Sustainable Eco-Industrial Development Strategy
Anthony SF Chiu

Kitakyushu Initiative Seminar on Urban Air Quality Management
UN ESCAP February 20-21, 2003
Outline of Discussion

A. Identification of Issues
   • Review of Urban Mobile and Stationary Sources

B. Preventive Strategies
   • Industrial Transformation (IHDP)
   • Cleaner Production (UNEP/UNIDO); ZERI (UNU)
   • Eco-Industrial Development (UNDP/UNEP)

C. Management Systems (UNEP IETC)

D. Best Practices
   • Ecocity Conference, IEAsiaNet, etc.

Note: Due to webspace constraint, this is a lite version of the presentation. The reference page can be found in the original ppt version.
A. Urban Air Pollution Issues

Types
- Acid Rain
- Domestic Smoke
- Smog
- The Greenhouse Effect
- Particulates
- Radionuclides
- Ozone Layer Depletion

Sources
- Domestic
- Industrial
- Transportation modes
- Re-suspended dust
The potent haze (cocktail of aerosols, ash, soot, black carbon, other particulate) lying over the entire Indian subcontinent -- from Sri Lanka to Afghanistan -- has led to some erratic weather, acid rain, sparking flooding in Bangladesh, Nepal and northeastern India, but drought in Pakistan and northwestern India.

- "Biomass burning" from forest fires, Residential Wood Combustion (RWC), vegetation clearing and fossil fuel
- Mobile Sources (MS)
(Mobile Source) Transport Case: Two-Stroke Engine Vehicles [WB]

- Technical issues
- Economic issues
- Environmental issues
- Social issues
- Policy issues
Environmentally Sustainable Transport

… is a new approach to transport policy development using a backcasting methodology. Current work focuses on developing implementation strategies and best practices for EST in OECD regions.

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(Stationary) Industrial Air Pollution

- Developmental Stages: from fight against dust and soot to sulfur oxide to nitrogen oxide
  - Governmental regulation
  - Procurement of low-sulfur crude oil
  - Desulfurization facilities
  - Private sector innovation of and investment in pollution management technologies such as flue-gas desulfurization facilities
Urban Industrial Complexes

- 1955, Yokkaichi coastal petrochem complex (interview with Professor Katsumi Yoshida)
- Mizushima industrial complex (1961) caused decay among agricultural plants
- Kawasaki, Amagasaki, and Kitakyushu
- Impact on economy, ecology, and society
B. Preventive Strategies

- Passive Waste Management
  - Foul and Flee
  - Dilute and Disperse
  - Concentrate and Contain
- Reactive Waste Management
  - End of Pipe (EOP) treatment
  - End of Pipe control / standards
- Proactive Waste Management
  - Preventive strategies
Sustainable Industrial Development

Scope and Results

EMS

Time and Work

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Sustainable Development

Industrial Ecology

Cleaner Production

Pollution Prevention

Waste Minimization

Recycling

Pollution Control

Waste Disposal
"Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products and services. It embodies the more efficient use of natural resources and thereby minimizes waste and pollution as well as risks to human health and safety. It tackles these problems at their source rather than at the end of the production process; in other words it avoids the 'end-of-pipe' approach."
Cleaner Production

- Is a system approach
- Is a strategy, not just a tool
- Is an innovative concept, not restrained by cited approaches
- Can be evolved to a larger system, beyond a firm-level, to eco-industrial development paradigm... eco-city, ecotown, ...
- Education is available (sometimes free!)
Input: Raw material, Energy, Water

Operations or Production:
- Raw material
- Energy
- Water
- Generation of NPO, disposal of NPO

Output: desired final product, Non-product Output (NPO)

Input-costs of NPO + Processing - Costs of NPO + Disposal - Costs of NPO = Total NPO-costs

10-30% of total cost of production
Elements of Cleaner Production Strategy

CONTINUOUS

PREVENTATIVE

INTEGRATIVE (air, waste, land)

STRATEGY FOR RISK REDUCTION

PRODUCTS

HUMANS

CLEANER PRODUCTION

PROCESS IN OPERATIONS/PRODUCTION

ENVIRONMENT

(source: UNEP-IE, 1994)
POINTS OF ACTION IN THE PROCESS

- Technological change
- Changes in input materials
- Good housekeeping
- Product Change
- On-site reuse

(source: UNEP-IE, 1994)

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Cleaner Production Tools

- Life Cycle Assessment
- Design for Environment (DfE)
- Environmental Management System
- Environmental Impact Assessment
- Environmental Audit
- Environmental Accounting

- Performance-base Contracting
- Environmental / Eco-Labeling / Green Purchasing
- Public Environmental Reporting
- Industrial Ecology
- Environmental Taxes
- Synergy Corporate System
<table>
<thead>
<tr>
<th>City Name</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Angeles City</td>
<td>300,000</td>
</tr>
<tr>
<td>2. Antipolo</td>
<td>1,3000,000</td>
</tr>
<tr>
<td>3. Bais</td>
<td>68,000</td>
</tr>
<tr>
<td>4. Dagupan</td>
<td>130,000</td>
</tr>
<tr>
<td>5. Iloilo</td>
<td>363,000</td>
</tr>
<tr>
<td>6. La Carlota</td>
<td>56,000</td>
</tr>
<tr>
<td>7. Mandaue</td>
<td>300,000</td>
</tr>
<tr>
<td>8. Naga City</td>
<td>130,000</td>
</tr>
<tr>
<td>9. Island Garden City of Samal</td>
<td>83,000</td>
</tr>
<tr>
<td>10. San Fernando</td>
<td>102,000</td>
</tr>
<tr>
<td>11. Tagaytay</td>
<td>32,000</td>
</tr>
<tr>
<td>12. Toledo</td>
<td>130,000</td>
</tr>
</tbody>
</table>
## Appendix 1: Lead Champions and Partners of the Cities

<table>
<thead>
<tr>
<th>Lead Champions and Partners</th>
<th>Name of Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAYOR / VICE MAYOR</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>CITY COUNCILS</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>DEPARTMENT HEADS</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>MULTI-SECTORAL</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>INDUSTRY</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>NGO's</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>ENVIRONMENT COUNCIL</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>YOUTH COUNCIL</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>RESIDENTS</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>SCHOOLS (highschool)</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>MEDIA</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
<tr>
<td>TOURISM COUNCIL</td>
<td>AG  AP  BS  DG  IL  LC  MD  NG  IS  SF  TY  TO</td>
</tr>
</tbody>
</table>

**Legend:**

- AG Angeles City
- AP Antipolo City
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- IS Island Garden City of Samal
- SF San Fernando City
- TY Tagaytay City
- TO Toledo City
## Appendix 2: Priorities of the Cities

<table>
<thead>
<tr>
<th>Priorities of the Cities</th>
<th>Name of the Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Management (MSW)</td>
<td>AG</td>
</tr>
<tr>
<td>Air and Water Pollution</td>
<td></td>
</tr>
<tr>
<td>Sewerage / Drainage</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td>Recycling</td>
<td></td>
</tr>
<tr>
<td>Traffic</td>
<td></td>
</tr>
<tr>
<td>Cleanliness</td>
<td></td>
</tr>
<tr>
<td>Advocacy</td>
<td></td>
</tr>
<tr>
<td>Anti-drug</td>
<td></td>
</tr>
<tr>
<td>Dumpsites</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **AG**: Angeles City
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# Appendix 3: Current Programs of the Cities

<table>
<thead>
<tr>
<th>Programs of the Cities</th>
<th>Name of the Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waste Management / ESWM</strong></td>
<td>AG</td>
</tr>
<tr>
<td><strong>Energy conservation / Water conservation</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sanitary Landfill / Dumpsites</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Environment Program</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Waste Minimization</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cleanliness</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pollution</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cost-sharing Scheme</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Site Visits</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Information Campaign</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Setting up of Ecology Center</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
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Science of Sustainability: From Cleaner Production to Industrial Ecology

Source: ISIE
Cross Industry Post-consumed Product Flow

Country A

- Primary & secondary commodities
- Final commodities
- Consumer products
- Post-consumed materials
- Disposed waste

Country B

- Primary & secondary commodities
- Final commodities
- Consumer products
- Post-consumed materials
- Disposed waste

Modified from van Beukering, 2000 by Anthony SF Chiu, 2002
Conceptual Diagram of Industrial Ecology

INDUSTRIAL ECOLOGY

Type I (a)
Ecosystem Components

Unlimited resources

Energy and limited resources

Limited waste

Energy

Type III (c)
Ecosystem Components

(a) Linear materials flows in Type I ecology.
(b) Quasicyclic materials flows in Type II ecology.
(c) Cyclic materials flows in Type III ecology.
Definition of EIP [Lowe]

• “A community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environment and resource issues including information, energy, water, materials, infrastructure, and natural habitat. By working together, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realize if it optimized its individual performance only.”
Conceptual Diagram of EIP

Present Industrial Park

- Manufacture
- Wastes
- Social Image

Eco-Industrial Park

- Manufacture
- Wastes
- Social Image
- Zero

Source: Lee, Korean NCPC
EID Strategy Model for Asia

1. Industrial metabolism
2. Inter-relationship among the system elements
3. Approaching a Mature Eco-system [Allenby]
   (Sustainable Development)

Eco-Industrial Development is a national flexible strategy used to build a competitive knowledge-based capability
Value Chain in an EID “System”
(Integrated Artery / Vein System)

<table>
<thead>
<tr>
<th>Supportive</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human Resources</td>
</tr>
<tr>
<td></td>
<td>Procurement</td>
</tr>
<tr>
<td>Others …… supportive elements / facilities</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary</th>
<th>Inbound Logistics</th>
<th>POM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Product Service By Prod Waste</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Outbound Logistics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mktg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services</td>
</tr>
</tbody>
</table>
Akbari (1988) has modeled energy and CO\(_2\) savings through the use of trees and albedo modifications. Yearly savings and direct savings are shown below:

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Small Commercial</th>
<th>Large Commercial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>10%</td>
<td>4%</td>
<td>0%</td>
<td>0.15</td>
</tr>
<tr>
<td>Direct savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect savings</td>
<td>20%</td>
<td>12</td>
<td>5</td>
<td>0.369</td>
</tr>
<tr>
<td>Total</td>
<td>30%</td>
<td>16</td>
<td>5</td>
<td>0.51</td>
</tr>
</tbody>
</table>

GIS shows 3.8B urban trees in USA, table uses 100M trees unit.
Kalundborg Industrial Symbiosis
Air Quality and EID
Comments from Ray Cote, February 14, 2003

• ONE HAS TO START FROM A BASELINE AIR QUALITY STUDY TO DETERMINE CURRENT AIR QUALITY, THEN FIGURE OUT HOW ONE GETS BACK TO AIR QUALITY LEVELS THAT ARE PROTECTIVE OF HUMAN HEALTH, VEGETATION, ETC AND FINALLY ASSESS NEW INDUSTRIAL AND URBAN DEVELOPMENT PROPOSALS WITH THAT IN MIND.

• That means looking for ways to reduce air emissions through public transit initiatives, setting limits on vehicles entering downtown or park, promoting district heating / cooling systems to reduce need for additional electricity generation capacity, etc. It might also involve setting limits to city growth and spreading development to other centers rather than concentrating things in a few major cities.
Study Case of China National CP Centre

Guigang City Guitang Eco-Industrial Sugar Industry Complex

Duan, IEAsia 2001
Key EID Issues at IEAsia 2001

1. Terminology and scope of EIX
2. Communications and education
3. Management structure
4. R&D
5. Financing of EID projects (most Asian firms are SMEs and TVEs)
6. Policy integration
7. Networking

And ............
Traditional Asian Model

- Economic Master Plan launched (for a firm, a business plan);
- Environmental management of the industrial activities, e.g. EMS for the industries;
- Hence, this model is integrating environmental dimension into the economic mainstream;
- Output expectation will be optimization of industrial performance with minimum environmental impact under the planned economic framework.
Sustainable Value Chain Result

- **A**: Conventional Industrial Activities
- **B**: Industrial Performance with environmental management
- **C**: Sustainable Value Chain Model

**System Efficiency**

- 200%
- 100%
- 90%

**Present Efficiency**

Leapfrog EST process technology
Sustainable Value Chain Model
Tools for Primary Components

Selection Process
(material and energy)
Economic
- Comparative Competitiveness of nations / region
- Input / Output Linkage
Environmental / Social
- Ecological footprint
- LCA / MFA / SFA / EPI
- SRI / GRI (not exhaustive)

Value adding Process
(vein / waste stream of the life cycle)
- EST Process Technology
- Renewable Energy
- EnTa, EVT/ETV
- Leapfrogged sustainable performance (economic, ecological, social)