Low-Carbon Green City for Sustainable Development
- Future Trend and Advanced 3D Compact-City Strategies -

2011. 10.

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Note: Most of this presentation is also addressed in the joint conference of KOTI-OECD in Paris, 2010
Climate Change and Korea

Future Trend & Seoul, Korea

Development and Application Analysis of Transport Technology in Future

Concept and Characteristics of Advanced 3-D Compact City

Conclusion and Policy Strategies
1. Climate Change and Sustainability

1. Seoul and Korea at Present
2. Future Trend on Seoul, Korea and the World
3. Future Trend Summary and Development Prospect

Source: http://www.epa.gov/climatechange/emissions/globalghg.html

Global Anthropogenic Greenhouse Gas Emissions in 2004


Source: http://www.epa.gov/climatechange/emissions/globalghg.html
Greenhouse Gas Emissions in Korea
- 16th rank in the world (594.4 Mt · CO₂, Yr. 2005)
- 4th rank among OECD countries in increasing rate during past 5 years
- 25% for Buildings and 17% for Transportation

Trend on Energy
- 35% for transport among total domestic GHS emissions

Split in Transport
- 81% for road part among transport energy consumption

Marine 9%
Airport 9%
Rail 1%
Road 81%
Future Trend & Seoul, Korea

1. Seoul and Korea at Present
2. Future Trend on Seoul, Korea and the World
3. Future Trend Summary and Development Prospect
1. Seoul Metropolitan Area (SMA) at Present

SMA Location

- **Seoul MA City**: 25 Districts (Gu)
- **Incheon MA City**: 8 Districts + 2 Counties (Gun)
- **Kyung-gi Province**: 27 Cities (Si) + 4 Counties
## Population and Economy

<table>
<thead>
<tr>
<th></th>
<th>Population (Yr 2005)</th>
<th>% Pop. To Entire Korea</th>
<th>No. of Employees in 2008</th>
<th>No. Firms (Yr 2008)</th>
<th>% No. of Employees to Entire Korea</th>
<th>% GRDP to Entire Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seoul</td>
<td>9,820,171</td>
<td>20.77%</td>
<td>8,158,554</td>
<td>1,439,374</td>
<td>25.0%</td>
<td>23.6%</td>
</tr>
<tr>
<td>Incheon</td>
<td>2,531,280</td>
<td>5.35%</td>
<td>1,487,299</td>
<td>310,145</td>
<td>4.5%</td>
<td>4.7%</td>
</tr>
<tr>
<td>Kyung-gi</td>
<td>10,415,399</td>
<td>22.03%</td>
<td>6,403,782</td>
<td>1,153,201</td>
<td>19.6%</td>
<td>20.3%</td>
</tr>
<tr>
<td>Total</td>
<td>22,766,850</td>
<td>48.15%</td>
<td>16,049,635</td>
<td>2,902,720</td>
<td>49.3%</td>
<td>48.6%</td>
</tr>
<tr>
<td>Entire Korea</td>
<td>47,278,951</td>
<td>100.0%</td>
<td>32,576,560</td>
<td>6,529,564</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

### Population(%)

- Seoul
- Incheon
- Kyung-gi
- Others

### GRDP to Entire Korea(%)

- Others
- Kyung-gi
- Incheon
- Seoul

II. Future Trend & Seoul, Korea

1. Seoul and Korea at Present

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THE KOREA TRANSPORT INSTITUTE
1. Seoul and Korea at Present

Population and Economy

**Population Density**

- under 3,000 persons/km²
- 3,000~5,000
- 5,000~10,000
- 10,000~20,000
- over 20,000 persons/km²

**Employment Density**

- under 5,000 persons/km²
- 5,000~10,000
- 10,000~20,000
- 20,000~30,000
- over 30,000 persons/km²
1. Seoul Metropolitan Area (SMA) at Present

**Road-Oriented Suburbanization**

- **Road Network at Present**
- **Suburbanization and its Direction**

**Expressway (X-way) Investment**

- **1970s**
  - Kyungin X-way
  - Kyungbu X-way
  - Youngdong X-way

- **1980s**
  - Riverside X-way
  - Jungbu X-way

- **1990s**
  - Inner-ring
  - Outer-ring
  - Arterial X-ways

- **2000s**
  - Incheon X-port X-way

**New Town Dev. Projects Without-City**

- 1971
- 1981
- 1990
- 2000

**Urbanized Area**
1. Seoul Metropolitan Area (SMA) at Present

Traffic Congestion and Costs

- Metropolitan area
- Korea
- Seoul

<table>
<thead>
<tr>
<th>Year</th>
<th>Metropolitan area</th>
<th>Korea</th>
<th>Seoul</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>124,201</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>118,270</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>119,658</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>134,001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>141,109</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>144,884</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Traffic Congestion Costs (Unit 100M Won) 1Us $ = 1,110Won
2. Future Trend in Seoul, Korea and the World

**Economic Growth**

**GDP Estimates in Future (Korea): Development Demand and Suburbanization ↑**

- 4% Annual Increase of GDP on average
- 3% increase of world economy

2. Future Trend in Seoul, Korea and the World

Urbanization, Suburbanization and Mega-city Region

Step 1. Urbanization

![Percentage of World Population](Image)


Step 2. Metropolitanization

![World Map](Image)


Step 3. Mega-regionalization

![Megaregions Map](Image)

* Source: http://www.america2050.org/maps/
2. Future Trend in Seoul, Korea and the World

Population Structure and Housing Demand in Korea

- Population estimates in future
- Estimated Households: Family Nuclearization

Super-Aging Society: Recentralization and Transit Demand ↑
2. Future Trend in Seoul, Korea and the World

Income Distribution and Travel Budget

Korea

- Wolfson index
- Esteban & Ray index

World: Income Distribution → Polarization and Transit Demand ↑


* Source: CEO Information (2006), SERI
2. Future Trend in Seoul, Korea and the World

Car Ownership and Travel Demand

- No. of Cars registered

Car-Oriented Mega-city Region?

- Motorization trend in Asia

Source: Jamie Leather (2009), p.4

Graphical data showing the number of cars registered and motorization trend in Asia from 2000 to 2030.
2. Future Trend in Seoul, Korea and the World

Fuel Price and Vehicle Technology

- Trend of World Fossil Fuel Prices

- Fuel efficiency (Liter/100km)

- CO₂ M. Tons per Year

* Source: European Commission (2009) "EU Energy Trend to 2030, p.16

* Source: Shell (2010)
2. Future Trend in Seoul, Korea and the World

Architecture and Civil Engineering Technology

- Skyscraper in Korea
- Skyscraper in the World

No. Floors & Energy consumption

*sources: CTBUH Journal(2009), left; Hammond & Jones (2008), right
# 3. Future Trend Summary and Development Prospect

## Summary of Future Trend in Seoul

<table>
<thead>
<tr>
<th>Category</th>
<th>Future Trend in 2030</th>
<th>Space and Transport Prospect</th>
</tr>
</thead>
</table>
| Economy      | - World Economy: Annual growth 3.53%  
- Domestic Economy: Annual growth 4%                                          | - Employment Demand †  
- Development needs †  
- Travel Demand †  
- Transportation Infrastructure †                                               |
| Urbanization | - 60% of the world’s population living in cities  
- Growth of metropolitan areas  
- megalopolis                                                               | - Seoul (GDP ranking: 20→17)  
- Urban sprawl  
- Travel Demand (between regions) †                                         |
| Population   | Number  
- Metropolitan area †  
- Seoul ‡                                                                   | Suburbanization †  
- travel distance †                                                           |
| Structure    | - post-aged society (24.3%)  
- Increasing 1~2person households (51.8%)                                      | Housing demand (in urban area) †  
- Medium/small-sized housing demand †                                         |
| Commute      | Car  
No. of car †                                                                 | Dependence on personal Vehicles †                                                            |
|              | Oil price  
Oil Price †                                                                  | Personal Vehicle demand ↓                                                                  |
| Technology   | Transportation  
Fuel/Engine Technology †                                                      | Travel costs ↓  
Personal Vehicles demand †                                                    |
|              | Architecture  
High rise / Energy saving Technology †                                         | Skyscraper †                                                                                 |
|              | civil engineering  
Underground Space Technology †                                                 | Underground Space Development needs †                                                      |
3. Future Trend Summary and Development Prospect

Prospect Scenarios and Climate Change

- Advanced 3-D Compact City-Region
- 3-D Compact City-Region
- Centralized Decentralization

Climate Change

Counter-Measure

Spatial Structure

Trend

Base

Opportunity ↑

Risk ↓

Recentralization

Decentralization (Suburbanization)

Income polarization
Strong dev. demand
High oil price

Aging society
Nuclear family

Skyscraper Underground

Strong dev. Demand
Motorization

Population Growth

Engine & Fuel Efficiency

Economy

Technology

Population

Future Transport System + Modes
Development and Application Analysis of Transport Technology in Future

1. Future Prospects of Transport System and Modes
2. Application Analyses for Future
### Long-Distance Transport System and Modes

<table>
<thead>
<tr>
<th>Automated Highway System, AH</th>
<th>MAGLEV, magnetic levitation</th>
<th>Transition Flying Car</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Image</strong></td>
<td>![Image of Automated Highway System, AH]</td>
<td>![Image of MAGLEV, magnetic levitation]</td>
</tr>
<tr>
<td><strong>Concept</strong></td>
<td>using existing roads, underground 9-25 Platoons</td>
<td>high speed magnetic levitation train</td>
</tr>
<tr>
<td></td>
<td>Manless driving</td>
<td>Maximum speed 6437km/h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(now 581km/h)</td>
</tr>
<tr>
<td><strong>case</strong></td>
<td>PATH Project(I-15 San Diego 1991)</td>
<td>MAGLEV(Tokyo-Osaka) trial run(2003)</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>safety and mobility, capacity ↑</td>
<td>High speed / Large capacity</td>
</tr>
<tr>
<td></td>
<td>energy and time save</td>
<td>minimized vibration</td>
</tr>
<tr>
<td></td>
<td>Efficiency of road space ↑</td>
<td>air Pollutant free</td>
</tr>
<tr>
<td></td>
<td>Just-In-Time</td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>Traffic congestion (slip road)</td>
<td>high construction costs(US$34.6M per kilometer)and operating costs</td>
</tr>
<tr>
<td></td>
<td>Uncertain environmental and land-use benefits</td>
<td>noise</td>
</tr>
<tr>
<td></td>
<td>Possibility of major accidents</td>
<td></td>
</tr>
<tr>
<td></td>
<td>social equality ↓</td>
<td></td>
</tr>
</tbody>
</table>
1. Future Prospects of Transport System and Modes

Sustainability and Speed: Maglev

- Car
- Air
- Bus
- Local Train
- Shinkansen
- MAGLEV

* Source: Morichi (2008)
주) MAGLEV Test Line: Tokyo – Osaka
### III. Development and Application Analysis of Transport Technology in Future

#### 1. Future Prospects of Transport System and Modes

<table>
<thead>
<tr>
<th>Short-Distance Transport System and Modes</th>
<th>Automated Public Transit System, APTS</th>
<th>Bike Rapid Transit</th>
<th>Neighborhood Electronic Car</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Image</strong></td>
<td>![Image of APTS]</td>
<td>![Image of Bike Rapid Transit]</td>
<td>![Image of Neighborhood Electronic Car]</td>
</tr>
<tr>
<td><strong>Concept</strong></td>
<td>2<del>6person, point-to-point, on-demand operating&lt;br&gt;Minimize interval&lt;br&gt;Max. 40km/h 3200</del>4800persons/hour&lt;br&gt;Using electric and hydrogen</td>
<td>overpass/underpass&lt;br&gt;Interchange&lt;br-Speed ↑ Impact of Climate ↓</td>
<td>Battery Electric Vehicles&lt;br&gt;Low-speed&lt;br&gt;for two people&lt;br&gt;Low Pollutant short distance&lt;br&gt;under 40km/hr</td>
</tr>
<tr>
<td><strong>Case</strong></td>
<td>Morgatown PRT, ULTra, CVS, PRT200 etc.</td>
<td>none&lt;br&gt;US Transglide 2000, Canada Velo-city, Germany Velovent etc.</td>
<td>California, US&lt;br&gt;Zero Emissions Vehicle (rebate $1,500)</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>Total Automation System&lt;br&gt;Occupy less space&lt;br&gt;Traffic congestion ↓&lt;br&gt;Pollutant free</td>
<td>Long-distance drive&lt;br&gt;Transportation Safety ↑&lt;br&gt;Energy saving /Pollutant free&lt;br&gt;Promotion of health&lt;br&gt;Door-to-Door/ minimize land use</td>
<td>Low Pollutant short distance vehicle&lt;br&gt;Minimize parking space</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>Not applicable in CBDs&lt;br&gt;Initial investment ↑</td>
<td>Energy consumption ↑ (high-tech systems)&lt;br&gt;Construction/operating cost ↑&lt;br&gt;Safety&lt;br&gt;Potential greenhouse effect</td>
<td>Land consumption</td>
</tr>
</tbody>
</table>
### Logistics System

<table>
<thead>
<tr>
<th></th>
<th>CARGOCAP</th>
<th>Advanced Multi-modal Freight System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Image</strong></td>
<td><img src="image1" alt="Image" /></td>
<td>None</td>
</tr>
<tr>
<td><strong>Concept</strong></td>
<td>Underground Capsule(48”×32”) Logistics System</td>
<td>.Rail-road freight transport system</td>
</tr>
<tr>
<td></td>
<td>using Electricity(500V)</td>
<td>.Minimize the time transshipment</td>
</tr>
<tr>
<td></td>
<td>Intelligent Logistics System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Better is high demand for small size of freight</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Just-in-Time pickup and Delivery</td>
<td></td>
</tr>
<tr>
<td><strong>Case</strong></td>
<td>.none (Applicable in Yr. 2015)</td>
<td>.none</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>.Traffic congestion ↓</td>
<td>.Addition costs is small (Present system use)</td>
</tr>
<tr>
<td></td>
<td>.Environment &amp;energy efficiency ↑</td>
<td>.24hours/365days none stop system</td>
</tr>
<tr>
<td></td>
<td>.Transportation Safety ↑</td>
<td>.Traffic congestion ↓</td>
</tr>
<tr>
<td></td>
<td>.land-use efficiency ↑</td>
<td>.Drivers' stress ↓</td>
</tr>
<tr>
<td></td>
<td>.Freight transport reliability ↑</td>
<td>.Reducing Traffic Accidents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.Environment &amp;energy efficiency ↑</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>.none</td>
<td>.Not applicable in short-term</td>
</tr>
</tbody>
</table>

---

**III. Development and Application Analysis of Transport Technology in Future**

**1. Future Prospects of Transport System and Modes**
2. Application Analyses for Future Transport

### Evaluation Criteria

- **Criteria 1: Practicality and Competitiveness**
  - Technology development, Compatibility
  - Spatial hierarchy, Competitiveness
    - Substitutes vs. Complements
    - Innercity vs. Intercity vs. International

- **Criteria 2: Cost and time budget limits**
  - Compared to income levels,
    - Constant travel budget (8~12%)
  - Travel time invariability (per day) (time vs. distance)
    - time and space Convergence
New system and modes are complementary, not competitive, goods
But, the role of old transport system and modes is becoming shrinking
2. Application Analyses for Future Transport

Evaluation Criteria

- Criteria 3: Sustainability
  - Economic Efficiency
    (time, construction costs, operating costs)
  - Social Equity
    (quality of life, the mobility Handicapped)
  - Environmental Preservation
    (Pollution, Land consumption)
III. Development and Application Analysis of Transport Technology in Future

2. Application Analyses for Future Transport

Evaluation Criteria 2

- Bike Rapid Transit
- High-Speed Electronic Train
- Super-High Speed Megalev
- Personal Rapid Transit (PRT)
- Automated Highway System (AHS)
- High-Speed EVs
- Transiton Flying Car
- Neighborhood Electronic Vehicle (NEV)

Travel Distance (Efficiency)

Sustainability

High
Low

Short
Medium
Long
Concept and Characteristics of Advanced 3-Dimensional Compact City

1. The Concept and Vision of Advanced 3-D Compact City
2. Advanced 3-D Compact City Development Panning
1. The Concept and Vision of Advanced 3-D Compact City

Concept and Planning Elements of Advanced 3-D Compact City
IV. Concept and Characteristics of Advanced 3-D Compact City

1. The Concept and Vision of Advanced 3-D Compact City

Need of Advanced 3-D Compact City

- Reduction of CO\textsubscript{2} emissions
- The Correlation between Land-use and Energy consumption

**Land Use Policy**

- Density
  - (urban, outer, inner)
  - residence
  - employment

**Land Use Mix**

- population acceptance of density level
- infrastructure investments
- attractive public transportation

**Change in Mode Choice**

- walking/cycling
- public transportation
- Private car

**Trip efficiency**

- Trip Length
- Trip Chaining

**Energy Consumption**

- Compatibility of employment and population


- Reduction of CO\textsubscript{2} emissions

**Graphs**

- Reduction of CO\textsubscript{2} emissions by mode of transport
- Correlation between land-use and energy consumption

**Diagram**

- Concept and characteristics of Advanced 3-D Compact City

**Unit**

- CO\textsubscript{2} tons per passenger or freight ton

### Concept and Vision of Advanced 3-D Compact City

**Concept and Vision of Advanced 3-D Compact City**

- **All-win (Economy, Society, Environment):**
  - Public Transportation
  - Low speed transit on the ground
  - Transportation Demand Management

- **Improvement of Accessibility:**
  - Multi-mode transit system
  - Diversity
  - Smart work center based on Information and Communication Facilities

- **Mobility and accessibility:**
  - Multi-mode
  - Dimensional dualistic transport system (Arterial & Feeder)

- **Convenient and safe city:**
  - Preservation of ground built environment in past and present
  - Traffic Calming + Sufficient open space on ground
  - Underground use for new transport and transfer system

- **Enhancement of land use and conservation of land resources:**
  - Global and domestic economic growth
  - Transport Hub
  - Hierarchy network
  - Multi-Dimensional Complex Developments Urban Growth Management

- **Compact and 24hours activity:**
  - High-density, high-rise, compact development
  - Underground Arterial traffic system
  - Automatic Logistics System

- **Advanced 3-D Compact city**

- **Time**

- **Space**

- **Activity**

- **Accessibility**

- **Transportation Mode**
Ⅳ. Concept and Characteristics of Advanced 3-D Compact City

2. Advanced 3-D Compact City Development Planning

Transport Planning

- UAHS: Underground AHS
- UMRT: Underground Metro Rapid Transit
- BRT: Bus Rapid Transit
- HS-EV: High Speed-Electronic Vehicle
- PRT: Personal Rapid Transit
- NEV: Neighborhood Electric Vehicle

Logistics System

Regional transportation system

District transportation system
IV. Concept and Characteristics of Advanced 3-D Compact City

2. Advanced 3-D Compact City Development Planning

Land-Use Planning

- **Vertical Land Use**

- **Medium-Low density land use**
  - Housing, Neighborhood Facilities
  - Floor area ratio: 100~250%

- **Medium-High density land use**
  - Housing, Education
  - Neighborhood Facilities
  - Floor area ratio: 250~400%

- **High density mixed housing**
  - Housing, Office, Commercial
  - Floor area ratio: 500~600%
  - 500m radius

- **High density mixed land use**
  - High density housing, Office, Commercial, Transportation Hub
  - Floor area ratio: over 600%
  - 250m radius

- **Horizontal Land use Model _ Urban Center**

- **Horizontal Land use Model _ Edge city**

- **Educational Cultural Complex**
  - Education, Cultural, Leisure Facilities

- **Medium-Low density land use**
  - Housing, Neighborhood Facilities
  - Floor area ratio: 100~250%

- **Medium-High density land use**
  - Housing, Education, Neighborhood Facilities
  - Floor area ratio: 250~400%

- **High density mixed housing**
  - Housing, Office, Commercial
  - Transportation Hub
  - Floor area ratio: 500~600%
  - 250m radius

Source: Towards an Urban Renaissance, Urban task Force, 1999, p62
Ⅳ. Concept and Characteristics of Advanced 3-D Compact City

2. Advanced 3-D Compact City Development Planning

**Urban Design Planning**

- Minimizing the block size → Walking accessibility ↑

*Source: http://neighbors.columbia.edu/pages/manplanning/proposed_plan/gallery.html

*Source: A Study on Approrite Size od Pedestrians-friendly City Blocks, Su-Min Lee, 2006, p50,52*
IV. Concept and Characteristics of Advanced 3-D Compact City

2. Advanced 3-D Compact City Development Planning

**Architecture Design Planning**

- Improve pedestrian environment _ Piloti Structure

- Improve pedestrian environment _ Set-back : Pedestrian-way width ↑

- Greening building and sky passageway


Conclusion and Policy Strategies

1. Needs of Advanced 3-D Compact city Development
2. Policy Strategies for its Realization
1. Needs of Advanced 3-D Compact City Development

Not demand, needs of Advanced 3-D Compact City

- Needs 1: Encouraging opportunities and discouraging risks
  - Strong economy growth
  - Income polarization
  - Aging society + nuclear family
  - High oil price
  - Architecture & civil engineering technology development
  - Climate change countermeasure

- Needs 2: People, utilitarian & advanced technology-oriented approach strategies
  - 3-Dimensional Compact City
    - Underground: Transport + SOC Facilities
    - Ground: People- & Environment -friendly Open Space and Transport
    - Sky: Skyscraper + Walking passageway + Flying car
  - Advanced City
    - Underground automated highway system / Megalev transit system
    - High and low speed EVs, PRT, BRT, E-bike, etc.
    - Advanced congestion pricing system for UAHS
V. Conclusion and Policy Strategies

2. Policy Strategies for its Realization

- Strong Support from Governments & Continuous Economic Growth
  - Change of spatial structure in a region can attained from strong support of gov.
  - A big-money investment and long-term construction project

- A Model City Development in Reality (Ex. Daegok Rail Station Area)
  - Realizing the expected impacts and encouraging the support

- Comprehensive & Integrated Planning and Policies
  - 3-D development ← integrated planning is necessary
  - Safety and disaster prevention planning is prerequisite

- Institutional Support for It
  - A new and advanced development project is achievable through institutional improvement
  - Integrating many related laws makes it easily achieve for future sustainability
Thank you