SUSTAINABLE DEVELOPMENT IN CENTRAL TOKYO: CASE STUDY ON ENERGY EFFICIENT CONSIDERATIONS THROUGH RESPONSIBLE PUBLIC-PRIVATE PARTNERSHIPS STRUCTURE

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Abstract: Even in the phase of serious economic depression, competitions between world leading cities are getting intensified year after year. As a strategy to accelerate enhanced economic growth of the major leading cities, further concentration of the urban functions that interact with various redevelopment actions are aggressively promoted. High-volume urban redevelopment projects promote vital investment that realizes efficient concentration of the urban functions. But from the environmental point of views, such projects surely increase tremendous amount of CO2 discharge in fact. Realization of the highly energy efficient urban redevelopment project, as a compensation to create larger, multifunctional, high-load building, is the primary responsibility of the developers. A regression to urban center is the actual phenomenon continued even in Metropolitan Tokyo. Eco Compact City Policy is the effective measures that achieve good balance between efficient concentration of the urban functions and reduction of environmental burdens.

In such actions for the sake of environmental consideration, land owners, developers and local authority must share the same goals and work together in coproduction. Public-Private Partnerships (PPP) is the key to the solutions.

"Marunouchi" is the 120ha premium business district that lies between the Imperial Palace and Tokyo Station, where Mitsubishi Estate Co., Ltd. has been taking lead over 100 years in area development and cultivation. In passed decade, "Marunouchi" has successfully transformed from solely business functioned area into multifunctional place through incremental Sustainable Development , aiming to achieve both diversified advanced redevelopment and the low-carbon district. What makes it possible? The answers could be the integration of PPP Development structure and Cutting-edge Environmental Technology.

In this paper, we intend to provide examples and ideas of environmental consideration, widely from development system structure to the individual redevelopment project details, to share the keys to the truly sustainable development actions.

1. The Structure of Development Frameworks Based on Public-Private Partnerships in the Marunouchi District
   - Urban Profile, Development Stage, Structure of PPPs
2. Examples of Measures in Energy Efficiency Already Implemented
   - District-wide Initiatives for the Supply of Energy
     District Heating and Cooling Systems for the Supply of Energy to 120 ha of Urban Infrastructure
   - Initial Adoption of Renewable-Energy-Based Power Generation by the Latest Buildings
     Direct Green Power: the Direct Purchase of Naturally Generated Electricity from Distant Sources
   - District-wide Community Transit Programs Supported by landowners
     The Marunouchi Shuttle, a Free Electric Shuttle Bus Service
   - Eco-Friendly Consumer Action with Prepaid Cards at Commercial Establishments District-Wide
     Environmental Point System for Purchases with Digital Money
   - An Array of Environmentally Friendly Technologies in the Newest Buildings
     The Marunouchi Park Building as a Project Case Study
   - Test bed Undertakings for the Commercialization of New Energy-Conserving Technologies
     Intelligent Lighting Systems and Radiant Heating and Cooling Systems
3. A Sustainable Development Path Paved with Opportunities Created through Redevelopment

Keywords: Public-Private Partnerships, mutual trust, eco-compact city, sustainable development, district–wide initiatives, economically and environmentally balanced district, private-led conferencing system, energy management system, renewable-energy, choice and concentration

1. The Structure of Development Frameworks Based on Public-Private Partnerships

Tokyo, the capital city of Japan. Its Marunouchi district is one of the nation's leading international business hubs, located on a 120-hectare (ha) stretch of land sandwiched between the Imperial Palace and Tokyo Station. Though it was once idle grassland owned by the national government, the district was sold off to private interests in 1890. It was purchased in its entirety by the Mitsubishi *zaibatsu* (conglomerate), which over the next hundred years sought to cultivate it into a center for Japanese business and finance with cooperation from other landowners. The advancement of Marunouchi has always been interlinked with the advancement of the national economy at large. Even today, the district continues to demonstrate sustained economic growth and cultural maturity underpinned by a responsible development framework based on public-private partnerships (PPPs). Mitsubishi Estate Co., Ltd. now owns and manages the land purchased by the Mitsubishi conglomerate. It owns 30 buildings in Marunouchi and holds rights to one-third of all land in the district.

Following is a summary of current statistics on the Marunouchi district.

Urban Profile of the Marunouchi District

Total land area: approx. 120 ha
Land use: 60 percent for building sites, 30 percent for roadways, 10 percent for railway use
Property stakeholders: 104 (all commercial entities, no private holders)
Number of buildings: 109 (of which 30 are owned by Mitsubishi Estate)
Combined building floor space: approx. 709 ha
Building ages:

Over 40 years	28 percent
30-40 years	22 percent
20-30 years	10 percent
10-20 years	8 percent
Under 10 years	26 percent
Under construction or renovation	6 percent

Total parking space: approx. 13,000 vehicles
Working population: approx. 231,000
Number of companies: approx. 4,000

With head office listed on Tokyo Stock Exchange 1st Section	75
Capitalization of listed companies	8,148.8 billion yen
Consolidated sales revenue of listed companies	124,106.1 billion yen (equivalent to approx. 23 percent of FY 2008 GDP)

Number of residents: None
Rail and subway stations: 13 stations serving 20 lines
Rail passenger volume: Approx. 1 million passengers per day

This paper is a case study of measures to improve energy efficiency in the Marunouchi district. Specially, it examines solutions to the task of making urban contributions through development, a challenge immediately confronting this downtown business center as it prepares for its second major redevelopment phase following its first 100 years of development. The existence of a framework for PPPs has evolved into a key background feature. In the Marunouchi district, sustainable development began with Japan's economic modernization but is now in a stage of transition that will lead to the creation of an economically and environmentally balanced district. The following developmental phases illustrate the way this community has adapted to changes in its expected social mission.

Figure 1. Marunouchi district (also know as OMY district)

Developmental Stages of the Marunouchi District

First Development Stage, Phase 1 (1890 through 1920s)

Social mission
Creation of a district of western-style rental office buildings to serve as essential elements of economic infrastructure for Japan's ongoing evolution into a modern state

Development strategy
- Western-style urban development plan modeled on London's financial district (Retaining the grid-style block divisions established by powerful territorial lords during the feudal era)
- Construction of (3-story) red-brick rental office buildings based on designs by leading British architects

First Development Stage, Phase 2 (1920s through 1940s)

Social mission
Redevelopment-based transformation into district of "functional" rental office buildings ready to handle domestic economic growth and demand on a par with the West

Development strategy
- Urban infrastructure development adapted to expansion in district's scale
- Redevelopment into district of New York-style high-rise structures (8 floors, 31 meters) utilizing the latest US structural engineering technologies

Second Development Stage (1950s through 1970s)

Social mission
Accelerated renovation and rebuilding (with intensive development focus on city center) to offset abrupt shortage of office space brought on by postwar reconstruction and a powerful economic boom

Development strategy
- Collection of funds for renovation work from existing tenants and continuation with series of rebuilding plans for structures specifically adapted for office use
- Construction of even taller high-rise structures (25 floors, 100 meters)
- Floor-space to site-area ratio of 1000 percent
- Development site expansion through district integration (reorganization into 100-m by 100-m blocks)

Third Development Stage, Phase 1 (1998 through 2007)

Social mission
Functional transition from a one-dimensional downtown office-focused district into a more diversified and appealing district with shopping establishments, educational facilities, and cultural amenities

Development strategy
- Continue with rebuilding and renovation projects aimed at creating world-class ultra-high-rise structures while earning extended floor-area ratio approvals for development-inspired social contributions under the existing floor-area ratio framework.
- Ever-taller high-rise office buildings (30 floors, 150 m) with multifunctional capabilities
- Floor-space to site-area ratio of 1300 percent plus ratio bonus tied to community contributions
- Efficient city center growth targeted by "smart growth" and "place-making" strategies

Third Development Stage, Phase 2 (2008 through 2017)

Social mission
Acting in response to the mounting crisis awareness worldwide over trends in environmental destruction and degradation, quickly transition to the development of an economically and environmentally balanced district while sharpening Tokyo's competitive edge in the global economy. (Adapt to government environmental regulations and standards.)

Development strategy
- Utilizing urban planning frameworks, sustain the trend toward higher floor-area ratios. However, apply efficient integration strategies that strive to minimize environmental strains through use of the latest construction and energy management technologies.
- Pursue the construction of even taller office buildings (38 floors, 200 m) in tandem with environmentally friendly measures.
- Implement "smart shrink," "eco-compact city," and "sustainable development" strategies to fulfill mission of transitioning to a low-carbon economy while maintaining city-center growth.




Figure 2. Transition of the building style from 1st to 3rd development stage

To achieve the shift to sophisticated urban functions targeted by the third stage of development that began in the Marunouchi district in 1998, it was essential to create new conferencing frameworks and implementation structures that enabled public and private participants to work together through responsible PPPs.

In the last 20 years, private-led conferencing systems have been put together to foster public-private dialogue and cooperation on redevelopment techniques that facilitate high floor-area ratios and appealing urban development programs for perpetual growth. That these frameworks were built on the basis of proposals tendered by the private sector is nothing short of revolutionary. Although discussions were initially focused on urban development frameworks, progress with redevelopment projects allowed diversification into a broader dialogue on topics in area management (a field concerned with the planning and implementation of management strategies for a community as a whole) and environmental strategy (a field concerned with fostering spontaneous environmental movements at the community level).

Structure of PPPs in the Marunouchi District

1988
Otemachi-Marunouchi-Yurakucho (OMY) District Redevelopment Project Council inaugurated.
(120 ha of OMY district generally called as “Marunouchi district”)
- An organization of 60 members, the majority of whom were private landowners, the Council launched redevelopment-oriented urban planning studies and basic surveys.
- As an alliance of private landowners, the Council forged a consensus on the shared interests that should be achieved through redevelopment and the shared responsibilities that should be fulfilled to create a vibrant, prosperous and feasible district.
- The PPP-based approach was clearly defined as a concept under which private landowners would have a leading role and cooperate with public administrators on an equal footing.

1994
Basic City-Planning Agreement approved.
- This agreement was approved and signed by all 76 members of the OMY District Redevelopment Project Council (currently 92 members).

1996
The Advisory Committee on OMY Area Development inaugurated.
- Participants in this Committee included the aforementioned Council, Tokyo Metropolitan Government, Chiyoda Ward and East Japan Railway Company (JR East) (large-scale landowners and a railway company).
- The public and private members of the Committee were engaged in discussions regarding a future vision for the Marunouchi community, rules to facilitate translating that vision into reality, and the development of institutional mechanisms to aid the implementation process.
- Matters agreed on by the private landowner-led planning committee were worked out through the PPP framework and elevated in status to shared ideals.

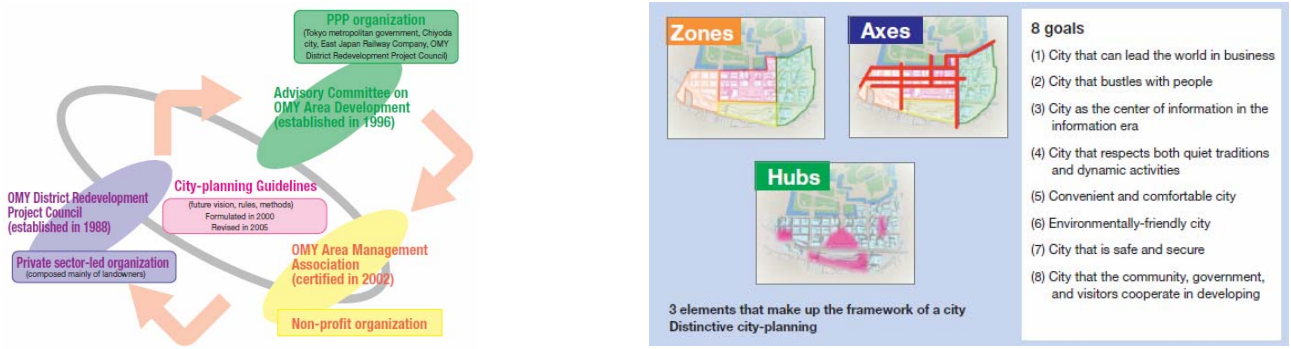

Figure 3. Responsible PPPs structure and the district framework from the guidelines

1998
“Broad Guidelines” for OMY area development issued.

2000
“City-planning Guidelines” issued.
- These were approved by public and private members in the Advisory Committee on OMY Area Development and established as common rules for all stakeholders involved in the Marunouchi district's redevelopment. Specifics of zoning and the master plan for the entire district took shape under these guidelines.
- The guidelines have been revised several times to achieve a better fit with actual redevelopment progress and are currently in their 3rd version. They have proved instructive for other redevelopment projects as a private-led master plan for entire communities.

- The guidelines demonstrate a total consensus on common rules for redevelopment, from the sharing of urban functions by designated zones, hubs, and Axes to the structure of above-ground and underground networks and the formation of scenic cityscapes. This has given shape to a master plan that effectively balances the expectations of both the public and private sectors.
- As with urban planning and construction regulations, the details agreed upon under the guidelines have led to a set of important rules for community development that government administrative agencies are certain to expect compliance with at the development project screening stage.

2002

OMY Area Management Association, a non-profit organization, launched.

- This association was set up to handle the affairs not only of redevelopment-related infrastructure upgrades but also the services-related dimension of area management.
- It is engaged in local activities designed to help strengthen the community's capacity for commerce and exchange and contribute to the community's appeal as a destination for urban tourism.
- The association has an instrumental role to play in promoting the presence of the Marunouchi district not as a collection of independently renovated or reconstructed buildings but as a well-balanced community with general appeal.

2007

The Association for Creating Sustainability in Urban Development of the OMY District (alias: Ecozzeria Association) incorporated.

- This is an organization of Marunouchi-based corporations engaged in efforts to draft detailed action plans and strategies for urban environmental coexistence through partnerships with government and academia.
- Each year, the association releases a Community Social Responsibility Report detailing the environmentally aware activities it pursues proactively in line with the OMY Environmental Vision.

“OMY Environmental Vision” released.

- Formulated by the OMY District Redevelopment Project Council.
- Sets out a nine-point roadmap of actions to translate the environmental vision into reality.
    1. Sensing, storage and application of environmental data
    2. Activities and information that extend beyond OMY
    3. Construction of an environmental and energy management system
    4. Creation of new transport and logistics systems with low environmental impacts
    5. Revitalizing the “Water City” with bioregion drainage systems
    6. Systematic use of outdoor and public spaces
    7. Multistage waste reuse system
    8. Mitigating environmental impacts from and reducing vulnerability to major disasters
    9. Creating and developing new environmental businesses

The Marunouchi district has evolved with a mission to serve as a leading center for the modernization and growth of the Japanese economy. Although that urban development-oriented social mission has undergone change over time in response to international trends and circumstances at home, the reliance on responsible PPPs has been unchanging as both a key to solutions and a strategy for the achievement of stated goals.

Striking a balance between the goal of ensuring Tokyo's competitive edge in the global economy and that of reducing environmental strains through redevelopment counts as the difficult social mission the Marunouchi district is expected to fulfill now.

Increasing floor-area ratios, adding urban functions, and diversifying services will help revitalize downtown Tokyo as the nerve center of the Japanese economy. One downside from the standpoint of environmental loads is that these trends can also be expected to increase total CO_2 emissions. Still, from the perspective of energy consumption, past approaches based on urban policies that broke up single concentrations of business

activity and relocated those activities to multiple sub-centers suffered from poor efficiency because the dispersed activities eventually grew independently of one another and developed redundant functions.

If, in the process of redeveloping a city center that has accumulated urban infrastructure over many years, it is possible to apply the latest environmentally aware technologies and reorganize that district in a way that helps curb energy consumption, that approach arguably will be more beneficial for the environment. One pronounced trend of recent years has been the re-influx of businesses and citizens to central Tokyo. The "eco-compact city" concept thus seems to be a viable solution to that trend.

Fusing development frameworks based on responsible PPPs together with cutting-edge environmental technologies will be the approach that makes such solutions feasible. It also will be important for landowners, developers, and public administrators to agree on and work together toward shared goals.

The following section is an overview that covers district-wide efforts as well as the specifics of independent redevelopment projects under way in the Marunouchi district, including environmentally aware projects that have already been put into effect as well as envisioned future projects. These ventures together hold the key to sustainable development.

2. Examples of Measures in Energy Efficiency

In recent years, the world has witnessed a growing sense of crisis over trends in environmental degradation. That sense of urgency has spurred action at the government level in many countries and led to the implementation of public regulations rather than voluntary measures for the achievement of CO_2 reduction targets.

The Japanese government has declared a CO_2 emissions reduction target of 25 percent relative to 1990 levels, for achievement by the year 2020. Metropolitan Tokyo Government has established an environmental ordinance mandating not only that new structures incorporate environmentally friendly functions but that existing large-scale buildings (buildings with total floor space of at least 20,000 m^2) by 2020 reduce their CO_2 emissions by 17 percent of their average for a discretionary three-year span chosen between the years 2002 and 2007.

As one action taken under the environmental policies of then-Prime Minister Fukuda in 2008, candidate cities were invited to vie as models of environmental awareness engaged in pioneering efforts to achieve sweeping CO_2 reductions as part of the shift to a low-carbon economy. Chiyoda Ward—the ward encompassing the Marunouchi district—was selected as that role model. Furthermore, projects under way in the Marunouchi district were among the environmentally aware undertakings specifically cited by Chiyoda Ward.

As Japan's preeminent center for international business and finance, the Marunouchi district in the past 10 years has undergone a dramatic makeover that has transformed it into a district of high-energy, nonstop operations, 24 hours a day, 365 days a year. More and more global companies that do business around the clock have opened offices in the district. Marunouchi has also witnessed an increase in the number of local financial institutions equipped with large computer servers and dealing rooms; in fact, such operations now account for 28 percent of the area's total tenant population. The percentage of commercial tenants in that total has also grown, by 2.8-fold in the past decade, and the area has also seen an increase in hotels and other non-office business operations that consume large amounts of energy.

The energy consumed by the Marunouchi district as a whole may be broken down as follows: 81 percent electricity, 17 percent district heating and cooling, and 2 percent town gas. Finding ways to cut electricity consumption will be a critical challenge.

Electricity use in ordinary office buildings breaks down as follows:

Tenant office lighting and appliances: approx. 40 percent
Tenant air-conditioning: approx. 30 percent
Facilities in common-use areas: approx. 20 percent

In other words, tenants currently account for about 70 percent of the total in electricity consumed.

Efforts to cut CO_2 emissions in the Marunouchi district will not make much progress solely through the efforts of building owners alone. Indeed, it will be essential to pursue reduction measures in coordination with the corporate tenants that account for a large share of all energy consumed.

Marunouchi is currently moving into Phase 2 of its Third Development Stage but has assigned building owners and developers most of the responsibility for developing and quickly implementing substantive visions aimed at offsetting the increased environmental strains expected to accrue as a result of ongoing urban development. On the other hand, thanks to the strong ties of mutual trust that have developed through many years of public-private cooperation, Marunouchi also actually serves as a test bed for various environmental load reduction measures approved by government agencies.

We selected several conspicuous examples of energy efficiency measures that the Marunouchi district has earnestly implemented on this redevelopment opportunity. The observed environmental benefits from these examples as well as certain issues demanding solutions are examined below.

2.1 District-wide Initiatives for the Supply of Energy
—District Heating and Cooling Systems for the Supply of Energy to 120 ha of Urban Infrastructure—

The Marunouchi district first adopted district heating and cooling systems in 1973. Initially, at a time when most buildings were still utilizing standalone boiler systems that burned heavy fuel oil, Mitsubishi Estate decided to find a solution to the air pollution caused by exhaust emissions throughout this 120-ha tract. That was a pioneering effort to transition to a low-carbon economy based on considerations for environmental quality. The area's district heating and cooling systems are operated by Marunouchi Heat Supply Co., Ltd. a private business in which several banks, Tokyo Electric Power Company, Inc. (TEPCO), and Tokyo Gas Co., Ltd. all have equity stakes. Currently, steam and cold water are supplied to the district in four zones delineated by proximity to buildings with installed heat sources.

Although district heating and cooling operations in the Marunouchi district are an integral component of urban planning in Tokyo, thus far buildings in the district are only obligated to explore enrolling in the system and are not actually obligated to enroll. Building tenants that do enroll in the district heating and cooling system have access to an uninterrupted supply of heating and cooling services 24 hours a day. The benefit for building owners is that they do not have to bear any costs associated with initial investments in heating facilities or in their operation, administration, maintenance, or repair. Furthermore, indoor spaces in their buildings may be utilized more effectively for other purposes.

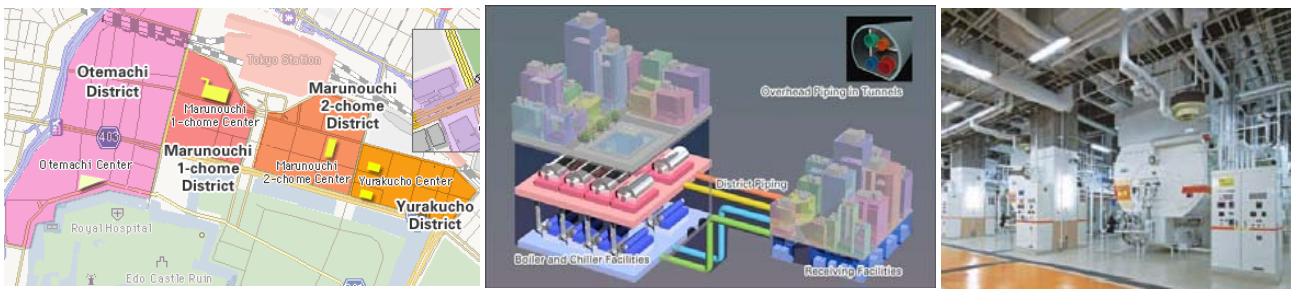

Figure 4. District heating and cooling system throughout OMY district

Environmental Benefits

- The district's system comprises the highly efficient sharing of local heat-generating plants and does not require that enrolled buildings have their own boilers, freezers, or fuel tanks. As such, it excels as a system that contributes to reductions in exhaust heat, air pollutants, and emissions of CO_2. It is estimated that this approach provides a 12–16 percent savings in energy consumption and an approx. 35 percent reduction in CO_2 emissions compared to scenarios in which all buildings have their own heat sources.
- The district has had a new energy management system in operation for two years now. Under that system, adjacent heat-supply blocks are connected to one another by pipe networks. Whenever energy demand from an area of buildings subsides, the local heat-generating plant may be shut down while connected blocks share steam heat as necessary. This approach is capable of cutting energy consumption and CO_2 emissions by a factor of approx. 4 percent. Among other benefits, the system can be implemented with limited renovation budgets while providing a stronger mutual backup framework for the plants and allowing plant facilities to be easily shut down as necessary.

Issues Demanding Solution

- In some cases, thanks to improvements in on-site facility performance, buildings that run their own energy supply systems have achieved levels of energy efficiency that surpass levels attainable through enrollment in district heating and cooling systems. Plant performance enhancements, renovations, and maintenance can confront a district heating and cooling system with an enormous burden of cost. What is more, a decline in the number of enrolled buildings can pose a risk of harm to system profitability and compromise the ability to generate funding for future renovation expenditures.
- Spurring fresh demand for district heating and cooling systems will require renovations that deliver new, value-added services. These systems will need to step beyond the traditional supply of steam and cold water: for example, by generating clean electric power with fuel cells and other chemical reaction-based forms of generation that do not rely on fuel combustion, or by more efficiently supplying energy through heat storage or the adoption of smart-grid control networks.
- Research is urgently needed on sources of energy that exploit temperature differentials as well as technologies for the efficient utilization of as-yet untapped sources of energy. Fresh efforts are under way to utilize the heat in groundwater and tap into the waste heat generated by subway facilities, transformer substations, and somewhat distant garbage incineration plants. By some estimates, if these untapped sources of energy can be effectively harnessed, they will allow an energy savings of approx. 22 percent compared to situations in which individual buildings run their own heat-generating systems. For the year 2030, Marunouchi is targeting a 25 percent increase in the energy efficiency of its entire district heating and cooling system relative to the level of efficiency set in 2007.

2.2 Initial Adoption of Renewable-Energy-Based Power Generation by the Latest Buildings —Direct Green Power: the Direct Purchase of Naturally Generated Electricity from Distant Sources—

In Japan, the national government and many local municipal governments have established their own independent targets for the reduction of CO_2 and codified those targets into ordinances and regulations with which building-related companies are expected to comply. Devising a surefire power consumption strategy for the achievement of CO_2 reduction targets has become a major hurdle. To date, the only way to do that was to apply an indirect offset strategy through the purchase, as "certificate," of environmentally added value in electric power generated using wind power, solar power, biomass, or other renewable energy sources. However, it would be possible to directly utilize pure, natural forms of electric power, provided one is able to have renewable energy transmitted and delivered directly from power stations that harness natural sources of generation.

"Direct green power" is an electric power delivery strategy whereby electric power generated with renewable energy resources in northern Japan is delivered to final consumers by the petroleum firm Idemitsu Kosan Co., Ltd., acting as power producer and supplier(PPS), over electric power networks owned by power utilities (e.g., TEPCO and Tohoku Electric Power Co., Inc.) for a service fee.

Last year, the Shin-Marunouchi Building owned by Mitsubishi Estate began meeting all its electric power needs with this direct green power.

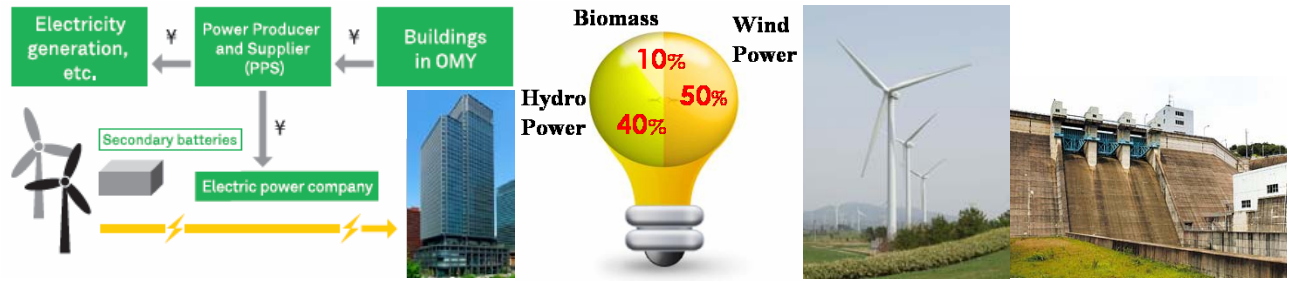

Figure 5. System of the Direct Green Power

Environmental Benefits

- Approx. 50 million kWh of power is supplied per annum. This has allowed the Shin-Marunouchi Building to cut its CO_2 emissions by a factor of 20,000 metric tons per year, a 70 percent reduction. Although rates for direct green power are somewhat higher than comparable rates charged by power companies for electricity generated using conventional energy sources, e.g., thermal, hydro, and nuclear power, that premium is still reasonable compared to the alternative of purchasing carbon offset certificate and it has earned growing social approval as a direct form of supplied power.
- Mechanisms that facilitate the transmission of electric power from remote districts can lead to new forms of business that effectively link the regions with the center. This can foster win-win relationships that contribute to rural community revitalization.
- Both the national government and the Tokyo Metropolitan Government support the idea of purchasing electric power through the green power mechanism. Under Tokyo environmental ordinances, it is officially recognized as a compliant source of electric power, provided the generating energy mix is 50 percent wind power, 40 percent hydro power, and 10 percent biomass. As a framework that allows for the acquisition of officially recognized renewable energy credits, direct green power counts as a "first" for Japan. Furthermore, electric power purchased through this mechanism is assigned a CO_2 emissions coefficient of "zero."

Issues Demanding Solution

- One rule for official government approval of a green power generating mechanism is that wind power account for at least 50 percent of the electricity generated. However, wind power is largely dependent on local meteorological conditions and for that reason, difficult to control as a stable source of supply. The challenge is to achieve stable, uninterrupted supplies of electricity through the dispersed installation of wind-based generating facilities. Unless power can be steadily generated and supplied, Idemitsu Kosan as PPS have no choice but to purchase supplemental power from existing, conventional power grids. That is why good planning is such a pressing issue in the case of wind power.
- If electricity demand from client buildings is heavy, as the supplier of direct green power, Idemitsu Kosan faces the business risk of having to purchase and guarantee the delivery of power from conventional power utilities to offset any shortfalls in supply. On the other hand, because it would face business losses from the generation of power in surplus quantities, in the years ahead Idemitsu Kosan will need to build power storage systems and in other ways develop technologies that facilitate improved operating efficiency.

2.3 District-wide Community Transit Programs Supported by Landowners —The Marunouchi Shuttle, a Free Electric Shuttle Bus Service—

When taking steps to upgrade urban infrastructure and curb environmental strains, revamping those mass transit systems that have a heavy influence on energy consumption and CO_2 emissions can be highly effective. Efficiently utilizing major downtown districts that already serve as connecting points in the mass transit network can be a key strategy to this end.

Launched in 2003, the Marunouchi Shuttle is a free shuttle service that runs electric-hybrid shuttle buses on a 40-minute, 4.2-km loop throughout the 120-ha Marunouchi district. The system currently has a fleet of three buses, each departing at 15-minute intervals on a route with 13 stops. Service runs from 8 AM to 8 PM on weekdays and from 10 AM to 8 PM on Saturdays, Sundays, and public holidays. The shuttle service currently handles about 50,000 passengers per year. It is possible to check the current location of each bus at any time from the Shuttle service website.

The joint development of low-carbon-emission buses by TEPCO and the Hinomaru Limousine Group (a group of bus and taxi companies) provided one impetus for the launch of the shuttle service. The buses chosen for the service were low-emission, low-noise Design Line (New Zealand) models running hybrid systems that combine a diesel engine with an electric motor.

The shuttle system is sponsored by a consortium of 20 local companies and 3 community development organizations. TEPCO, the local power monopoly, has organized a steering committee, which it heads. The system has continued to operate as a free service with annual subsidies averaging 3 million yen from each corporate sponsor. Sponsors enjoy environmental improvements and advertising benefits while contributing to the increased mobility of visitors to the district.

Figure 6. Marunouchi Shuttle covers entire OMY district

Environmental Benefits

- This is a low-carbon-emitting mass transit system that utilizes hybrid vehicles, thus freeing itself from dependence on fuel-combustion-based operations.
- As a free shuttle bus service covering the entire Marunouchi district—a district with a "compact city" vision, the Marunouchi Shuttle also contributes to the reduced use of taxis and automobiles.

Issues Demanding Solution

- Hopes are that shuttle service within the Marunouchi district will eventually shift to fully electric operation at an early date.
- Currently the buses are only capable of recharging at night while parked at the fleet depot facility. The shuttle service needs to install quick-recharge stations at certain locations along the Marunouchi route and develop a framework that facilitates recharging operations whenever necessary.
- To sustain the shuttle as a free service, it is urgent that new sources of sponsoring funds be found and tapped. Due to scenic and aesthetic zoning restrictions, city authorities have yet to approve the display of advertising materials on the buses. However, it is desirable that such advertising be allowed and utilized as an additional source of operating funds. Increasing the number of local corporate sponsors and strengthening district-wide support frameworks for the service also will be important.

2.4 Eco-Friendly Consumer Action with Prepaid Cards at Commercial Establishments District-Wide —Environmental Point System for Purchases with Digital Money—

Over 90 percent of all office workers commuting to the Marunouchi district possess smart card-based commuter passes. Utilized as prepaid cards on a daily basis, these passes had the hidden potential to contribute to environmentally aware activities on an individual consumer basis.

The point system works by contributing to environmental programs 1 percent of the proceeds from payments made for shopping purposes or meal purchases by a worker with a prepaid smart card issued by JR East or Tokyo Metro Co., Ltd. (the subway management company). This approach enables individual consumers to readily contribute to environmental programs every day and hopes are that it will have the effect of making such environmentally oriented actions a commonplace routine.

Whenever a consumer uses an authorized commuter pass smart card to pay for goods and services at a member-retailer affiliated with this eco-friendly system, 1 percent of the purchase price is pooled into a fund for projects in environmental protection and contribution. The consumer in return accumulates points (each worth 100 yen or $1) that may be exchanged for environmentally friendly items of gift merchandise.

Mass-transit companies assess a 2.5 percent settlement fee for smart card-based transactions and contribute the equivalent of 0.5 percent into a fund for environmental contributions along with a matching 0.5 percent contribution from the sales proceeds of affiliated retailers. However, tie-ups by mass-transit firms and retailers can be expected to have the effect of drawing more customers and create new opportunities for increased sales revenue from eco-oriented activities of this kind.

Consumers amass points for purchases involving environmental contributions. This pattern of consumer behavior is linked together with the fun of exchanging points for gift items. Actions of this nature that contribute to the environment can be expected to develop into a spontaneous practice.

Launched in October 2009, the eco point system now has 190 member retailers with some 4,000 registered users.

Figure 7. Environmentally friendly ties in local community through eco-purchase

Environmental Benefits

- A sum equivalent to 1 percent of purchase-derived revenue is pooled into a fund for environmental contributions.
- The system encourages daily environmental contributions on an individual basis by consumers, not corporations.

Issues Demanding Solution

- The enrollment of more consumers and member-retailers will be the key to the viability of this program. Expansion will also be essential to offset program management costs.
- It will be important to develop a broader selection of attractive gift items for point exchange that encourage more consumer purchases and that are associated with environmental protection.

2.5 An Array of Environmentally Friendly Technologies in the Newest Buildings —The Marunouchi Park Building as a Project Case Study—

As part of the Third Development Stage, various urban redevelopment projects have been launched in the Marunouchi district within the last 10 years.

To the extent their project budgets permit, some of the projects have endeavored to implement the latest in environmentally aware technologies. Among those engaged in efforts to replace older buildings with new structures capable of competing in the rental office marketplace, not all are guided by the singular objective of expanding floor-area ratios to boost profitability. Priority challenges include converting buildings originally designed solely for office use into multipurpose structures and upgrading others to eco-buildings that harness the latest technologies for the reduction of environmental loads.

In the decade to date, Mitsubishi Estate has rebuilt 7 of the buildings it owns. Most of those projects were for the construction of new office buildings with around 30 to 38 above-ground floors on a grid of sites measuring 100 m by 100 m each. From time to time and within the limits allowed by operating budgets, steps have been taken to implement the latest in environmental technologies.

As one example, consider the environmental load reduction technologies integrated into the Marunouchi Park Building that was completed in 2009. Using the new technologies described below, this structure has been designed to consume 30 percent less energy and emit 40 percent less CO_2 than the typical large-scale office building in Tokyo.

Rooftop Technologies

- **Photovoltaic power generation**
  Approx. 600 m^2 of photovoltaic panels were installed on open rooftop spaces. With a combined maximum generating capacity of approx. 60 kW, the system is powerful enough to meet the entire building's nighttime outdoor illumination needs. In a city that still has few examples of office buildings equipped with photovoltaic paneling, the generation of this much power can be described as a relatively large-scale undertaking.
- **Cool roofing**
  The building's roof surface has been coated with a fluoroplastic heat-insulating paint layer that reflects the sun's rays. The material has a reflection efficiency of approx. 60 percent and has effectively cut the surface temperature of the roof by 15 °C. This helps keep indoor temperatures from rising and reduces building heat dissipation into the atmosphere at night. Consequently, indoor air conditioning systems can be set 1 °C higher, allowing for an annual savings of 10 percent in electric power consumption.

Figure 8. Solar cells and cool roofing (hourly deference of the surface temperature with and without coating)

Indoor Technologies

- **High-efficiency ceiling lighting**
  The light fixtures in a typical office building are usually equipped with two fluorescent tubes providing an average luminosity of 750 lux. The fixtures in the Marunouchi Park Building incorporate resourceful efficiency enhancements in their reflective backings and paint coatings, providing as much as 700 lux with only one fluorescent tube. This approach has resulted in a power savings of approx. 36 percent compared to conventional dual-tube fixtures.

- **Air-flow window system**
  In many typical office buildings, the windows utilize only a single pane of glass due to cost constraints, among other factors. The Marunouchi Park Building was designed to use double-skin glass and its windows have outer layers of low-emissivity ("low E") glass, which excels in its heat-insulating properties. The layer between the two panes integrates a shade-blind mechanism that automatically tracks the angle of the sun's rays for maximum heat blocking performance and an air regulation system that draws in, circulates, and removes heat from room air, thus reducing up to 85 percent of the heat from areas near the windows.

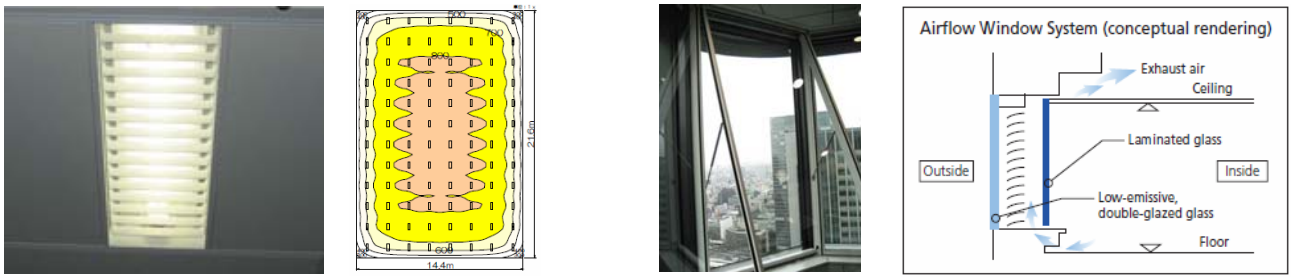

Figure 9. High-efficiency ceiling lighting and air-flow window system

Building Surface Technologies (Heat Island Countermeasures)

- **Green landscaping**
  This building enlists extensive green landscaping. Vegetative cover has been planted on 1,500 m^2 of space at ground level around the building, 300 m^2 of rooftop space, and along 800 m^2 of building walls and pillars for a combined total of 2,600 m^2 in vegetative landscaping that helps keep perimeter temperature spikes under control. At least 35 percent of the building's premises have been voluntarily planted in vegetative cover.

Figure 10. Green landscaping (mist spray to ease the heat island phenomenon)

- **Moisture-retentive pavement**
  Above-ground paved surfaces on the building premises utilize approx. 1,000 m^2 of a special ceramic particle-mixed block. This ceramic block pavement is watered with a buried sprinkler system that is fed from stored rainwater. The resulting evaporation effect from the ground surface is capable of holding ground surface temperatures some 10–20 °C below the levels typically measured on conventional asphalt pavements. Furthermore, in the summer season, pillar sections in landscaped zones spray a fine mist that helps lower perimeter temperatures.

Figure 11. Moisture-retentive pavement and rainwater recycling system

- **Rainwater recycling system**
  Rainwater is collected from upper levels of the building, stored in tanks, and reused in landscaped areas, on moisture-retentive pavement, and for spray-mist applications.

2.6 Test bed Undertakings for the Commercialization of New Energy-Conserving Technologies —Intelligent Lighting and Radiant Heating and Cooling Systems—

Government ordinances in Japan mandate that building management firms reduce building CO_2 emissions by a certain level. However, the drastic cuts in energy consumption that would bring those CO_2 reduction targets within reach will be impossible to achieve unless conventional perceptions of office work styles undergo change.

The design specifications for ceiling lighting in the majority of Japanese office buildings call for a uniform 700–750 lux of illumination as measured at desktop level. However, in an age where personal computer displays are replacing printed paper documentation, desktop lighting this bright is no longer necessary.

The intelligent lighting system was studied and developed by Doshisha University Professor Mitsunori Miki. Alerted to the potential energy-conserving benefits, Mitsubishi Estate has installed pilot versions of the system in some buildings as test beds for product development purposes.

This system enables individual office workers to adjust lighting to their own preferences and control the levels automatically from their PC displays. An artificial intelligence program controls the balance of the illuminated environment throughout the office at large.

The ability to control unneeded levels of lighting enables offices to conserve on power consumption and helps workers reduce eye fatigue and stress. Furthermore, because the system allows workers to create a more comfortable work environment suited to their own preferences, it also can be expected to lead to improved office productivity.

These test bed offices have also installed radiant air conditioning systems in their ceilings and walls for test purposes. In years past, Japanese offices standardized on the use of fan-driven air conditioning units of the kind that were the mainstream at one time in the US. The reason was that fan-driven units were effective during the hot and humid summer season in Japan. However, in many Central European countries, radiant air conditioning systems are now in widespread use. These are heating and cooling systems that utilize the radiant property of heat to move across gradients from higher to lower temperatures without passing through material objects. One of their beneficial features is a temperature index that feels 2 °C more comfortable than the actual room temperature. This enables offices to set their temperature controls to conserve energy without compromising office worker comfort.

Radiant air conditioning systems have also been used in the products of the Swiss firm, MWH Barcol-Air AG with Japanese firm, TOYOX Co., Ltd. The reverse sides of metal paneling in ceilings and walls are covered with plastic hoses that circulate water heated to a level reflecting room temperature settings. Although offices were reluctant to adopt this system out of concern it might cause office water leaks, the technology in the current generation of the product has been improved, resulting in a reliable system. Now that all viable strategies of reducing environmental loads are considered indispensable, this new air conditioning technology seems likely to gain widespread acceptance even in Japan.

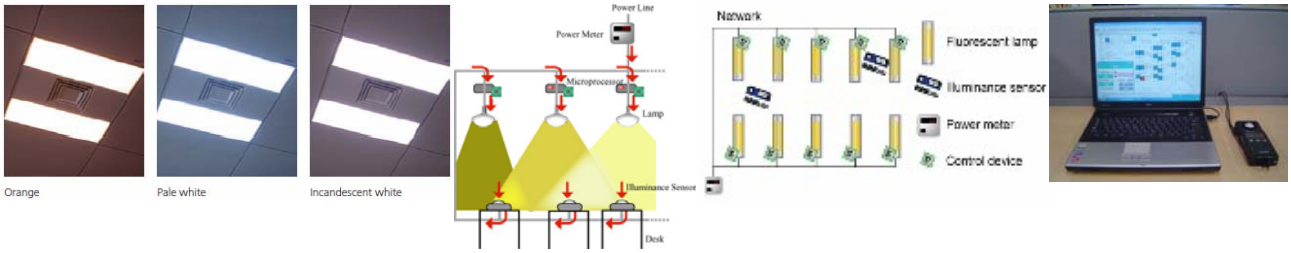

Figure 12. Intelligent lighting system utilizing LED

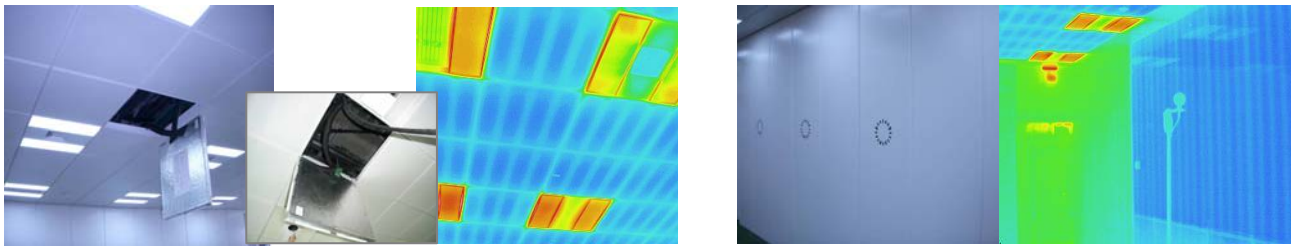

Figure 13. Radiant heating and cooling system in ceilings and walls

Environmental Benefits

- Intelligent lighting systems enable office workers to freely adjust lighting levels as needed from the convenience of their own computer displays and have that lighting dimmed or turned off whenever they leave their desks. This ensures that electricity for lighting purposes will be consumed only in the amounts required.
- Traditionally, the design specifications for office buildings have called for uniform illumination in the range of 750 lux. However, most office workers actually prefer a level around 400 lux and virtually no worker wants anything brighter than 700 lux.
- This finding has enabled tenants in test bed offices to achieve a power savings of 40 percent or more compared to offices that are lighted to traditional specs. If the intelligent lighting system were adopted by all office spaces, the savings in electric power consumption by the building as a whole would be around 10 percent.
- Although the system also allows workers to simultaneously select the color temperature of their lighting, the majority of workers apparently find a color temperature closer to the orange range of the light spectrum more pleasant than pure white light.

- Harnessing the properties of radiant air conditioning systems allows offices to adjust their room temperature controls to conserve energy without compromising worker comfort. Unlike conventional fan-blown systems, radiant systems do not cause sudden, unpleasant spikes in body surface temperature.
- The adoption of radiant systems will enable offices to reduce the power consumed by air conditioning system fan and pump components by 25 percent.

Issues Demanding Solution

- It will be important to allow a majority of office workers to experience for themselves the realization that excessive lighting is actually unnecessary. Fostering that change of awareness will lead to significant cuts in energy consumption.
- The basic theories and systems themselves have already been perfected. However, it will still be necessary to develop systems that are capable of handling large-scale office spaces.
- These systems should be transitioned into the product development stage with the aid of manufacturer technology and expertise.

- Radiant air conditioning systems are already available and sold as commercial products. However, developing technologies to control the formation of condensation under the high-humidity conditions typical of Japan's climate will be the most important hurdle facing efforts to win acceptance for these systems in Japan.

3. A Sustainable Development Path Paved with Opportunities Created through Redevelopment

Cities and rural communities should develop on a sustainable basis, achieve maturity, and grow in value. In communities that are expected to fulfill a leading role in a given country, the term "sustainable development" does not refer exclusively to considerations for achieving a balance between natural environmental health and economic or urban development. Such communities are capable of developing on a sustained basis and fulfilling their social mission only after they have assimilated a diverse array of advanced technologies, enriched cultures, and lofty ideals and have engaged in successful "place-making," that is, the creation of "places" endowed with an abundance of appeal and that offer their human inhabitants the opportunity to pursue active and comfortable lives.

The true value of a city does not materialize at the end of its development stage. That is only the beginning. The question of importance is how that city succeeds in maturing in a sustained way as a city with appeal. The key will reside in the technologies harnessed for infrastructure maintenance and management, the frameworks established for continual enhancements and improvements, and the social systems that support these endeavors financially.

In the process of transitioning to an urban structure that eases environmental strains, urban policy formulation and urban planning by the public sector will have an enormous impact, with transportation systems being a prime example. At the same time, there are limits to the scale of a community that the private sector is capable of planning through its own initiative. Nevertheless, absent the economic vitality of private-led initiatives in redevelopment, a city will not achieve sustained growth and development. PPPs are the alliance that can fill the void. It is the enthusiasm and consensus of both the public and private sectors that can make sustainable development a reality and craft the alchemy for a brighter future.

This paper will conclude with a discussion of the creation of five crucial windows of opportunity for the achievement of sustainable development highlighted by an abundance of appeal.

i. ***Redevelopment is an opportunity for innovations in urban infrastructure.***
Attain efficient integration in line with the "compact city" concept for adaptation to a changing social structure.

- Growing cities eventually suffer from development-induced urban sprawl. When a city experiences changes in social structure marked by the shrinkage and advanced aging of its general population, it faces the "choice and concentration" dilemma of deciding where its important urban functions should best be allocated. The compact-city concept rests on the idea of efficient urban advancement or sophistication. The most effective approach to putting that concept into practice is not to let urban functions be inefficiently scattered out but to resume utilizing city centers in full and pursue innovations in urban infrastructure that build on those infrastructure assets the city center has developed and refined over many years. If a compact structure can be efficiently achieved using the latest technologies, the term "concentration" will be synonymous with "efficiency" and contribute to the mitigation of environmental strains.

ii. ***Redevelopment is an opportunity for the transition to a low-carbon society.***
Innovations in the structure of urban energy consumption can demand huge expenditures. Pursue more economical approaches by timing such innovations to building renovations and the renewal of elements of urban infrastructure.

- Modifying the structure of urban energy consumption can entail enormous investments at all levels, from urban infrastructure down to individual buildings, and may also impose a heavy burden on building owners. For these reasons, it is crucial that efforts in innovation be more economically implemented with good timing. Actively exploit the timing of redevelopment projects to enthusiastically assess and approve public and private actions that are capable of contributing to the city’s interests. Skillfully utilize development incentives through the affirmative use of urban planning frameworks. In this context, it also

will be important to facilitate economic forms of support for undertakings aimed at transitioning to a low-carbon society.

iii. ***Redevelopment is an opportunity to harness the investment power of private firms.***
Provide incentives for development-based contributions and foster heightened environmental sensitivity with the financial power of the private business community.

- Private property can be developed with project financing from private interests. However, despite limited municipal finances, the public sector must bear the cost of developing properties for public use and no doubt faces obstacles in that regard. During private redevelopment projects, an extremely effective option would be to treat nearby public properties as project components and redevelop those public properties at the same time with private-sector funding. As entities pursuing redevelopment projects on a for-profit basis, private companies have the power to implement the transition to urban structures that are more environmentally sound. Harnessing expanded floor-area ratios and other government incentives as well as private finance initiatives and similar mechanisms for public-private cooperation and taking steps to actively apply the vitality of private corporations while balancing the objectives of urban contributions with economic viability would be an effective strategy for project financing.

iv. ***Redevelopment is an opportunity to harness the managerial strengths of private firms.***
Enlist mechanisms for public-private cooperation to handle the costs and framework development tasks associated with the maintenance and management of desirable community environments over the long term.

- It is standard practice to plan redevelopment ventures as a series of projects from start to finish. Government agencies also estimate the costs required to bring building projects to completion and provide development incentives accordingly. However, from a sustainable development perspective, project completion is just the beginning. Effectively maintaining and managing that developed property over the long term and endeavoring to add to its value are also important. It is imperative that redevelopment projects incorporate plans for the development of long-term property maintenance and management frameworks and account for the related management costs. To this end, creating a US-style system of Business Improvement District under PPPs would be one viable approach. Redevelopment strategies based on PPPs should include adequate consideration for mutually beneficial "aftercare" with incentives attached.

v. ***Redevelopment is an opportunity to strengthen ties of mutual trust through PPPs.***
Implement reliable system operations with the shared visions, frameworks, and agreements that derive from PPPs.

- To create sustainable communities of strong character, it is extremely important to have the full participation and full consensus of private stakeholders, developers, infrastructure firms, and government agencies involved in the district concerned. Redevelopment projects implemented on the basis of full participation and full consensus after adequate dialogue within a PPP framework will be properly maintained as necessary through follow-up negotiations regardless of future trends and capable of prospering on into the distant future while maintaining a powerful framework for cooperation.
- It is important that redevelopment projects designed on the basis of shared public-private visions and with attention to local environmental attributes lead to a positive chain of events: i.e., praise for environmental contributions, area designations, higher real estate market valuations, the attraction of companies and individuals that share a strong sense of responsibility for action against environmental crises, and finally, sustained evolution into a community of even stronger character.

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