KRIHS SPECIAL REPORT 2010

Green Growth: A Paradigm Shift in Regional Development
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Hiroaki Suzuki has more than 20 years of the World Bank operational experiences in infrastructure sector and public sector management. Having worked in East Asia and Pacific Region, as East Asia Urban Sector Leader/China Urban Sector Coordinator for the last five years, he joined the World Bank’s corporate Finance Economics & Urban Department (FEU) in 2009 as Lead Urban Specialist. He is the main author of “Eco² cities: Ecological Cities as Economic Cities (www.worldbank.org/eco2)”. Eco² Cities Initiative which helps cities in developing countries achieve ecological and economic sustainability is a World Bank’s new urban sector business line which has been adopted as an integral part of the World Bank’s new urban sector strategy launched in November 2009. He graduated from MIT Sloan School of Management and Yokohama City University and obtained French Diploma from Caen University, France.

Hinako Maruyama is an Urban Specialist in Urban & Local Government Unit of the World Bank. As a member of the Eco² Cities team, she has written Case Studies for the Eco² Cities book and been involved in the book production as well as various assignments for Eco² promotion and dissemination. Prior to the World Bank, Hinako was an urban planner at a planning consultancy firm and worked in Vietnam and Indonesia. She holds Bachelor of Engineering in Architecture and Master of Science in City and Regional Planning.

Eco² Cities:
Ecological Cities as Economic Cities and Extended Platform for Collaborative Regional Development
Innovation and Regional Development: International Experiences on Innovation Clusters

**Byung-ho Oh** is Professor at KDI School of Public Policy and Management. He received his Ph.D. in Urban and Regional Planning from the Massachusetts Institute of Technology in the United States. His professional interests are: 1) Urban Planning; 2) Regional Development Planning; 3) Real Estate (Development, Financing, Marketing, and Site Analysis); 4) Infrastructure (Private Financed Infrastructure Development); and 5) Program Evaluation areas. Major Research works include 「Planning Free Economic Zone」(2010), 「Urban Management」(2009), 「Daedeok Innopolis: A Model for Regional Competitiveness」(2009), and 「Korea national real estate asset management advancement strategy」(2009).

Energy-Efficient Transport Systems and Urban Policy

**Nam-geon Cho** is senior research fellow of KRIHS. He received his Ph.D. in Engineering from Graduate School of Environmental Studies, Seoul National University. His major research fields include transportation planning, road projects appraisal and ex-post evaluation, high speed train and its impacts, and green growth policy. Major research works include 「A Study on the Arterial Road Network Systems in Regional Metropolitan Areas」(2010), 「Green Growth and National Territorial Development : Transportation Sector Analysis」(2009), 「Mitigation of Local Conflicts over the New Ansan Railroad Line」(2009), 「A Basic Plan for the Ring Road of Ulleungdo(Island)」(2009), 「A Basic Study on 1.5 Lane Road: Focusing on Improving of One Lane Road」(2008), 「Improvement on the Connection of Express Highways for the Preparation of Emergency Situation」(2008), 「Improvement measures on Road Related Law System」(2008), and 「Ex-post Evaluation on Chungbu and Other 5 Routes of Express Highway」(2006). He is currently head of the Center for National Infrastructure Policy at KRIHS.
Korea will be hosting the G20 summit meeting in November this year. It is a proof that Korea is emerging as an international leader in politics and economics. The Korea Research Institute for Human Settlements (KRIHS) has been promoting international cooperation and exchanges with advanced nations and providing aids to developing countries over the past 30 years. In 2009, KRIHS and the World Bank Institute (WBI) have jointly hosted an international seminar under the theme *Green Growth: A Paradigm Shift in Regional Development*. The goal of the seminar was to devise strategies to support green growth initiatives of developing countries and promote cooperation between KRIHS and WBI.

The reason for selecting green growth as the main theme of the seminar was because currently, the world is suffering from energy depletion crisis, with the entire world dependent upon fossil fuels for 85% of its energy. The use of fossil fuels generates greenhouse gases, which in turn, causes global warming that threatens the existence of mankind. The average global temperature is rising by 0.74 degrees annually, and it is creating such bizarre phenomena around the world as drought, flood, heat wave, and the destruction of the natural habitat.

These gave rise to interest in green growth; since the oil crisis in the 1970s, increasing number of countries have been trying to apply green growth models, emulating models of nations such as Denmark and Germany, which achieved energy independence.

Korea also jumped on the global bandwagon towards green growth. On August 15, 2008, in a speech commemorating the 60th anniversary of the foundation of Korea, President Lee Myung-bak set “low-carbon, green growth” as the national vision for the next 60 years. Since then, the Presidential Committee on Green Growth has been formed to deliberate government’s policies, plans, and action plans.
At the seminar, various efforts taken by the Korean government to achieve green growth were introduced by Korean professionals. They include the restoration of four major rivers, formation of green growth strategies, and designation of special economic zones as new growth engines. It was a venue for sharing global issues related to urban development; eco city initiatives; green growth initiatives of emerging economies; policies and strategies for improving fuel economy and saving energy; and regional development and innovation in this knowledge-based economy. In addition, 2010 World Development Reports were presented for the first time at the seminar. It emphasized that we should “act now,” as today’s actions determine tomorrow’s options and much as at risk already due to the rapid climate change; “act together,” meaning that high-income countries need to take the lead but that all have a role to play in this global initiative; and “act differently,” referring to the need to make robust rather than optimal decisions.

This special edition of the Special Report contains three presentations covered at the seminar. The first one is “Eco² Cities: Ecological Cities as Economic Cities and Extended Platform for Collaborative Regional Development” by Mr. Hiroaki Suzuki, Lead Urban Specialist of the World Bank, and Ms. Hinako Maruyama, Urban Planner of the World Bank. It describes Eco² Cities initiative and introduces the Hammarby Model, a good example of an integrated planning that helped reduce the use of resources and emissions; and an overview of the Auckland Sustainability Framework. It discusses how to go from ecological cities versus economic cities (Eco versus Eco) to ecological cities as economic cities (Eco² cities). “Innovation and Regional Development: International Experiences on Innovation Clusters” by Mr. Byung-ho Oh, professor of KDI School of Public Policy and Management, outlines the growth of East Asian economies and innovation clusters and designation of Special Economic Zones. It introduces overseas case studies including Chinese and Singapore case studies as well as domestic case studies. The last presentation, “Energy-Efficient Transport Systems and Urban Policy” written by Mr. Nam-geon Cho, head of the Center for National Infrastructure Policy at KRIHS, communicates energy saving measures for current transport system, which include development of green cars, hybrid vehicles, and alternative fuel, and eco-driving and education. It also discusses urban policies that help save energy: setting restriction on car use, promoting the use of public transportation, and forging bicycle and pedestrian-friendly cities.
I believe this Special Report would provide you with a better understanding on the importance of green growth. It is my pleasure to recommend you this special edition of the Special Report. My sincere thanks goes to all who have contributed to this report and especially to the staff of KRIHS and the World Bank who have organized this seminar and put together the presentations in this special edition.

Thank you very much.

Yang-ho Park, PhD
President
Korea Research Institute for Human Settlements
It is my pleasure to have the chance to review the senior policy seminar on *Green Growth: A Paradigm Shift in Regional Development* held Nov 9-11, 2009 in Seoul, Korea. It was one of the annual seminars on Regional Development co-organized by the Korea Research Institute of Human Settlement (KRIHS) and the World Bank Institute (WBI).

The goal of the seminar was to strengthen the capacity of policy makers in pursuing green growth, i.e., low carbon, high economic growth. It aimed to i) provide policy makers with current perspectives and policy instruments for green growth; ii) enable policy makers to develop the strategy for green growth; and iii) provide a venue for exchanging views on green growth and building regional networks.

It was targeted towards senior level government officials from Ministries of Planning, Development, Environment and/or Finance in East Asia and the Pacific (EAP) Region. It was truly a successful event: Roughly more than 70 persons participated, including 16 officials from 8 EAP countries, 5 resource persons invited by WBI, 6 resource persons from Korea, and other researchers, students, and audiences.

The seminar came at both an opportune and challenging time: with the EAP Region, like the rest of the world, still in the midst of a financial crisis on one hand; and during the run up to the then-upcoming global conference on climate change in Copenhagen on the other hand.

Indeed, one of the key issues we have discussed during the seminar was how to balance immediate needs to address the financial crisis with longer-term needs for policies and strategies that are both economically and environmentally sustainable and which take into account both national interests and the regional and global imperative to take action on climate change.
While these are issues of global concern, they are particularly important to the EAP Region, as several countries in this Region are among the fastest growing sources of greenhouse gas emissions worldwide. As we know, many EAP countries are vulnerable to climate related threats due to rapid industrialization and fast-growing population. Especially, three of the EAP countries—China, Malaysia, and Thailand—have the highest rate of growth in fossil fuel CO₂ emissions and two—China and Indonesia—have the highest greenhouse gas emissions.

Also it is well known that the EAP Region is very vulnerable to climate change induced natural disasters, as evidenced by recent occurrences in the Philippines, Indonesia and Southern China.

Recent global financial crisis can aggravate the present burden to meet the challenge and draw attention away from long term dangers of climate change. Previous experiences with the 1997 financial crisis showed that developing countries sought direct and emergent impact from economic policies, at the cost of environmental damage. It is, therefore, crucial to find policy options that can achieve both economic growth and environmental sustainability.

Some countries in the EAP region see the opportunity to tackle the challenge and use the “green stimulus,” including energy efficiency, water management, and low carbon infrastructure. In South Korea, 80.5 percent of its fiscal plan is allocated to “green” investments. A large part of the investment in China—$221 billion of $586 billion—is low carbon spending in stimulus package. Thailand also included alternative energy and efficiency of water system in their fiscal package.

Public investments in energy efficient infrastructure are expected to support economic recovery through job creation and improve resilience to climate change. For instance, in South Korea, investment in infrastructure, water management, and energy efficiency

2) Understanding the Links between Climate Change and Development (p.59), 2009.
3) Transforming the Rebound into Recovery, EAP Update November 2009 (p.85), 2009.
is expected to create an estimated 960,000 jobs in the next four years. Also China devotes 155 billion to energy saving infrastructure in transport, electricity, and road\textsuperscript{4).

To assist client countries in the EAP Region, the World Bank has conducted analytical works, i.e., need assessment and country environment analysis; provided technical assistance in carbon finance; and developed large Global Environment Facility projects. This seminar is counted as one of those efforts by the World Bank.

During the two days, we discussed and shared experiences on how these issues are being addressed by various countries around the EAP Region and looked at what can be done both by individual countries and through regional coordination and collective action to address the challenges ahead. The topics included i) International experiences in Green Growth from OECD countries and EAP countries; ii) Low carbon infrastructure: transport, road, and water management; and iii) Energy-efficient technology.

The main findings and messages of some of the research that the World Bank has conducted on these subjects were shared with the participants, including 2009 and 2010 World Development Reports which focused respectively on climate change and economic geography. The main message—act now, act together, act differently—of WDR 2010 was picked up and presented by Mr. Kirk Hamilton; it was also used by the partner institute, KRIHS.

Mr. Oesha Thakoerdin from CE-DESD described the international perspective on strategic management for regional development towards pro-environmental growth. Regional development strategy under climate change and Korean experience on green growth strategy were presented by Mr. Bon-jin Koo from the Ministry of Strategy and Finance in Korea.

We also talked about various programs and facilities that the World Bank (and other International Organizations) can make available to support this agenda, including Climate Investment Fund, Global Facility for Disaster Reduction and Recovery, and

\textsuperscript{4) Understanding the Links between Climate Change and Development (p.59), 2009}
Eco² Cities Initiative. Especially, Mr. Hiroaki Suzuki presented on the frontier WB program named “Eco² Cities: Ecological Cities as Economic Cities.”

Ms. Sophie Punte from CAI-Asia Center and Mr. Nam-geon Cho from KRIHS covered issues on investment for energy efficient technology and shared some implications from international experiences on how to combine this technology with urban development. Four-Major-River Restoration in Korea, presented by Mr. Hong-suk Kim, professor of Seoul National University, covered the issues on enhancing the quality of life through the construction of large, pro-environmental infrastructures.

We looked at policies and experiences in such areas as eco-efficient urban planning, infrastructure, and transport, as well as at how innovative solutions such as low-carbon and energy-efficient technologies could be fostered. Three Korean speakers, Mr. Sam-ock Park from Seoul National University, Mr. Byung-ho Oh from KDI School of Public Policy and Management, and Mr. Hyung-seo Park from KRIHS, spoke on specific innovation policies and special economic zones using case studies and discussed implications from international experiences on how to combine them with regional development.

While we have assembled a number of experts from the World Bank, KRIHS, and other relevant institutions in Korea, I believe that the most important resource we had were the participants—all of whom were on the front lines of these issues in their respective countries. So I would like to express my appreciation for their active participation in the discussions and sharing of their experiences and ideas.

Let me conclude by once again thanking all the staff of KRIHS and the World Bank for preparing the seminar and providing us with a chance to publish some of the papers that were covered at the seminar.

Thank you very much.

Eon-seog Song
Director General
Ministry of Strategy and Finance
Eco² Cities: Ecological Cities as Economic Cities and Extended Platform for Collaborative Regional Development
The World Bank has recently adopted Eco² Cities Initiative: Ecological Cities as Economic Cities, as an integral part of the World Bank Urban and Local Government Strategy. Eco² Cities Initiative is to help cities in developing countries achieve their ecological and economic sustainability. As cities are expanding rapidly their geographical boundaries as well as the range of their economic activities, the coordinated regional development has become critical issue for cities in achieving sustainable urban development. This paper first introduces Eco² Cities Initiative as practical approach for cities’ sustainable development and highlights the needs for extended platform for collaborative design and decision-making for regional planning and development. The case of Auckland, New Zealand, was introduced to demonstrate an example of planning framework and process for the regional collaboration. This paper is based on Eco² book published by the World Bank (www.worldbank.org/eco2).

1. Introduction

Urbanization in developing countries may be the most significant demographic transformation in our century, as it restructures national economies and reshapes the lives of billions of people. It is projected that the entire built-up urban area in developing countries will triple between 2000 and 2030, from 200,000 to 600,000 square kilometers (Angel, Sheppard, & Civco, 2005). These 400,000 square kilometers
of new urban built-up area that will be constructed within only 30 years equal the total built-up urban area throughout the world as of 2000 (Angel, Sheppard, & Civco, 2005). One might say that we are building a whole new urban world at about 10 times the speed in countries with serious resource constraints (natural, fiscal, administrative, and technical). We are doing so in an increasingly globalized context characterized by many new, constantly fluctuating, interlinked, and uncontrollable variables.

What is driving this massive rate of urbanization? Historically and across most regions, urbanization has propelled the growth of national economies. On average, about 75% of global economic production takes place in cities, and, in developing countries, this share is now rapidly increasing (World Bank, 2009). In many developing countries, the urban share of national GDP already surpasses 60% (World Bank, 2009). In most regions of the world, the opportunities provided by urbanization have enabled large segments of populations to lift themselves out of poverty.

However, urbanization at this rate and scale is certain to be accompanied by unprecedented consumption and loss of natural resources. Calculations already show that, if developing countries urbanize and consume resources as developed countries have, resource base equivalent to four planet earths will be needed to support the growth (Rees, 2001). But, of course, we have only one Earth. The resource base essential for sustaining the rural-urban transition will not be available unless the cities in developing countries and in developed countries find more efficient ways to meet the needs of their populations.

It is clear that, if we are to absorb and sustain this powerful wave of urbanization in developing countries, while managing the existing built stock, a paradigm shift will have to occur. The fundamental questions to be addressed are: How can cities continue to harness effectively the opportunities for economic growth and poverty reduction offered by urbanization, while also mitigating the negative impacts? How can cities accomplish this given the speed and the scale at which urbanization is progressing and given their own capacity constraints? How can ecological and economic considerations be dovetailed so that they result in cumulative and lasting advantages for cities? How do we go from ecological cities versus economic (Eco versus Eco) to ecological cities as economic cities (Eco² cities)?

Innovative cities have demonstrated that, supported by the appropriate strategic approach, they may greatly enhance resource efficiency by realizing the same value from
a much smaller and renewable resource base, while decreasing harmful pollution and unnecessary waste. By achieving this, they have improved the quality of the lives of their citizens, enhanced their economic competitiveness and resilience, strengthened their fiscal capacity, provided significant benefits to the poor and created an enduring culture of sustainability. Urban sustainability of this kind is a powerful and enduring investment that will pay compounding dividends. In a rapidly paced and uncertain global economy, such cities are the most likely to survive shocks, attract businesses, manage costs, and prosper.

Most encouraging about the efforts made by these innovative cities is the fact that many of the solutions are affordable even if budgets are limited, and they generate returns, including direct and indirect benefits for the poor. At the same time, much of the success may be achieved by using existing, well-tested methods and technologies and by focusing on local, homegrown solutions.

The challenge that lies ahead is to take full advantage of the many opportunities created by the rapid rates of change and by successful innovations for sustainable growth. Inappropriate institutional structures and mind-sets are commonly cited as the single greatest challenge whenever cities try to take advantage of such opportunities. Best practices exist for long-term planning and regional growth management, and the emergence of new tools for systems analysis and mapping offers potential for more well integrated, practical, and rigorous analysis and planning. Methods for collaborative design and decision making among key stakeholders have also proven effective. Realizing that successful cities are often fundamental to successful nations, the higher levels of government are becoming key partners in helping cities take the initiative.

It is for the purpose of enabling cities in developing countries to benefit from the promise of a more rewarding and sustainable growth trajectory while the window of opportunity is still open to them that the Eco² Cities initiative has been developed.
2. Ecological Cities as Economic Cities

*What Do We Mean by “Ecological Cities”?* Ecological cities enhance the well-being of citizens and society through integrated urban planning and management that harness the benefits of ecological systems and protect and nurture these assets for future generations.

Ecological cities strive to function harmoniously with natural systems and value their own ecological assets, as well as the regional and global ecosystems on which we all depend. Through their leadership, planning, policies, regulations, institutional measures, strategic collaborations, urban design, and holistic long-term investment strategies, they drastically reduce the net damage to the local and global environment, while improving the overall well-being of their citizens and the local economy. Ecological cities also learn from and incorporate management and design solutions that arise from the efficient and self-organizing strategies used by ecosystems.

*What Do We Mean by “Economic Cities”?* Economic cities create value and opportunities for citizens, businesses, and society by efficiently utilizing the tangible and intangible assets of cities and enabling productive, inclusive, and sustainable economic activity.

Often, when people talk about economic cities, they are referring to a narrower definition of productive cities that is driven by a singular emphasis placed on the indicator of GDP. While productivity is certainly an attribute of economic cities, it is not the only attribute, and the short-term and excessive pursuit of productivity often displaces fundamental social and cultural considerations and may undermine longer-term economic resilience. In some cases, an overemphasis on productivity overshadows our basic value systems and exposes us to substantial and systemic risk, as evidenced in the causes and consequences of the current global economic crisis. We propose a more balanced notion of economic cities whereby the emphasis falls on sustainable, innovative, inclusive, and resilient economic activity within the context of a larger cultural and value system.

*What Do We Mean by an “Eco’ City”?* As the name implies, an Eco’ City builds on the synergy and interdependence of ecological sustainability and economic sustainability and the fundamental ability of these to reinforce and strengthen each other in the urban context.

Innovative cities have demonstrated that, supported by the appropriate strategic
approach, they are able greatly to enhance their resource efficiency by realizing the same value from a much smaller and renewable resource base, while decreasing harmful pollution and unnecessary waste. By achieving this, they improve the quality of the lives of their citizens, enhance their economic competitiveness and resilience, strengthen their fiscal capacity, provide significant benefits to the poor and create an enduring culture of sustainability. Urban sustainability of this kind is a powerful and enduring investment that will pay compounding dividends. In a rapidly paced and uncertain global economy, such cities are most likely to survive shocks, attract businesses, manage costs, and prosper.

It is for the purpose of enabling cities in developing countries to realize this value and take on a more rewarding and sustainable growth trajectory that the Eco² Cities Initiative has been developed.

3. Overview of Eco² Cities Initiative

Eco² Cities initiative is a comprehensive support program which provides cities with a practical, scalable, analytical and operational framework that can be applied to the particular challenges of each city. The framework also includes methods and tools that make it easier for cities to adopt the Eco² approach as part of their city planning, development and management. It also assists cities in developing countries access financial resources needed for strategic urban infrastructure investments.

A number of innovative best-practice cities around the world have demonstrated how ecological and economic progress can go hand-in-hand. For example, Stockholm has demonstrated how integrated and collaborative planning and management can transform an old inner city industrial area called Hammarby Sjöstad into an attractive and ecologically sustainable district, based on a cyclical urban metabolism. The district is seamlessly integrated into the larger urban fabric, and has provided inspiration for more initiatives in the city and catalyzed change. Some of the initial results have been a 30% reduction in nonrenewable energy use and a 41% reduction in water use. Below Figure 3.1 shows the Hammarby Model of the district, which is the good example of integrated planning and management based on a cyclical urban metabolism that leads to substantial reductions in resource use and emissions.

Four Principles of Eco² Cities Initiative: Cities that have benefited greatly by
undertaking comprehensive approach such as above case have been carefully assessed. Also major challenges that have prevented most other cities from accomplishing similar achievements have been examined in detail. Subsequently, a framework for Eco2 has been structured around four key principles that have been found to be integral to lasting success. These principles are the foundation upon which the initiative is built. They are (1) a city-based approach enabling local governments to lead a development process that takes into account their specific circumstances, including their local ecology; (2) an expanded platform for collaborative design and decision making that accomplishes sustained synergy by coordinating and aligning the actions of key stakeholders; (3) a one-system approach that enables cities to realize the benefits of integration by planning, designing, and managing the whole urban system; and (4) an investment framework that values sustainability and resiliency by incorporating and accounting for life-cycle analysis, the value of all capital assets (manufactured, natural, human, and social), and a broader scope for risk assessment in decision making (see table 3.1).
Table 3.1. The Eco² Cities Principles, Core Elements and Stepping Stones

<table>
<thead>
<tr>
<th>Principles</th>
<th>Core Elements</th>
<th>Stepping Stones (Actions to be taken)</th>
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<tbody>
<tr>
<td>1. A city-based approach</td>
<td>• A development program that supports cities in making good decisions and implementing these decisions using all levers of city influence and control</td>
<td>• Review the Eco² initiative and adapt the Eco² principles to the local context, especially current issues of concern and the local political constraints</td>
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<td></td>
<td>• A planning philosophy that recognizes the fundamental role played by local ecological assets in the health and wealth of cities and their surrounding rural communities</td>
<td>• Identify champion(s) and the specific groups or individuals who are vital to success</td>
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<td>• An action-oriented network that provides city leaders with the full support of national governments, the international development community (including the World Bank), and global best practice cities</td>
<td>• Obtain commitments from city councils and influential groups and people</td>
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<td></td>
<td>• A decision support system with methods and tools that adapt to varying levels of knowledge and skill and provide cities with the technical, administrative, and financial capacity to develop an Eco² pathway</td>
<td>• Work closely with national governments and, where possible, dovetail the Eco² elements so they clearly fit within national priorities</td>
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<td></td>
<td>• Review the Eco² initiative and adapt the Eco² principles to the local context, especially current issues of concern and the local political constraints</td>
<td>• Seek a partnership with the international development community (including the World Bank), best practice cities, and Eco² initiative partners</td>
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<td></td>
<td>• Identify champion(s) and the specific groups or individuals who are vital to success</td>
<td>• Outline a process for building capacity and enhance the skills and knowledge of local professional staff</td>
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<td></td>
<td>• Obtain commitments from city councils and influential groups and people</td>
<td>• Develop fluency of concepts among local decision makers using case studies from this book and other supporting materials</td>
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<td></td>
<td>• Work closely with national governments and, where possible, dovetail the Eco² elements so they clearly fit within national priorities</td>
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<tr>
<td>2. An expanded platform for collaborative design and decision-making</td>
<td>• A three-tier platform that enables a city to collaborate (1) as a model corporation, engaging all city departments; (2) as a provider of services, engaging residents, businesses, and contractors; and (3) as a leader and partner within the urban region, engaging senior government officials, utilities, rural settlements, private sector stakeholders, nongovernmental organizations, and academia</td>
<td>• Initiate a process for collaborative decision making and integrated design to develop the Eco² approach as a corporation, as a provider of services, and as a leader within the larger urban area</td>
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<td>• A shared long-term planning framework for aligning and strengthening the policies of the city administration and key stakeholders and for guiding future work on Eco² projects</td>
<td>• Prepare a mandate and budget for a secretariat that can support collaborative committees through background research on cross-cutting issues and the facilitation of regular meetings, communications products, and event planning</td>
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<td></td>
<td>• Prepare a long-term planning framework, in collaboration with others, and seek consensus on common goals and indicators of performance, an overarching growth management strategy, and an adaptive management approach</td>
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<td>• Select a catalyst project suitable for demonstrating the Eco² principles, aligned with the goals and strategies identified in the long-term planning framework</td>
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Table 3.1. The Eco² Cities Principles, Core Elements and Stepping Stones (Continued)

<table>
<thead>
<tr>
<th>Principles</th>
<th>Core Elements</th>
<th>Stepping Stones (Actions to be taken)</th>
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<tbody>
<tr>
<td>3. A one-system approach</td>
<td>• Integrated infrastructure system design and management focusing on enhancing the efficiency of resource flows in an urban area</td>
<td>• Provide just-in-time training and capacity building, arrange for multiple opportunities for local professionals to become comfortable with the one-system approach, and make the best use of technical support so it may be truly transformative and valuable</td>
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<td>• Coordinated spatial development that integrates urban forms with urban flows, combining land use, urban design, urban density, and other spatial attributes with infrastructure scenarios</td>
<td>• Conduct a series of integrated design workshops to create important opportunities for planners, designers, and engineers to come together and use new methods and information; a series of short workshops can clarify goals and set targets; the long-term planning framework can guide, design, and stimulate creative solutions</td>
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<td>• Integrated implementation by (1) correctly sequencing investments, (2) creating a policy environment that enables an integrated approach, (3) coordinating a full range of policy tools, (4) collaborating with stakeholders to align key policies with long-term goals, and (5) targeting new policies to reflect the differing circumstances involved in urbanization in new areas and in improving existing urban areas</td>
<td>• Explore design solutions and prepare a concept plan for review; an integrated design process should be used to generate alternative proposals on ways to design, construct, and manage the project; an intensive, multiday urban systems design charrette can facilitate the integrated design process; the integrated design process should culminate in a recommended concept plan for implementation, including any policy reforms</td>
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<td>• Provide just-in-time training and capacity building, arrange for multiple opportunities for local professionals to become comfortable with the one-system approach, and make the best use of technical support so it may be truly transformative and valuable</td>
<td>• Align a full set of policy tools to ensure successful implementation, in collaboration with stakeholders, to sequence and enable a one-system approach and to coordinate actions across sectors; a strategic action plan can be prepared to clarify who is responsible for what tasks and to show how policies interact</td>
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The principles described above underlie the Eco² approach. The four principles are interrelated and mutually supportive. Using the analytical and operational framework, a city may apply the principles through a set of core elements and use these elements to create a phased, incremental Eco² pathway (see the figure 3.2). The Eco² pathway of each city will be designed in consideration of the city’s own needs, priorities, and capacities. While the analytical and operational framework enables a city to chart out its Eco² pathway, the city-based decision support system introduces the methods and tools that provide cities with the capacity to undertake more well integrated development and navigate this pathway more effectively.

<table>
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<th>Principles</th>
<th>Core Elements</th>
<th>Stepping Stones (Actions to be taken)</th>
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| 4. An investment framework that values sustainability and resiliency | • Incorporation of life-cycle costing in all financial decision making  
• Equal attention to protecting and enhancing all capital assets: manufactured capital, natural capital, social capital, and human capital  
• Proactive attention to managing all kinds of risk: financial risk, sudden disruptions to systems, and rapid socioeconomic environmental change | • Use a life-cycle costing method or tool to understand the life-cycle costs and cash flows  
• Develop and adopt indicators for assessing the four types of capital and for benchmarking performance  
• Forecast the impacts of plausible changes in climate, markets, resource availability, demographics, and technology by hosting a forecast workshop  
• Implement a catalyst project in ways that protect and enhance capital assets and reduce vulnerabilities; the best way to learn the accounting methods is in practice in a catalyst project; a base case scenario may be developed as a benchmark for comparing alternative approaches  
• Monitor feedback results, learn, and adapt to improve performance |
4. Collaborative Design and Decision-Making at Regional Level

To explore application of Eco² approach for sustainable growth at the regional level, Principle 2 “an expanded platform for collaborative design and decision making” will be discussed in detail.

The principle of the expanded platform speaks to the importance of adopting a design and decision-making process that is more well integrated, adaptable, and lasting. If we want to improve economic and ecological performance through integrated, fine-scaled, flexible, and long-lasting solutions, we must also pursue shifts in the institutional arrangements that enable design and decision making. In many ways, the constructed environment is a mirror of the way we think and relate.
The solution is twofold: (1) engage stakeholders at all scales in a collaborative process as part of every major project and (2) develop an overarching planning framework for sustainability and resiliency that includes goals, targets, and strategies. Each of these elements is discussed in this chapter. The elements are mutually supportive. The collaboration at all scales generates the skills, goodwill, and creative interchange needed to adopt new business models. The shared planning framework provides the context for integrated project design and also aligns everyone’s plans and policies with a common set of community goals.

Collaboration is also a new form of governance. By engaging stakeholders at all scales, the city creates a planning forum that is more appropriate to mixed economies in which private sector groups often control a majority of the infrastructure systems. Because the process is driven by long-term goals and strategies, it can help cities compensate for the impacts of frequent election cycles, which tend to focus attention on short-term agendas and crisis issues.

The single greatest difficulty in adopting collaborative arrangements is the lack of any institutional champion to lead and guide the process. Almost by definition, no department, group, or government has the mandate, funds, or independence to undertake such a broad, cross-cutting process. Without a sponsor or host, the process never gets started. This is one reason so few collaborative models exist at the city scale. It is also a key reason the Eco² Cities Initiative proposes that cities assume leadership in creating a platform for ongoing collaboration. Methods and tools to help cities organize an expanded platform for collaboration and to help cities use this platform to develop effective planning frameworks, including regional growth strategies, are included in the city-based decision support system.

The city can lead a collaborative process on at least three levels or tiers. Each tier affects the others, and, in an ideal world, every city should lead a collaborative working group at every tier. In practice, the process may be incremental or periodic. However, it is still important to differentiate the options. The tiers reflect the varying levels of control and influence. A three-tier platform that enables a city to collaborate is described as follows: (1) Inner tier: as a model corporation, engaging all city departments; (2) Middle tier: as a provider of services, engaging residents, businesses, and contractors; and (3) Outer tier: as a leader and partner within the urban region, engaging senior government officials, utilities, rural settlements, private sector stakeholders, nongovernmental...
organizations, and academia (see figure 4.1).

The outer tier of collaboration focuses on the urban region. In a metropolitan area, this may mean focusing on the city of cities. In almost all locations, it means expanding beyond the strict boundaries of the municipality to include adjacent towns, cities, rural lands, and natural areas that are part of the economic region and the bioregion. This scale is the most challenging for cities, but potentially the most rewarding. At the outer tier, the city is merely one player among many. It is not immediately clear why or how the city becomes a leader. It is also difficult to find (except in the case of island states) any one definition of boundaries for a region because the ideal boundaries will change with each issue. The urban region is always a fuzzy concept. However, many examples now exist

Figure 4.1. A Triple-Tier Platform
of cities that have risen to the challenge and, in so doing, greatly enhanced the capacity of their communities to articulate and achieve economic and ecological goals. To a large extent, the sustainability of a city depends on the city’s capacity to provide leadership and collaborate at the scale of the urban region in which it is immersed.

Stakeholders at the outer tier may resist attempts to develop a formal platform for collaboration. For an electrical utility, for example, the service territory may form a logical planning unit, not a particular urban region. For adjacent towns and cities, the habitual mode may be competition for land rents and a tax base or access to development funding. The focus of collaboration needs to be long term to find common purposes. Absent a collaborative process, the regional stakeholders will almost certainly be working at cross-purposes. Collaboration provides an unusual and important opportunity for such groups to meet, develop personal relationships, agree on long-term directions, and discuss current plans. For example, electricity companies might meet with natural gas companies and begin a conversation about the best long-term uses for scarce energy resources within the city. The owners of buildings might likewise discuss with city departments the appropriate level of investment to be made to upgrade existing building stock for resource efficiency. These are crucial issues for Eco² cities, and they can only be resolved through a continuous, well-managed dialogue and collaborative decision making.

The outer tier collaborative platform requires a strong structure. It may include senior statepersons at the core; team leaders selected from private firms, knowledge institutions, and public bodies; and experts and champions from a variety of sectors. The structure may build on existing partnerships and committees if these exist and if they are consistent with the collaborative process. A collaborative working group does not need to be time limited. Ad hoc subgroups may be formed to meet regularly on specific issues as appropriate.

From 2003 to 2009, the urban region of Auckland, New Zealand undertook a collaborative process, including the preparation of a shared long-term (100-year) planning framework. The process of developing a framework was highly inclusive, with many conversations feeding into the framework and into the emerging responses. The regional growth strategy, for example, facilitated region wide discussions and a reference group of council members to provide direction and support. Similarly, local authorities and the central government formed a working group to ensure representative influence,
enable shared responsibility for funding the Auckland Sustainability Framework, and ensure that staff would be actively involved. The process was neither linear nor predictable, and its messiness may be seen as an inherent quality of the positive outcome. A key collaborative element was the relationship between central and local governments aligned with common governance elements, including a joint commitment to developing a shared long-term view of a sustainable Auckland (see box for detailed case study).

### Regional Collaboration, Including a Planning Framework: Auckland, New Zealand

The Auckland metropolitan area is New Zealand’s largest and most populous urban area. The Auckland Region is home to over 1.3 million people, about one-third of the national population. The region’s population grew by 12.4% between the 2001 and 2006 censuses. Auckland is characterized by ethnic diversity; 37.0% of the region’s residents were born overseas. In the region, there are four cities and three districts, each with its own council; there is also one regional council.

Currently, each council develops its own plans and strategies. This results in areas of overlap and competing priorities. Collective regional strategies for growth, the urban form, economic development, and transportation planning have been devised. However, they do not have common goals or principles to ensure their alignment.

The lifestyle typical of the Auckland Region and the employment opportunities there continue to attract new inhabitants, but drawbacks have also become evident, namely, a lack of a cohesive and effective approach to ongoing transportation problems and concerns about the pattern and nature of urban growth. The Auckland Regional Growth Forum was therefore

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1) The government of New Zealand is in the process of restructuring the Auckland local government and plans to replace the existing seven local councils and one regional council with one super council and 20 to 30 local community boards.
established in 1996 as a cooperative meeting place for political representatives of the Auckland Regional Council and the local territorial authorities in the region. The aim of the forum is to develop and implement a strategy for managing the effects of growth.

**Governments at every level recognize the need for a collaborative, regional process**

The interconnectedness of national and local Auckland issues, such as housing and education, with growth and innovation and the major required investments, particularly in land transport, have created complex and difficult issues among multiple authorities. Despite Auckland’s importance to the New Zealand economy and the areas of common interest, such as transportation and energy provision, the national government did not initially play a close role in directing regional and local government planning. Concern emerged that, without agreement on an overarching regional strategy and framework, decision making in the region could become ad hoc and adversarial if each stakeholder tried to have a say from a narrow perspective and without viewing the region as a whole. As a result, there was a clear need for coordinated strategic planning across the Auckland Region to ensure that Auckland could compete in the 21st century. The response involved a process undertaken in 2001 to prepare a regional growth strategy that aimed to provide a vision of what Auckland could be like in 50 years. This was backed by the adoption of a spatial growth plan and a legislatively binding limit on the extent of the metropolitan urban area.

In parallel with the work on a regional growth strategy, a three-year Auckland Sustainable Cities Programme was initiated in 2003. In 2006, as a result of the program, the eight local authorities (Auckland City, Auckland Region, Franklin District, Manukau City, North Shore City, Papakura District, Rodney District, and Waitakere City), at the instigation of a forum of territorial chief executives, engaged with the central government to develop a long-term sustainability framework. Initially called START (Sustaining the Auckland Region Together), the approach represented an attempt to evaluate the forces that might play a more significant role in the long term as part of a
100-year vision to align government efforts and create strategic directions. The engines of START included the need for resilient systems able to respond to persistent pressures over short and long time horizons with no obvious alternative solutions and to many vested interests with apparently irreconcilable demands.

**Making a START: Gathering information**

The START working group developed a prototype framework with a cascading set of deliverables, including a vision, goals, initial foundation, process principles, initial themes, and some potential responses, which included catalyst projects, long-term sustainability goals, and the development of indicators to measure progress. Critical to progressive development was consideration of the forces that would shape Auckland’s future over the next 100 years. Also significant to the development of the framework was the involvement of expert groups that included academics and experts from the business and community sectors, who, through facilitated workshops, developed theme papers on key issues identified in the prototype framework, namely, the built environment, urban form and infrastructure, energy, economic transformation, social development, cultural diversity and community cohesion, and environmental quality. Each group deliberated around four sustainability principles—resilience, prosperity, livability, and ecology—and considered how these might be influenced by the forces that would shape the future.

In a linked, but parallel process, a working group representing all Maori tribes (New Zealand’s indigenous people) of the Auckland Region developed its own collective long-term framework, the Mana Whenua Framework. The working groups involved in these processes built links between the two frameworks, including a basic common structure, common analysis via the forces and theme papers, a Maori goal in the overall framework, and an indigenous concept of sustainability, which fed into the definition of sustainability in the overall framework. Meanwhile, the overall

2) See Frame (2008) for a critical analysis of the regional planning process and outcome.
framework acknowledges Mana Whenua as the first peoples of the region and as an intimate part of the region’s ecological and cultural fabric.

In August 2006, a three-day START design workshop enabled 120 representatives of local authorities and the central government, academia, and the community and business sectors to contribute expertise and perspectives to the development of the draft 100-year framework. The methodology drew heavily on the Vancouver Cities Plus model, which progressed from a high-level vision to responses and indicators through an adaptive management approach to the development of a resilient urban planning framework able to address future challenges (CitiesPlus, 2002). The workshop relied on a charrette format, a process whereby new design ideas emerge and evolve quickly. The process is interactive and harnesses the talents of a range of parties to resolve planning challenges. The charrette format is particularly successful in helping local government authorities engage communities in planning. The product is usually a tangible plan ready for immediate implementation.

**Stakeholder consultations and interagency coordination**

As a result of feedback and wider strategic discussions following the START workshop, it was decided that the framework should include the following:

- A shift from business as usual as a key component of the framework
- The addition of integrated goals, key directions, leadership goals, and Maori goals
- The adoption of a revised version of a regional vision developed by a youth contingent
• The development of a draft set of indicators
• The development of a process and tools for the application of the framework

A governance and reporting structure was set up whereby the project was overseen by a steering committee of the council officers that was sponsored by the chief executives forum responsible for final approval of the framework. Consultation with stakeholders and the public took place from February to May 2007 through 19 workshops involving around 200 participants, plus written submissions from several individuals, four organizations, and two regional councils.

A revised version, the Auckland Sustainability Framework (ASF), was endorsed in September 2007 by the Auckland Regional Growth Forum after it had been endorsed by all member local authorities and government agencies. It also received high-level support within the central government. The ASF goals and visions were consistent with central government priorities, especially in the substantive shifts that would be required (see box). In turn, the ASF was expected to provide a tool to review the effect of national policies on Auckland. However, it was also clear that a better understanding was needed of the methods for achieving goals and of the proper indicators for assessing progress.

The ASF is also intended to guide and align regional strategies (such as the Regional Growth Strategy, the Regional Land Transport Strategy, and the

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Eight Goals Direct the Auckland Framework

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<tr>
<td>The Auckland framework is built around eight interrelated long-term goals that will enable the region to take a sustainable development approach:</td>
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<tr>
<td>Goal 1 A fair and connected society</td>
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<td>Goal 2 Pride in who we are</td>
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<td>Goal 3 A unique and outstanding environment</td>
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<td>Goal 4 Prosperity through innovation</td>
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<td>Goal 5 Te puawaitanga o te tangata (self-sustaining Maori communities)</td>
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<td>Goal 6 A quality, compact urban form</td>
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<td>Goal 7 Resilient infrastructure</td>
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<td>Goal 8 Effective, collaborative leadership</td>
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Note. From RGF, 2007.
Auckland Regional Economic Development Strategy). The process of developing a framework was therefore highly inclusive, with many conversations feeding into the framework and the emerging responses. The Auckland Regional Growth Forum, for example, facilitated region wide discussions, joint political decision making, and the establishment of a reference group of council members to provide direction and support. Similarly, local authorities and the central government formed a senior officers steering group and an officers working group. Key collaborative elements were the relationship between the central government and local governments and the common governance elements, primarily because of the involvement of the Government Urban and Economic Development Office, including a joint commitment to the development of a shared long-term view of a sustainable Auckland.

The final framework that was adopted consists of the following:

- The identification of key challenges to sustainability that the region will need to address
- A 100-year vision
- The eight long-term goals
- Eight shifts from current practice that are required to meet the goals
- Suggested strategic responses
- A measurement framework and monitoring process
- A toolkit to apply the framework to strategies, significant decisions, and plans and to integrate regional planning

The Auckland Sustainability Framework

The framework’s role consists of the following:

- To align existing regional strategies and projects, for example, the Regional Growth Strategy, the Regional Land Transport Strategy, and the Auckland Regional Economic Development Strategy
- To align future regional strategies and projects
- To guide the development of a single regional plan (the One Plan; see below)
To provide methods to adapt business-as-usual scenarios, for example, the 10-year community investment plans of a local council.

To identify strategic responses that must be undertaken to achieve sustainability goals.

The ASF “will provide direction so that our local authorities and central government agencies can work together with a common purpose to embrace the opportunities and face the challenges associated with developing a truly sustainable region” (ARC 2009).

**Keys to success**

*Extended peer communities.* The overall process created considerable buy-in at political and administrative levels, and the resulting framework is owned by all parties. However, there has been a considerable change in political representation at the local and national levels since the adoption of the ASF. Many new council members have not been involved in the development of the framework, and the national government has redefined
sustainability into the narrower concept of natural resource management.

Nonetheless, the ASF has been used to develop a collective investment plan, which is referred to as the One Plan, as well as a number of local council plans, including the Manukau 2060 Strategic Framework and the Waitakere City Council’s social strategy.

**Stretching thinking.** The framework and, especially, the participatory process have stretched the thinking of many participants with regard to the following topics:

- Recognizing that the world and Auckland are going to experience exponential change over the next 50 years and that they have limited time to prepare for this change
- Recognizing that many business-as-usual practices will have to be altered or abandoned
- Understanding the meaning of sustainable development, especially by bringing in a Maori perspective
- Developing the Mana Whenua Framework

The development of a separate, but linked Maori framework has ensured that the long-term planning for Maori is being undertaken by Maori. The depth of indigenous understanding of generational thinking and the holistic and spiritual understanding of the relationship between the environment and people are fully realized in the Mana Whenua Framework and have challenged and stretched the thinking on the ASF.

**Lessons learned in the Auckland case**

Two groups appear to have been less well represented in the process of the development of the ASF: business representatives and the developers who would eventually implement the strategies and activities based on the ASF. A special process may be needed to engage these groups because they are typically reluctant to attend open meetings and because they require a process that is especially efficient.

After the ASF was adopted, the region quickly focused on new
priorities. As a consequence, one component of the framework—winning hearts and minds—did not achieve progress. Winning hearts and minds acknowledged the importance of the social learning that council members, key staff, and stakeholders experienced through the development of the ASF. Continued dialogue and education on the challenges and solutions involved in achieving sustainability are required among these key decision makers and the public.

While the ASF has been adopted as a guiding framework, no hard targets have yet emerged for planning and strategy making. Likewise, no bottom-line thresholds for public sector decision making have appeared. Without these elements, the ASF may become a useful tool for some parties, but may be ignored by others. The new national government is restructuring the eight local government bodies within the region into a single unitary council, and it remains to be seen whether this new council will adopt the ASF as the guiding regional framework.

Source: Suzuki et al., 2010.
Bibliography


Innovation and Regional Development: International Experiences on Innovation Clusters

KRIHS SPECIAL REPORT 2010

Byung-ho Oh
1. Introduction

The East Asian Economies, especially newly industrialized economies (NIEs) achieved rapid economic growth in recent years (Amsden, 1989; Chang, 1994; World Bank, 1993). The East Asian NIEs are confronting a growth process in a new paradigm such as green growth, knowledge-based economy and global competition. In the future, growth will increasingly come from the strength of innovation clusters in NIEs.

1.1 Growth of East Asian economies

Many countries in East Asia have successfully completed the “catch up” phase of development. Recent research points out that the “catch up” paths taken by countries are different. Lee and Lim (2001) have identified the three different patterns of “catch up” in the following way: (1) a Path-Following “catch up,” where the late-comer country follows the same path taken by the forerunners; (2) a Stage Skipping “catch up,” where the late-comer country follows similar path as 1 but skips some stage, saving some time; and (3) a Path-Creating “catch up,” where the late-comer countries explore their own path of technological development. Then, some countries make quick progress and save time taking advantage of new technology-led economic development paradigm or skip some stages or even create their own path which is different from the forerunners. In a way, every country is a beginner in terms of the newly emerging technology led economic development paradigm in knowledge-based
This implies the possibility of leapfrogging by late-comers like the East Asian NIEs (Perez, 1988). The idea of leapfrogging is that some late-comers may be able to leap-frog older technology in the framework of knowledge-based economy. For example, NIEs bypass heavy investments in previous out-dated technology system and catch-up with advanced countries (Perez & Soete, 1988). The increasing trend of green growth, globalization and development of information technology makes the leapfrogging argument ever more plausible as evidenced in the case of digital TV (Lee, Lim, & Song, 2005).

Global competitiveness and climate change (green sustainability: adaptation and mitigation) suggest that East Asian NIEs need to diversify their engine of growth. In global environment with international concern of importance on green growth today, successful and economic vibrant communities depend on their ability to adapt to fast-changing international market forces. For East Asian economies to move towards green growth, a low carbon revolution will be required. To address climate mitigation and climate adaptation, a massive transition to urban and regional development is needed. Green growth can achieve climate mitigation and adaptation by enabling urban and regional development that has lower carbon emissions and less vulnerability to sea level rise.

East Asian NIEs focus on innovation clusters and green industry as key sources of future growth. Science and Technology Parks (STPs) are one path to enhancing innovation capability within a knowledge–based economy as demonstrated in the case of Korea.

The key factors which led to economic success in Korea can be summarized as follows:

- Investment in infrastructure and manufacturing capacity as well as R&D
- Emphasis on export and import substitution
- Mobilization and channeling of savings and capital investment by financial institutions
- Well educated and trained low-cost labor
- Foreign direct investment and participation in international production networks
- Market institution and economic freedom
- Government leadership and guidance lead to economic and political stability
However, Korea and East Asian NIEs face rapidly changing global economy which requires new direction for sustainable development as demonstrated by the following reasons.

- Decreasing returns from current resource driven, export dependent model
- Commoditization of main manufactured exports
- Shorter product life cycles, especially for many electronic and ICT products
- Competition from China across a wide range of products and services
- Opening of domestic markets to competition due to WTO, bilateral FTAs
- Changes in the organization of global production and producer-supplier relationships
- Consolidation of some industries across the East Asian region—changing geography of production

This paper focuses on international experiences on innovation clusters as a new direction for green growth in knowledge-based economy. Section 2 examines special economic zones (SEZ) and draws some successful examples of innovation clusters. Section 3 utilizes Korean case of innovation cluster within science and technology parks with special reference to Daedeok Innopolis as an example. Section 4 draws conclusions and further studies.

2. SEZ and Innovation Cluster

The rapid proliferation and economic impacts of special economic zones (SEZs) have been demonstrated in many countries. SEZs as an instrument for economic development were successful in East Asian economies, Central America, and the Caribbean basin. According to a report by FIAS of the World Bank Group, there are approximately 3,000 zones in 135 countries today, accounting for over 68 million direct jobs and over US$500 billion of direct trade-related value added within zones (World Bank, 2008).

While there have been various manifestations of Specialized Zones and other innovation cluster models, historically, technology and science-led economic development has followed a common trajectory. The traditional technology and science-led development model centered on providing physical space for companies near
Innovation and Regional Development: International Experiences on Innovation Clusters

Universities, research institutions or other knowledge creators, marketing to attract those companies, and providing supportive business services (e.g. Silicon Valley, USA; Sophia Antipolis, France; Oulu Science City, Finland; Kista, Sweden, Hsinchu Science Park, Taiwan; Zhongguancun, China, etc.). As markets and global economic trends change, the characteristics of Special Economic and Free Trade Zones or Science Parks and other technology and science-led development are also changing. There is a need to look at current, fully-functioning models of knowledge ecosystems and innovation-based economies and the various ways they have reacted to changing economic and global trends and demands.

2.1 Evolution and type of SEZ

A variety of different zone setups have evolved under the SEZ concept:

Figure 2.1. Evolution of SEZ
Free trade zones (FTZs; known as commercial free zones) are fenced-in, duty-free areas, offering warehousing, storage and distribution facilities for trade, transshipment, and re-export operations.

Export processing zones (EPZ) are industrial estates aimed primarily at foreign markets. Hybrid EPZs are typically sub-divided into a general zone open to all industries and a separate EPZ area reserved for export-oriented, EPZ-registered enterprises.

Enterprise zones are intended to revitalize distressed urban or rural areas through the provision of tax incentives and financial grants.

Free ports typically encompass much larger areas. They accommodate all types of activities including tourism and retail sales, permit on-site residence and provide a broader set of incentives and benefits.

Specialized zones include science/technology parks, petrochemical zones, logistics parks, airport-based zones, etc. (Source: Special Economic Zones Performance, by the World Bank Group, April 2008.)

SEZ has evolved over time. Initial production type (e.g. Shenzhen, China), free trade type (e.g. Masan, Korea), off-shore finance center (e.g. Bahrain) transformed to mixed type such as Hong Kong and Singapore. Later, “knowledge link” such as R&D and industry cluster were injected to mixed type zones evolving SEZ to knowledge creating type zones.

Special economic zones were established by China to serve “demonstration areas” for policy reforms and to encourage foreign investment. The economic impact of these zones has been far-reaching, transforming entire regions and economies.

The Shenzhen Special Economic Zone provides a snapshot of the impact of the SEZs on China’s economic development. Twenty-three years of growth has transformed Shenzhen from a small, sleepy fishing village into a thriving urban metropolis. Today, Shenzhen is an export-oriented economy with an export value in 2003 of US$48 billion (14% of the national total), some US$30 billion in FDI, and 3 million directly employed.
What is less well known is the fact that the SEZs host hundreds of national level zones, all with special and differing incentive regimes, including.

- 14 open coastal cities
- 15 free trade zones
- 17 export processing zones
- 54 economic and technology development zones
- 15 border economic cooperative areas

Many other provincial- and city-level zones exist as well.

Note. From Special Economic Zones Performance, by the World Bank Group, April 2008.

### 2.2 Asian innovation clusters

Asia is fast emerging as a global innovation center in the biomedical sciences industry. Some examples are: Singapore’s biotech cluster and Korea’s Osong and Daegu Medical City Projects.

The Biopolis in Singapore is a biomedical research and development hub at One-North, Buona Vista. Its phase I opened in 2003. One-North has 183 ha and is located adjacent to High Educational Institutes (such as the National University of Singapore, the Institute of Technical Education, and the Singapore Polytechnic), the National University Hospital, the Singapore Science Park, and Fusionopolis which is another R&D innovation centre for electronics and technology.

Biomedical sciences account for 6% of Singapore’s GDP and its manufacturing output is over Singaporean $23 billion. On January 25, 2010, JTC Corporation announced the fourth phase of Biopolis. Scheduled for completion by 2012/13, the fourth-phase will include improvements to lab design for clinical trial support. Construction of this phase will cost between $80 million and $100 million, raising the total cost of Biopolis to Singaporean $700 million (Parson, Stem Cell, September 2007, pp.248-250).

Attracting biomedical sciences companies and accessing Global Talents: Singapore’s Biopolis has been a magnet for both global and regional talent. More than 30 leading biomedical sciences companies have established their regional headquarters (include Abbott, Bayer, Bristol-Myers Squibb, and Roche). It has established its position as a leading global manufacturing site for innovative medicines.
Singapore attracted the world’s top star scientist and business talents. Some of star scientists such as Edward Holmes (former Vice Chancellor, University of California, San Diego), Judith Swain (University of California, San Diego), Colin Blakemore (UK Medical Research Council), Axel Ulrich (Max Planck Institute for Biochemistry, Germany), Philippe Kourilsky (College de France, France), Sydney Brenner (Nobel Laureate, Salk Institute of Biological Sciences), and Yoshiaki Ito (University of Kyoto, Japan) have moved to Singapore.

Singapore offers good intellectual property protection, excellent infrastructure and a skilled manpower base to drive process development and support the commercial-scale production of the industry’s most innovative products. Singapore government committed to working with the industry to upgrade employees’ skills, train new workers and promote best practices (Source: www.pharmaceutical-technology.com/projects/biopolis).

Korean government announced to support two medical cities complex at Daegue and Osong in August, 2009. The Health Ministry selected two cities to house new high-tech medical facilities worth at least 5.6 trillion won (US$4.6 billion). In Daegu, the Shinseong-dong “innovation city” will have a cutting-edge medical complex. Daegu has been noted as a major manufacturer of textiles and machinery. Osong was selected to house the Korea Food and Drug Administration and several other health-related government offices at the Osong Bio-Life Science Industrial Complex.

Under the original plan, the government announced it would designate a specific city for a one-million-square-meter complex similar to the biotechnology cluster in the Boston area. The complex was also intended to develop new drugs. Now, two cities will be involved.

Of the 5.6 trillion won originally to be spent by 2038, the central government was to pay 1.9 trillion won and the city up to 300 billion won. The remaining 3.4 trillion won, or 61% of the total, was to come from the private sector, such as pharmaceutical firms. Construction is expected to finish by 2012. The government hopes the project will create 382,000 jobs (Source: Yunhap News, August 10, 2009).

In Malaysia, Multimedia Super Corridor (MSC) is a Government designated innovation zone, designed to leapfrog Malaysia into the information and knowledge age. It has an area of approximately 15 km² × 50 km² near Kuala Lumpur and incorporates the towns of Putrajaya and Cyberjaya. The Multimedia Super Corridor aims to attract companies with attractive tax breaks and facilities such as high speed internet and proximity to the local international airport. The Multimedia Development Corporation -
MDeC (formerly MDC) was created to oversee development of the MSC.

The International Tech Park Bangalore (ITPB) development was set up by a consortium comprising Indian and Singaporean private enterprise in 1994. Opened in 1998 as India’s first work-live-play business environment, ITPB is virtually a self-contained city spread over a sprawling 28-hectare estate. The Park integrates office, retail, residential, and recreational facilities in a single location, set amidst a refreshing and aesthetically appealing lush landscape. It is managed by Ascendas, Singapore and has become the benchmark of excellence for IT parks across India. At ITPB, over 24,000 professionals work for more than 145 companies in the fields of IT, bioinformatics, software development, telecommunications, electronic, and other hi-tech industries (Source: www.itpbangalore.com).

For job creation and regional development, most innovation clusters have been successful in Asia. Some key success factors are good infrastructure, well trained labor, zeal for education and training, political stability, and strong government support.

3. Innovation Cluster: Science and Technology Parks (STPs)

3.1 Promoting innovation & green growth with STPs

STPs are the habitat for businesses and institutions of the global knowledge economy. STPs promote the economic development and competitiveness of regions and cities by:

- Creating new business opportunities and adding value to mature companies
- Fostering entrepreneurship and incubating new innovative companies
- Generating knowledge-based jobs
- Building attractive spaces for the emerging knowledge workers
- Enhancing synergy among research institutes, universities and companies.

What is STP? A Science Park is defined as an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions.
A Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes and provides other value-added services together with high quality space and facilities (IASP Official definition).

Why focus on STP? STPs are set up in urban areas. Its agglomeration of knowledge-based economy, environmental impacts, and entrepreneurship concentrated in urban settlements. The reasons to focus on STPs for innovation and green growth are:

- Salience of the urban economy: Share of population and GDP is rising steeply. 
  – 85% of GDP is urban in high income countries, 55% in low income countries.
- Importance of city size for agglomeration and scale economies which can make important contributions to urban productivity.
- Major cities which are nodes of global urban network attractive for professional business services (e.g. finance, legal, and accounting) and foreign direct investment.
- Demographic patterns: Currently, a high percentage of the population is of working age.
- Impact of cities on environment, resource use and health. In the United States, buildings account for 65% of electricity use, 36% of energy consumption, and 30% of greenhouse gases.

An interesting point about the East Asian economies is that microeconomic interventions are combined with technology and education, so the costs of distortions (rent-seeking) are not as heavily felt since continuing growth generates new additional rents. As in the case of many other developing countries, Korea also faced external imbalances with persistent trade deficits during the first two decades of industrialization in the 1960s and 1970s. However, since the 1970s the government kept the emphasis on technological development by conducting publicly funded R&D and giving the results to private firms. The government also promoted private R&D by tax incentives and even initiated public-private joint R&D for bigger and risky projects in the 1980s. As shown in table 3.1, the early 1980s was the first time that R&D/GDP ratio surpassed 1% and the share of private R&D surpassed stably that of public R&D. The ratio finally reached around 80% in the 1990s.
The number of college students was doubled in the mid 1980s, with the enrollment ratio in tertiary education more than doubling within 5 years from 14.7% in 1980 to 34.1% in 1985 and thus surpassing the average level of the developed countries.

Table 3.1. R&D/GDP Ratio Trends in Korea

<table>
<thead>
<tr>
<th>Year</th>
<th>R&amp;D/GDP</th>
<th>Share of Private Sector</th>
<th>Year</th>
<th>R&amp;D/GDP</th>
<th>Share of Private Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>0.39%</td>
<td>28.6%</td>
<td>1990</td>
<td>1.87%</td>
<td>80.6%</td>
</tr>
<tr>
<td>1975</td>
<td>0.42%</td>
<td>33.3%</td>
<td>1991</td>
<td>1.92%</td>
<td>80.4%</td>
</tr>
<tr>
<td>1980</td>
<td>0.56%</td>
<td>48.4%</td>
<td>1992</td>
<td>2.03%</td>
<td>82.4%</td>
</tr>
<tr>
<td>1981</td>
<td>0.78%</td>
<td>44.8%</td>
<td>1993</td>
<td>2.22%</td>
<td>83.1%</td>
</tr>
<tr>
<td>1982</td>
<td>0.98%</td>
<td>50.4%</td>
<td>1994</td>
<td>2.44%</td>
<td>84.0%</td>
</tr>
<tr>
<td>1983</td>
<td>1.07%</td>
<td>66.1%</td>
<td>1995</td>
<td>2.50%</td>
<td>81.1%</td>
</tr>
<tr>
<td>1984</td>
<td>1.24%</td>
<td>72.3%</td>
<td>1996</td>
<td>2.60%</td>
<td>77.8%</td>
</tr>
<tr>
<td>1985</td>
<td>1.52%</td>
<td>75.2%</td>
<td>1997</td>
<td>2.69%</td>
<td>76.5%</td>
</tr>
<tr>
<td>1986</td>
<td>1.69%</td>
<td>76.7%</td>
<td>1998</td>
<td>2.55%</td>
<td>73.0%</td>
</tr>
<tr>
<td>1987</td>
<td>1.79%</td>
<td>75.3%</td>
<td>1999</td>
<td>2.47%</td>
<td>73.1%</td>
</tr>
<tr>
<td>1988</td>
<td>1.86%</td>
<td>78.7%</td>
<td>2000</td>
<td>2.65%</td>
<td>75.0%</td>
</tr>
<tr>
<td>1989</td>
<td>1.90%</td>
<td>79.6%</td>
<td>2001</td>
<td>2.92%</td>
<td>73.5%</td>
</tr>
</tbody>
</table>

Note. From Annals of Science and Technology, Korea.

Table 3.2. Tertiary School Enrollment Ratio (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>14.7</td>
<td>21.7</td>
<td>26.6</td>
<td>34.1</td>
<td>38.6</td>
<td>52.0</td>
<td>65.0</td>
<td>71.7</td>
<td>77.6</td>
</tr>
<tr>
<td>Average of 9 Middle Income Countries (MICs)</td>
<td>13.5</td>
<td>15.8</td>
<td>17.3</td>
<td>19.1</td>
<td>20.1</td>
<td>24.5</td>
<td>26.4</td>
<td>26.9</td>
<td>29.6</td>
</tr>
<tr>
<td>Average of Developed Countries</td>
<td>27.2</td>
<td>28.0</td>
<td>29.3</td>
<td>30.4</td>
<td>39.1</td>
<td>52.0</td>
<td>54.5</td>
<td>56.9</td>
<td>59.0</td>
</tr>
</tbody>
</table>

Note. From OECD data base. For middle income countries, UNESCO Statistics.
9MICs are Argentina, Brazil, Chile, Costa Rica, Malaysia, Mexico, Thailand, Turkey, and Uruguay. *Developed countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States.

Korea’s heavy investment in R&D expenditure and higher education laid the basis for knowledge-based economic growth, which can be confirmed by the rise of the US
Table 3.3. Number of Utility Patent Applications Filed in the United States (By Country of Origin)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>33</td>
<td>64</td>
<td>129</td>
<td>295</td>
<td>775</td>
<td>1,624</td>
<td>2,820</td>
<td>5,452</td>
<td>5,705</td>
<td>7,937</td>
<td>10,411</td>
</tr>
<tr>
<td>Taiwan</td>
<td>367</td>
<td>394</td>
<td>760</td>
<td>1,246</td>
<td>2,035</td>
<td>2,874</td>
<td>4,054</td>
<td>7,412</td>
<td>9,046</td>
<td>12,488</td>
<td>13,786</td>
</tr>
<tr>
<td>China</td>
<td>7</td>
<td>10</td>
<td>24</td>
<td>122</td>
<td>111</td>
<td>135</td>
<td>144</td>
<td>181</td>
<td>469</td>
<td>888</td>
<td>1,034</td>
</tr>
<tr>
<td>Average of 9 MICs</td>
<td>23</td>
<td>31</td>
<td>26</td>
<td>23</td>
<td>30</td>
<td>34</td>
<td>40</td>
<td>60</td>
<td>91</td>
<td>88</td>
<td>105</td>
</tr>
<tr>
<td>Total Foreign</td>
<td>42,231</td>
<td>44,009</td>
<td>53,132</td>
<td>64,633</td>
<td>73,915</td>
<td>74,788</td>
<td>88,419</td>
<td>107,579</td>
<td>131,131</td>
<td>150,200</td>
<td>153,500</td>
</tr>
</tbody>
</table>

Note. Country of origin is based on the residence of the first inventor. From search using the US PTO website.

patents filed by Koreans. As shown in table 3.3, in the early 1980s the number of US patent applications by Koreans was about the same as other developing countries (around 30). But in the early 1990s the Korean applications (more than 770 in 1990) grew to more than 20 times than the average of other middle income countries. This with

Figure 3.1. Korea’s History of Economic Development

- Initial Stage of Development
  - Historical background
    - Colonial rule & war
    - Socio-political instability
    - Negative consciousness of the people
  - Extreme poverty
    - $79 (1960)
    - Shortage of food
    - Subsistence depending on aid
    - Chronicle deficiency in int’l BOP
  - Korea viewed as a hopeless country

- Unique Development Strategy

- Performance of Korea
  - Over 200x increase in per capita GDP
    - $89 ('61)→$11,432 ('95)→$20,500 ('07)
  - Modern industrial state
    - World’s manufacturing base in steels, autos, semi-conductors, etc.
    - Knowledge society based on ICT
  - Assessment from the world
    - Independent country from a colony
    - Industrialization based on a 40 min population vs 100 mn global criteria
    - Industrialization 200→100→30 yrs
government policy initiative succeeded in bringing in trade surplus during the late 1980s. Korea’s R&D to GDP ratio exceeded even 2% in the early 1990s with the private R&D accounting for more than 80% of the total.

### 3.2 Economic development and export commodity

Korean export commodity changed as technology evolved. In 1960s and 1970s, light industry products, labor intensive items such as wig and textile were major export commodity. 1980s evolved into heavy industry products such as automobile, white electricity items. Since 1990s, human computer interaction products were major export items which involved semiconductors, mobile phones, DTV, Display, shipbuilding, etc. There are changes of export commodity based on international market situation. Korea export commodity profile shows this change. This reveals economic development of Korea from basic manufacturing (industrialization) to information technology and knowledge-based economy.

Evolvement of the Korean Economic Development Model is outlined below:

- From factory-intensive to productivity-driven growth
- From imitative to innovative growth
- From reliance on markets in a few industrialized countries to greater reliance on regional and global markets

**Figure 3.2. Changes in Export Commodity Profile**
Utilized SEZs for export, job creation, FDI, and Research & Business Development.

### 3.3 Daedeok Innopolis case

Regional innovation policy based on technopolis in Korea is critical to achieving regional economic development and green growth through networked collaboration between High Educational Institutes (HEI), research institutes, industries and government. This is particularly apparent in Daedeok Innopolis which utilizes technology-led development as a means of promoting regional innovation for green growth and regional development in Daejeon city (Oh, 2004).

The Daedeok development in Daejeon City is a case example worth analyzing. The major interest is focused on the question “what kinds of shifts have been made on the changing process from pure science city to innovation cluster in the last 36 years.”

#### 3.3.1 Technopolis and regional innovation cluster

The technopolis concept emphasizes the need for a balanced approach to high technology development. Instead of only focusing on technology, it involves the creation of new settlement, complete with research park, new universities, technology centers, housing and cultural facilities (Tatsuno, 1986; Masser, 1991). Some researchers have pointed out that technopolises are larger in scale and often linked to the development of infrastructure and facilities on the new town model, whereas science parks are more limited in scope. Technopolises also tend to be more production oriented than science parks and have both national and regional objectives. The national and technological objectives are to offer to high-tech industries adequate industrial land and an environment suitable for creative research. These resources have become scarce in the major metropolitan areas. Consequently, the regional and technological objective is to promote technological development in less developed areas. For this purpose, physical, scientific and institutional infrastructure is developed in a decentralized pattern by a combination of measures taken at the local and regional levels and by national government (Stoehr & Poeninghaus, 1992).

A useful distinction can be made between a technopolis and science city. Whereas new settlements with many high-tech production firms but relatively few basic research
institutes are referred to as technopolises, “science cities are areas dominated by basic research institutes, with relatively few high-tech production firms.” These two terms and the type of communities they represent are not mutually exclusive. For example, Silicon Valley in the USA is well established as both a science city and technopolis (Rosers & Dearing, 1990). The term “science city” applies best to Tsukuba science city in Japan, which was consciously planned as a basic research city. Table below summarizes the key features of science city and technopolis with respect to their nature and physical characteristics. The development aspects are summarized with the structure in relationship and linkage, the activity in R&D and the network among heterogeneous R&D activities.

The regional innovation cluster can be defined as a specific area(s) with networked location(s), where innovating actors are concentrated and interacting. It functions as the source of innovative activities for the surrounding region, and supersedes other areas in terms of innovation competitiveness (Yim, 2002). It is a system for innovation composed of actors, process, interaction mechanism, culture, etc. In addition, innovation cluster is the unit of competition and has various advantages in science and technology knowledge production, transfer and utilization. Innovation networking in cluster aims to enhance the innovative capacity and foster the strategic industry for regional and national competitiveness through the interaction and close linkage among government, R&D center, research institutes, HEIs, high-tech industry, partnership of universities and industries, commercialization, marketing and financial support.

<table>
<thead>
<tr>
<th>Type</th>
<th>Physical characteristics</th>
<th>Focus</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science City</td>
<td>Creation of new settlement (research park, new town)</td>
<td>Basic R&amp;D</td>
<td>Tsukuba, Japan</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Daedeok Science Town, Korea('80-'90)</td>
</tr>
<tr>
<td>Technopolis</td>
<td>Creation of new settlement including production activity</td>
<td>High-tech production</td>
<td>Kumanoto, Japan; Sophia Antipolis, France; Daedeok Science Town, Korea('98-2005)</td>
</tr>
<tr>
<td>Regional Innovation Cluster</td>
<td>Clustered development of Technopolis and Science Park in the Region</td>
<td>Innovative and entrepreneurial cluster in the region</td>
<td>Daedeok Innopolis, Korea (2005– )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Silicon Forest, Silicon Valley, USA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Milano Clothing Industry, Italy</td>
</tr>
</tbody>
</table>
Regional Innovation Cluster is to develop a network building of available intellectual, innovative, and entrepreneurial resources. A favourable business, social, and political environment necessary to effectively utilize the intellectual, innovative, and entrepreneurial resource are key for regional innovation cluster. Regional innovation cluster is a new path for development in knowledge-based economy provided with good development policy and insight to regional competitiveness. Figure below shows changing role of Daedeok Innopolis from leading government research institutions to formation of innovation cluster at Daedeok.

**Figure 3.3. Changing Role of Daedeok Innopolis**

3.4 Development impact of regional innovation cluster

In 2002, Korean central government has designated Daedeok Science Town and its vicinity as Daedeok Innopolis for further development of technology commercialization based on R&D. This variety of high-technology based development activities enable the Daedeok Innopolis to be designated as the first National R&D Special Zone to carry out the pilot project of regional innovation and technology-led
Innovation and Regional Development: International Experiences on Innovation Clusters

economic development with strong support from central government.

Growth of venture business is demonstrated in sales increases. According to the investigation of Daejeon Metropolitan City (2002), the amount of turnover by venture businesses in Daejeon area was 382.5 billion won (US$375 million) in 2000. It is about double that of 1999, and corresponds to about 5.6% of all output of manufacturing industries in Daejeon area. If those figures are classified by scale, venture firms which had less than 30 million won showed the highest ratio by 38% of all firms in 1998. However in year 2000, venture firms which had sale over 500 million won showed the highest ratio of 35%. Venture firms in Daejeon made great strides. Average sales value per company was shown to have grown 36 times, from 25.9 million won in 1998 to 928 million won in 2000 in relative terms.

3.5 Growth of R&D centers

Daedeok Innopolis is host to a concentration of 21 Government Research Institutes including Electronics and Telecommunications Research Institute (ETRI), 10 public research institutes, and 40 private research Institutes. ETRI led the world’s first ever

Figure 3.4. Growth of R&D Centers and Related Institutions in Daedeok

![Graph showing growth of R&D centers](http://ddinnopolis.or.kr/)


1) National R&D Special Zone: all accommodating within the Daejeon Metropolitan City—Daedeok Science Town (DST), Daedeok Techno-Valley (DTV), Industrial Complex, Yuseong Tourist zone.
commercialization of CDMA and has been instrumental in developing DRAM technologies. Other prominent research institutes including the Korea Atomic Energy Research Institute (KAERI), which successfully produced localized atomic fuel, are part of our complex as well. Daedeok Innopolis is also home to the Korea Aerospace Research Institute which developed KITSAT satellites 1-4 which are widely recognized as embodying globally advanced technologies (Daedeok Innopolis Management Office, 2006).

The industrial activities of Daedeok have focused on venture business from spin-off firms. At the initial stage, there were a few venture start-up activities in Daedeok. Recently, active spin-offs are increasing in the research institutes and universities in DST. Actually, 7.1% of total venture firms in Korea are located in Daejeon City and South Chungcheong Province (6% in Daejeon, 1.1% in South Chungcheong Province). It is the highest concentration outside the Capital Region.

The start-up activities in Daedeok began to be observed from the time when institutions in Daedeok launched their technology business incubators. When venture firms from the major 10 R&D centers in Daedeok were surveyed until 2004, there were 2 firms in Daedeok in 1990, 20 firms in 1996, but it grew up to 172 firms in 2004. If job creation is analyzed for the same years, 35 persons were employed in 1990. It grew up to 187 employees in 1996, 2,212 persons in 2002, and 3,237 persons in 2004. The total

Table 3.5. Comparison of R&D Center: Number (Employee)

<table>
<thead>
<tr>
<th>Description</th>
<th>Public Sector</th>
<th>Private Sector</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive R&amp;D</td>
<td>4 (1,230)</td>
<td>1 (83)</td>
<td>5 (1,313)</td>
</tr>
<tr>
<td>Bio technology</td>
<td>4 (482)</td>
<td>5 (455)</td>
<td>9 (937)</td>
</tr>
<tr>
<td>Information technology</td>
<td>3 (2,655)</td>
<td>5 (848)</td>
<td>8 (3,503)</td>
</tr>
<tr>
<td>Precision chemical</td>
<td>1 (403)</td>
<td>9 (1,672)</td>
<td>10 (2,075)</td>
</tr>
<tr>
<td>New material (including high molecule)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechatronics (including marine science)</td>
<td>2 (571)</td>
<td>2 (305)</td>
<td>4 (876)</td>
</tr>
<tr>
<td>Resource, Energy development</td>
<td>5 (2,173)</td>
<td>2 (76)</td>
<td>7 (2,249)</td>
</tr>
<tr>
<td>Astronomy, Aerospace, Astronautics</td>
<td>3 (806)</td>
<td>1 (109)</td>
<td>4 (915)</td>
</tr>
<tr>
<td>The others</td>
<td>6 (2,483)</td>
<td>2 (112)</td>
<td>8 (2,595)</td>
</tr>
<tr>
<td>Total</td>
<td>28 (10,803)</td>
<td>32 (4,209)</td>
<td>60 (15,012)</td>
</tr>
</tbody>
</table>

firms of 219 companies were created from 10 public research institutes in Daedeok by 2004. ETRI, KAIST and Korea Standard Science Research Institute are the main bodies, which actively contributed to technology commercialization.
4. Conclusion

Innovation regional clusters (STPs) have been instrument for regional development. International experiences on innovation clusters demonstrated regional growth. Daedoek Innopolis case showed its contribution to economic development and Korean investment in R&D and education as an engine for leapfrog. Future research should address how to use special economic zones such as STPs to meet challenges of paradigm shift toward innovation and knowledge based economy in climate control era.

STPs could be utilized as a Green Growth Engine of Technology Innovation since most CO₂ emissions come from large cities with substantial agglomeration effect, particularly urbanization economies. Green growth through mitigation and adaptation could implement STPs facilities to develop green building with roof top garden to reduce carbon dioxide. STPs infrastructure could utilize green transportation, energy efficiency measures and increase citizen awareness. They are key areas for green growth. Presence of universities and research institutes generate skills area for research and can serve as the core of clusters.

Climate smart world requires technology innovation. STPs could retain strengths of the past with more research, development, and demonstration on four key technology areas (World Bank, Economic Development Report 2010): Energy Efficiency; Carbon Capture and Storage; Next-generation Renewable Energy; and Nuclear Power.

STPs could transform themselves into Green Cities by overcoming the remaining weaknesses of the present Polluting Mega Cities. They could anticipate/and overcome challenges of Green Growth by promoting innovation through:

- Openness to new ideas
- Quality of tertiary level training and research institutions: experience/skills of staff, laboratory and equipment
- Global circulation of knowledge workers and face-to face interaction
- International research collaboration in green technology
- Strong private sector research effort
- Incentives for commercializing research
- Climate change (technology innovation)
These efforts require supporting policies in following areas:

- Macroeconomic policies such as exchange rate, demand-related, fiscal, etc.
- Institutional policies such as financial, venture capital development, carbon tax, and regulatory and legal aspects of climate control
- Technological policies such as green research and business development, international collaboration and dissemination and awareness of climate control measures
- Urban renewal and new towns policies to generate Green Cities and Green STPs

Future Imperatives and research should focus on following areas in order to address green growth and innovation:

- How to shift towards a knowledge economy that promotes innovation & productivity-led growth. To address how STPs with university-industry-research institutions could apply green growth innovation capacity building.
- How to improve effort to move up value chain and create profitable activities at global market places in green growth by utilizing global network of operations with competitive business environment.
- How to increase scale and scope of carbon pricing for catalyzing market-driven innovation and adoption of mitigation technologies at STPs to research green technology.
- How to plan and develop attractive urban environment for knowledge workers and successful businesses and entrepreneurs.
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Energy-Efficient Transport Systems and Urban Policy

KRIHS SPECIAL REPORT 2010

• Nam-geon Cho
1. Outline

With oil prices skyrocketing to US$120 per barrel triggered by the unstable international situation, the world was faced with an energy crisis in 2008 again after 1973 and 1979. Fortunately, the prices stabilized more quickly this time unlike the previous times. Nonetheless, the world economy is still showing some undesirable aspects due to the global economic crunch caused by the subprime mortgage crisis of the US. Since international oil prices are still showing large fluctuations daily depending on the international situation, the energy crisis may still likely erupt any time.

Energy is the growth force of international economic activities. All the modern things we are using are being operated by energy. If it gets depleted, a huge crisis will ensue. Computers, transportation, and home electronic appliances will stop, and we might have to go back to the primitive state. Even the small motions of people rely on energy. The movement of people and goods is a basic economic activity, and it is driven entirely by energy consumption. Accordingly, energy is an indispensible resource for individuals, societies, and nations as well as the world to continue exchanging and carrying out their activities.

In a situation wherein an energy crisis might erupt again, we always require countermeasures. As Korea mainly depends on import for its energy needs, measures for saving energy are more crucial. Even for countries that produce energy, the resources are not infinite; measures for saving them are required at all times.
Especially, energy consumption is directly related to the generation of carbon dioxide. Therefore, we should reduce the “evil” chemical compound and come up with strategies for the reduction of energy consumption to practice green growth as part of efforts to respond to climate changes.

Traffic activities are directly connected to energy consumption and generation of CO₂; as such, measures for efficiently reducing energy consumption can bring about green growth in the end. This paper will examine the measures and urban policies of Korea as well as the world to reduce energy consumption efficiently in the transport system.

2. Transport and Energy

Transport activities account for 19% of the total energy consumption and 23% of energy-related CO₂ emission of the world; these rates are expected to grow gradually (IEA, 2009). Korea is in a similar situation. Ranked tenth in the world in terms of energy consumption (236.5 million TOE) and seventh in the world in terms of petrol consumption (105.5 million TOE), Korea consumes energy at a rate that is even higher than that of developed nations; its consumption per capita is also higher in terms of income level. Energy consumption by the transport sector of Korea has steadily increased; in 2007, in particular, it accounted for 21% of the total energy consumption and around 36% of the consumption of petrol products. In fact, road transport sector accounts for 79% of all transport related energy consumption (MOE, KEEI, 2008).

Energy consumption is directly related to economic activities. In the US, transport-related goods and service accounted for about 11% of GDP. EU and Japan showed high rates in transport-related energy consumption, their energy consumption growth rates reaching 133% between 1970 and 2002. Specifically, consumption by the transport sector of Japan increased 160% during the same period (OECD, 2006).

The alarming fact in relation to energy is that Korea is importing 96.5% of its energy needs from other countries. It is the world’s fourth largest petrol importer and the second biggest LNG importer. Accordingly, changes in oil prices of other countries have direct impacts on the economy of Korea and life of people in Korea. Therefore, Korea has higher need for measures for efficiently using or saving energy even in the transport sectors than any other countries.
### Table 2.1. Energy Consumption Changes by the Transportation Sector of Korea

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Energy Consumption</th>
<th>Energy Consumption by the Transportation Sector</th>
<th>Total Rate</th>
<th>Total Petrol Product Consumption</th>
<th>Petrol Products Consumption by the Transportation Sector</th>
<th>Total Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>75,107</td>
<td>14,173</td>
<td>18.9</td>
<td>45,252</td>
<td>14,086</td>
<td>31.1</td>
</tr>
<tr>
<td>1995</td>
<td>121,962</td>
<td>27,148</td>
<td>22.3</td>
<td>82,876</td>
<td>27,010</td>
<td>32.6</td>
</tr>
<tr>
<td>2000</td>
<td>149,852</td>
<td>30,945</td>
<td>20.7</td>
<td>93,595</td>
<td>30,770</td>
<td>32.9</td>
</tr>
<tr>
<td>2003</td>
<td>163,995</td>
<td>34,632</td>
<td>21.1</td>
<td>96,154</td>
<td>34,286</td>
<td>35.7</td>
</tr>
<tr>
<td>2007</td>
<td>181,455</td>
<td>37,068</td>
<td>21.0</td>
<td>100,622</td>
<td>36,149</td>
<td>36.0</td>
</tr>
</tbody>
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**Note.** TOE (ton of oil equivalent) = Unit of energy standardized in calorie released by a ton of crude oil


### Table 2.2. Energy Consumption Changes by Transportation Sector

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<tr>
<th>Year</th>
<th>Total</th>
<th>Road</th>
<th>Railway</th>
<th>Seaway</th>
<th>Airway</th>
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<td>1987</td>
<td>9,276</td>
<td>6,881</td>
<td>352</td>
<td>1,472</td>
<td>571</td>
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<tr>
<td>1990</td>
<td>14,173</td>
<td>11,205</td>
<td>392</td>
<td>1,669</td>
<td>907</td>
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<td>1995</td>
<td>27,147</td>
<td>21,218</td>
<td>464</td>
<td>3,617</td>
<td>1,848</td>
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<td>2000</td>
<td>30,946</td>
<td>23,554</td>
<td>513</td>
<td>4,705</td>
<td>2,174</td>
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<tr>
<td>2003</td>
<td>34,632</td>
<td>27,419</td>
<td>549</td>
<td>4,477</td>
<td>2,188</td>
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<tr>
<td>2007</td>
<td>37,068</td>
<td>29,195</td>
<td>441</td>
<td>4,235</td>
<td>3,197</td>
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**Note.** From *Yearbook of Energy Statistics*, by the Ministry of Knowledge Economy, Korea Energy Economics Institute, 2008.
3. Energy Saving Measures for the Current Transport System

Energy saving measures by retaining the current transport system include the following: making fuel efficient engine of vehicles, making use of vehicles less, developing alternative fuels, providing incentives to stimulate the purchase of energy saving vehicles, and training eco-driving for less fuel consumption.

3.1 Green car development

Even before the energy crisis in 2008, there were many efforts toward energy saving in the transport sector. Korean automobile companies are also producing vehicles with desirable fuel efficiency, thereby enhancing the energy saving effects further.

Fuel efficiency is steadily being improved. In particular, EU presented standards for the fuel efficiency of vehicles and automobiles, and they have been voluntarily observed by EU auto-makers. Korea realized 16.5% improved fuel efficiency by implementing regulations on fuel efficiency from 2008 instead of 2012. According to the regulations, standards for vehicles less than 1600cc of engine size stipulate an increase from 12.4l/km to 14.5l/km, and vehicles over 1600cc of engine size, from 9.6l/km to 111.2l/km after 2012. Meanwhile, EU is planning to strengthen its fuel efficiency standards further in 2015 and 2020 (refer to the official website of the Ministry of Knowledge Economy).

Driven by the effects of high oil prices in 2008, the US government also demanded the improvement of fuel efficiency of the automobiles produced in the country. This is one of the policies for dealing with climate changes; in fact, President Obama called for the improvement of American automobiles to 35.5 miles per gallon (100km/6.6l) by 2016. This represents 30% higher fuel efficiency than the new light-duty vehicles produced in 2005.

The fuel efficiency of cars sold in Korea seems to have improved gradually. The average fuel efficiency of cars sold in Korea in 2008 was 11.47l/km, 3.9% higher than 11.04/km in the previous year. Subsequently, the average CO₂ emission decreased by 5.3% from 200.6g/km in 2007 to 190.5g/km in 2008. The higher fuel efficiency brought
about a reduction of approximately 50 million liters of automobile fuels, which is equivalent to improvement in trade balance of US$13 million. It was also believed to have helped reduce CO₂ emission by 103 thousand tons per annum (refer to the official website of the Ministry of Knowledge Economy).

### 3.2 Hybrid vehicles and alternative fuel development

Hybrid vehicles using internal combustion engines and electronic motors together are being sold following their commercialization in 1997. The vehicles have 49% higher fuel efficiency and 42% less emissions than regular ones (see the official website of Seoul City). Recently, hybrid buses and trucks have been produced. Environment-friendly, they have high fuel efficiency and cause minimal pollution but cost quite a lot. According to an experiment, their fuel efficiency was better in cities with high traffic density; in highways, however, it was almost the same as that of vehicles with internal combustion engine.

One of the ways to reduce the fuel waste of gasoline vehicles is to use appropriate engine oils and warm the cold engines rapidly. If related technologies are successfully developed and used for crowded city sections, energy efficiency is expected to improve by around 10% on the average and 20% in winter (OECD/IEA, 2005).

Fossil fuels such as gasoline and light oil are mainly used for vehicles. Note, however, that research on alternative energy sources is in progress. Sweden, Spain, the Netherlands, and Italy are carrying out research on bio-ethanol. Dubbed the BEST (Bioethanol for Sustainable Transport) Project, the research is participated in by central governments, local governments, universities, automobile companies such as SAAB and Ford, and oil-refining companies.
Meanwhile, the development of electricity vehicles and hydrogen vehicles using fuel cells will play a role in coping with energy issues in the future. In particular, the supply of “green cars” with high fuel efficiency and related government support will be expanded as a means of tackling climate changes since they have low CO\textsubscript{2} emission.

3.3 Incentives for the purchase of fuel saving vehicles

Measures for providing incentives for the extension of supply of fuel saving vehicles and low emission vehicles are being widely used. Since the economic crisis in 2008, incentives have been given to vehicle purchasers in Korea to stimulate domestic sales. In particular, for the purchase of compact cars with higher fuel efficiency, registration tax and acquisition tax equivalent to about 10% of the price of the vehicle are waived. In addition, to promote energy saving, 50% reduction in express highway tolls and parking fees are offered for small cars. Among the cars sold in Korea, only 8.2% (82,162 units) were light-duty vehicles less than 1000 cc in 2007; the number increased to 13.5% (134,296 units) in 2008, recording a 63.5% growth rate compared to the previous year. The dramatic increase in the sale of compact cars was due to the surge in oil prices, outbreak of the global economic crunch, and unprecedented level of incentives from the government in 2008. In particular, the increase in the standard for the engine displacement of light-duty cars from 900cc to 1000cc contributed to the growth in sales of small cars.

In other countries, compensation or subsidy is provided to foster the purchase of vehicles with high fuel efficiency. In 2002, the UK reformed its tax system on company cars to raise the demand for “clean” cars with high fuel efficiency. Under the new tax system, taxes are decided on the basis of CO\textsubscript{2} emission and fuel of the vehicle at the time of purchase. For example, 3\% additional tax is imposed on diesel vehicles, whereas a 3\% tax reduction is applied for hybrid vehicles. Moreover, if the CO\textsubscript{2} emission of the car is 140g/km, 15\% of the tax is imposed on the car; 1\% tax is added by 5g/km emission, applying 35\% if the car emits 240g/km CO\textsubscript{2} as the maximum standard (see the official website of the Department of Finance and National Tax Office of the UK, www.hmrc.gov.uk). According to the UK’s recent evaluation on company cars, the improvement of fuel efficiency and reduction of driving distances were both successful. A similar system was operated in Sweden several years ago (OECD/IEA, 2004).
France is making efforts to raise energy efficiency by imposing higher taxes on large cars and giving subsidies for the purchase of cars with high fuel efficiency. For the purchase of New sports utility vehicle (SUV), up to €3,500 is imposed; for the purchase of vehicles with high energy efficiency, however, up to €700 is given as subsidy (OECD/IEA, 2004).

In the US, the federal government and state governments are obliged to buy out 75% for every new light-duty car purchased every year. Through the Smart Way Transport Partnership, the Environmental Protection Agency decided to offer incentives for trucks reducing greenhouse gases in operation (OECD/IEA, 2004).

Hybrid vehicles are quite expensive compared to regular ones. Therefore, Korea is planning to raise the supply rate of hybrid vehicles by supporting up to 70% of the purchase costs when public institutions buy them. Japan also reduces the taxes for the purchase of hybrid vehicles.

### 3.4 Eco-driving and education

Major factors in fuel wastes include (1) low temperature, (2) short distance driving especially at low temperature, (3) driving behaviors including reckless driving, (4) combination of urban driving and suburb driving and slower driving speed compared to the given road conditions, and (5) use of air conditioners (OECD/IEA 2005).

The following driving methods can save energy: changing the speed of vehicles as soon as possible, gasoline and LPG vehicles should be adjusted to 2500RPM at the most and 2000RPM for diesel vehicles, retaining a certain speed at the state of maximum transmission if possible, looking ahead and following the traffic flow around if possible, and when slowing down or pulling over the car, stepping off the pedal of the accelerator at the appropriate time while the engine is working, and leaving the car in gear state (Interpretation of Driving Style Tips in TNO report for Nov. 2002 cited by OECD/IEA, 2005).

As one of the websites of the UK government recommending the reduction of fuel wastes to drivers, Environment and Greener Driving shares the following tips:

- At 70 miles per hour (mph) you could use up to 15% more fuel than at 50 mph given the same distance.

- A vehicle traveling at 37 mph in third gear uses 25% more fuel than it would at the same speed in fifth gear (quoted from the website http://www.direct.gov.uk/en/
Energy-Efficient Transport Systems and Urban Policy

Since proper driving habits help reduce fuel wastes, some countries are conducting education or training on eco-driving. By implementing eco-driving, Netherlands, Sweden, Germany, and Hungary realized desirable effects in terms of improvement of fuel efficiency.

At the Frankfurt motor show in Germany in Sept. 2007, 20.65% fuel reduction (or equivalent amount of CO₂ reduction) was identified as a result of short-term education for 765 drivers (Wolfgang, 2008).

In 2002, the Swedish Road Authority carried out a study after providing education on eco-driving methods for a thousand drivers. The study revealed a 12~13% reduction in fuel consumption. According to a long term follow-up study, 5~10% reduction under actual road traffic conditions was observed. Since most of the drivers were truck drivers, their companies appreciated the high economic gains.

In the Netherlands, hundreds of thousands of new drivers have voluntarily participated in the eco-driving education since 2002. Beginning 2005, such form of driving was designated as a regular test. For the education, simulators were used to save time and resources of educators, yet it proved to be just as effective as actual road driving. Educators were able to realize a 10% fuel reduction on the average, with some drivers saving more than 30%. Note, however, that this driving education is effective only for manual transmission driving (OECD/IEA, 2005).

Korea will introduce eco-driving education and training in keeping with the recently legislated related laws¹. Accordingly, programs to educate green driving or correct drivers’ undesirable habits will be developed, and they are expected to contribute to energy saving eventually.

¹) Sustainable Transportation Logistics Development Law will be implemented beginning Dec. 2009.

Urban policies play a key role in the energy saving efforts of the transport system. When humans settled down for the first time, their villages were within a 500-meter radius. The scale enabled all activities to be accomplished by walking. Today, however, it is very hard to expect a small city structure due to motorization.

Urban policies that can apply to the reduction of transport energy of the city are designed to make its structure consume less energy. In other words, it should retain a transport system that facilitates walking, cycling, and using public transportation. If non-motorised modes and public transportation are convenient, the use of passenger cars will naturally be reduced.

The use of passenger cars can be forcefully restricted to reduce energy consumption of urban transportation. Urban traffic congestion is the main cause of energy waste. To reduce traffic congestion, circular roads and measures for the use of the intelligent transport system within the city are a matter of urgency.

4.1 Restriction on the use of cars

With energy issues emerging due to steadily rising oil prices, Korean government applied a regulation called odd and even number system\(^2\) in public institutions until the first half of 2009. The system was operated only in public institutions; since oil prices have stabilized, and signs of economic recovery have been noted recently, however, it was changed to a system of no-car driving once a week. This kind of measure has been carried out in Seoul Metropolitan City.

Seoul City has been operating a voluntary no car-driving day system since July 2003. The “no car driving day system” refers to a voluntary system wherein drivers can choose a weekday when they will not drive their cars. As of May 2008, 790 thousand cars are participating. This is equivalent to around 35% of all cars registered in the city. In

\(^2\) A driver has to drive his car every other day during weekdays under this system. Particularly, the car is able to run when the last digit of his car number plate is odd on an odd number of date.
fact, the attachment of electronic tags in the system was voluntarily started for the improvement of traffic congestion. Various incentives are being offered to drivers participating in the program, e.g., 5% reduction in automobile tax, 2.7% reduction in automobile insurance premium of owner and descendant, 10~20% discount of public parking fees, 50% discount on Namsan Tunnel congestion pricing fees3), provision of resident priority parking lots, and up to 40% reduction in Traffic Creation Allotment (see the official website of Seoul Metropolitan City). These policies can serve as means of saving energy by restricting the use of cars.

Transfer by vehicles is inevitable in performing economic activities in cities; note, however, that the reduction of unnecessary transits brings about smooth traffic flow. In this sense, road pricing can be considered one of the methods for controlling unnecessary trips. The system that is currently being implemented in London, Stockholm, Singapore, and Seoul contributes to restricting the use of cars, especially those cars with drivers only, reducing traffic, promoting the use of public transportation, and increasing travel speed.

The road pricing operated in London has been useful in ameliorating traffic congestion; in fact, it has also reduced energy consumption of cars. According to the fifth monitoring report issued by Transport for London (TfL 2007), total traffic declined by 16% from 2002 since cars and buses passing the congestion charging areas dropped by 36% and increased by 25%, respectively (Twenty-one percent in case of vehicles with more than four wheels). Traffic accidents in areas went down alongside the decreasing congestion and emissions owing to less traffic and increased speed of vehicles. Presumably, if traffic is reduced, traffic flow improves, fuel efficiency of vehicles increases, and emissions from vehicles decrease; eventually, such may be helpful in the reduction of energy consumption, although related detailed research has yet to be conducted (OECD/IEA, 2004).

Stockholm relieved traffic congestion and raised traffic reliability by reducing traffic by 22–28% on weekdays through the collection of congestion charging from January to July compared to the same period in 2005. According to surveys conducted before and after the introduction of the system, citizens’ perception changed, with the

3) Seoul city has been charging road pricing fees to cars with less than three passengers passing through Namsan tunnel, the mouth of the central business district in Seoul, between 7 AM and 9 PM weekdays since Nov. 1996. Low emission vehicles like hybrid cars and LPG cars are exempted the fees since 2007(refer to the official website of Seoul City).
system viewed as a positive move. Encouraged by this positive effect, the city is reducing traffic congestion by operating the system in downtown areas beginning August 2007.

Led mainly by Europe, around 70 cities in 8 nations recently established low-emission zones to regulate the vehicles causing heavy pollution and adversely affecting the health of people (http://www.lowemissionzones.eu). Moreover, in Korea, Seoul Metropolitan City announced a regulation to ban the use of old light oil vehicles beginning February 2010. Limiting the use of vehicles for environmental reasons can also be helpful in the reduction of traffic.

According to the study of Meyer (1999), however, traffic demand management policies show considerable differences depending on the policy; in fact, finding measures that contribute to a sharp decline in the driving distances of cars is very difficult. This is because drivers that rely heavily on their own cars are hardly willing to change their behaviors by shifting to public transportation.

4.2 Alteration of passenger cars into public transportation

Since programs for improving the urban transport system into a public transportation-focused one are useful for controlling the use of cars, they induce the actual improvement of the urban environment and reduce the fuel consumption of cars. Although undeniably convenient, cars consume more energy than public transportation. A most desirable effect can be realized if car users switch to public transportation.

Seoul City has implemented a number of transport instruments since several years ago. In particular, the city introduced Bus Rapid Transit (BRT) to reduce the use of passenger cars and increase the use of public transportation. Speeds in transits are faster than other lanes. Moreover, introducing the system to more areas and reducing the time taken for long distance transits pose competition to car users.

Low-floor buses have been introduced to increase the use of public transportation by traffic-disadvantaged people. Making subways and trains “express” also helps promote the use of public transportation by car users. In particular, express electrified metros are being operated in the recently opened Seoul Subway Line No. 9; their cruise time is shorter than regular ones, securing the high satisfaction of users. The bus information system (BIS) of announcing the arrival times of buses is also helpful in promoting the use of buses.
Seoul City is changing its transport system into a public transportation-focused one, yet finding proof that the use of cars has been absolutely reduced is difficult. After the improvement of the city’s public transport system, however, the use of public transportation has increased slightly, whereas the use of cars has not increased.

4.3 Walking and bicycle-friendly city

Walking-friendly cities have high accessibility. Cars are good for door-to-door travel, whereas walking and bicycle-friendly cities are helpful in reducing energy and CO₂ emissions through the replacement of cars for short distance travels. If the aim is to halt the use of a car in order to save the energy, public transportation should be easy to use and the walking environment should also be comfortable to walk.

According to the Passenger Travel Study of Seoul Metropolitan City, short-distance travels with less than 5 km accounted for 52% (13.5 million trips) of the total travels of the city and 44% (2.2 million trips) of the total travels of cars. Travels to school and private institutes with less than 2km accounted for 11.3% of the travels of cars, and 2~3km travels constituted 14% of the shopping trips (Lee and Kwon, 2004). This suggests the high possibility of changing the short-distance travels by cars into the use of public transportation and bicycles.

Areas where many people gather should retain a space system wherein public transportation can be used instead of cars. A city structure where workplaces and residences are clustered and occurrence of unnecessary travels is low should be established; this is essential in forming highly compact urban spaces.

Most importantly, comfortable and safe pathways for people’s walking should be secured. They should be safe and convenient as well for the use of bicycles. In using public transportation, such should facilitate getting to one’s destination. Since more barrier-free facilities are being built in public areas used by the general public, traffic-disadvantaged people can easily approach the areas. Routes to public facilities, schools, shopping centers, and medical institutions used by multitudes of people should be established for the convenient use of public transportation. These efforts can be helpful in transforming car-dependent spaces into public transportation-friendly ones.

In the UK, local governments perform evaluations on the accessibility of pedestrians through the local transport plan. They assess the routes of public transportation at public facilities, schools, hospitals, and shopping centers and
accessibility from bus stops to destinations (DfT, 2004). Such assessment can facilitate the reduction of the use of cars since it helps make the use of public transportation more convenient; thus eventually contributing to the energy saving of the transport system.

### 4.4 Establishment of circular roads to reduce traffic congestion

Cities are places where traffic issues mainly occur. Urban traffic makes up 40% of CO₂ and 70% of the pollutants generated by road traffic. Traffic congestion in urban areas is a chronic issue, causing traffic delay and pollution. Annual economic loss caused by traffic congestion in cities of EU was pegged at around €100 billion or 1% of GDP of EU (CEC, 2007).

One of the ways of easing urban traffic congestion is to build circular roads around the city. Circular roads do not go through the city but go around the city as shown in the pictures below. The roads reduce the traffic congestion of the entire city since traffic flows are decentralized to the outskirts of the city, thereby helping improve the traffic environment by reducing energy consumption and minimizing traffic accidents.

Most of the European cities retain bypasses. Less traffic congestion by 32km of the Amsterdam Circular Road Network opened in 1990 brought down the total travel time loss by 20%. After the opening of the road, departure time changed, thanks to the changes in the route of drivers; traffic that passed through the city was reduced by half, with the total driving distance within the city decreasing by 38%. Moreover, traffic accidents declined by 4% including emissions and noise.

Bypasses are being built in a number of cities in Japan. Short bypasses with less than 5km can help reduce costs generated by traffic congestion since they increase the

![Traffic Flows of Circular Roads](image)

**Figure 4.1. Traffic Flows of Circular Roads**

*Note. From Effects of the Opening of the Amsterdam Orbital Motorway, by Rijkswaterstaat, 1992.*
driving speed in roads going through the city, reduce the traffic delay distances, and minimize traffic accidents. Moreover, less traffic congestion within the city through bypasses is helpful in the reduction of traffic delay areas, waiting time for buses, and noise generation and CO₂ emission (refer to the official website of Japan’s Ministry of Land, Infrastructure, Transport and Tourism).

5. Conclusion

Moving and retaining the current urban and transport system require energy. Energy saving efforts have been made since the 1970s when the energy supply became unstable due to oil price increases effected by oil-producing states. Moreover, policies for reducing CO₂ emission to tackle climate changes have called for the improvement of the transport system. Toward this end, automobile companies have steadily improved the fuel efficiency of their vehicles and developed alternative fuels. Incentives are given for the purchase of energy saving vehicles to promote further supply. Energy saving is possible by changing the driving habits, e.g., eco-driving. From experiences in the experiment of eco-driving, approximately 10% of energy has been saved. Education or training on eco-driving is expected to be carried out as well in Korea after the legislation of related laws.

Among transport activities, walking and bicycling do not use energy. Note, however, that these non-motorized modes are appropriate for short-distance travels, not long-distance ones. Cars enable door-to-door travels, yet they consume large amounts of energy. Short-distance travels by cars should be changed into ones by walking, bicycles, or public transportation. In particular, public transportation is cheap, but the routes are fixed; it is also inconvenient compared to cars. Encouraging car users to use public transportation by making the transfer of public transportation easy and convenient is one of the tasks of urban policies. Seoul Metropolitan City implemented a large-scale reform of its public transportation system, and this played a role in increasing the use of public transportation. The number of car users has not decreased, but the travel of cars has not increased either. As such, this can be viewed as a desirable result.

If urban spaces are convenient for walking and bicycling, and priority is given to
public transportation in the areas, they will be helpful in controlling the use of cars. Apparently, the use of cars will be reduced if urban transport systems improve into ones focusing on pedestrians, bicycles, and public transportation.

A great amount of energy consumption within the city takes place through traffic congestion; to deal with this issue, circular roads around the city are necessary. Moreover, the intelligent transport system should be used for less traffic congestion.

Energy for transportation systems is indispensable for social and economic activities. Still, transport activities can be proportionate to the economic activities of the nation. When traffic is smooth, the quality of our life increases. Saving transport energy means saving the earth and making our economy grow. Since energy resources are finite, efforts to save energy in the transport system are essential and should be made steadily.
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<td>Yeong-kook Choi, Jin-kyu Chung, Eun-sun Im, Ou-bae Sim, Myung-soo Kim, Moon-woun Lee, kwang-ik Wang, Yeon-mi Seo, Jung-eun Park</td>
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<td>Eun-sun Im, Dae-jong Kim, Gyong-ju Lee, Young-joo Lee, Kirl Kim, Yoon-young Jeong, Jong-duk Park</td>
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