

## ECO-EFFICIENT AND SUSTAINABLE URBAN INFRASTRUCTURE APPROACH- AN INITIATIVE FOR GREEN ECONOMIC GROWTH

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### ABSTRACT

Infrastructure is a key element for realizing sustained economic growth and sustainable development to achieve the United Nations' Agenda 2030, with its Sustainable Development Goals (SDGs). No country can expect to succeed without a solid infrastructure base. It is also increasingly understood that negative environmental and social impacts of poorly conceived infrastructure investments will place additional burdens on current and future generations. As the country like India is increasingly feeling the effects of climate change, these issues have become all the more important. Climate change impacts are threatening existing infrastructure and rolling back hard-won development gains. Furthermore, as the impacts of climate change become greater, the region's remaining poor people become more vulnerable, as they will be most affected by natural disasters, rising sea levels, and droughts. Infrastructure development will place further stress on the environment. Eco-efficiency concept can satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life-cycle to a level at least in line with the Earth's estimated "Carrying Capacity". This concept will help in reducing the Ecological Footprint, simultaneously improving quality of life within the capacity constraints of the city. In this paper different approach of eco-efficiency for sustainable urban infrastructure development in line with Sustainable development frameworks and models, Extended Urban Metabolism Model and Agenda 2030 has been discussed. This will support in making a strategic shift towards more sustainable patterns of urban infrastructure.

**KEYWORDS:** Eco-Efficiency, Sustainable Development Goals, Carrying Capacity, Urban Metabolism, Agenda 2030

Infrastructure is a key element for realizing sustained economic growth and sustainable development to achieve the United Nations 2030 agenda for sustainable development. The Sustainable Development Goals (SDGs), officially known as transforming our world - the 2030 Agenda for Sustainable Development, which is a set of 17 "Global Goals" with 169 targets covering a broad range of sustainable development issues (UNCED,1992).The foundational principle of United Nations' Agenda 2030 is "No One Behind". This principle with its Sustainable Development Goals, targets, and implementation plans, forms the most comprehensive blueprint for eliminating extreme poverty, reducing inequality, and protecting the planet the world has ever seen (Brundtland, 1987). Development of sustainable urban infrastructure will help to achieve the Sustainable Development Goals (SDGs)and in particular, Sustainable Development Goals1- End poverty in all its forms everywhere, Sustainable Development Goals 6 - Ensure availability and sustainable management of water and sanitation for all, Sustainable Development Goals 9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, Sustainable Development Goals 13 - take urgent action to combat climate change and its impactsand Sustainable

Development Goals 15- Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (WSSD, 2002).The unmet demand for social and physical infrastructure to support the delivery of housing, transportation, energy, water services and to overcome the deficiency of food limits economic opportunity and is therefore a major barrier to the achievement of Sustainable Development Goals1.Patterns of infrastructure development determine the environmental sustainability of "green" economic growth (Brundtland,1987).

Eco-efficiency is a quantitative management tool that enables the consideration of life cycle environmental impacts of a product system alongside its product system value to a stakeholder. Eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the Earth's estimated carrying capacity(WSSD, 2002). Eco-efficiency is based on the withstanding principles of the use of high efficiency production technology and methods, the use of less natural resources and energy

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for the same amount of production and the production of less waste. With this property, eco-efficiency does not just address environmental concerns; instead it also addresses “preservation of natural resources”, “industrial efficiency” and “economic development”. In short, eco-efficiency provides both environmental and economic benefits through production efficiency. In short; it is concerned with creating more value with less impact. In turn, eco-efficiency - should be one of the key criteria for the development of sustainable infrastructure. Eco-efficiency of infrastructure has long term and significant impacts on both economic and environmental sustainability (ESDN, 2015).

## **INITIATIVE FOR GREEN ECONOMIC GROWTH**

Important worldwide initiatives for green economic growths are:

### **United Nations 2030 Agenda for Sustainable Development**

The journey started in June 2012, with the "Rio+20" Conference on Sustainable Development, where Governments decided to develop global Sustainable Development Goals, building on the Millennium Development Goals (which expired at the end of 2015) but also including issues such as natural resources management, sustainable consumption and production, effective institutions, good governance, the rule of law and peaceful societies.

The 2030 Agenda for Sustainable Development (2030 Agenda) contained in the document entitled “Transforming Our World: The 2030 Agenda for Sustainable Development” was adopted by the United Nations General Assembly on 25 September 2015. The new agenda seeks to leave no one behind and aspires to transform the world in which we live. The 2030 Agenda forms the new global development framework anchored around 17 Sustainable Development Goals (SDGs) with a total of 169 targets covering economic, social development, and environmental protection. Poverty eradication is the overarching goal of the new agenda which is taking a far more ambitious approach than the Millennium Development Goals (MDGs) by promising to address the unfinished business of the MDGs and meet the growing challenges in the interlinked economic, social and environmental dimensions of sustainable development. The SDGs are the core of this new program for development. The universal nature of the agenda will

provide an opportunity for engagement and a new type of partnership to address the global challenges. In particular, under developed countries can take advantage of this universality of the 2030 Agenda to create partnerships across the goals and ensure effective implementation. Unlike the MDGs, the new agenda is applicable to all countries, developing and developed-rich and poor (ESDN, 2015).

The preamble is presented under the themes of the people, planet, prosperity, peace and partnerships, all of which are interlinked to sustainable development. The 29-page document titled “Transforming Our World: The 2030 Agenda for Sustainable Development,” states:

“We are resolved to free the human race from the tyranny of poverty and want and to heal and secure our planet. We are determined to take the bold and transformative steps which are urgently needed to shift the world onto a sustainable and resilient path. As we embark on this collective journey, we pledge that no one will be left behind (ESDN, 2015 and ECDGICD, 2015).

The 2030 Agenda itself consists of 4 sections: (i) A political Declaration (ii) a set of 17 sustainable Development Goals and 169 targets (iii) Means of Implementation (iv) a framework for follow up and review of the Agenda. In addition, the 2030 Agenda integrates in a balanced manner the three dimensions of sustainable development – economic, social and environmental. The 2030 Agenda is also indivisible, in a sense that it must be implemented as a whole, in an integrated rather than a fragmented manner, recognizing that the different goals and targets are closely interlinked. Moreover, in order to ensure progress and long-term accountability, the 2030 Agenda includes a strong follow-up and review mechanism which will allow all partners to assess the impact of their actions (WSSD2002, ESDN 2015, 2015 and ECDGICD, 2015).

### **Sustainable Development Goals (SDGs)**

The Heads of State and Government and High Representatives, in a meeting at United Nations Headquarters in New York from 25 to 27 September 2015 in celebration of the Organization’s seventieth anniversary, decided new global Sustainable Development Goals. Sustainable Development is a set of 17 "Global Goals" with 169 targets covering a broad range of sustainable development issues ((UNCED 1992, WSSD 2002 and ADB 2008)..Main focuses of the goals are on:

- **People:** To end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment.
- **Planet:** To protect the planet from degradation including sustainable consumption and production , sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations .
- **Prosperity:** To ensure that all human beings can enjoy prosperous and fulfillment lives so that economic and social and technological progress occurs in harmony with nature
- **Peace:** To foster peaceful, just and inclusive societies which are free from fear and violence. There can be no sustainable development without peace and no peace without sustainable development
- **Partnership:** To mobilize the means required to implement this Agenda through a revitalized Global Partnership for Sustainable Development, based on a spirit of strengthened global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders and all people

The 17 Sustainable Development Goals and 169 targets which we are announcing today demonstrate the scale and ambition of this new universal Agenda. They seek to build on the Millennium Development Goals and complete what they did not achieve. They seek to realize the human rights of all and to achieve gender equality and the empowerment of all women and girls. They are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental. The Goals and targets will stimulate action over the next 15 years in areas of critical importance for humanity and the planet.

### **Sustainable Development Goals**

Goal 1: End poverty in all its forms everywhere

Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3: Ensure healthy lives and promote well-being for all at all ages

Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5: Achieve gender equality and empower all women and girls

Goal 6: Ensure availability and sustainable management of water and sanitation for all

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10: Reduce inequality within and among countries

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12: Ensure sustainable consumption and production patterns

Goal 13: Take urgent action to combat climate change and its impacts

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development

The Sustainable Development Goals and targets are integrated and indivisible, global in nature and universally applicable, taking into account different national realities, capacities and levels of development and respecting national policies and priorities. Targets are defined as aspirational and global, with each Government setting its own national targets guided by the global level of ambition but taking into account national circumstances. Each Government will also decide how these aspirational and global targets should be incorporated into national planning processes, policies and strategies. It is important to recognize the link between sustainable development and

other relevant ongoing processes in the economic, social and environmental fields (UN-ESCAP, 2010).

### **Eco-efficiency**

Eco-efficiency emerged in the 1990s as an Eco-efficiency is based on the withstanding principles of the use of high efficiency production technology and methods, the use of less natural resources and energy for the same amount of production and the production of less waste. With this property, eco-efficiency does not just address environmental concerns; instead it also addresses “preservation of natural resources”, “industrial efficiency” and “economic development”. In short, eco-efficiency provides both environmental and economic benefits through production efficiency. Eco-efficiency generates more value through technology and process changes whilst reducing resource use and environmental impact throughout the product or service's life (Mickwitz et al., 2009)

In the eco-efficiency approach, once waste has been generated instead of using disposal and treatment which are set forth in the “end-of-the-pipe method” a more integrative and pro-active approach involving a broad range of prescribed management involving environmental impact product design, buying preferences and production processes. Eco-efficiency conceptually corresponds to the “Cleaner Production” approach. In each of the two concepts, during the production process “natural resources and energy consumption”, “toxic and hazardous chemical use” and “waste, waste water and emission generation” are to be minimized in some manner of controlling means ((Mickwitz et al.,2009).

World Business Council on Sustainable Development in 1991 (WBCSD) defines eco-efficiency as - Eco-efficiency = Product or service value / Environmental influence. The main aspects of eco-efficiency are - reduction of energy, water and virgin material use, reduction of waste and pollution levels, extension of function and therefore product/service life, incorporation of life cycle principles, consideration of the usefulness and recyclability of products/services at the end of their useful life and increased service intensity. Implementing eco-efficiency measures gives businesses a greater understanding of their activities and impacts as eco-efficiency requires the development of organizational, financial and environmental profiles. In addition, businesses using eco-efficiency principles are more profitable and competitive as they use less virgin resources, water and energy, generate less waste and pollution, improve

production methods, develop new products or services and use or recycle existing materials <sup>(9)</sup>.Eco-efficiency measures required integration into management and environmental plans, policies and strategies. Measurement (through the use of appropriate indicators) of eco-efficiency actions is important to determine success (financial and environmental), identify and track trends, prioritize actions and issues and ascertain areas for improvement. Reporting, both internally and externally is also required to communicate progress and obstacles, build shareholder and consumer confidence and report to regulators. Reporting can be integrated into existing reporting and communication mechanisms (ESCAP 2009).

### **Urban Metabolism Urban Infrastructure Development**

The metaphor of a city, or living environment, as a living organism with a collective urban metabolism can be traced back for more than 150 years. More recently, the concept of urban metabolism has been used as an analytical tool to understand energetic and material exchanges ‘between cities and the rest of the world’ (Kenedy, 2011). It is tangential to concepts of ‘regenerative design’, ‘cradle to cradle’ and the emerging academic fields of industrial ecology (Kenedy,2011and Mathew, 2010).Basis is that ecology needs to be the paradigm for technological advancement if global ecosystem health is to be restored. Metabolism is a precondition of life, along with homeostasis (regulation of the internal environment), structural organization, growth, adaptation, response to stimuli, and reproduction. Urban metabolism here is a framework for modeling complex urban systems’ material and energy streams as if the city were an ecosystem. This approach allows the dynamics of cities to be studied in relation to scarcity, carrying capacity and conservation of mass and energy (Mathew, 2010). From this perspective, buildings, districts and entire regions as not only consumers but also potentially significant contributors to essential energy and resource streams. Urban metabolism in a way is opposed to traditional urban planning, in which social, cultural, political and technical dimensions dominate over the biophysical dimension: hence, it synthesized environmental and biological science into the urban planning discipline. It may be stated that- The ‘make-ability’ of our environment is limited and we have to develop new patterns of interaction with the environment including inevitable adaptations of our way of living, working and recreation. Even to those who are thoroughly inured to warnings of impending catastrophe, the World Bank’s recent report on climate change made for alarming

reading. Looking at the consequences of four degrees of global warming, a likely outcome under current trajectories, the Bank concludes that the full scope of damage is almost impossible to project. Even so, it states: ‘the projected impacts on water availability, ecosystems, agriculture, and human health could lead to large-scale displacement of populations and have adverse consequences for human security and economic and trade systems ((The world Bank 2014).The new Urban Economics focus of today identifies urban environments as “greener” than suburban or rural areas; city dwellers use fewer physical resources and emit fewer greenhouse gases per capita than their suburban or rural counterparts. But in terms of human well-being, the quality of the urban environment matters as much as cities’ overall environmental footprint. The urban environment’s capacity to generate ecosystem services has been largely overlooked. This will have to become an important starting point for the development of changed focus in Urban Planning (Timmeren, 2014).

The relevant types of physical infrastructure which are considered in regard to the concept of Urban Metabolism are - Water supply; water extraction and purification, drinking water supply network, Wastewater treatment; sewer, wastewater treatment plants, recovery installations, Solid waste management; solid waste collection, separation facilities, transportation, infrastructure, landfills, incineration facilities, Energy supply; electricity generators, electricity grid, heat network, pipelines for liquid or gaseous energy carriers, Food supply; farms, nutrient supply, storage facilities, Transportation; roads, bicycle infrastructure, pedestrian infrastructure, canals, Public transportation. The morphology of infrastructure is directly linked to the quality of urban metabolism. The infrastructure present in the city will have significant repercussions on the ecological footprint of the inhabitants, without any change in behavior (Timmeren, 2014).

### **Carrying Capacity Based Urban Infrastructure Development**

The carrying capacity concept is based on the fact that the earth can only hold a definite amount of human growth for a definite time. This concept holds a crucial position in determining the quality and state of an ecosystem with respect to the pressures meted by the demands of the dwelling population. In other words carrying capacity of an area refers to an extreme limit. This limit defines the population carrying capacity of the area

.The urban carrying capacity can be defined as the level of human activities, population growth, patterns & extent of land use, physical development, which can be sustained by the urban environment without causing serious degradation and irreversible damage (Jeong et al 2005). If this limit is crossed then the nature will react by imposing pressure to resist the abrupt growth and development of the people resulting into equilibrium. These pressures can be in the form of floods, droughts, landslides, famine etc. The pattern and extent of resource usage serves to be the primary factor that affects the carrying capacity a lot. This indeed depends highly on the socio-economic status of the people. Secondly, the use of technology also influences the carrying capacity (Rees 1992).

The sustainability of an environment can be understood as its endurance capability, i.e. making the resources available for usage forever. So, it can be well said that sustainability can be measured by the carrying capacity. Thus sustainable developments indirectly govern the Carrying Capacity. The carrying capacity concept can be utilized in planning and development of urban areas to keep a balance between built environment and natural environment which is currently a challenging task. Under prevailing socio-economic conditions, the application of carrying capacity concept enables to determine the optimum population that can be supported within a given area with adequate infrastructure facilities so that Development is environmentally hazard free and sustainable (Perrin 2013). Carrying capacity is not static but is based on the complex relation of preferences, application of technology and patterns of production & consumption. They are also contingent on the state of interactions of the biotic and abiotic environment. So the different workers have come up with various models<sup>(18)</sup> which give an idea about calculation of carrying capacity: Graphical model, Uni-constraint model, IPAT equation, Ecological Footprint model, Energy analysis model, Pressure-State-Response model (Perrin, 2013).

Since, ecological footprint and carrying capacity are both measured in the same units, they can be compared directly. If the ecological footprint of a region is larger than the carrying capacity, the region runs an “ecological deficit”. On the contrary, if the carrying capacity of a region is larger than the ecological footprint, the region runs an “ecological remainder. USA was having a larger ecological footprint with respect to its available ecological capacity, i.e. it was facing an ecological deficit in the year 1997. However, New Zealand was having an ecological

remainder in the same year. Our country India was just at the threshold level in the same year (Ewing et al., 2008).

## ECO-EFFICIENT AND SUSTAINABLE URBAN INFRASTRUCTURE IN ASIA AND THE PACIFIC

The infrastructure we build today will shape the way we produce and consume for the decades to come. In an era of rising natural resource scarcity and increasing vulnerability to climate change, infrastructure eco-efficiency has vital implications for both economic and environmental sustainability. In spite of its remarkable economic performance, Asia-Pacific is still faced with significant developmental challenges. The region is home to 2/3 of the world poor, more than 600 million lack access to safe drinking water, 1.5 billion are without proper sanitation and 800 million without electricity, among others. The need for increased economic growth to overcome these challenges raises the question of how to support the consequential levels of production and consumption. With a lower carrying capacity and a population density 50% higher than world average the region is in fact already living beyond its means (Jeong et al., 2005).

Countries in the region cannot afford to follow the conventional development path of “grow first, clean-up later”. Hence, the urgent need to decouple economic activities from environmental pressures. It is necessary to deliver better goods and services with less resources and lower pollution; in other words, to improve the eco-efficiency of our societies and pursue an environmentally sustainable economic growth, or Green Growth. Currently 1.6 billion people or 40% of Asians live in urban areas. By 2030, a majority (around 2.7 billion) will live in cities and towns. This means adding a new town of roughly 130,000 people every day for the next 21 years (Perrin et al., 2013).

This trend represents a tremendous challenge in delivering cost-effective and affordable services to the population. Considering that cities contribute 67% of world’s primary energy demand and are responsible for 71% of global CO<sub>2</sub> emissions, the imperative is to do so in the most environmentally-friendly manner. Infrastructure systems are an integral part of urban development and a deciding factor in determining urban form, delivering services to communities, and supporting economic growth. Infrastructure has also immediate and long-term environmental impacts. Building infrastructure not only disrupts the local eco-system and often requires intensive use of physical resources and energy; it also locks cities

into consumption and production patterns for decades. Buildings alone are estimated to contribute up to 40% of energy use and greenhouse gas emissions over their life span. Traffic congestion costs, which is as high as 6% of GDP and poor-quality infrastructure have been found to be the main factors negatively influencing competitiveness of urban areas. Cities in Asia and the Pacific are at a crossroads in developing and expanding infrastructure in support of fast economic growth and rapid urbanization. Choices made in urban infrastructure development today will determine the competitiveness, quality of life and sustainability of cities in the region for decades to come (Zhao et al., 2005).

In order to assist cities in the region in responding to these challenges, “Eco-efficient and Sustainable Urban Infrastructure” highly recommended. Eco-efficiency should be promoted as a key criterion for sustainable infrastructure development (Zhao et al., 2005).

## INTEGRATION OF ECO-EFFICIENT AND SUSTAINABLE DEVELOPMENT GOALS FOR URBAN INFRASTRUCTURE DEVELOPMENT

After discussing various experiences and policy options of infrastructure development, it may be suggested that for development of Eco-efficient and Sustainable Urban Infrastructure following approaches should be adopted (Arrow et al., 2005, Ewing et al., 2005 and Mathew et al., 2010)

- It is necessary to develop sustainable infrastructure development policies and strategies, taking into account the eco-efficiency concept that includes all aspects of infrastructures and also seeks to merge and combine such systems, such as transportation and energy
- A holistic approach is needed in infrastructure development, considering both consumption and production aspects, physical and non-physical aspects, different stages of infrastructure development, different levels of organizations, and role of different stakeholders;
- Conventional Environmental Impact Assessment (EIA) is not enough to reflect the long-term environmental impact of infrastructure development. Thus, Strategic Environmental Assessment (SEA), which takes into account the long-term ecological impact of infrastructure, can be an important policy tool in promoting sustainable infrastructure

- Green GDP should be used as a tool in promoting green growth which will make it possible to measure pollution cost. However, it has also a limitation as the valuation of environmental degradation is difficult and it does not cover the social cost causing from inefficient use of resources;
- The technical expertise of the private sector in development of infrastructure will definitely be beneficial. However, the private participation does not automatically guarantee the promotion of sustainable infrastructure. The private participation in infrastructure development needs to be carefully evaluated and scrutinized
- It is necessary to develop strategies for attitude change, including education and awareness raising and ensuring decision making processes that give conscious attention to environmental and social objectives
- There is a need to apply eco-efficiency concept into water infrastructure development. Not only efficiency of infrastructure investment but also eco-efficiency of operation and maintenance of water infrastructure need to be improved;
- Opportunities for improving eco-efficiency in water infrastructure should include reducing water demand by increase public awareness, applying integrated water resource management, increasing water recycling, and minimizing water loss
- New paradigm for rainwater management is required in order to maintain environmental sustainability and mitigate flooding and drought. Rainwater could be the main source of water supply with less energy input
- There is a need for developing countries in the region to include a goal such as “enhanced energy independence” in their infrastructure development plans so that local and renewable energy resources may be used to generate power for buildings and fuel for transportation.
- Climate responsive building design codes applicable to each country need to be developed. Such climate responsive building design code will have the goal to reduce the heat gain, while using natural ventilation and natural cooling
- Development of Green building concept and code
- Eco-efficient and effective air-conditioning systems need to be developed, taking into account the climate of the countries and the use-side of energy efficiency
- It is necessary to develop energy efficiency strategies in respect to which will increase awareness and education in housing and building design and householder behavior
- “Agile energy” infrastructures can be created that combine “central grid” and local “on-site distributed” energy from renewable energy transmission over lines from long distances to local green building complexes that use energy conservation, efficiency and solar energy;
- It is necessary to work towards improving the eco-efficiency of transport sector by developing and realizing an appropriate vision of eco-efficient and sustainable transport firmly rooted in the concept of green growth
- Regional approach to promote eco-efficient and sustainable transport is needed, in such areas as regulation, technology, and innovation. In order to move towards eco-efficient transport systems,
- It is necessary for the countries in the region to develop guidelines for eco-efficient and sustainable transport based on local traffic and land use conditions.

Thus, as part of the environmentally sustainable growth agenda, project proponent should support the use of environmentally friendly technologies, the adoption of environmental safeguard measures, and the establishment of institutional capacities to strengthen the enforcement of these measures. At the convergence of these two development agendas lies the concept of sustainable infrastructure. Its basic principles which can be suggested are:

- Promoting low-carbon development and minimizing impacts on local environments (e.g., renewable energy);
- Advancing solutions that help communities deal with the unavoidable impacts of climate change (e.g., climate resilient infrastructure);
- Improving the access of poor people to education, health, and basic social protections, as well as to markets and productive assets;
- Emphasizing gender equality and the empowerment of women;
- Improving the transparency and efficiency of public resource management (e.g. controlling wasteful public spending and corruption); and
- Attracting direct private sector investments that support inclusive growth and improve the environment.

## CONCLUSION

The way we build our cities and their infrastructure is critical for developing competitive and livable cities. Cities in Asia-Pacific are already suffering from severe environmental problems, while the basic needs of millions of urban citizens are yet to be met. The unprecedented urbanization trend in the region poses an even greater challenge for providing adequate housing, transportation, energy, water and sanitation to all. To make sure that cities develop into attractive, competitive and livable places, a major shift is needed in the way infrastructure is designed, planned and managed. Eco-efficiency and social inclusiveness principles and criteria can help realize the necessary win-win situations. Inclusively planned and developed eco-efficient infrastructure can be a driver of economic growth and competitiveness, increase employment opportunities, improve quality of life, contribute to poverty alleviation, enhance energy security, improve the environment and avoid future costs and risks.

Eco-efficiency is a management philosophy which will encourage municipalities, businesses and communities to seek environmental improvements that will generate parallel economic and social benefits. An inclusive planning and development approach will promote equal opportunities for all people. When eco-efficiency concept will be applied to infrastructure, this will increase access to and the quality of services, such as housing, transportation, energy, water and waste treatment, while reducing costs and environmental problems, such as pollution, inefficient energy use and traffic congestion.

Infrastructure systems need to be redesigned and developed in accordance with eco-efficiency and social inclusiveness principles and criteria. Essential strategies should be developed for cities to achieve win-win situations and develop into attractive, competitive and livable places.

Following aspects should be considered for further analytical and policy work:

- Carrying out in-depth studies and analysis of regional experience on eco-efficiency project development compilation of good practices, as well as organization of capacity-building programme, and development of pilot or demonstration projects
- Furthering the work on the eco-efficiency indicators to include eco-efficiency indicators for sustainable infrastructure development, while considering existing

indicators such as water loss rate, solid waste generation rate, and energy use rate/intensity in transportation

- Dissemination of information on the importance and good practices of eco-efficiency in sustainable infrastructure development among decision-makers, planners, academics and related stakeholders
- Developing conceptual methodologies to improve eco-efficient infrastructure, such as congestion cost estimation to include not only time delay and oil consumption, but also environmental cost
- Developing guidelines for achieving eco-efficient infrastructure development in the region using existing information as much as possible, considering potential policy tools and strategies that are appropriate to different sectors, development stages, urban and rural conditions

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