportation and Retail Businesses (Tokyu Corporation 2013a). It is assumed that a strong collaboration between those core business areas will generate greater synergies among them and consequently will increase growth. Therefore, three growth strategies have been developed by the Tokyu Corporation (Tokyu Corporation 2005; Environmental Defense FInd 2013):

- PEAs Strategy: The land along the Tokyu railway lines is classified into four areas – the station, the town, the area served by Tokyu and the railway line itself – shown in the figure below. Thereby, each area is analyzed according to the characteristics of its residents and passengers and a specific business strategy is drawn up for it.

- Expand the development of major points: Key locations around the major stations belonging to Tokyu Corporation are developed according to the

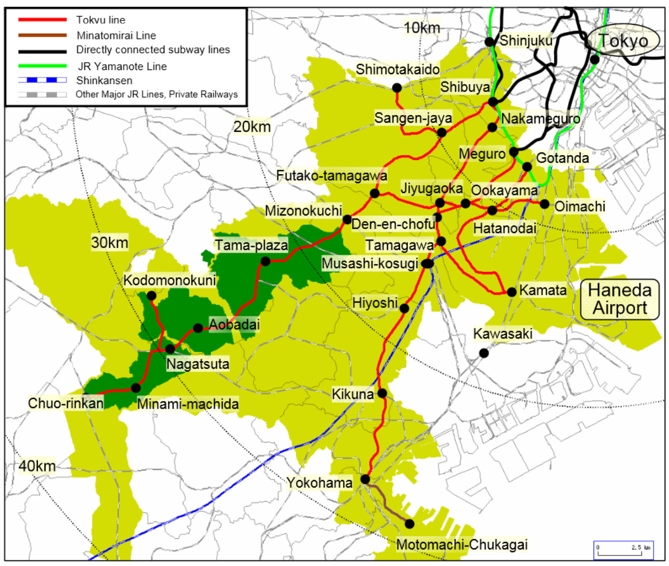


Figure 87: Tokyu Corporation Rail Service Area (Tokyu Corporation 2013b)

area strategies. These plans focus on a wide variety of activities and facilities in order to use synergies among the three core businesses to attract new residents, promote consumption and increase daytime passenger volume. Thereby, a major success factor is that most of the Tokyu developments go in line with and take advantage of several government policies, such as the stimulation of daytime and reverse transportation (from the centre to the suburbs of Tokyo) to decentralize Tokyo and relieve its core in terms of transportation.

- Grow retail-related business: By promoting retail-related businesses, Tokyu hopes to support the lifestyle of its residents and therefore improve their quality of life. Additionally, Tokyu aims to generate synergies among its commercial facilities through the development of a retail refinement plan in which stations are divided into different retail types. Each type serves as a particular market and focuses on specific facilities. In line with the retail types, the existing and planned commercial facilities are to be redefined.

In summary, the Tokyu Corporation's overall strategy is a type of business development that keeps creating life-value in the areas which are served by its railway lines or, as Paul Chorus wrote,"Tokyu Corporation aims to play a role as a life-style design supporter oriented towards maintaining and increasing the vitality of communities served by its own railway lines" (Chorus 2009).

In its vision, formulated in the Three-year Medium-term Management Plan 2012, the Tokyu Corporation keeps its rail service areas as the main focus. In practical terms, this means that the areas served by Tokyu´s railway lines are becoming the most popular areas in Japan to live in. Shibuya, the Tokyu urban development hotspot, has become the most popular town in Japan to visit and Futako-Tamagawa, a business- and commercial center outside of the Tokyo City Centre (developed mainly by Tokyu), has become the most popular town in which to work.

4.12.3 Implementation / Measures

In general, the Tokyu Corporation can be seen as the prototype for a company which implements measures that are in line with most of the success factors listed in the previous chapter (4.12.4), especially those listed under high quality service/customer orientation and government policies.

Furthermore, the Tokyu Corporation is an example of best-practices in terms of being a highly profitable company which links public transport with urban development projects and lifestyle services. Tokyu's business model, and its success, is based on a variety of different measures of which, of course, not all address sustainability. The following examples should give an overview of additional Tokyu-specific measures which are not already listed in the general overview in chapter 4.12.4 and address whether environmental, social or economic sustainability has been addressed in a certain way.

Measures in the context of transportation can be summed up under quantitative and qualitative network development. One key issue for Tokyu´s extensive network development has been to create mutual direct train service with adjacent rail companies to increase travel comfort for its customers. For example, direct through-service, connecting Tokyu´s Toyoko Line with Toyko Metro´s Fukutoshin Line, which allows seamless and fast travel from Yokohama to Shibuya has been achieved.

Another key issue, in the context of the aging Japanese society, is barrier-free access to Tokyu´s stations and railway lines. Tokyu already provides barrier-free access to each of its 98 stations and is continuing to improve both stations and trains in a superior manner when compared to other private rail companies.

Tokyu offers a wide range of so-called Lifestyle Services, which mainly address social issues and also support public transport as the main mode of travel. This is achieved by minimising the distances people must travel in their everyday lives and by concentrating retail and department stores, supermarkets, sports facilities, cultural facilities, as well as other services which support the everyday life of Tokyu´s customers, at its stations.

As already mentioned, Tokyu analyses each area according to the characteristics of its residents and passengers and a specific business strategy is drawn up for that specific area.

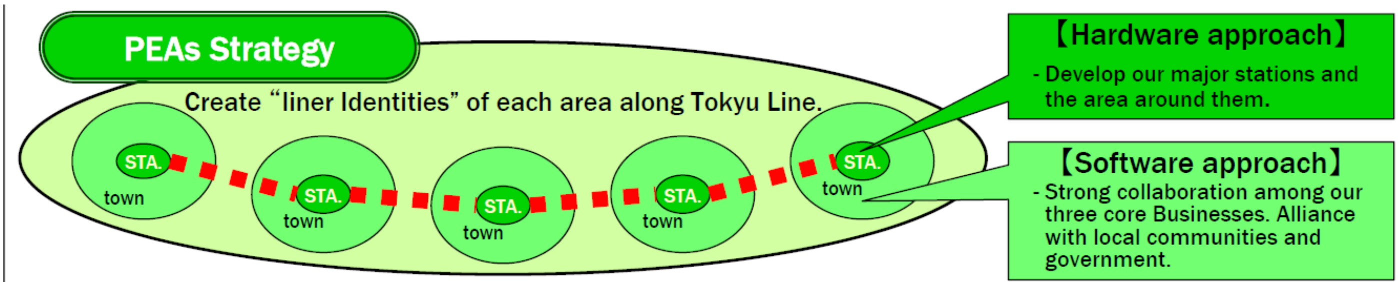


Figure 88: Four areas defined in the Tokyu Corporation´s PEAs Strategy (Tokyu Corporation 2005)

That includes the set-up of support services for the needs of different social groups who live in the Tokyu area. The main groups being focused on are senior citizens and young families. Tokyu develops housing typologies for the elderly, situated close to stations to ensure easy access to the public transport system (Tokyu Welina). At the same time, Tokyu creates attractive framework conditions for young families to move to freed-up detached houses with more distance to the stations. With this, Tokyu aims to create a smooth generational change in its communities and offers a service called Relocation NEXT, which is housing development consisting of support from „preparation before relocation" to „living after relocation" and thereby create a relocation cycle tailored to diverse lifestyles support by different services. These include before- and after-school care programs (Kids Base Camp), private educational corporations and foundations from kindergarten to university, culture schools and sports facilities for young families and home-delivery services (Tokyu Bell), museums, and health-centers for senior citizens. In summary, Tokyu aims to encourage „an influx of young adults and families by offering an safe and well-developed environment" and „create value for living by providing a place to learn and promote health" (Tokyu Corporation 2013a). Safety, as an issue for both families and the elderly, is addressed by the Tokyu Security Company, which is a professional version of a neighbourhood watch.

4.12.4 Planned Steps

Steps planned for the future are mainly consistent development of already existing measures. In terms of network development, the next concrete steps will be the creation of mutual direct train service between the Toyoko Line and Sotetsu Line until 2019 and an extension of barrier-free accessibility in stations and trains. Another focus is on the development of environmentally-friendly stations which conserve energy and reduce CO_2-emissions on the part of buildings. Another key issue is the new Airport Line Improvement Program, which will enhance access to Haneda Airport by reducing travel times in order to respond to an increased number of flight passengers departing from Haneda and to revitalize the Kamata Area. In parts, existing railroad tracks will be transferred underground to allow for the activation and development of the urban space.

In terms of societal changes in Tokyu´s service areas, the focus lies on consistent development of existing lifestyle support services within an overall strategy which is defined by the Tokyu Corporation as Next-Generation Suburban Town Planning and identifies age-deterioration, an aging population and a low birthrate as the main fields of action. Tokyu has noticed a mismatch between the existing lifestyle infrastructure and the aging of local residents, as well as the attractiveness of the community with the lifestyles and expectations of the younger generation.

The fundamental principles of Tokyu´s Next-Generation Suburban Town Planning include:

- Sustainability and the re-utilization of buildings and infrastructure in existing communities
- A focus on people, lifestyles and communities in order to aim at sustainability, circulation and diversity
- Solving the problems of an aging society and a declining population in a practical manner

An elemental part of Next-generation Suburban Town Planning is a powerful cooperation between the communities, the governmental institutions, the private sector and

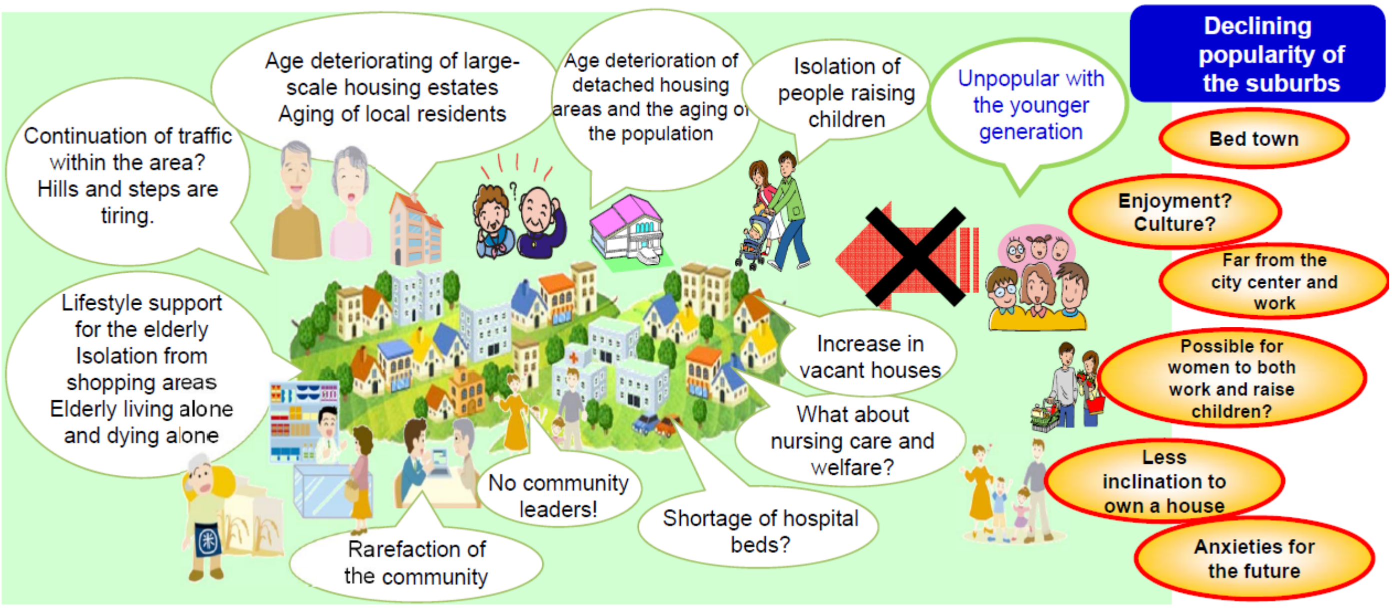


Figure 89: Issues with suburban residential areas from Tokyu´perspective (Toura 2013)

academics/research institutions which develop policies to support the conversion of suburban communities in the following ways (Toura 2013):

- Establishing a lifestyle infrastructure network to cater to the needs of the next generation through the practical unification of transportation, medical care, nursing care, child care, energy, employment, social interaction and the community with housing and living through town planning.
- Citing community living models in suburban residential areas by suggesting new suburban lifestyles consisting of both facilities and residences in which lifestyle infrastructure is located and typologies which support the elderly with multi-generational co-existence models.
- The creation of systems consisting of people and communities capable of sustaining the suburbs with area management:
    - o New public facilities established by town planning leaders and town planning bodies consisting of cooperation between the governmental and private sectors
    - o A system to ensure the circulation of money: businesses diversified in scale and objectives to create local jobs

Toyku already initiated a Next-Generation Suburban Town Planning process, together with all relevant stakeholders (communities, the governmental institutions, academics/research institutions) in 2012/13. Measures which have already taken place included resident workshops in the communities, seminars at Tama Plaza University and the creation of a thematic subcommittee to investigate lifestyle infrastructures on a community-level:

4.12.5 Actors / Financing

For a detailed overview of the actors involved and the interdependencies within financing rail development please compare with chapter 4.12.3 and figure 64 and replace „private company" with Tokyu.

Tokyu is one of the most profitable railway operators in

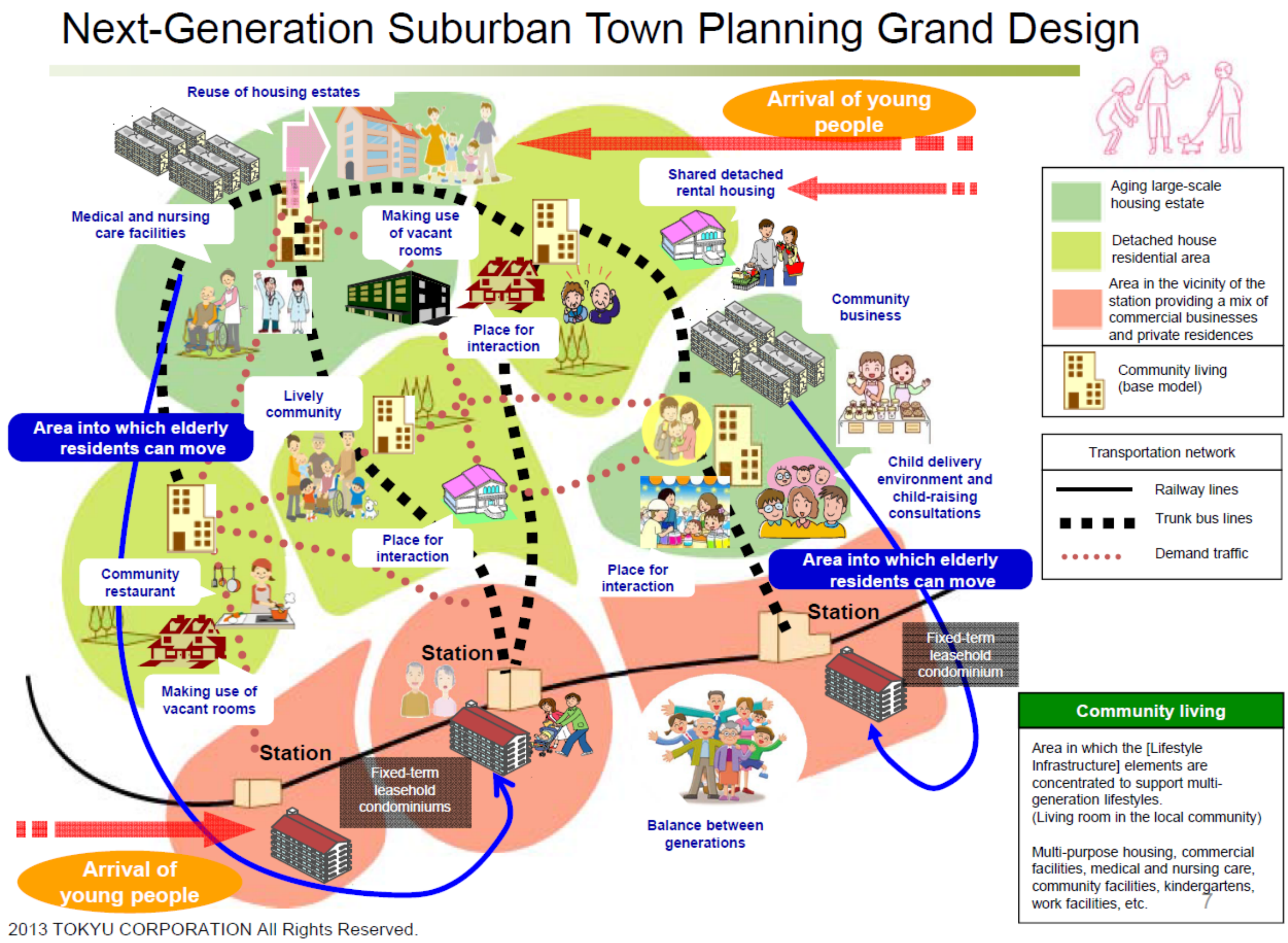


Figure 90: Next-Generation Suburban Town Planning (Toura 2013)

the country, with net profits of 58.72 billion ¥ (587 million US$, 441 million€) on operating revenues of 263.7 billion ¥ (2.63 billionUS$, 1.98 billion€) in 2006 (Tokyu Corporation 2007). Real estate and transportation each bring in an equal share of net profit (33.5%), with the rest coming from retail (20.2%) and other sources (Calimente 2012).

4.12.6 Barriers / Challenges

Tokyu struggles with the same general challenges as other private rail companies and urban developments, listed in 4.12.5. However, on most of the issues, Tokyu is one step ahead in responding to them and taking them into account in terms of business development. This is illustrated best with the aging and decreasing population along the railway network. Tokyu already identified this as an issue decades ago and undertook measures to strategically distribute customers and residents of all ages in its urban development areas by addressing certain lifestyles with specific housing and infrastructure. As a result, the population trend in the 17 cities and wards served by Tokyu´s railway lines is considerably less critical compared to the national population trend.

4.12.7 Success criteria / Framework Conditions

Success critieria and framework conditions for this example are also analogous to the overview listed in chapter 4.12.4. However, as in addressing the main challenges in the previous section, Tokyu is also one step ahead in its consequences, such as in linking its different business areas with one another, where each provides a certain contribution to the overall growth strategy of Tokyu.

The following scheme illustrates how consistent improvements in Tokyu´s Rail Network have resulted in considerably increasing passenger numbers as well as revenue per passenger:

Furthermore, as Chorus pointed out in his book Station Area Developments in Tokyo, the Tokyu Corporation has managed to attract passengers to its railway lines through non-transportation related investments. As the figures below illustrate, the number of passengers at Minami-Machida station has increased considerably since 2000 when a new shopping mall was opened in the vicinity of the station. Especially the share of non-commuters (blue bars) has gone up which is a clear indication that this station is increasingly being used after peak hours. In addition, ist retail sales have also gone up, as illustrated on the right side of the figure 94 (Chorus 2012).

4.12.8 Transferability

The Tokyu Corporation's success is strongly related to a close interaction between public and private stakeholders in Japan in general and, in particular, in the field of railway development (see chapter 4.12.3). These strong Public Pri-

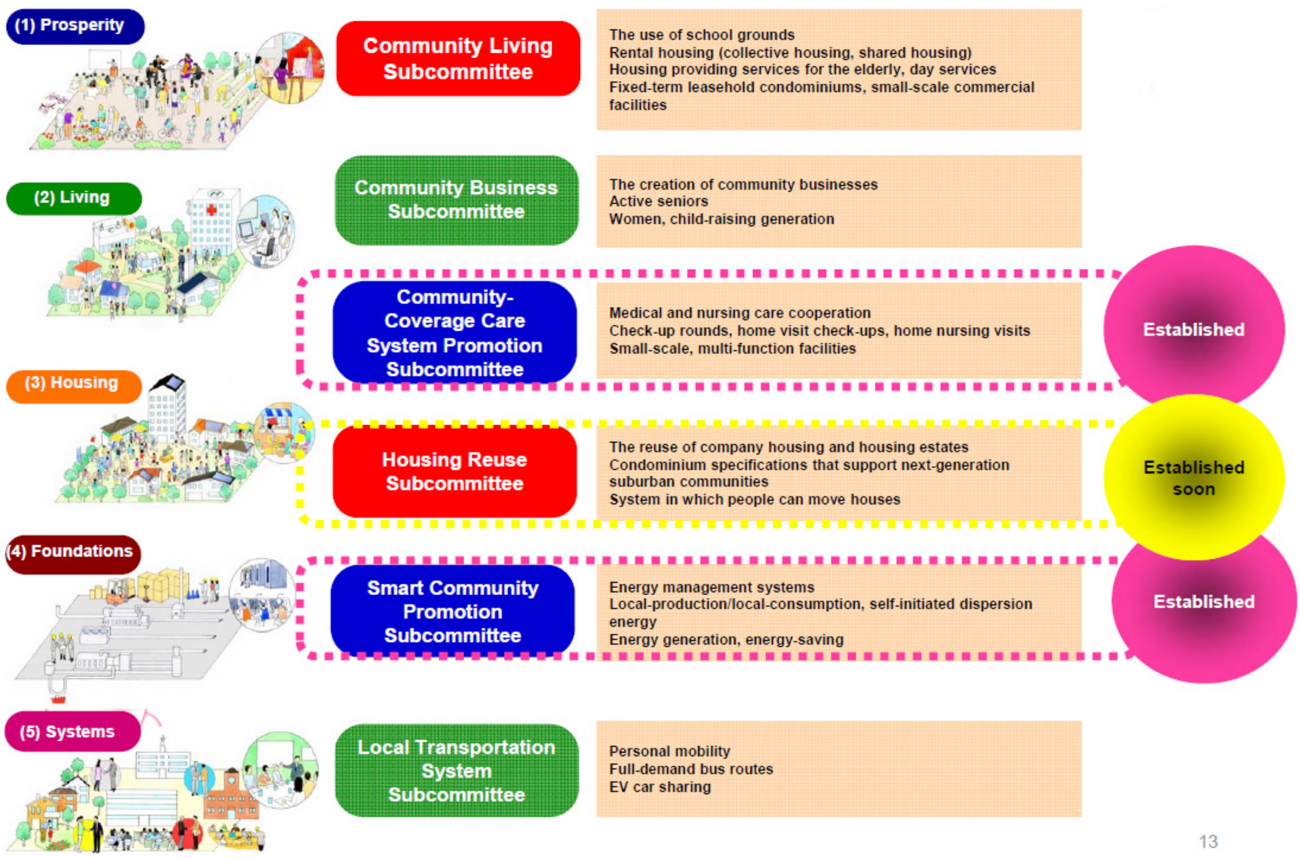


Figure 91: Next-Generation Suburban Town Planning – Subcommittees (Toura 2013)

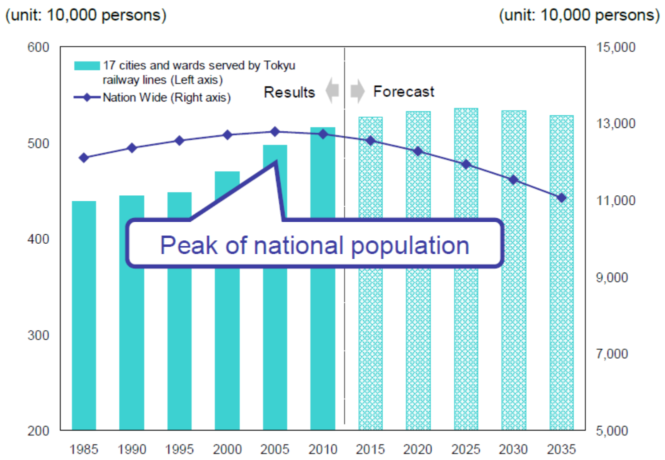


Figure 92: Population trend in the Tokyu Service Area compared to the national population trend (Tokyu Corporation 2013a), compiled by Tokyu based on „Nihon no tokei 2010" (statistics about Japan) by Statistics Bureau and 2008 data of the National Institute of Population and Social Security Research

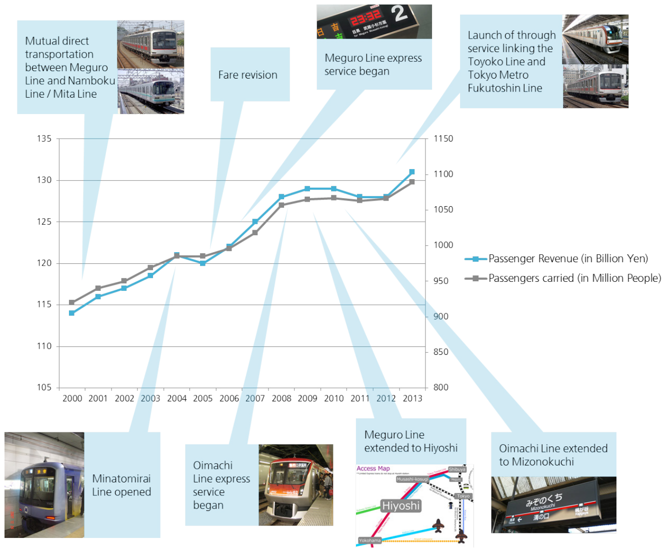


Figure 93: Effects of Tokyo´s rail network improvements on passenger numbers and –revenue (m:ci illustration based on figures in Tokyu Corporation 2013a)

vate Partnerships are typical within the Japanese economy and are not really comparable to a completely different situation in Europe or even in the US. However, they might provide a good example for implementing new models and methods of public-private cooperation, in terms of the sustainable development of cities, in other parts of the world. Another issue that limits the transferability of the Tokyu model, especially to Europe, is that a considerable number of the measures implemented by Tokyu only work for new urban developments and not in already existing structures.

4.12.9 Sustainability

As already mentioned in the previous sections, not all of Tokyu´s measures address sustainability issues. However, Tokyu´s strategy provides a good example of how successful business (thus economically sustainable) can be combined with sustainable urban development in ecological terms (public transport, building quality, reduction of CO_2-emissions, etc.) and in social terms (lifestyle support services, strengthening of local communities).

An important issue in the context of Tokyu and sustainabilty is that a major part of Tokyu´s business model is to earn money through offering a transport service. That means that Tokyu has an interest in people having to travel, and facilitates this by distributing certain functions, such as working, living or shopping along its railway lines by developing sleeping cities, working cities, etc. Although public transport can generally be considered a sustainable mode of travel, it is not sustainable to keep people in motion simply in order to maintain a business model, instead of planning and

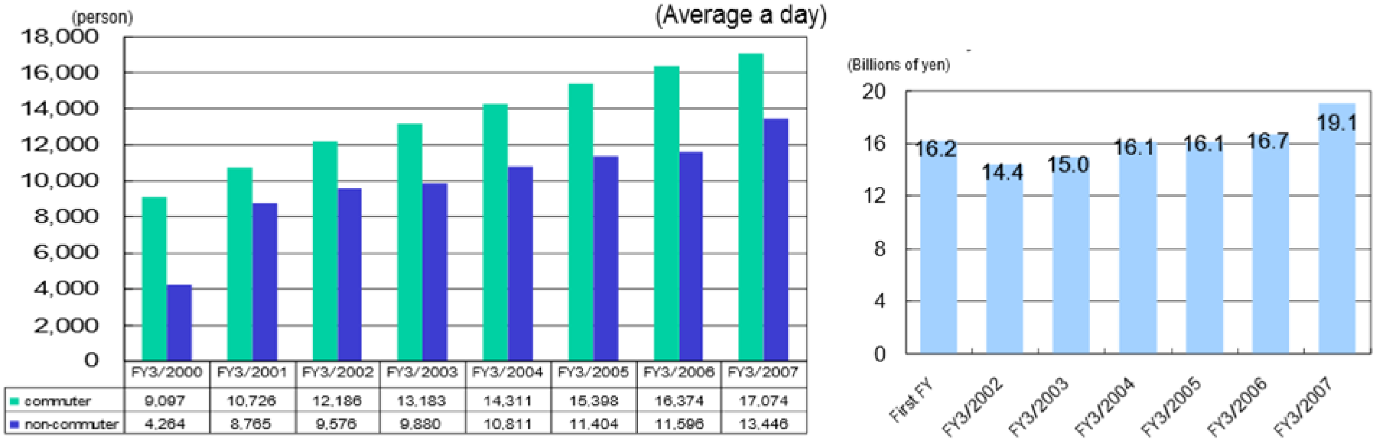


Figure 94: Passenger numbers (left) and sales (right) at Tokyu´s Minami Macheda Station after the opening of a new shopping mall

developing mixed-used cities and districts to minimize the distances residents are forced to travel.

4.13 INTEROPERABLE ELECTRONIC TICKETING

4.13.1 Introduction

Using public transportation in Tokyo is very convenient; even for foreigners, who have never been there before. One of the reasons for this is the electronic ticketing system, which is available at almost all rail and bus routes in the Tokyo metropolitan area. Instead of waiting in line at a ticket machine, passengers can simply touch one of the ten[18] accepted national IC cards[19] to the automatic fare-collecting gates and pass through immediately. Moreover, passengers no longer need to study route maps to determine the fares to their destinations, nor worry about switching transport companies or modes of transport (train, metro, bus, taxi, etc.). These features promote spontaneous and carefree use of public transportation.

4.13.2 History

JR East, the world's largest passenger railway company, was the first company in Japan to introduce a large-scale IC card automatic fare collection system. In November 2001 they launched the Suica (Super Urban Intelligent Card) in the Tokyo metropolitan area at 424 stations, replacing the magnetic cards which had been used thus far. After just 19 days, over one million cards had already been sold, making the launch a huge success. Due to its head start, JR East was able to define a de facto standard for IC cards used in Japan's public transport.

From the very beginning, Suica was not seen as a one-to-one replacement for the magnetic cards, instead, it was called a "dream card" (JR East Japan Railway Company 2002) in reference to the possibilities provided by this new technology. One central idea was a deeper integration of original transportation services with other areas of life. In July 2003, JR East launched the View Suica card, a common credit card with Suica functions. This was a single card which could be used for both rail travel and shopping. In March 2004, electronic payments were feasible at shops with Suica. After one year, roughly 12.6 million card holders could pay at approximately 1,000 stores, and since 2006, Suica supports dual-use ID cards, which combine the functions of Suica cards and employee ID cards (time recording, access control, etc.).

In addition to this diversification strategy, the continuous improvement of electronic ticketing for primary transportation services has been constantly promoted. For example, the number of useable stations was doubled in just three and a half years. Also, new technologies were enabled with Suica functionalities. In January 2006, Mobile Suica was launched. It enables users to pass through automatic ticket gates by holding their cell phones near gate sensors, as is

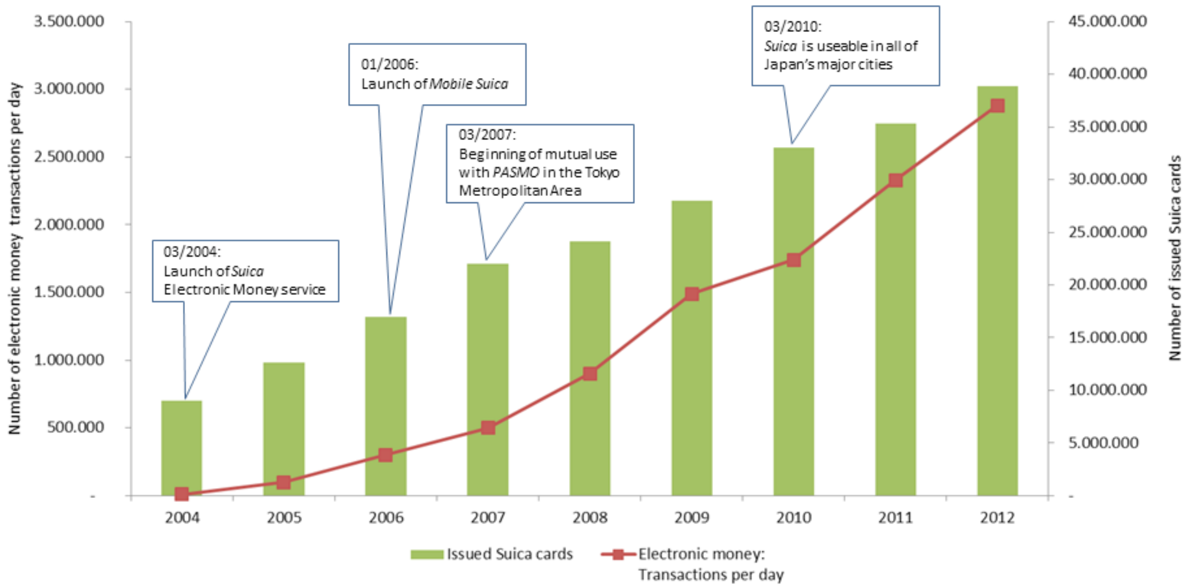


Figure 95: Development of the number of Suica cards issued and electronic money transactions (own diagram based on East Japan Railway Company 2002, East Japan Railway Company 2011; JR East Japan Railway Company 2012)

18) The brand names of the cards (in alphabetic order): Hayakaken, ICOCA, Kitaca, manaca, nimoca, PASMO, PiTaPa, Suica, SUgoca and TOICA.

19) A card with an embedded IC (Integrated Circuit) is called an IC card. IC cards provide more functionality than for example the widely-used magnetic stripe cards. The embedded IC chip allows storing a large amount of information directly on the card. Plus, an IC chip can perform mathematical calculations, enabling the card itself to perform many calculations just like a computer can. Furthermore, IC cards are more difficult to counterfeit and decrypt, making them a much more secure choice.

done with Suica cards. Solutions for new mobile platforms were provided in time, for example, Mobile Suica for Android was available in July 2011. And, since summer 2009, an internet service allows customers to charge and settle their Suica account on their personal computers.

Finally, JR East continuously pursued cooperation with other transport companies and inter-operability with their IC card systems. In 2005, approximately 50 transportation companies agreed on the commencement of the mutual use of the Suica system in the Tokyo metropolitan area, offering the amenity of being able to travel anywhere in Tokyo using only one card. Even when a consortium of several strong transport companies, mainly from the greater Tokyo area, launched their own IC card based electronic ticketing system (called PASMO) in March 2007, interchangeability was ensured from the first day of service. This was made possible through the constitution of an Interoperation Committee, years in advanced. Since the spring of 2010, Suica and most of the other national IC cards, are useable in all of Japan's major cities.

4.13.3 Challenges

Because it would affect so many people, a core challenge for the seamless operation of the electronic ticketing system in greater Tokyo was to set the time for the launch of Suica and PASMO. In a public transportation system with approximately 30 million passengers per day, even a small error can cause a massive disruption. Therefore, extensive field testing and monitoring had been conducted. Another key challenge was the cooperation and coordination of the transportations companies involved. At the beginning in 2007, more than 100 operators had already been brought together. However, the size and complexity of the railway network in Tokyo itself was a challenge. Fair validation for more than 1.23 million different travel patterns was necessary.

The major technical challenges were the protection of personal information and the framework design for collaboration across several transport companies. Because of strong laws and requirements regarding the protection of personal data in Japan, advanced security measures were necessary. Especially the information of personalized commuter passes requires strong protection. In accordance with the common ISO 15408 (Common Criteria for Information Technology Security Evaluation), Suica obtained an EAL 4 (Evaluation Assurance Level) security evaluation and certification. In this context, it should be mentioned that Suica and PASMO are controlled by the financial authorities and not by the transport authorities. This is due to the fact that the IC cards are used for electronic money transfers. The interoperability of the system was realized through a high extent of technical integration across the operators. The core is a shared IC card clearing data center which exchanges data with all participating operators.

4.13.4 Impact Factors

It is important to recognize that the adoption of electronic ticketing and electronic money is strongly tied to Japanese conceptions of the aesthetic and moral virtue of smooth flow and the avoidance of commotion (Czerwinski et al. 2008). For instance, Suica is a play on the Japanese onomatopoeia sui-sui which can be translated with "flowing quick and smooth". Avoiding commotion (meiwaku), in Japan, is a far more widespread and deep concern than an institutional imperative for efficiency. To this effect, from the passenger perspective, the touch-and-go ticket and cash card can be seen as a pro-social measure. In the case of electronic cash, the Japanese love for tokushita (obtaining a gain, benefit, profit, or advantage) plays a crucial role as well. Loyalty-rewards provide the opportunity of getting "something for nothing" through a kind of playful, perhaps addictive activity. In summary, this social framework is very critical since social and cultural factors may make or break the success of a system.

The high acceptance of electronic ticketing systems in Tokyo is also based on the successful cooperation between the transportation companies. Although in competition with one another, they realized the chance provided by a common standard for IC cards and implemented one of the biggest and most conveniently seamless transportation networks in the world. However, all none-transport companies which enrich the use of the electronic ticket systems with their services are also included in the successful cooperation: shops and vending machines that except electronic payments, airlines that participate in bonus point clubs or companies that use dual-use IC cards.

Another important factor was that the purpose of electronic ticketing ("dream card") was not limited to transportation services. Additionally, the fact that public transportation plays an important role for the citizens of Tokyo in general also promoted innovations in the field. Finally, one must admit that the Suica example is a perfect showcase for strategic and technical implementation. Not surprisingly, Suica has been called an "ideal technical solution" by a recent European study (AECOM 2011).

4.13.5 Achievements and Benefits

In general, electronic ticketing offers a large number of benefits to authorities, transportation companies and passengers compared to traditional ways of payment (further reading e.g. EMTA 2008). The example of JR East's Suica shows dramatic savings in terms of maintenance costs due to the negligible burden placed on moving parts within the automatic ticket gates compared with magnetic cards. With the increased distribution of Suica, the number of automatic ticket vending machines necessary at the stations declined, allowing JR East to exploit the space created for

Table 12: Suica facts

***Suica* facts** (national wide, data as of 2012)	
Issued cards	38,880,000
Useable stations	2,990
Electronic money Points of acceptance	177,630
Electronic money Transactions per day	2,880,000
Mobile Suica memberships	2,820,000

Source: JR East Japan Railway Company 2012

other revenue-generating ventures. Additionally, rapid processing at automated gates and during bus boarding is very important. Particularly in Tokyo – which has a high passenger flow – a reduction in processing times from 0.7 seconds per passenger (magnetic card system) down to 0.1 seconds (IC card system) is a great advantage (JR East Japan Railway Company 2002).

Info box: MANTA

Nowadays, Japanese commuters can use up-to-date mobile telecommunications technologies such as3G and LTE services at almost all stations and tunnels during their train rides in Tokyo, without interruptions. Although the public transport operators generally request that people refrain from using their mobile phones while travelling, area-wide cellular networks are essential for communication in the event of a crisis or disaster. The major earthquake in March 2011 reinforced the risk of being stuck underground without appropriate communication tools.

Additionally, Tokyo Metro has initiated a free Wi-Fi service trial for several of its train stations, which started in April 2013 and will presumably end in January 2014. By registering for an application called MANTA (Metro Amusement Network Trinity App), commuters are able to connect their smartphones to free Wi-Fi access points inside the stations. The new portal service acts as an online subway guide that automatically updates itself as passengers move between stations. It provides schedules, station maps, information on crowded areas and which train cars to board for the easiest access, as well as news and entertainment.

The service is based on a new Wi-Fi network technology that allows for the delivering of value-added services to specific locations (access points). Thus, store owners at stations, airports, or malls can deliver specific information to specific audiences ("only for now", "only for here", "only for you"). In addition, the user-data allows a service provider such as Tokyo Metro to improve train operation or services at train stations after analysing the data. In the future, Tokyo is thinking of integrating MANTA into more serious applications, such as disaster management. In this context, the app could deliver location-based escape-route information to passengers.

Passengers profit from the system through increased convenience and speed. Seamless journeys in multimodal and/or multi public transportation schemes became easier in Tokyo. For commuters, the possible ways of charging a card or replacing it in case of a loss are meaningful features. In addition, extra services (e.g. electronic payments at stores, vending machines, lockers or taxis) while traveling are features appreciated by the customers. These benefits lead to a high level of acceptance of the available IC card system and this consequently leads to higher use of public transportation.

4.13.6 Sustainability and Transferability

Electronic ticketing makes the use of public transportation easier and more convenient. Thus, environmental benefits can be expected from increased use of public transport either by those travellers who use the services more often than before or by those travellers who would otherwise use other modes of transportation. Since plenty of international standards for IC cards and electronic ticketing systems are already available (AECOM 2011) as well as practical experience around the world, transferability should be relatively easy. The major challenge will not be technical in nature, but rather organizational. Cooperation is necessary in order to achieve the critical mass required to reap the benefits of electronic ticketing in a large-scale transportation network.

4.14 IMPROVING ROAD TRAFFIC IN TOKYO – THE VEHICLE INFORMATION COMMUNICATION SERVICE (VICS)

4.14.1 Background

Tokyo developed around its rail network, rather than being designed around the car, as was the case for many other major cities at the time. Rail-bound public transport has been the dominant transport mode ever since. As a matter of fact, in 1998, two years after the introduction of the VICS , the share of public transport already accounted for 48% of all transportation in the TMA and 75% in Tokyo's core region, made up of 23 wards.

Despite its rather low share in the modal split, the sheer number of inhabitants resulted in average road speeds of only 15.7 km/h in the 23 wards of Tokyo in 1994 (Vogel n.y.). According to Sato Nobuaki, Director General of the MLIT's Road Bureau at the time, congestion in various parts of Japan was responsible for 5.3 billion wasted hours annually, corresponding to an economic loss of JPY 12 trillion per year (approx. 98 billion Euro/a) (Sieg 2014). The VICS was introduced in 1996, as one measure to encounter these problems by providing drivers with relevant information and suggesting alternative routes.

4.14.2 The VICS System

The VICS is a nation-wide information and guidance system which provides real-time traffic information and routing via car navigation systems. The system started being used in 1996 in the Metropolis of Tokyo, ahead of similar systems elsewhere in the world. The general mechanism of the VICS system is explained in Figure 97. Information is collected from different types of sensors by road administrators, prefectural police headquarters, and the Japan Road Traffic Information Center and transmitted to the VICS Center, where it is processed and delivered to the On-Board Units (OBUs) via three types of media: FM multiplex broad-casting, radio wave (RW) beacons and infrared (IR) beacons. Information and guidance is provided on the navigational display in the form of text, simple graphics and maps.

RW beacons are installed mainly on express ways, providing information for a range that extends approximately 200km ahead of the vehicle in 1-Minute intervals. The type of information transferred includes the time required to reach the next highway junction, service area, congestion and alternative routing (including non-expressway neighboring streets), as well as information on accidents, construction sites, disasters and general weather conditions. IR beacons are used on major trunk routes, providing information for a range that extends 30 km ahead of the vehicle and 1 km behind the vehicle. They provide much of the same information as do RW beacons, however, information on parking space availability is also provided through IR beacons (Cervero 1999). FM multiplex broadcasting can be received on all types of roads within the transmission range and is used to provide area-wide information, regardless of the direction of travel (Chorus 2012). FM information is updated in 5-Minute intervals. VICS data may be complemented by floating car data from the vehicle manufacturers for their respective fleets.

4.14.3 Initiation and Development

Triggered by the so-called Tokyo Traffic Wars [20], Government and industry came together in 1991 to found the VICS promotion center. Subsequently, in 1995, the VICS Center was established by a total of 85 infrastructure builders, component manufacturers, and automobile manufacturers. Since then, market penetration of the VICS units has increased rapidly from 130,000 units in 1996 to a total of 36,530,682 units in 2012 (Cervero 1999).

While FM receivers are built into basically any navigation system, an extra receiver (or more recently a 3-media built-in receiver) must be purchased in order to receive IR and

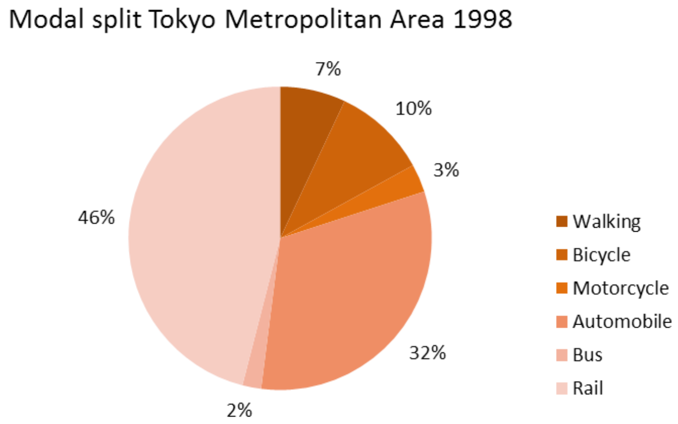


Figure 96: Modal Split Tokyo Metropolitan Area 1998/2008 (own illustration based on data from Calimente 2012)

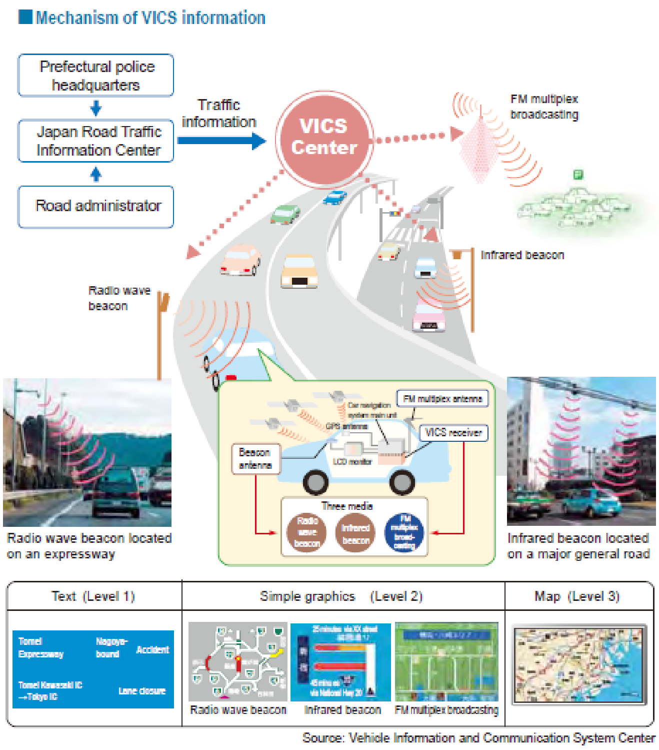


Figure 97: Mechanism of the VICS System (Calimente April 2009)

RW information (cost: approx. 300€). Further, in 2009, the so-called ITS Spot Service was introduced. This service uses the three-media built-in navigation system plus a new DSRC OBU. The ITS Spot Service now operates on a 5.8 GHz transmission instead of the former 2.4 GHz, resulting in a longer transmission range of up to 1000km. Also, the DSRC unit allows for two-way communication, enabling the feed-in of probe data and improving data quality. The new system also has a built-in Electronic Toll Collect (ETC) function and supports V2X safety systems. According to the VICS Center, three-media-units, DSRC units and extra

20) The term was introduced after the number of traffic fatalities was found to exceed the Japanese casualties in the Sino-Japanese War. In 1988, traffic fatalities reached a peak at more than 100,000 deaths (Curtis, Renne 2009).

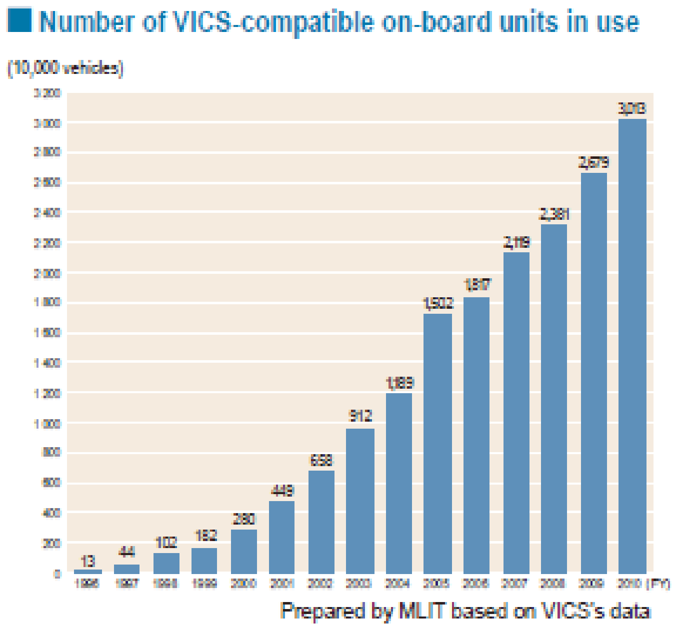


Figure 98: Development of VICS OBU installments (Calimente April 2009)

receivers for IR and RW – in total – account for only 10% of the total number of VICS units.

Today, VICS covers around 47% of all roads in Japan (Cervero 1999). Given the vast rural areas and partly very narrow and dendritic roads of traditional residential districts in the Tokyo Metropolitan Area, it can be assumed that all major roads are covered by the service.

4.14.4 Financing

Although coordinated by government bodies, the VICS system is financed almost completely without national funds. Roadside equipment and installation, as well as operation and maintenance, is paid for by approximately 90 private companies, while installation and operation /maintenance

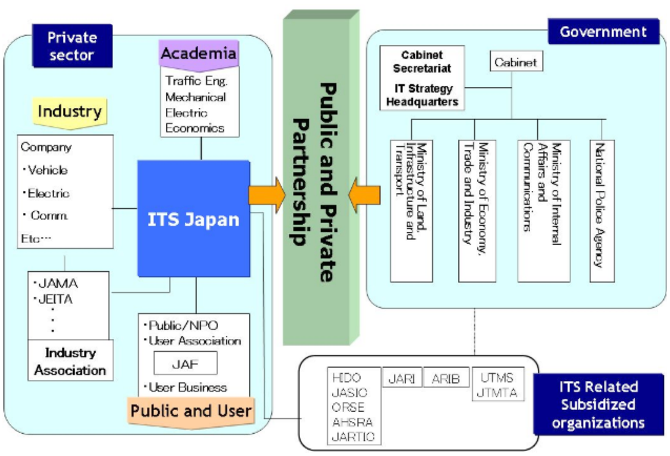


Figure 99: Institutional set-up of ITS planning, including VICS (Chorus 2009)

work is carried out by the National Police Agency and the private highway operators, respectively. The VICS Center is operated on a non-profit basis, receiving a rather symbolic fee of 315 Yen (approx. 2.5 €) for every OBU sold (approx. 3 million Units/a). It is operable on such low costs as it receives the information free of charge and approximately two thirds of the center's staff is commissioned by car manufacturers (Chorus 2012).

4.14.5 Institutional Setup

Along with other Intelligent Transport Services (ITS), VICS is driven by an inter-ministerial council composed of three ministries; the National Police Agency, the Ministry of Public Management, Home Affairs, Posts and Telecommunications, and the Ministry of Land, Infrastructure and Transport. The council works hand-in-hand with ITS Japan (formerly VERTIS – Vehicle, Road and Traffic Intelligence Society), an organization that comprises 159 related companies, 23 associations and organizations, as well as academia and the city governments (Chorus 2009).

Information collection is carried out by the prefectural and national police (Tokyo Metropolitan Police) in the case of local and national roads and by private road operators in the case of expressways. The VICS Center gathers and processes the information and transmits it to the OBUs. The Center also has a connecting function, as it redistributes information to the individual collection entities as required.

4.14.6 Achievements

In 2012, the system had been installed in more than 60% of all personal vehicles throughout Japan, including a substantial number of vehicles in the middle and lower class sections (Cervero 1999). The high acceptance and deployment rate alone may be considered a success, especially considering the fact that the 'Intelligent Traffic Guidance System' (ITGS), which was introduced in Tokyo at about the same time as the VICS by the Daimler Chrysler subsidiary debis AG, was discontinued in 2002 due to negligible market penetration rates. A technically more elaborate system, the ITGS was designed as a personalized premium system based on two-way communication and offering additional services such as individual routing and weather forecasts or stock information. However, it only achieved an overall deployment rate of 15,000 OBUs (Toura 2013).

In terms of sustainability, the VICS belongs to one of the few systems worldwide which have been able to achieve actual emission reductions and improvements in average speeds. According to MLIT calculations, the total CO_2 emission reductions induced by the system, on a national level, accounted for 2.4 million tons in 2009 (Tokyu Corporation 2005).

Travel time savings were assessed in a 2011 experiment carried out by the VICS Center, in which a reference group of cars followed a predetermined route and another group of cars followed a detour route suggested by the VICS. The experiment found that, overall, 20% less time was used for the group following the VICS advice. Numbers provided by the TMG indicate 1.9km/h increase in average speeds (comparing 1994 and 2005 data) for the 23 wards, while traffic volumes decreased by a total of 100,000 vehicles within the same period.

4.14.7 Success factors

Extensive cooperation between the public and private sectors and the strategic and goal-oriented approach with which the system was introduced were key factors for its successful introduction. The system was not designed as a premium service, as is common practice among car manufacturers, but was rather designed as a basic service offered at low cost to benefit a wide audience (the premium version, including RW/IR receiver and later the DSRC unit, are being designed as top-up options). The importance of the cost of the system becomes clear when looking at the ITGS, where the price of 3000€/unit, plus additional monthly charges, is believed to have been the main cause for the failure of the system (Ryosuke Toura 2013). The VICS, in contrast, only requires an initial investment of approximately 1200€ for the basic system, without additional monthly charges. As a matter of fact, it is built into virtually every car navigation system in Japan today.

The cooperative effort between approx. 90 companies under which the system was set up was also crucial for the quality and comprehensiveness of the system. As a result, a nationwide standardized solution, using the same frequency and technical characteristics for all cities and regions, was achieved. This broad range, along with generally high data quality (information is updated in 1-5 minute intervals) has resulted in high acceptance of the system and consequently high market penetration, which in turn allowed for cars to be used as probes – again increasing data quality (in later systems using DSRC).

In terms of sustainability, the overriding national architecture can be seen as a key success factor of the VICS. The built-up a of a consistent system of high quality at low cost was aided essentially by the establishment of technology-specific inter-ministerial bodies and industry associations and the set-up of binding and comprehensive guidelines. Most company-specific traffic information and guidance systems are designed to benefit the driver rather than alleviate the overall traffic situation. As a matter of fact, Halbritter et al. state that traffic information and guidance services may even have negative effects on the environment, such as increased traffic in reduced-traffic-areas as routing is guided by individual gains (Toura 2013). The comprehensive and extensive planning engaged in by the Japanese Government, including binding guidelines, framework conditions, and deployment programs, have, in contrast, enabled extensive public-private cooperation and allowed VICS to focus on overall traffic burden alleviation rather than individual gains.

Table 13: Traffic Volume and Traffic Speed in Tokyo

Traffic Volume and Traffic Speed in Tokyo

	Unit	Year							
		1983	1985	1988	1990	1994	1997	1999	2005
Traffic Volume	1,000,000 Car × km / 12Hours	39.6	39.9	41.5	42.9	44.1	45.2	46.7	45.1
Traffic Speed (23 Wards of Tokyo)	km／Hour	22.6	17.7	18.5	18.5	15.7	18.5	17.5	20.4

Source: Vogel n.y.

4.14.8 Transferability

The main success factor of the system can be seen as the establishment of technology-specific inter-ministerial bodies and industry associations and the set-up of binding and comprehensive guidelines. If not for this national overriding architecture, a nationally consistent system of high quality at low cost would not have been possible. A similar structure does not necessarily exist in other countries. On the European level, with ERTICO, there is a similar industry organization as for ITS ini Japan, however, national architecture is limited to some non-binding target definitions, guidelines and provisions e.g. in Germany. Of course, the establishment of such architecture is possible, an example of which can be seen in the national architecture which was established for the energy sector in Germany.

4.15 BIOSKIN FAÇADE

4.15.1 Origin and Objectives

Thinking and brainstorming on the BIOSKIN façade began with a building tender by the Sony Corporation for an environmental impact-mitigating, innovative, safe and pleasant to work in new R&D location[21] in Tokyo. NIKKEN SEKKEI Corporation offered a bid with a skyscraper design focusing on security/disaster aspects, energy reduction and heat island mitigation. The idea of applying a "bioskin exterior" arose intuitively, within only four hours of brainstorming by NIKKEN's design section.

Different facts finally led to the idea of combining exterior balconies with water-porous ceramic handrails for the façade, on the principle of a louvre, based on the following (Lenz 2013):

- An increased heat island effect has occurred in Tokyo during the past, due to replacement of traditional materials (e.g. wood) by artificial ones with a high thermal mass (e.g. concrete);
- The perception of missing exterior emergency exits for skyscrapers in Tokyo in case of disaster;
- The knowledge of traditional Japanese culture [22]

on how to cool down urban areas in summer via vaporization, using clay pots for water cooling or using traditional shading devices [23];

- The presence of large water retention basins or storage tanks in buildings with buffer functions, as Tokyo's urban water drainage system is not strongly equipped to deal with the high amount of rainwater during summer times.

As a result, a 25-story building with approximately 120,000 m² floor area was designed to cool down the surrounding air via water vaporization.Thus, the building reduces the air conditioning load and contributes to the reduction of CO_2 emissions as well as the heat island phenomena in the nearby building environment (NIKKEN SEKKEI LTD. 2011).

4.15.2 Organization / Structure / Measure

NIKKEN SEKKEI Corporation, as the contractor, developed the "BIOSKIN" system for the façade in cooperation with TOTO, a ceramic manufacturer for sanitary interiors. Initially, a 1m x 1m mock-up was designed. Equipped with both water-permeable handrails made of aluminium and ceramics, the differences in performance during vaporation were evaluated for both materials. Experimental evaluation on the northeast side of the building showed favourable results for combining an exterior pipe made from porous ceramics and an interior core made from aluminium for stabilization (39). Furthermore, a temperature decrease of 10°C on the handrail surface and a 3°C overall temperature decrease in the air surrounding the mock-up was observed (Lenz 2013).

Figure 100: Facade view of the Sony City Osaki building project and the BIOSKIN system (NIKKEN SEKKEI LTD. 2011).

With this knowledge, the simulations were expanded to the size of the actual building facade area to which the system would be applied (140m x 140m). Air flow simulations indicated that the building's surface temperature would decrease by about 10°C and that ground surface temperatures would decrease by about 2°C on a clear day. Monitoring with thermal cameras after building construction also helped to confirm the urban effects of heat island mitigation (Lenz 2013; NIKKEN SEKKEI LTD. 2011).

The system works with the following elements):

- Single modules of porous, water-permeable ceramic handrail pipes which may be operated in conjunction or individually,
- Several water tanks (rainwater, sterilized water, filtered water),
- Chlorine sterilization and
- An electrical pump operated by PV.

Rainwater is collected on the roof and then flows down through the pipes of the handrails. During flow and under influence of sunshine, the water evaporates through the ceramic pipes and reduces their surface temperature, the temperature of the adjacent air and thus the building cooling load. For hygienic reasons, the rainwater is pre-treated with chlorides to prevent bacterial growth. Water circulation is ensured via a small pump which is operated with solar-generated energy. The necessary amount of daily rainwater consumption for the circulation system is estimated at 10 m³.

The BIOSKIN system has been implemented on the entire east façade of the 25-story building. It is made of single modules offering the possibility of either partial or total operation from spring to autumn. During the winter, the system is not operated due to the decreased availability of rainwater and lower exterior temperature loads. Apart from its contribution to heat island mitigation, the BIOSKIN systems supports screening out of direct sunlight by functioning as a shading device and has the potential of filtering out nitrogen oxide emissions via silver irons that have been added to the ceramic handrail pipes. Based on the Japanese principle of "Mottanai"[24] , the system can therefore be used for multiple purposes (Lenz 2013, NIKKEN SEKKEI LTD. 2011).

21) Sony Corporation Sony City Osaki building project
22) Known as Japanese tradition „Uchimizu", which is the sprinkling of water in Japanese gardens and streets.
23) Known as „Sudare", preventing buildings from direct sunlight, rain and insects.
24) In English roughly: „What a waste!" or „Don't waste".

4.15.3 Financing / Business model

Apart from the innovative handrails and balconies, necessary equipment for operating the system is already present within the building design (e.g. rainwater storage tank, pumps etc.). Exact investment costs are difficult to calculate as the development and then final sizing has taken nearly two years (equalling the building construction time) and as the solution has been applied for the first time in this case. Cost reductions for the operation of the building may be estimated by taking into account the possibility for reducing indoor air temperatures from 28°C to 26°C (2° difference), thus requiring approximately 2% less energy for air-conditioning (electricity) (Lenz 2013).

4.15.4 Main actors / Supporting stakeholders

The most important actor during the planning and construction process was the NIKKEN SEKKEI Corporation, with their architectural and engineering services. Mr. Tomohiko Yamanashi, as chief architect, was responsible for the first concrete ideas for the "bioskin" exterior façade system and the overall building design. TOTO Corporation was entrusted with material development and involved in manufacturing the system right from the beginning of the project (Lenz 2013).

4.15.5 Obstacles and Challenges

The challenges encountered during the development of the BIOSKIN system were mainly related to technical implementation, as a result of the high requirements on the quality of both its performance and functionality. The idea was created quickly, but corresponding technical development and system sizing required the help of several engineers and experts from various disciplines. Material development and material combination, in particular, played a key role.

Another challenge arose from contracting by way of a new model called IDP (Integrated Design Policy). This policy offered the possibility of integrating specialized manufacturing companies as early on as the design phase, and thus preventing one-stop-solutions (from design to construction) by only one large contracting company. The state-of-the-art contracting policy is characterized by involving specialized manufactures quite late in construction tendering and not having them participate in the conceptual design of the project. There are pros and cons to each of these approaches. Bringing in specialized companies late into the process means a higher risk for them and therefore higher construction costs. In addition, knowledge of innovations may be shared less between all parties involved. On the other hand, one-stop-solutions have shown a high potential for manipulation within the past and are seen critically for advances in building innovation (Lenz 2013).

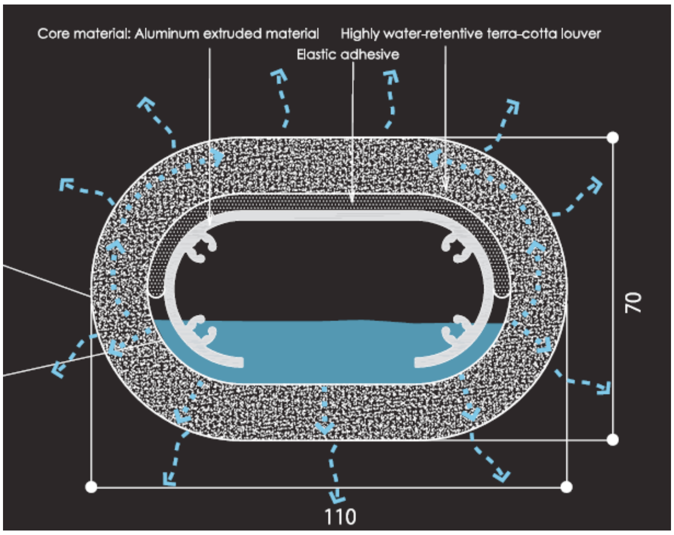


Figure 101: Handrail cross-section of the BIOSKIN system (NIKKEN SEKKEI LTD.).

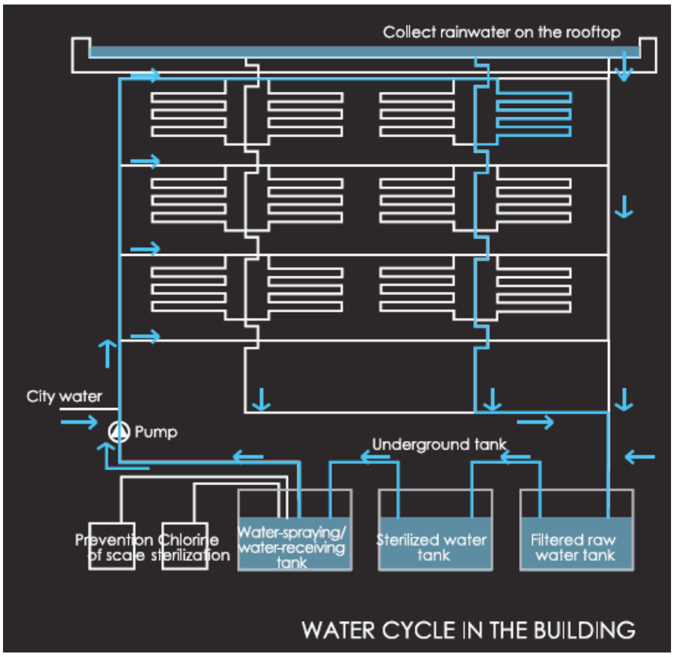


Figure 102: Schematic view of water cycle and BIOSKIN system elements (NIKKEN SEKKEI LTD.)

4.15.6 Impact Factors

As already mentioned, different factors were found to have influenced the development of the BIOSKIN system. They are listed as follows:

- Hot and sweltering weather conditions in Tokyo in conjunction with the increased heat island phenomena (Tokyo Metropolitan Research Institute for Environmental Protection 2009) and high availability of rainwater during summer times,

- High environmental and security requirements for building designs,
- Japanese cultural traditions to learn from, such as „Uchimizu", referring to the religious connotation of sparkling water,
- Partnership and cooperation with specialized manufacturers from the beginning of the design phase.

4.15.7 Achievements and Success Criteria

Achievements and successes of the BIOSKIN system were evaluated via a technical mock-up as well as thermal simulations and monitoring in the two years of building construction and development. In general, the effectiveness of the façade system has been evaluated based on the following values (Lenz 2013, NIKKEN SEKKEI LTD. 2011):

- Temperature decreases in the nearby building environment and thus reduction of the cooling load (up to 10°C in the nearby building environment, compared to when the BIOSKIN system is not activated),
- Reduction of electricity consumption for air-conditioning and thus reduction of CO_2 emissions (approximately 2% compared to when the BIOSKIN system is not activated),
- Amount of rainwater necessary for operating the system (approx. 10m³, or 10,000L per day),
- Estimation of the system's "town cooling efficiency" equal to 20,000 m² of green park (equivalent to the building site area)

4.15.8 Sustainability

As a result of its multiple functions, the BIOSKIN system contributes to sustainability in various ways. From an environmental point of view, the system contributes to urban heat island mitigation in the nearby urban environment and offers the possibility for natural ventilation, thus lowering electrical energy consumption for air-conditioning and corresponding CO_2 emissions related to building operation. In addition, the system functions as a sun shading device and emergency exit, facilitates the cleaning and replacement of windows, lowers building operation costs or, at the very least, contributes to a thermally comfortable indoor building environment (NIKKEN SEKKEI LTD. 2011). The Sony City Osaki building, equipped with the BIOSKIN system, was the winner of the "Completed Buildings - Production, Energy and Recycling" category at the World Architecture Festival in 2012 (TMG 2002).

4.15.9 Transferability

The idea of the BIOSKIN system has the potential to be transferred to other regions all over the world, assuming similar climatic conditions exist. The decision for or against the final application of the system will most probably require detailed simulation studies and monitoring.

In the future, NIKKEN plans to evaluate the large-scale application and effect of the BIOSKIN solution via thermal simulations on a district level.

4.16 TOKYO FIBERCITY 2050 (CONCEPTUAL URBAN PLANNING)

4.17.1 Origin and Objectives

Tokyo Fibercity 2050 is a prospective urban planning concept initiated and developed by Prof. Hidetoshi Ohno at the University of Tokyo. It focuses on aspects of city compaction, as a response to a shrinking population and an aging society. In the future, demographic changes in industrialized countries will lead to lower productivity and higher costs associated with caring for the elderly. In conjunction with environmental concerns and limited resources, it is necessary to stop unrestrained consumption and the unchecked sprawl of cities. The concept does not focus on offering solutions for city expansion, but rather for city development under shrinkage, as the future of Tokyo demands a new ideal in urban planning that limits growth.

At global level there are already a significant number of cities that have to deal with the challenges of shrinking:

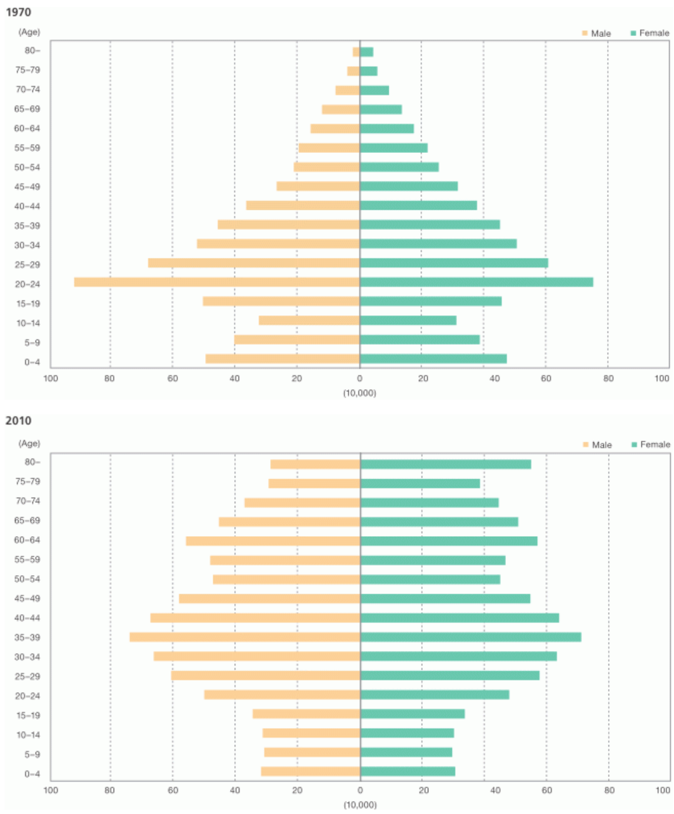


Figure 103: Change in population age structure by gender in Tokyo (1970 and 2010, Ministry of Internal Affairs and Communications; "Population Census" (TMG 2006-2010)

Tokyo is suffering from a strongly aged society and will need to deal with challenges of shrinking within the nearer future. Figure 104 shows the difference in the population of Tokyo 1975 and 2010.

Prof. Ohno therefore proposes to intervene in existing cities with linear elements and transform them to satisfy future needs instead of rebuilding and erecting new structures. The Fibercity concept emphasizes transformation instead of construction, mobility as a human right and the importance of high redundancy in transportation and building systems (Ohno 2012b, Ohno 2006, Ohno 2013, Ohno 2012c).

4.17.2 Organisation / Structure / Measures

To date, Fibercity remains a planning concept to be implemented in the future. It is a dynamic measure with the goal of sustainability, which is constantly evolving, that focusses on aspects of security, mobility and the promotion of civic involvement and social identification with the city.

For the Tokyo Metropolitan Area, four essential and overlapping individual measures (called "elements" or "project types") have been identified thus far (Ohno 2006):

1. The "Green Finger" is a re-organization strategy for areas affected by population decline that aims to concentrate housing in areas within walking distance to train stations.
2. The "Green Web" argues for the conversion of the Tokyo Metropolitan Expressway's Central Ring Road into roads for emergency disaster relief (esp. in case of earthquakes) and linear parks. Additionally, it suggests the construction of piping as an air control system above the expressway and the installation of an energy plant underneath the elevated structure.
3. The "Green Partition" aims to increase green areas and minimize potential fire damage in urban areas with a high density of wooden structures by dividing dense areas into small sections with green fire walls.
4. The "Urban Wrinkle" measure suggests the creation of distinctive linear spots of interest (called "meisho"), to be made accessible to all residents by improving worn-out landscapes and 'expired sights' to increase the residents' identification with their surroundings.

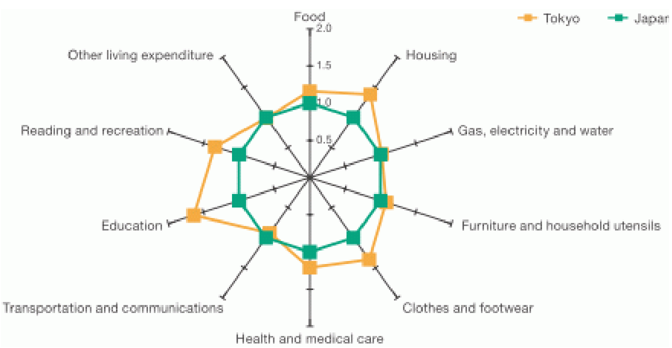


Figure 104: Consumption expenditure ratios for Tokyo compared to the nation (all house-holds for 2010; nation = 1.0), Statistics Division, TMG Bureau of General Affairs; "2010 Annual Report on Living Conditions of Tokyo Residents" (TMG 2006-2010)

New research has also been conducted on the use of restructuring small or mid-size cities, and the concept proposes a set of additional elements with which to manage depopulation and poorly designed public transport systems (Ohno 2012b):

1. "Orange Rounds", recommends supporting life in depopulated and weakening areas by providing public transport services to vacant buildings.
2. "Orange Tables", offer community dining facilities that are easily accessible by foot as well as affordable, in order to meet the needs of an aging and lonely society.
3. "Orange Web", is a plan to implement a public transportation system that allows residents to go to the places they desire by using only public transport and walking. It focuses on implementing slim buses operating electrically and an intelligent transport system.

4.17.3 Financing / Business models

Funding for the university laboratory was provided by public non-profit organizations such as the Tokyo University itself or the Japanese Housing Research Foundation, as well as private industry such as Lixil (former TOSTEM Foundation for Construction Materials Industry Promotion) (Ohno 2006).

Costs associated with the practical implementation of the Fibercity concept within Tokyo or any other city cannot be quantified nor estimated at this moment. They will depend on the extent to which the proposed elements of the concept will be implemented or will have to be adapted to the city context.

4.17.4 Main Actors / Supporting Stakeholders

For the current conceptual phase, Prof. Ohno (as initiator) is one of the most important actors – both for the design and its constant evolusion. Since the concept is based on Prof. Fumihiko Maki's (Tokyo University) concept of the "line segment" from 1988, Prof. Maki can also be seen as the first "mentor" with regard to the basic idea. Due to the nature of collaborative development and constant publication, the development of the concept was also supported by an urban design study in Hong Kong in 1990/1991, participation in the Rotterdam Biennale in 2003 and the foundation of the Tokyo Vision Research Group (mainly university research) as well as the German architect Philipp Oswalt (Ohno 2006).

For the successful future implementation of the concept, Prof. Ohno refers to two other actors: the participation of the residents, for whom the concept was developed and on whom its success largely depends, as well as the city district governments, which have an important role to play in the distribution of funding and which are able to issue and implement new planning concepts (Ohno 2013).

4.17.5 Obstacles and Challenges

The biggest issue in terms of sustainable urban planning in Tokyo is the short life span of the buildings, mainly due to historic and cultural reasons, of approximately 25 to 30 years (Tsukamoto 2012). Fire disasters and the Second World War led to constant rebuilding and the people of Tokyo became used to that. This principle is reflected in a specific valuation of new things, which are understood to bring happiness, development and growth, especially within private building construction (Ohno 2013).

Within the construction industry, the formation of very large construction companies, or industry sectors with a powerful lobby, inhibits changes and is seen as critical for the implementation of new urban planning concepts.

Political challenges for the Fibercity concept include outdated law-making with regard to new buildings as well as land ownership and taxation. Due to the fact that property is partitioned into many small pieces of land, it is difficult to convince land owners to sell their land (which is a prerequisite for the Fibercity concept, as it targets the transformation of large urban areas). Private land owners are always waiting for land prices to increase with the hope of being able to sell for the best price. As a result, expansion takes a lot of time and the government is reluctant to force people to give up their land. Therefore, a system of regulations on how to handle land ownership (trading, renting, and shareholding) would be crucial, especially for the success of the "Green Partition" program. The Fibercity concept aims to enable people to live in close proximity to the public transportation system. However, land prices and living expenses near railway stations are very high in comparison to other areas. The cooperation of the tax system and/or financial assistance by banks and the government are therefore needed to create equal opportunities for everyone.

Lastly, there is a discrepancy between necessary future urban development planning and current architecture, as the two are very separate from one another other. Individual building designs do not take into account the cityscape or urban planning concepts, which makes it difficult to create homogeneous districts (Ohno 2013).

4.17.6 Impact Factors

On a socio-cultural level, the shrinking population and the aging society require special mention. In 2006, 22% of the population was over 65 years old; projections to 2050 show an increase of this population group up to 40%. These elderly people will have small incomes and may not be able to own and/or drive a car due to financial difficulties and health problems. As a result, public transport will become increasingly important when attempting to meet the needs of this lonely and aging society. Politically, the introduction of a heavy inheritance tax after World War II had a major effect, which is felt even today. It has resulted in the fragmentation of urban areas by the selling out of individual parcels of land, as tax loads became too expensive for the individual. Therefore, Tokyo's urban area is characterized by a very large number of private small land owners and the creation of tiny crowded spaces as well as small living areas. From an environmental point of view, the high level of consumption in Tokyo, despite limited resources, and the uncontrolled sprawl of the city has had an influence on the design for the Fibercity concept. In terms of geographic position, Japan is located in a natural disaster area, which affects the cultural perception of security and is also taken into account within this urban planning concept (Ohno 2013, Ohno 2012a).

4.17.7 Achievements and Success Criteria

The Fibercity concept has not been put into practice thus far. As an initial piece of evidence for its potential environmental success, a theoretical study of different urban development concepts for city compaction was carried out by Prof. Ohno's Laboratories (University of Tokyo) on the basis of environmental and cost data. The success criteria identified include the reduction of CO_2 emissions and the respective timespan to reach a minimum CO_2 level, the total costs for reorganization of the city system and average building density (defined via the story height of the buildings). The study examined three different scenarios for the mid-sized Japanese city of Nagaoka until 2050, by taking into account the decrease in population/settlement, urban activities for reorganization and renewal as well as operation of the city system (especially building supply and transportation). The reorganization period describes the timespan in which the transformation of the city system takes place and is set for 40 years. The operation period describes the timespan after reorganization, taking into account that the city system maintains its state for a certain period. The three scenarios analyzed included a so called market place scenario (which represents a type of city development without any restrictions), a monocentric scenario (compact development) and a polycentric scenario (based on the Fibercity concept with multiple districts). The results show advantages for both the monocentric and the polycentric scenario for city development compared to the market place scenario. Reductions of CO_2 emissions in the operation period were only 33% (monocentric) and 25% (polycentric) compared to the emissions for operation within the market place scenario. The minimum level of CO_2 emissions was achieved after 37 years (monocentric) and 13.7 years (polycentric) after reorganization in relation to the market place scenario. Respective average building heights associated with the different reorganization processes was typically 8 stories for the monocentric and 6 stories for the polycentric scenario (Ohno 2012a).

4.17.8 Sustainability

The Fibercity concept offers linkages to different aspects of sustainability. From the perspective of mobility, it aims to secure mobility for all. As Tokyo already has an effective and well-functioning public transportation system (dense, punctual and safe subway network), its maintenance is important for the future, especially that of the railway system. The concept is consistent with this requirement as it is based on former historic city development, existing infrastructures and a minimum of deconstruction and investment. This will enable the formation of socially and physically cohesive living areas that simultaneously allow enjoyment of the city as well as the development or implementation of new (user-friendly) and existing technologies requiring only a small amount of investment or energy. Furthermore, the Fibercity concept intends to provide not only social services, but opportunities for the elderly, so that they are able to live independently and improve their quality of life. Provisions for infrastructure (mainly health care, shopping and transportation) will be of importance in less densely populated areas. Connecting existing energy plants within a network (a technical solution for the theoretical urban design concept) and enhancing the use of public transportation offers possibilities to reduce CO_2 emissions and support environmental sustainability. The prevention of the spread fire and the establishment of safe routes to evacuation areas though the "Green Partition" elements are crucial to increase the residents sense of security and create a safe living environment. Improvements to this environment will also result in an increase in its economic value (Ohno 6/3/2013, Ohno 2012a).

4.17.9 Transferability

In general, the Fibercity concept is transferable to other existing cities, as it describes as a vision for transformation in an age of population shrinkage. It may, however, not be used for new city developments as a tabula rasa. Starting with the Tokyo Metropolitan area, the elements of the Fibercity concept have continuously and will continue to be further developed to apply to small and mid-sized city systems (Ohno 2012a).

4.17 CASBEE SUSTAINABILITY CERTIFICATION

4.17.1 Origin and Objectives

During the 1990s, against the backdrop of discussions about climate change and energy consumption, there has been a growing movement towards sustainable construction. This has led to the development of various national methods for evaluating the environmental performance of buildings such as BREEAM (1990), LEED (1998) and GBTool (1998). In 2001, a project consortium, consisting of industrial, governmental and academic partners, initiated the development of a similar tool for buildings in Japan. Supported by the Housing Bureau, a branch of the MLIT, the Japan Sustainable Building Consortium (JSBC) was established in 2001 – the starting point of CASBEE, the Comprehensive Assessment System for Building Environmental Efficiency. In parallel, the first draft of Tokyo's Green Building Program was introduced by the TMG, requiring the submission of specific green building plans indicating specific measures taken to reduce environmental loads for buildings to be constructed in Tokyo. In contrast to the TMG's Green Building Program, sustainability assessments with CASBEE express Building Environment Efficiency (BEE) as a quotient of the environmental quality (Q) and the environmental load (L). Today, advancements on CASBEE are driven by CO_2 emission reduction initiatives, discussion on low carbon societies and the effectiveness of city-led policies, the use of environmental friendly construction materials and technologies, energy efficiency improvements and zero-energy housing and districts (JSBC 2011; IBEC 2011a).

4.17.2 Organization / Structure / Measures

Since their introduction in 2001, the CASBEE specifications continuously become more demanding and several versions of the CASBEE tool have now been developed. The tool is now able to do more than simply evaluate or rate

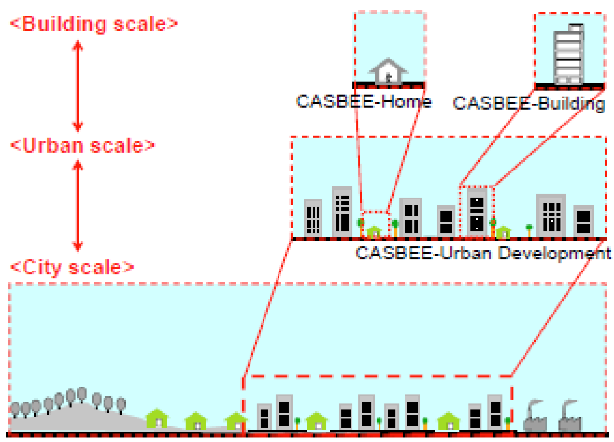


Figure 105: Hypothetical boundaries of CASBEE on the building, urban and city scales (Iwamura 2012)

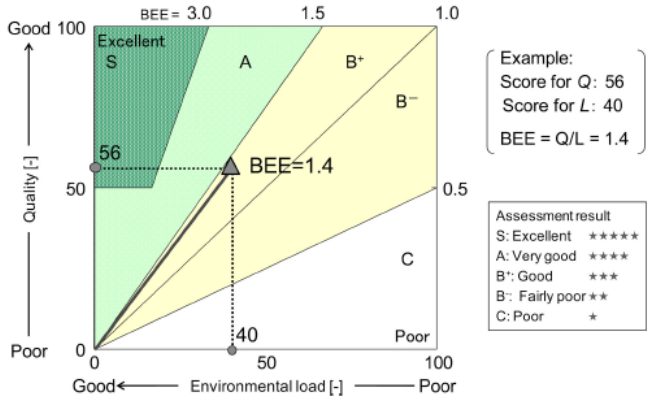


Figure 106: BEE chart and example of assessment result presentation (Kawakubo et al. 2011)

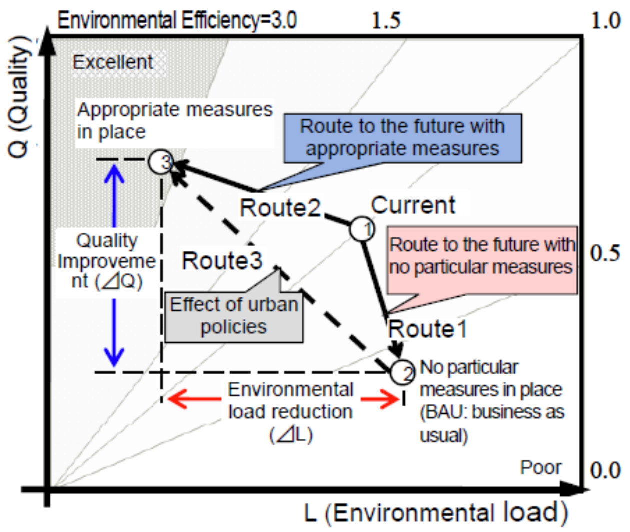


Figure 107: Visualization of current and future assessment results as well as effectiveness of urban policies (JSBC 2012)

the environmental performance of buildings (building scale). The specifications are also used for the assessment of urban districts (urban scale) or the effects of municipal policies (city scale) with regard to sustainable city development. The different versions of the CASBEE family are constantly being improved through communication with industrial, governmental or academic initiatives to ensure broad acceptance and practicability.

The basis for assessment with CASBEE is a triple-bottom-line approach, taking into account environmental, economic and social aspects. The Building Environment Efficiency (BEE) for buildings or the Built-Environment Efficiency (BEE) for urban areas / cities is calculated as the quotient of the environmental quality (Q) and environmental loads (L). For the determination of Q and L, a hypothetical boundary is set for the respective assessment item. The BEE value is finally used to create a sustainability ranking ranging from a "poor" (C) grade to an "excellent" (S) grade.

The following items (Table 14), related to the environmental quality (Q) and environmental loads (L) are assessed by using both qualitative and quantitative indicators.

CASBEE Cities is available in both a standard and professional edition. The standard edition is based on public statistical information, coupled with a respective database, as well as a simplified assessment framework to ease effort and provide for a user-friendly tool with graphic information system (GIS) layer. This has been validated through a comparison of 12 case study results from both standard and professional versions to ensure reasonable results. The professional version allows for a more comprehensive assessment to gain deeper understanding for the effects of city policies and city conditions. The main feature of CASBEE cities is the assessment of both a current and future status for city development based on selected policy measures, thereby indicating the effectiveness of the urban policies included (JSBC 2012; Kawakubo et al. 2012).

4.17.3 Financing / Business model

Information on financing or yearly budgets spent for the development or future maintenance of the CASBEE assessment system is not available as there are many diverse project partners (academic, industry, governance) who work on a partially voluntary basis. The assessment itself may be conducted as a voluntary self-assessment or within an official certification process. All manuals and tools are made publicly available and are free of charge. Since 2005, however, an Accredited Professional (AP) with specific expertise is required for the qualitative items of the system as well as for official certification. Costs for AP training courses and exams add up to approximately 50,000 Yen (400 Euro). As of December 2011, there were over 1.000 CASBEE-APs, equaling educational costs of 50,000,000 Yen (400,000 Euro) spent from 2005 to 2011 ((Ebert et al. 2010), Institute for Building Environment and Energy Conservation (IBEC) 2011a).

As for Tokyo's Green Building Program, sustainability assessments with CASBEE for buildings is expected to drive demand and investment towards green construction and thus a green economy. Thereby, the system also addresses economic market mechanisms, such as ((Institute for Building Environment and Energy Conservation (IBEC) 2011b), Institute for Building Environment and Energy Conservation (IBEC) 2009):

- Linking CASBEE with real estate property valuation via CASBEE for Property Appraisal or its latter version, CASBEE for Market Promotion.
- Increase in property value (higher trading prices) through an increase in net property income or reduction in capitalization rates through buildings with Design for Environment (DfE) or environmental value addition.

Table 14: Overview of CASBEE items sorted by scale of assessment

Scale	Buildings	Urban Development*/ District	Cities
Quality related aspects (Q)	**Indoor:** - sound - thermal comfort - lighting - air quality **Quality of services:** - service ability - durability & reliability - flexibility & adaptability **Outdoor environment:** - biotopes - townscape & landscape - local characteristics & outdoor amenities	**Natural Environment (microclimate & ecosystem):** - in pedestrian space in summer - terrain related - water environment - habit related **Service functions (performance):** - supply & treatment systems (water, energy) - information system - transportation system - disaster & crime prevention - convenience of daily life - universal design **Contribution to the local community (history, culture, scenery, revitalization):** - use of local resources - development of social infrastructure	**Environmental:** - nature conservation - quality of local environment - resources recycling - CO_2 absorption **Social:** - living environment - social services - social vitality **Economic:** - industrial vitality - financial viability - emission trading
Environmental load related aspects (L)	**Energy:** - building thermal load - natural energy utilization - efficiency in building service system - efficient operation **Resources & materials:** - water - use of non-renewable resources - use of materials with pollutant content **Off-site Environment:** - global warming - local environment - surrounding environment	**Impact on microclimate, façade, landscape:** - thermal impact in summer - mitigation of impact on geological features - air pollution - noise vibration and odor affects - wind hazard and sunlight obstruction - light pollution **Social infrastructure:** - water supply - rainwater discharged load - treatment load from sewage & grey water - waste treatment load - traffic load - effective energy use **Management of the local environment:** - global warming - environmentally responsible construction management - regional transportation planning - monitoring & management system	**CO_2 emissions from energy sources:** - industrial - residential - commercial - transportation **CO_2 emissions from non-energy sources:** - waste disposal & others

Source: TEPCO 2013 / * Excluding the building scale and focusing only on the area surrounding building construction.

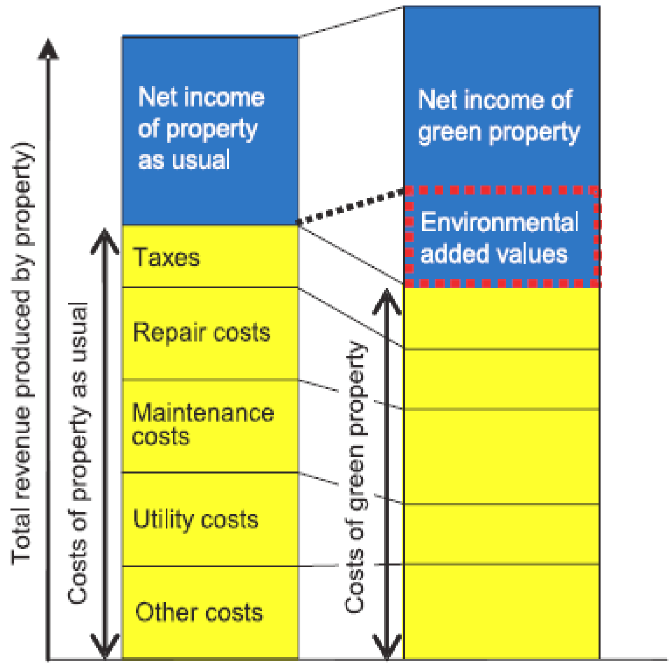


Figure 5: Environmental added values related to increased net income

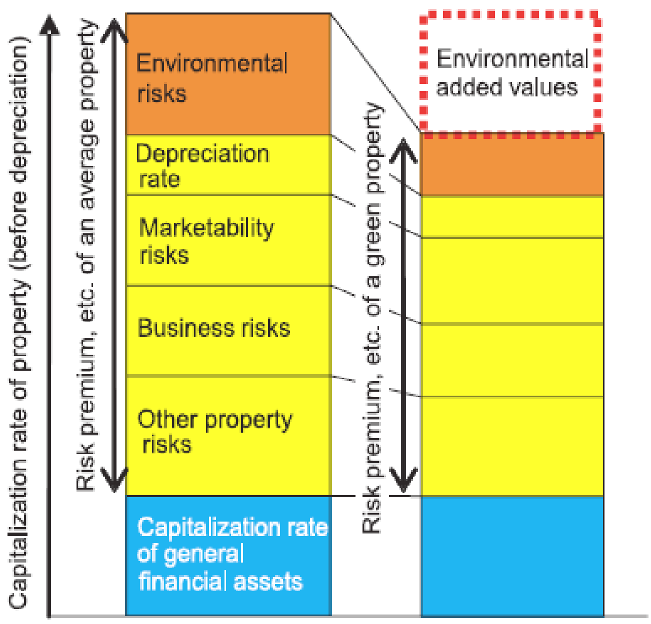


Figure 6: Environmental added values related to reduced risk premium

Figure 108: Environmental added value of green property related to increased net income (left side) and environmental added value related to reduced capitalization rate (right side) (IBEC 2009)

The possibility for nationwide city ratings with CASBEE cities is indirectly linked to economic aspects by supporting:

- The identification of effective municipal (policy) measures to be implemented, thus effecting decision-making on respective budgets spent.
- The revitalization of municipalities and an improvement of international competitiveness, thus attracting new businesses and citizens.

4.17.4 Main Actors / Supporting Stakeholders

Governmental and municipal actors involved in this project are listed as follows:

- The MLIT; initiator;
- Promotion Council for Low Carbon Cities;
- Eco-Model Cities Initiative (ECM);
- Various cities (e.g. from the ECM); provide case studies and data for tool evaluation as well as testing of practical applicability.

Non-governmental actors include:

- JSBC;
- Japan Green Building Council (JaGBC);
- IBEC; responsible for education of CASBEE professionals and market promotion.

Academic actors:

- Various universities such as Keio University and Tokyo City University; providing the scientific basis for the project.

Industrial actors:

- Various construction companies such as Shimizu Corporation, Taisei Corporation, Takenaka Corporation, Nikken Sekkei, Kajiima Corporation, ensuring applicability of the system.

4.17.5 Obstacles and Challenges

Sustainability assessments and rating tools should provide reasonable results that are simple, inexpensive and highly compatible with another. The CASBEE assessment system is faced with these challenges as well, as it provides both brief and complete assessment methodologies.

In the specific case of CASBEE for buildings, it became obvious that the tool was not yet being widely used for promoting green properties to the real estate market. Therefore, CASBEE for Property Appraisal was released in 2010, coupling real estate property pricing with CASBEE assessment items. As it was lacking in ease of use and contained too many items to be considered, CASBEE for Market Promotion as created as a follow-up version. This version was additionally challenged with including the United Nations Environment Programme (UNEP) SBCI and UNEP FI PWG (Japan Smart City Portal 2014b) common world metrics for building sustainability (e.g. energy use, greenhouse gas emissions, water use, waste, indoor environment, biodiversity, economics) as well as ensuring evaluation compatibility with existing certification systems such as LEED (Tokyo Metropolitan Government Bureau of Urban Development 2011).

The future challenges for CASBEE cities will include data availability (especially for small-scale cities) and the selection of appropriate assessment items (e.g. only greenhouse gas emissions are currently considered). Improving ease of use and user-friendliness as well as introducing measurable indicators for environmental and economic aspects as well as verification of CASBEE assessment results based on citizens surveys with regard to their perception of liveability and urban comfort are also of importance (Greve 2013; Tsutsumi et al. 2011).

4.17.6 Impact Factors

Factors with an impact on the development of CASBEE are listed below (Sorensen et al. 2010; Waley 2013):

1. Discussions on energy and the environment as well as policy and decision making:

- The oil crisis in the 1970s;
- Japan Energy Conservation Law in the 1970s;
- Agenda 21 on Sustainable Development, created at the Earth Summit in Rio in 1992;
- Kyoto Protocol in 1997;
- Mandatory Energy Conservation Measures in Japan in 2003;
- Japan's commitment to reduce greenhouse gas emissions by 25% by the year 2020 and 80% by the year 2050, based on 1990 levels;
- The Japanese Basic Law for Prevention of Global Warming.

2. The modern Green Building (GB) movement: Starting in the 1980s with the development of GB-Tool, LEED and BREEAM.

4.17.7 Achievements and Success Criteria

The success of the CASBEE assessment system may be evaluated based on the following information (Hilty et al. 2013):

- Number of certified buildings (193 as of December 2011);
- Number of Accredited Professionals (1,000 as of December 2011);
- Number of different CASBEE versions and diversity of application (approximately nine basic and nine subversions for buildings, urban districts, heat island effects, cities and property appraisals);
- Number of Japanese local governments who have adopted CASBEE for building construction permit (24 as of December 2011);
- Number of building assessments with CASBEE reported to these local governments (approximately 6,650 from 2004 to 2010).

The system is widely used for self-assessment throughout Japan's construction industry (e.g. construction companies, design offices, real estate developers) and by local governments for the selection of future innovative urban projects to be subsidized or cities to be supported in pursuing balanced development.

4.17.8 Sustainability

With its variety of application options, CASBEE may be used for single buildings, entire urban districts or city certification. Based on life-cycle thinking and the three pillars of sustainability, various environmental, economic and social aspects are considered. The assessment system is seen as a Design for Environment (DfE) tool, assisting planers, investors and policy makers with sustainable urban construction design. Interfacable with Building Information Modelling (BIM) systems such as Autodesk Revit, CASBEE assessment results may be easily included within early design stages (Yoshioka et al. 2010).

With regard to the real estate market, CASBEE supports the economic valuation of green property. Furthermore, assessment with CASBEE is expected to have a direct impact on the development of innovative carbon reduction technologies resulting in energetic and non-energetic benefits for transforming not only buildings or cities, but entire societies, into low-carbon entities.

4.17.9 Transferability

Nowadays, certification systems for sustainability are already in wide use, and both available to and strongly adopted within the international construction industry. These systems are expanding, based on the possibility of and necessity for nationwide transferability. Transferring the Japanese assessment methodologies to other regions should therefore be feasible when national and regional specifics (e.g. mandatory regulations with regard to energy-efficiency, climate and culture etc.) have been appropriately considered.

5

5 RECOMMENDATIONS

5.1 CITY LEVEL AND ACTORS / ACTORS WITHIN THE CITY

The two-week m:ci research stay in Tokyo, including many interviews, provided an in-depth understanding of the practice examples being studied and allowed for important insights to be gained about associated processes, interactions, and actor structures. In this way, a good understanding of Tokyo's success in sustainability projects was gained. Nevertheless, this research does not make the claim of having completely or exhaustively analysed the practice examples or to have wholly captured the city's dynamics and its many interactions, as this is not possible taking into consideration the complexity of the processes and the time frame available for this research.

In total Fraunhofer experts conducted interviews with 120 representatives of institutions and stakeholders that impact upon the sustainable development of Tokyo. The interviewees ranged from project initiators, decision-makers, interest groups, project managers, planners and implementing businesses, to the users of and those affected by the projects. A list of the important actors in Tokyo's sustainability projects, who were interviewed during the research stay, can be found – categorized by sector – in the annex.

This list of stakeholders shows the large quantity of different actors that are involved in the sustainable development of Tokyo. It is – indeed – not possible to define, which actors are the most important ones. In terms of centrality, however, it must be stated that certainly the Tokyo Metropolitan Government with over 165.000 employees and an annual turnover of 580 Billion € is the most prominent actor steering the urban development system of Tokyo.

5.2 PROJECTS AND PROCESSES

Japanese local government enjoys specific legal status in Japans legal framework, specifically through the »Local Autonomy Law« from 1946. Local government is tasked with responsibilities that in other countries could be the task of the central government, e.g. for social insurance and healthcare. While local government has a role to play in strategic planning, development control is from minor importance.

On the other hand, some public services exists which are not influenced by local governments yet. For example, the electricity sector is organized in Japan as an oligopoly of 10 electricity companies. In the Tokyo region Tokyo Electric Power Company TEPCO is the energy monopolist.

Political Realm Administration (33 interview partners)

- TMG - Headquarters of the Governor of Tokyo
- TMG - Administrative Reform Section
- TMG - Bureau of Sewerage
- TMG - Bureau of Social Welfare and Public Health
- TMG - Planning Section, Automotive Pollution Control Division
- TMG - Urban Sustainability Planning Section
- TMG - Bureau of General Affairs
- TMG - Electric Power Reform Promotion Section
- TMG - Bureau of Environment
- TMG - Bureau of Environment, Cap and Trade Section
- TMG - Bureau of Environment, Environmental Policy Planning Section
- TMG - Bureau of Environment, International Cooperation Section
- TMG - Bureau of Environment, Urban and Global Environment Division
- TMG - Bureau of Environment, Urban Sustainability Planning
- Tokyo Metropolitan Assembly
- Local Ward Administration – Ota Ku
- National Ministry of Land, Infrastructure, Transport and Tourism

Private Industry & Business (51 interview partners)

- Accenture Japan
- BMW Group (Japan)
- Chademo Conference
- Charging Network Development Organization, LLC
- City of Yokohama, Climate Change Policy Headquarters
- Energy Advance Co., Ltd.
- JX Nippon Oil and Energy Corp
- Nikken Sekkei Ltd
- NTT BROADBAND PLATTFORM
- NTT DOCOMO
- Otto Japan Inc.
- RTS Corporation
- Schenker-Seino Co., Ltd
- Shimizu Corporation, Business Development, International Division
- Shimizu Corporation, Project Design Department, Design Division
- Taisei Corporation
- Tokyo International Air Cargo Terminal Ltd.
- Tokyo Metro
- Tokyu Corp.
- Toshiba, Smart Community Division
- Toshiba, System Control Technology Group
- Toyota
- Vehicle Information and Communication Centre
- Yamato Transport Co., LTD.
- Yokohama Smart City Project - Model house

Research / NGO / Political Advisors (36 interview partners)

- Association for Creating Sustainability in Urban Development of the Otemachi Marunouchi Yurakucho district
- Centre for Low Carbon Society Strategy, Japan Science and Technology Agency (JST)
- Centre for Research and Development Strategy (JST)
- Foundation for Transport Studies and Publications
- Hosei University, Department of Architecture
- Institute for Building Environment and Energy Conservation
- Institute for Global Environmental Strategies
- Institute for Transport Policy Studies
- Institute for Transportation Statistics
- Japan Institute of Logistics Systems
- Japan Renewable Energy Foundation
- Keio University, Department of System Design Engineering
- Kogakuin University
- National Institute of Advanced Industrial Science and Technology (AIST)
- Research Centre for Advanced Science and Technology
- Ristumeikan University Kyoto
- Sophia University
- The University of Tokyo
- Tokyo Metropolitan University, Department of Architecture and Building Engineering
- Tokyo University
- Tokyu Living & Lifestyle Research Institute Inc.
- Waseda University, Institute of e-Government

In contradiction to the energy sector, competition is part of the public transport sector, though two governments owned companies, Tokyo Metro and Toei Subway operating the subway within Tokyo city, but 10 private companies operating subways and railways in the greater Tokyo area with metro lines, which are directly connected to the subway lines. Astonishingly, often the private metro companies are initiating new metro lines in the greater Tokyo area to enlarge their railroad grid. Since they are interested to attract traffic on these lines, these companies developing housing districts along these new lines as well. The plans must be adopted by the city government; however the private sector plays a much stronger role in initiation, planning and implementation of such projects than in other countries. This special public-private relationship where the private sector plays an important role in developing social development is based on a culture, where the companies feel a social responsibility.

However, the local government is able to change the type of cooperation with the private sector if it does not fulfill the expectations. For example, after the nuclear disaster in Fukushima, a lot of people were disappointed how TEPCO managed the nuclear accident. As a consequence, TMG is today supporting the liberalization of the electricity market. TMG is building up a know-how and capacity in energy market and as a first step invited utilities from other regions to bid on the supply of electricity for larger governmental buildings.

Due to the size of the city of Tokyo and its administration, the different types of projects and the specific cultural way to develop and implement projects in a cooperative way, it was not able to identify typical pattern of initiation, goal setting, designing, planning, implementation and evaluation of projects in Tokyo. However, following characteristic aspects could be identified as examples.

1. Aspects, which stimulates sustainability projects in Toyko:

- Social trends like the aging society are important drivers for Japanese local governments to initiate projects, since social aspects are from high importance in the Japanese society and local governments are responsible for social services
- Private companies are initiating projects, e.g. new housing districts and metro lines, since they feel a social responsibility as well
- International leadership in sustainability is a motivation for large Japanese cities like Tokyo to start projects
- Citizens are rather active on the level of the neighbourhoods and wards in formulating their proposals

2. Aspects, which influences the design and planning process of projects:

- Since the Japanese culture is consensus-oriented and the private sector is usually a key player in sustainability projects, the projects are usually designed in an iterative and dialogue oriented approach together with the private sector.
- The local government can stimulate the private sector to contribute to the sustainability targets by offering win-win situations (e.g. private actors can benefit from an easement of regulation like increased building high if the build recreation parks or exceeding emissions regulations)
- The local government set goals and expects voluntary commitments of the private sector to achieve these goals. However, if the goals are not achieved by the voluntary commitments, as a next step requirements can be established. This means that such projects are developed step by step, e.g. the Tokyo Cap and Trade system was voluntary between 2002 and 2008 and is mandatory since 2008.

5.3 KEY DRIVERS AND FRAME CONDITIONS

The success and also the shortcomings of the sustainable development of Tokyo heavily depend on external framework conditions that impact on the city, but also on a broad range of factors that are important at project level.

At framework level, a set of passive drivers and external events have been identified that have a large influence on the sustainable development of Tokyo and on the way Tokyo is adressing it. These are as listed:

- The population size and the density of the city.
- The Galapagos Effect (Japan as rather remote island that loses connection).
- Olympia 2020: the city now heavily invests into urban refurbishment and new district design.
- The dwindling business with fossil resources – new energy sources and services gradually become attractive.
- The demography of Tokyo: The city is aging and population growth has stagnated.
- Fukushima as huge disaster has triggered a large amount of investments into resilience and infrastructure.
- The Economy Bubble in the 90s and the economic crisis in 2008 has hit Tokyo severly and politics and strategies are heavily dominated by these experiences.
- The general economic structure. Tokyo has a strong building sector and a strong tertiary sector, but rather little heavy industry.

Taken together, these factors impact strongly on strategies of the TMG and on investments that are being done by private business. They are characterized by a low influenceability (the city cannot manage them, it has to react to them) and in sum they are responsible for a shift in Tokyo's sustainability strategy towards a higher valuation of resilience, attracting foreign companies and investing in demography and society.

5.4 IMPACT FACTORS

Apart from the factors that cannot be steered or managed, there are several impact factors that help Tokyo deal with sustainability and that can be rated as success factors for its sustainable development.

Following the methodological framework the Tokyo team collected a large amount of factors, structures and specific processes in the development of Tokyo in a large mind map that served as background for the development and rating of the most important local impact factors. Figure 109 shows an extract of the Tokyo mind map:

In total 30 larger impact factors that function as catalysts (or some also as barriers) to the sustainable development of Tokyo. They can be roughly sorted into the five categories regulations, civil society & culture, project structure, external factors and financing. When rating the impact of the single factors on the Tokyo best practises, interestingly regulations and project structure were the most important categories, followed by external factors, civil society and culture and financing.

The most important impact factors are listed in the tables below:

Impact Factors - regulations

- Well-functioning link between national legislation and local demand (buildings)
- Prioritization of new construction before existing building stock in political legislation for city infrastructures.
- Floor Area Ratio Policy (allows trading of high units and makes building more profitable)
- Tightened sustainability requirements for new buildings. Existence and application of certification systems.
- Specific restrictions on building processes regarding noise, etc.
- Very fragmented distribution of private lands (results in lacking connected areas for conversion) through high taxation of real estate.
- Provision of recommendations for action – oriented towards concrete measures for improving the building performance
- Mandatory Reporting / complete data as basis for action

Impact Factors - Project structure

- Strong and successful collaboration between private business, public bodies and research
- Japan AG -> High degree of interlinkage between governmental bodies and large companies
- Economic influence of building industry (This factors functions as driver and as barrier likewise).
- Bureau of Environment as strategic unit for the sustainable urban development of Tokyo (functions as cross-cutting unit).
- Competition between public transport companies
- Sectorial specific exhibitions (biennial arts festival) and public discussions
- Low linkage of measures & aims with indicators and control systems (acts as barrier)

Impact Factors – Financing

- Public or private subsidies and funding for research activities - Job tickets for using public transport - Public funding of sustainability-related infrastructure (TMG finances charging infrastructure for electric vehicles) - High cost pressure on buildings

Impact factors – External factors

- High exposure of city to natural catastrophes (earthquakes, storms, …) and high strive for security of the city - High density of population - Demographic change (aging & shrinking society) - Japan ICT faces „Galapagosization" - Fukushima (triple catastrophe of earthquake, tsunami & nuclear meltdown) - Lehman Shock, commercial crisis

Impact factors – Civil society and culture

- Common good as individual value (collective conscience) - „Meiwaku" (don't cause trouble) - Machizukuri (city development through bottom up participation) - High degree of trust in the government (political leaders = moral leaders) -> high expectations for political guidance - Tokushita (obtaining a gain / advantage)

When rating the impact of the identified factors on the best practices under analysis we obtain a diverse picture that shows the relative meaning of all factors analysed. Figure 109 shows the distribution and relative significance of the analysed factors.

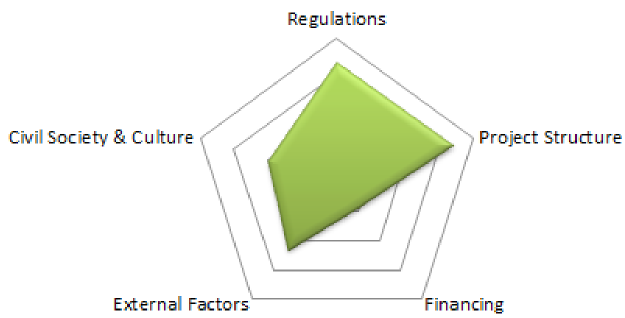


Figure 110: Significance of impact factor categories for a successful sustainable development of Tokyo (own illustration)

5.5 FIELDS OF SUSTAINABILITY / KEY ACTION FIELDS

The concept of sustainability can be applied for almost all fields of a society. In the following, some key action fields identified based on the evaluation of the practice examples are described.

1. Urban Planning and Infrastructure

- Planning and development of new metro lines and new housing districts should follow the aims of minimizing land use and traffic (city of short routes) and ease the replacement of individual car traffic by walking, bicycling, and public transport
- Planning of the urban road system should aim to distribute the traffic and reduce the impact of the traffic to the citizens (toxic emissions, noise,…)
- To enable the introduction of electric vehicles, the city of Tokyo could provide the charging infrastructure

2. Urban Governance

- Sustainable development means also the increased participation of the citizens on governmental decisions. This requires a high transparency of relevant data in the city based on monitoring of these data
- To stimulate the transition process and successfully implement the existing plans, it is important to set clear goals, monitoring the development and adjust the goals if necessary. In addition, a broad range of adapted instruments must be used like awareness campaigns, incentive programs and regulations to stimulate progress on sustainability.
- Since sustainability is part of most of the activities of governments, a cross-sectional department for sustainability in the administration, which consults and supports all other administrative units by implementing sustainability projects.

3. Building processes

- Today, a typical building in Tokyo has lifetime of only 25-30 years. In order to allow higher investments in thermal insulation and earthquake resistance as well as reducing the demand on embodied energy, measures and regulations should be established with the aim to increase the lifetime of buildings in Tokyo.
- In order to reduce the costs and the construction time (inclusive the related burden), the technique of prefabricated construction could be further developed and supported.

4. Business development & processes

- Private companies with a high level of diversification play an important role by planning and developing urban infrastructure (inclusive development

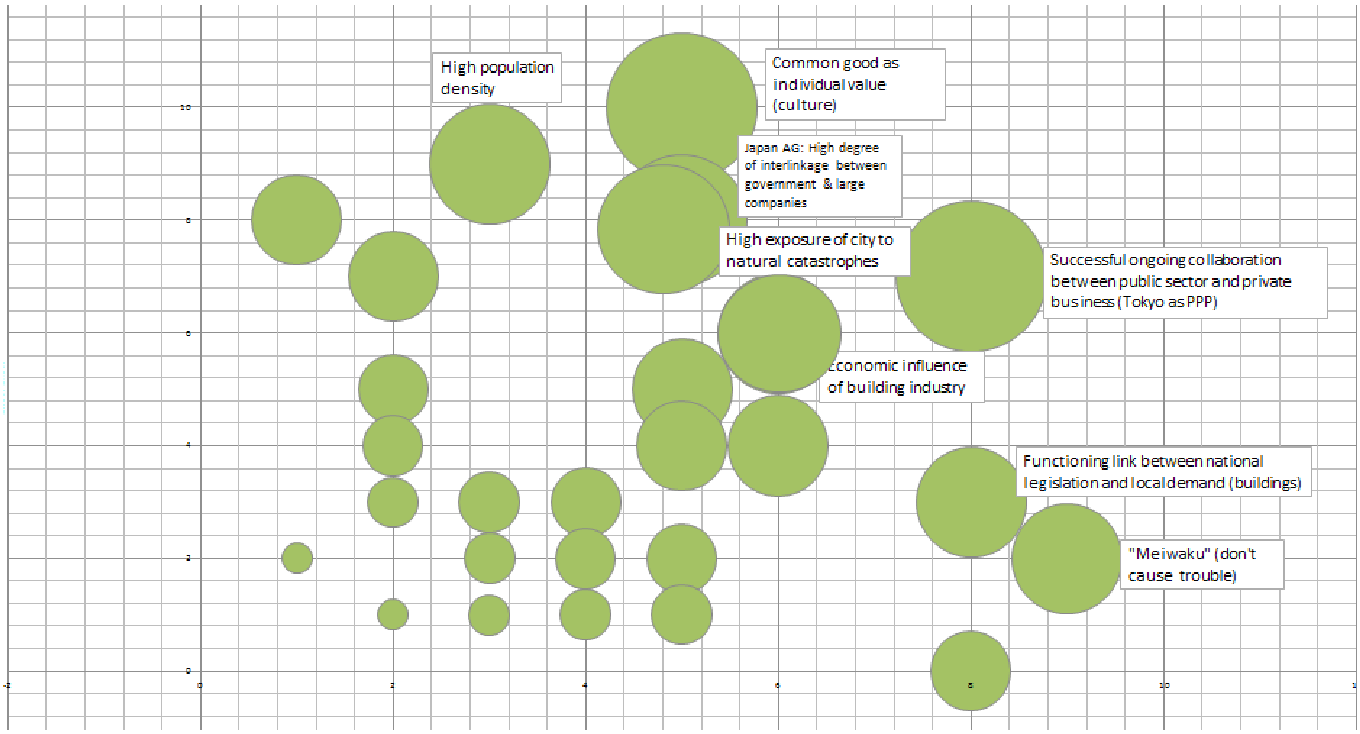


Figure 110: Tokyo impact factors (own illustration)

Enabler / Technologies

1. Urban production systems
2. Factory apartments
3. Big Data Analysis
4. High-end Mobile communication technologies
5. Local Smart Grids
6. Electronic Ticketing
7. Certification Systems
8. Data driven traffic management systems

Economic development and regional economic policy

1. Attraction of foreign companies
2. Social Services for families
3. Reduction of barriers for external HR and investors
4. Increasing attractivity of city for foreigners
5. Support of small and specialized SME

Business development & processes

1. High diversification of companies
2. Urban planning & planning and implementation of infrastructure by private companies

Urban Planning / Infrastructure

1. Transport oriented development
2. Reduction of traffic by urban planning
3. Participation of civil society in urban planning processes
4. Free provision of infrastructure for e-Mobility
5. Optimization of road network and transport

Urban Governance

1. Regulations for shifting traffic towards public transport
2. Mandatory data reporting & transparency
3. Incentives (subsidies for sustainable technologies)
4. Environmental regulations (absolute caps & thresholds)
5. Creation of Markets, market mechanisms & market rules
6. Induction of awareness and acceptancy for sustainability
7. Scientific council towards politics
8. Creation of administrative structures for sustainability

Building processes

1. Cost reduction through prefabrication
2. Minimizing impact by regulations

Figure 111: Fields of sustainability (own illustration)

of new districts and metro lines). In order to assure, that the development is oriented on sustainability goals, a close cooperation between the city government, administration and the private sector must be established based on an agreement on common sustainability goals for the development. In addition, structures must be established by the government to monitor and evaluate the development and regulations to correct not sufficient developments.

5. Enabler / Technologies

- Urban production should be part of sustainability strategy. This includes workplaces close to the living area of the people to reduce the traffic in the city and the wasted time of the citizens by travelling to work. Therefore the development of mixed living and industry areas with low pollution workplaces should be stimulated. This includes the development of logistic structures related to this type of industry.
- ICT is one of the most important enabler for a city to become efficient and smart. Big data analysis, mobile spatial statistics, simulation tools for planning processed, powerful mobile communication infrastructure, local smart grids, electronic payment systems, multimodal transport systems, smart traffic control systems and a lot of further fields of a systematic integration of ICT technology should be considered. An ICT strategy with the aim to enable the development of a sustainable city is recommended.
- An important enabler of economic and sustainability development is the provision of data for citizens, companies and all other actors in the city. This includes a monitoring system gathering relevant data (e.g. on sustainability development) and transparency on these data (easy access via internet).

6. Economic development and regional economic policy

- Economic development policy should be oriented on the superior target of sustainability. This includes incentives for the special development zones, accompanying measures like kinder gardens for working parents, reducing barriers for international experts to work in the city, increasing the quality of live in the city (green city) etc.
- Regional sustainability development can be supported by incentives for using renewable energy sources, investing in energy efficiency measures, using electric vehicles, or adopting regulations on CO_2-emission and developing local markets on energy or CO_2-emissions (certificates), as already established in Tokyo for a part of the buildings.

5.6 KEY FINDINGS: RECOMMENDATIONS

Many of the solutions analysed in Tokyo have been able to develop here because of an individual background of history, culture and economic development. The density of living, the will to place urban development in the hands of private companies, the conflict avoiding approach to new legislations etc. all link to specific framework conditions of Tokyo society.

Yet, there are several interesting conclusions to be drawn from the analysis of Tokyo's best practices and a range of impulses and new ideas can be derived from this:

5.6.1 Recommendations for municipal authorities

Intensify evidence-based decision making

- Nowadays more and more urban data are available. Municipal authorities should consider these new datasets during their decision making process and thus improve the outcome by traceability and quality.

Openness for research and new technologies

- Municipal authorities should establish a climate of openness for research and new technologies inside their organization. That way they can establish fruitful collaborations with local universities and companies and access state-of-the-art solutions in favour for use cases and real data.
- Municipalities should consider establishing an active innovation management linking local research and business with the development demand of the city. By this they not only benefit from innovative and more efficient solutions, they also impulse local value creation.

Quantitative sustainability assessment systems may provide a profound basis for municipal decision/policy making as well as monitoring and supervision of municipal goals

- Mandatory reporting of a defined set of stakeholders stands at the beginning of successful market-oriented sustainability regulations and strategies. By having all relevant figures at hand the right measures can be derived and – even more important – all stakeholders can be convinced to support the municipal strategy.
- Quantitative evaluation results may be used to supervise urban construction activities, environmental quality and development via setting requirements such as reporting for building construction permits or for enhanced building regulation, via measuring effectiveness of own policies or via decision making on sustainable subsidizing.

Mandatory and holistic targets for regulation on building or district level are the starting point for green economy development in building construction if coupled with adequate incentive systems

Future municipal regulation shall not only focus on energetic aspects but also on specific environmental ones such as emission reduction, water use or climatic influence on the built-environment. Incentive systems (e.g. emission trading, subsidizing for applied measures) provide for additional finance and stimulate the integration or development of new technologies (e.g. low carbon ones).Development of a logistic cockpit

- Municipal authorities should develop and collect key indicators, which enable the evaluation of logistics´ conditions, activities, quality, efficiency and sustainability of the city.

Create win-win situations through smart regulations and invite private business to design and implement a joint approach to sustainability.

- Tokyo always starts with voluntary commitment of the private sector and when this does not work it tightens regulations.
- Tokyo directly draws on the asset of the private sector (efficiency, innovation & business orientation) for implementing sustainable development strategies
- It does so by offering win-win situations. Private actors are allowed to benefit from a loosening of regulations (e.g. building height etc.) and in turn have to make an active contribution to the sustainability targets (e.g. creation of parks, meeting or exceeding emissions regulations etc.

5.6.2 Recommendations for industries

Develop seamless and cross-company solutions for public transportation

- One of the key success factors of public transportation is the seamless usability in day to day life. Passengers should not care about different pricing or ticket systems from several transport operators in one city.

Reflect the role of your solutions in case of an emergency in advance

- In case of emergency even small things can make a difference and help to mitigate the consequences of a crisis:-vending machines run on manual without electricity, access points do not require authentication or shared cars are free to use.

Provide for urban lighthouse projects with regard to future sustainable development in cooperation with municipalities/academia and effectively promote them to attract follower projects

- Project types addressed may be specific building projects, urban development projects or cooperation for building programs and initiatives which may be promoted to demonstrate applicability (e.g. of municipal regulation) or technology development, thus stimulating the market for future projects.

Include life-cycle based concepts/tools/considerations for urban development and building design projects or when developing innovative technologies and business models

- On the background of future technology development that will have influence on more than one specific city sector, life-cycle based considerations provide for additional support in sustainable decision-making especially with regard to keeping future flexibility or predicting of environmental, social and economic effects of changing boundary conditions (e.g. energy prices/supply, tightened building regulation, investment costs etc.).

Develop city compatible manufacturing sites

- Due to conflicts between residents and production, especially small industrial enterprises left Tokyo. Production should be carried out in a city friendly manner so that fluctuation can be reduced.

6

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7

7 APPENDIX

A1: Interviews conducted in the Context of the Practice Example

Forename	Surname	Institution	Role	Best Practice / Theme
Hirotaka	Komatsu	TMG - Headquarters of the Governor of Tokyo	Coordinating Supervisor	Cap & Trade, Green Building
Takahiro	Narita	TMG - Administrative Reform Section	Coordinating Supervisor	ICT at TMG
Masaki	Ishiguro	TMG - Bureau of Sewerage	Senior Staff Member	Cap & Trade, Green Building
Kenji	Ogawa	TMG - Bureau of Social Welfare and Public Health	Senior Staff Member	Cap & Trade, Green Building
Takeaki	Orihara	TMG - Planning Section, Automotive Pollution Control Division	Team Leader	Energy
Katsuhiko	Terashima	TMG - Urban Sustainability Planning Section	Deputy Director	Urban Planning
Hiroshi	Uda	TMG - Urban Sustainability Planning Section	Team Leader	Urban Planning
Hiroaki	Ueki	TMG - Urban Sustainability Planning Section	Team Leader	Urban Planning
Nobuyuki	Nagai	TMG - Urban Sustainability Planning Section	Team Leader	Urban Planning
Kaoru	Nakanishi	TMG, Bureau of Environment	Deputy Director	Three loop roads project
Katsumi	Takano	TMG, Bureau of General Affairs	Director, Administrative Reform Section	ICT at TMG
Shingo	Yamaguchi	TMG, Bureau of General Affairs	Director	ICT at TMG
Kazuhiko	Wakabayashi	TMG Electric Power Reform Promotion Section	Director	Energy
Shoji	Kobayashi	TMG Electric Power Reform Promotion Section	Team Leader	Energy
Maiko	Uehara	TMG Electric Power Reform Promotion Section	Team Leader	Energy
Hajime	Kamiyama	TMG Electric Power Reform Promotion Section	Team Leader	Energy
Yuko	Nishida	TMG, Bureau of Environment	Planner, Urban & Global Environment Division, Bureau of Environment, TMG,	Cap & Trade
Teruyuki	Ohno	TMG, Bureau of Environment	Director General	Cap & Trade, Green Building
Yuki	Arata	TMG, Bureau of Environment, Cap and Trade Section	Director	Cap & Trade

Forename	Surname	Institution	Role	Best Practice / Theme
Ryouko	Karaki	TMG, Bureau of Environment, Emission Cap-and-Trade Section	Senior Staff Member	Cap & Trade, Green Building
Yuko	Nishida	TMG, Bureau of Environment	Planner, Urban & Global Environment Division, Bureau of Environment, TMG,	Cap & Trade
Teruyuki	Ohno	TMG, Bureau of Environment	Director General	Cap & Trade, Green Building
Yuki	Arata	TMG, Bureau of Environment, Cap and Trade Section	Director	Cap & Trade
Ryouko	Karaki	TMG, Bureau of Environment, Emission Cap-and-Trade Section	Senior Staff Member	Cap & Trade, Green Building
Ken	Tabei	TMG, Bureau of Environment, Emission Cap-and-Trade Section	Senior Staff Member	Cap & Trade, Green Building
Yasuo	Furusawa	TMG, Bureau of Environment, Environmetal Policy Planning Section	Deputy Director	Cap & Trade, Green Building
Kanako	Okano	TMG, Bureau of Environment, International Cooperation Sec-tion	Senior Staff Member	Cap & Trade, Green Building
Kaoru	Nakanishi	TMG, Bureau of Environment, International Cooperation Sec-tion	Deputy Director	Cap & Trade, Green Building
Satoshi	Chida	TMG, Bureau of Environment, Urban and Global Environment Division	Director for Emission Trading	Cap & Trade, Green Building
Yutaka	Tanigami	TMG, Bureau of Environment, Urban Sustainability Planning	Senior Director	Cap & Trade, Green Building
Naoki	Yokomori	TMG, Headquarters of the Gov-ernor of Tokyo, Planning and Coordination Division	Senior Staff Member	Cap & Trade, Green Building
Nobuko	Asakai	Accenture Japan	Senior Manager	YSCP
Toko	Oizumi	BMW Group		Mobility System
Dr.	Rothhardt	BMW Group		Mobility System
Dr.	Hofmann	BMW Group		Mobility System
Lutz	Rothhardt	BMW Japan	Director	V-2-X, Mobility
Marc	Hoffmann	BMW Japan	Manager	V-2-X, Mobility
Osamu Toshi	Maruta Ohashi	Chademo Konferenz Charging Network Develop-ment Organization, LLC	 Director	Chademo Chademocharge
Toshinori	Mishima	City of Yokohama, Climate Change Policy Headquarters	Assistant Manager	YSCP
Isamu	Iida	Energy Advance Co., Ltd.	Vice President	Energy Advance / Shinjuku operation center
Shinya	Taguchi	JX Nippon Oil and Energy Corp		Smart Grid – Yoko-hama Smart City

Forename	Surname	Institution	Role	Best Practice / Theme
Tomohiro	Yamanashi	Nikken Sekkei Ltd	Executive Officer, Principal Architectural Design Department	Bioskin Facade
Hiroyuki	Yamada	NTT BROADBAND PLATTFORM	Senior Manager	MANTA
Masayuki	Terada	NTT DOCOMO	Research Engineer	Mobile Spatial Statistics
Tomohiro	Nagata	NTT DOCOMO	Research Engineer	Mobile Spatial Statistics
Yoshiko	Konishi	Otto Japan Inc.	Executive Officer	Yamato/Otto
Mikio	Hiraoka	Otto Japan Inc.	General Manager, Logistics Division	Yamato/Otto
Bernhard	Schaeffler	Otto Japan Inc.	Representive Director&President	Yamato/Otto
Izumi	Kaizuka	RTS Corporation		Renewable Energies
Herber	Wilhelm	Schenker-Seino Co., Ltd	President&CEO	DB Schenker
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Forename	Surname	Institution	Role	Best Practice / Theme
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Kazuo	Igarashi	Ministry of Land, Infrstructure, Transport and Tourism: Road Project Coordination Division	Senior Specialist for Construction Work	Three loop roads project
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