Green Development of Industrial Parks in China

Prof. Chen Lyujun

School of Environment
Tsinghua University
chenlj@tsinghua.edu.cn
Overview of industrial park development in China

Challenges in greening Chinese industrial parks

Government actions for greening Chinese industrial parks

Overview of eco-industrial park development in China

Typical eco-industrial park case
What is an industrial park?

According to the inherent need of economic development, a large tract of land is delimited by government (or organization) to cluster and integrate various factors of production, which could enhance the degree of industrial aggregation, take full advantage of industrial characteristics, optimize the functional and geographic distribution of industries, improve market competitiveness, and promote industrial upgrading.
Development of Industrial Park in China

- **1979.2**: Shenzhen Shekou Industrial Zone, the first industrial park, only 2 km²
- **1984.5**: 14 coastal open cities
- **1988**: High-tech Development Zone—Shanghai Caohejing Hi-Tech Park (CHJ)
- **1992-1994**: Beijing Economic and Technological development area
  - Suzhou-Singapore Industrial Park
- **2004**: The provincial industrial parks number was adjusted from 6866 to 1586
- **2018**: 552 national industrial parks and 1991 provincial industrial parks
The first industrial park in China——Shekou Industrial Park

From: http://news.xinhuanet.com/photo/2008-10/20/content_10221083.htm
Development of Industrial Park in China

Beijing E-town

Kunshan High-tech zone

TEDA

Suzhou Industrial park

Hangzhou EDA

Guangzhou EDA
By 2018, China had 2543 national and provincial level industrial parks, contributing about 50% of gross industrial output value.
## Category of Industrial Parks in China

<table>
<thead>
<tr>
<th>Category</th>
<th>Level</th>
<th>Administrative organization</th>
<th>Total number (till 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic and technical development area (ETDA)</td>
<td>National</td>
<td>Ministry of Commerce</td>
<td>219</td>
</tr>
<tr>
<td>High and new technology development zone (HTDZ)</td>
<td>National</td>
<td>Ministry of Sci &amp; Tech</td>
<td>156</td>
</tr>
<tr>
<td>Customs Supervision Zone (Export Processing Zone, Bonded Zone)</td>
<td>National</td>
<td>Customs Administration</td>
<td>135</td>
</tr>
<tr>
<td>Border/Cross-border Economic Cooperation Zone</td>
<td>National</td>
<td>Ministry of Commerce</td>
<td>19</td>
</tr>
<tr>
<td>Others</td>
<td>National</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Provincial-level IP</td>
<td>Provincial</td>
<td>Provincial institutions</td>
<td>1991</td>
</tr>
</tbody>
</table>
219 state-level economic development zones accounted for 10.6% of the country's total GDP and accounted for 20.3% of the country's total import and export volume in 2018.

156 national high-tech zones accounted for 11.5% of the country's GDP and 30.1% of the applications submitted for PCT patent applications in 2017.
# Chemical Industrial Parks in China

<table>
<thead>
<tr>
<th>Level</th>
<th>Total number 676 (till 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Chemical Industrial Parks</td>
<td>57</td>
</tr>
<tr>
<td>Provincial Chemical Industrial Parks</td>
<td>351</td>
</tr>
<tr>
<td>Prefectural Chemical Industrial Parks</td>
<td>268</td>
</tr>
</tbody>
</table>
14 chemical industrial parks with an industrial output value of more than 100 billion CNY

33 chemical industrial parks, 50~100 billion CNY

224 chemical industrial parks, 10~50 billion CNY

405 chemical industrial parks, less than 10 billion CNY

Chemical industrial parks contribute 60% of total output value of chemical industry in China.
How to Manage the Industrial Parks

- Industrial parks are typically located in the suburban regions of a major city.
- Within the area, an administrative committee, commonly selected by the local government, oversees the economic and social management, which is an arm of the local municipal or provincial government.
- Each industrial park also has its own Development Co., Ltd., whose main task is to attract direct investment—that is, to convince foreign enterprises to take up residence in its park.

Source: Douglas Zhihua Zeng, 2011. How do special economic zones and industrial clusters drive China's rapid development?
OUTLINE

- Overview of industrial park development in China
- Challenges in greening Chinese industrial parks
- Government actions for greening Chinese industrial parks
- Overview of eco-industrial park development in China
- Typical eco-industrial park cases
Contributions and concerns of industrial parks

- Primary engine of economic development
- Large consumers of resources and energy
- Main emitters of industrial pollution
- Key sites of environmental risks and security accidents
Typical Problems in the Development of Industrial Parks

Distribution & Management Problems

- Unreasonable distribution
- Industrial similarities
- Multi-head management
- Incomplete industrial structure
- Unable to form industrial aggregation
- .......
Safety & Green development Problems

Typical Problems in the Development of Industrial Parks

- Lack of scientific program for environmental protection and energy conservation
- Weak infrastructure
- Potential safety hazards in production, especially in chemical industry parks
- Imperfect mechanism of environmental protection and energy management
- Supervision "blind area"
- Uneven pollution control level
- Immature service market for production safety, environment protection and energy conservation
- ...

......
Challenges in Greening Chinese Industrial Parks

• Moving towards the high value end of global value chain
  – Still competes mainly on low-cost manufacturing, based on cheap labor and cheap environmental resource
  – At the low end of the global value chain
• The Sustainability of Export-Led Growth
• Environmental and Resource Constraints
  – Serious domestic water, air, and land pollution and the huge amount of industrial waste
  – Challenges of climate change and increasingly tough eco-standards set by industrial countries for products exported from developing countries, such as RoHS, WEEE, EuP
  – Expensive and limited land, skilled labor, and energy resources
• Institutional Challenges
• Lagging social development

RoHS (Restriction of the Use of Certain Hazardous Substances), WEEE (Waste Electrical and Electronic Equipment), and EuP (energy use profile, energy-using products).
Transformation of Industrial Parks

- Industrial park is no doubt a epitome of China’s development after Reform & Opening Policy in 1978, ‘they are standing at a cross road after 30-year rapid development’---vice Premier Wang, Yang (Sep. 4th, 2014)
- IPs are the barometers of China’s real economy, their Green development, Circular economy, and Low carbon development are highlighted, but still a daunting task.
- Four transformation
  - From speed hunting to quality aspiring
  - From government leading to market driven
  - From homogeneous competition to differentiated development
  - From hard environment to soft environment
Strategies for Greening Industrial Parks

- Emphasis on systematic thinking and perspective of life cycle
- Dual Control of Total Resource Consumption and Intensities (Energy, Water and Land)
- Stricter and more transparent supervision on pollution control
- Environmental Risk Prevention and Control
Overview of industrial park development in China

Challenges in greening Chinese industrial parks

Government actions for greening Chinese industrial parks

Overview of eco-industrial park development in China

Typical eco-industrial park cases
Laws and Acts related to Greening Industrial Parks in China

- Environmental Protection Act (Effective since January 1, 2015)
- Circular Economy Promotion Law (Effective since January 1, 2009)
- Cleaner Production Promotion Law (Effective since January 1, 2003)
- Renewable Energy Law (Effective since January 1, 2006)

**Article 4**
Environment Protection is the basic state policy. The state adopts economic and technological policies and measures that are conducive to saving and recycling resources, protecting and improving the environment, and promoting harmony between mankind and nature, so as to coordinate economic and social development with environmental protection.

**Article 5**
Environmental protection shall adhere to the principles of giving priority to protection, putting prevention first, comprehensive governance, public participation and liability for damage.
There is an increasing number of policies for the transition and development of industrial parks issued by Chinese central government in recent years.
Programs by the Chinese Government to Promote the green Development of IPs

Circular Transformation of Industrial Parks Program (CTIP)
✓ Led by National Development and Reform Commission (NDRC) and Ministry of Finance (MOF)
✓ Started in 2011
✓ 129 national IPs have been approved as demonstrations or pilots

National Demonstration Eco-industrial Park Program (NDEIP)
✓ Led by Ministry of Ecology and Environment (MEE), Ministry of Commerce (MOFCOM), and Ministry of Science and Technology (MOST)
✓ Started in 2007
✓ 93 approved national demonstrations and pilots

National Low-carbon Industrial Park Pilots (NLCIP)
✓ Led by Ministry of Industry and Information Technology (MIIT) and National Development and Reform Commission (NDRC)
✓ Started in 2013
✓ 51 approved national demonstrations and pilots

Courtesy of Prof. Bin Zhu
The “Circular Transformation of Industrial Parks (CTIP)” Program

- In 2011, the National Development and Reform Commission (NDRC) and the Ministry of Finance (MOF) jointly launched the “Circular Transformation of Industrial Parks (CTIP)” program.

- CTIP means that the existing IPs of various types will follow circular economy principles (i.e. “reduce”, “reuse” and “recycle”, with priority given to “reduce”) to optimize spatial layout, adjust industrial structure, develop key technologies for linking various components of circular economy, extend the industrial chain appropriately and link its various parts into a circular loop, build infrastructure and public service platforms, and renovate organizational and administrative mechanisms, so as to realize efficient and circular utilization of resources and “zero discharge” of wastes, thereby continuously strengthen IPs’ capacity for sustainable development.

<table>
<thead>
<tr>
<th>Objective</th>
<th>By 2020, circular transformation should be carried out in 57% of national IPs and 50% of provincial IPs</th>
</tr>
</thead>
</table>

Courtesy of Prof. Bin Zhu
# National Low-Carbon Industrial Park Pilots (NLCIP)

## Objective

The pilot parks should achieve large reduction in carbon emissions in terms of per unit industrial value added. Significant achievements should also be made in low-carbon transformation of traditional industries and the development of new low-carbon industries.

## Key tasks

1. Make great effort to promote **low-carbon production**.
2. Actively promote **innovative lowcarbon technologies** and their application.
3. Carry out innovative **low-carbon management**.
5. Increase international cooperation.

---

**Purpose**

The program aims to promote wide use of renewable energy, accelerate low-carbon transformation of key energy-intensive industries, foster a large number of low-carbon enterprises, and popularize some low-carbon management models that are fit for China's industrial parks.

---

*Courtesy of Prof. Bin Zhu*
National Demonstration Eco-industrial Park Program (NDEIP)

**Objectives**
The demonstration parks should be national leaders in economic development, materials saving and recycling, pollution prevention and control, and park management, and serve as models and promoters for the sustainable development of various types of IPs.

**Key tasks**
1. Prevent and control pollution during the whole process to improve environmental quality.
2. Pay high attention to development planning to promote green transition of the parks.
3. Develop and implement eligibility criteria for projects wishing to enter into parks, and strengthen auditing for cleaner production.
4. Highlight the unique features of the parks, and create radiation effect to promote regional development.
5. Strengthen fine management for parks, and promote their core competitiveness.
6. Effectively prevent environmental risks, and safeguard the environmental safety of parks.
7. Encourage “pioneering”, with a view to promoting innovative environmental management mechanisms.

**Purpose**
A new type of IPs designed according to cleaner production requirements, circular economy theories, and industrial ecology principles, aiming at closed-loop flow of materials, multi-level utilization of energy, and minimization of waste generation.

Courtesy of Prof. Bin Zhu
OUTLINE

- Overview of industrial park development in China
- Challenges in greening Chinese industrial parks
- Government actions for greening Chinese industrial parks
- Overview of eco-industrial park development in China
- Typical eco-industrial park cases
### What is an eco-industrial park (EIP)?

<table>
<thead>
<tr>
<th><strong>PCSD</strong>  &lt;br&gt; (President's Council On Sustainable Development)</th>
<th>An <strong>eco-industrial park</strong> is “a <strong>community</strong> of <strong>businesses</strong> that <strong>cooperate</strong> with each other and with the local community to efficiently <strong>share</strong> resources (information, materials, water, energy, infrastructure and natural habitat), leading to <strong>economic gains, gains in environmental quality</strong>, and <strong>equitable enhancement of human resources</strong> for the business and local community”.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indigo</strong></td>
<td>An <strong>eco-industrial park or estate</strong> is a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance.</td>
</tr>
<tr>
<td><strong>U.S. EPA</strong>  &lt;br&gt; (Environmental Protection Agency)</td>
<td>An <strong>eco-industrial park</strong> is a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water, and materials. 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”.</td>
</tr>
</tbody>
</table>

Eco-industrial parks (EIPs) are the best practice of eco-civilization in the industrial sector, and also a significant carrier and implementation pathway of promoting green and high-quality development in industrial parks. EIPs are as well a typical practice of circular economy at the industrial-park level.

A new type of industrial parks designed and constructed with the principles of industrial ecology and the theories and methods of systems engineering, to enhance the utilization efficiency of resources and energy, reduce pollutant emission, improve environmental quality, and promote sustainable economic development.
Features of Eco-industrial Parks

- At the park level:
  - building an eco-industrial chain
  - Infrastructure sharing, especially environmental infrastructure
  - ecological and digital management

- Inter-enterprise:
  - industrial symbiosis
  - material recycling
  - energy cascade utilization
  - waste exchange and utilization

- Inner-enterprise: cleaner production, product eco-design
Industrial symbiosis can be defined as the exchange of materials or waste streams between companies, so that one company's waste becomes another company's raw materials.

— Ellen MacArthur Foundation
A new cooperative relationship is established between enterprises through the exchange and utilization of by-products, energy and even unused space and facilities. In such a partnership, "waste" from one company can be used as "raw materials" that another company needs.
Diagram of Industrial Symbiosis Network

Firm 1

Firm 2

Firm 3

Firm 4

Firm 5

Firm 6

Firm 7

Firm 8

Firm 9

Resource 1

Resource 2

Resource 3

Resource 4

Resource 5

Resource 6

Resource 7

Resource 8

Resource 9

Resource 10

Resource 11

Resource 12

Resource 13

Industrial Symbiosis at Kalundborg

Source: Marian Chertow, 2000, INDUSTRIAL SYMBIOSIS: Literature and Taxonomy
Industrial Symbiosis at Guigang Eco-industrial Park

- Sugarcane field
  - Sugarcane
  - Bagasse and sugar residues
- Sugar refinery
  - Syrup
  - Bagasse and sugar residues
- Winery
  - Waste alcohol
  - Steam
- Power plant
  - Steam
  - Fly ash
  - White precipitate
- Market
- Market
- Market
- Market
- Market
- Chemical fertilizer plant
- Paper Mill
- Pulp mill
- Cement plant
What is cleaner production?

Cleaner production refers to constantly improving designs, using clean energy and raw materials, applying advanced technologies and equipment, enhancing management and comprehensive utilization, so as to achieve pollution prevention, improve resource efficiency, reduce or avoid pollutant emissions in production, services and products used, and mitigate or eliminate the harm to human health and the environment.

---Cleaner Production Promotion Law
In China, EIP is mainly preferred to the National Eco-industrial Demonstration Park.

The development of EIP is under the joint guide of MEP, MOST and MOFCOM.

EIP development is based on transformation of the existed developing zones, under the principle of industrial ecology and circular economy.

MEP: the Ministry of Environmental Protection, P.R.China
MOST: the Ministry of Science and Technology, P.R.China
MOFCOM: the Ministry of commerce, P.R.China
By Oct 2019, 48 EIPs have passed examination, and 45 EIPs have been approved for construction.
Procedures for Demonstration Eco-industrial Park

Procedures for EIP planning, implementation, and nomination:

1. Application to National EIP Office
2. Make a work scheme
3. Named as National Trial EIP
4. Evaluate the annual progress for 3~5 years
5. Implemented the scheme
6. Named as a National Demonstration EIP
Procedures for Demonstration Eco-industrial Park

**Stage of EIP planning**

- **Industrial parks**
  - Apply to the National EIP LG Office for becoming a National Trial EIP
    - Approved by the LG Office:
      - Yes: Make a plan & technical report for constructing a National Demo EIP
      - No: Go back to the national LG Office for being named as a National Demo EIP
  - End or reapply

**Stage of EIP implementation**

- Implement the EIP plan & evaluate the annual progress for 3-5 years
  - Meeting the EIP criteria?
    - Yes: Apply to the National EIP LG Office for being named as a National Demo EIP
    - No: Reapply in the future
  - Approval by the review panel?
    - Yes: Nominated by MEP, MOC & MOST as a National Demo EIP
    - No: Reapply in the future
  - Continue or cease to be a National Demo EIP
### National Standard of Eco-industrial Park

<table>
<thead>
<tr>
<th>Category</th>
<th>No.</th>
<th>Indicator</th>
<th>Unit</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Development</td>
<td>1</td>
<td>Industrial added value (IAV) per capita</td>
<td>10^4 CNY/capita</td>
<td>≥15</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Annual growth of IAV</td>
<td>%</td>
<td>≥15</td>
</tr>
<tr>
<td>Material Reducing and Recycling</td>
<td>3</td>
<td>IAV per industrial land</td>
<td>10^6 CNY/km²</td>
<td>≥9</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Energy consumption per IAV</td>
<td>tce/10^4 CNY</td>
<td>≤0.5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Elasticity coefficient of energy consumption</td>
<td>-</td>
<td>&lt;0.6</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Freshwater use per IAV</td>
<td>m³/10^4 CNY</td>
<td>≤9</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Elasticity coefficient of freshwater use</td>
<td>-</td>
<td>&lt;0.55</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Wastewater generation per IAV</td>
<td>t/10^4 CNY</td>
<td>≤8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Solid waste generation per IAV</td>
<td>t/10^4 CNY</td>
<td>≤0.1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Repetitive use rate of industrial water</td>
<td>%</td>
<td>≥75</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Use rate of industrial solid waste</td>
<td>%</td>
<td>≥85</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Use rate of reclaimed water</td>
<td>%</td>
<td>≥40/25/12</td>
</tr>
<tr>
<td>Pollution Control</td>
<td>13</td>
<td>COD emission per IAV</td>
<td>kg/10^4 CNY</td>
<td>≤1</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Elasticity coefficient of COD</td>
<td>-</td>
<td>&lt;0.3</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>SO₂ emission per IAV</td>
<td>kg/10^4 CNY</td>
<td>≤1</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Elasticity coefficient of SO₂</td>
<td>-</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Hazardous waste treatment and disposal rate</td>
<td>%</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Centralized treatment rate of domestic sewage</td>
<td>%</td>
<td>≥85</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Harmless disposal rate of domestic garbage</td>
<td>%</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Waste collection and centralized disposal capacity</td>
<td>-</td>
<td>Qualified</td>
</tr>
<tr>
<td>Park Management</td>
<td>21</td>
<td>Environmental management institution and</td>
<td>-</td>
<td>Qualified</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Completeness of eco-industrial information system</td>
<td>%</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>Preparation of environmental reports</td>
<td>Time per year</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>Audit rate of cleaner production in key enterprises</td>
<td>%</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>Public satisfaction rate with the environment</td>
<td>%</td>
<td>≥90</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>Public awareness rate of eco-industries</td>
<td>%</td>
<td>≥90</td>
</tr>
</tbody>
</table>
Society level
- off-site service of infrastructure in industrial park (inner to outer)
- Public utilities expanding service toward industrial park (outer to inner)
  — transportation, education, employment and training
- Outsourcing of human resource management
- Outsourcing of Hazard waste disposal
- Public engagement
- Public sustainable consumption
- Government green purchasing

Park level
- Infrastructure
  — Cogeneration, multi-generation
  — cleaner and renewable energy
- WWTP
  — reclaimed water
- Public platform
- Industrial symbiosis
- Access requirement
- Environmental management
- Appropriate both for industry and living

Industrial cluster
- Leading enterprise
- Industrial chain upstream and downstream partner

Firm level
- LCA, DfE, AT, RD, PP, GSCM, EPR, CP, EM

Government
- Playing the leading role

Market
- Serving as an incentive

Enterprise
- Actors in the exercise

Macro level
- Harmonization

Meso level
- Ecological industry

Micro level
- Efficiency improvement

Strengthen socialization
- Sharing infrastructure

Eco-industrial development
- Pillar industry cluster in park

Life cycle management
- Design for Environment

LCA: Life cycle assessment; EM: Environmental management; AT: Advanced technology; GSCM: Green supply chain management; DfE: Design for Environment; CP: Cleaner production; RD: R&D platform; EPR: Extended producer responsibility; PP: Pollution prevention

Measures to Improve EIP Performance

- Cleaner production and environmental management
  - Mandatory CP audit (CP promotion law amended in Feb 2013), ISO14001 certification

- Infrastructure sharing
  - Cogeneration of heat and power (CHP), concentrated wastewater treatment plant (CWWTP), reclaimed water usage, and bulk solid waste recycling
  - Transiting coal-fired CHPs to natural gas fired CHPs
  - Transiting heat and power generation CHPs toward heat, power, hot water, and cooling cogeneration
  - CHP acting as a scavenger (waste-to-energy), such as sludge of CWWTP

- Energy-saving practices at the firm level
  - Energy audit, doing small things

- Fostering pillar industries

- Industrial symbiosis

Performance improvement between the year of EIP planning and EIP accreditation, generally 2-4 years.

Benefits of EIP development

(1) Providing new management tools for industrial parks

(2) Acting as benchmarks of green development for other industrial parks

(3) Driving green technical innovation in industrial parks

(4) Promoting delicate management for industrial parks

(5) Bringing additional economic and environmental benefits
Actions of Scientific and Academic Communities

- Supporting the project of *National Economic-technological Development Zones & International Cooperation Eco-industrial Parks*
- Publishing *Green Development Report of National Economic-technological Development Zones* annually
- Releasing *Green Development Index of National Economic-technological Development* annually
- Founding *Innovation & Cooperation Alliance for National Economic-technological Development*
- Establishing *Eco-industry Branch of Chinese Society for Environmental Sciences*
- Establishing *Industrial Park Green Development Branch of Chinese Association of Circular Economy*
- Promoting Training Activities and Research Projects for EIP development
OUTLINE

- Overview of industrial park development in China
- Challenges in greening Chinese industrial parks
- Government actions for greening Chinese industrial parks
- Overview of eco-industrial park development in China
- Typical eco-industrial park cases
Zhejiang Hangzhou Bay Shangyu Industrial Area (HSEDA)

Typicality and representativeness:

- 100 billion grade fine chemical industry park
- The largest base of disperse dyes in the world
- The largest quinolone antibiotic production base
- Important production bases of peroxide, ultraviolet initiator and special fluorine materials in the world

Our cooperation began in 2005
Layout of Infrastructure in Shangyu Park

- Household waste incineration power plant
- Coal-fired CHP
- Steam supply: 490 tons/hour
- Reclaimed tidal flat
- 130 companies
- Fine chemicals
- WWTP: 300 thousands tons/day
- Hazard waste incinerator: 30 tons/day
- Landfill: 0.74 million m²
Relative decoupling means that the growth rate of resources used or environmental impact is lower than the growth rate of a relevant economic indicator (for example GDP). From 2009, HSEDA stepped into a track of relative decoupling development.
Material Exchange Network in Shangyu Park

Chemical web in dye production

喹诺酮医药产业链清洁生产集成技术与工程示范

每年少排1.3万吨5%的硫酸-盐酸废水，减排COD 65吨，液碱节约1200t/a，节约成本100万元/a

（1）四氯苯酐合成，氯磺酸高效分离再利用及六氯苯减量化技术
（2）结合SYIA副产物，尾气中氢气、氯化氢分离及资源化利用技术；
（3）含盐酸盐酸废水催化氧化去除含氯有机物，酸性废水资源化技术
（4）付克反应三氯化铝减量化，异构体分离技术
（5）一甲胺高效分离回收套用技术
（6）氯化反应催化剂设计及开发，并利用催化剂混合物分离技术
（7）水体系加压脱氨代替三正丁胺脱氨技术
（8）BTC替代氯化亚砜合成酰氯产业化技术
（9）流程缩短：四氟苯甲酰氯合成(左)
（10）BTC替代氯化亚砜，无溶剂、无SO2法合成环丙胺
（11）霍夫曼降解管道化反应技术
（12）氨基丙醇催化加氢一步法绿色合成技术及产业化
（13）清洁溶剂替代：缩脲反应催化剂，水体系替代二甲亚砜溶剂体系
（14）产品分离技术：高纯度多晶型左氧氟沙星结晶及干燥技术

每年节水12万吨，节约蒸汽1.4万吨，节电330万kWh，减排COD 500吨；消除SO2排放，节约成本600万元

每年减少废水排放3500吨，减排COD162吨，减少废水COD500吨，节约成本285万元

9项专利
Chemical production-related carbon metabolism

Physical border of SYIA

Pharmaceuticals: 10,310 tons

8.4 %

Interfirm flow: 897 tons

Dyes: 41,677 tons

33.8 %

Interfirm flow: 3,185 tons

Other fine chemicals: 33,543 tons

27.2 %

Interfirm flow: 115 tons

VOC: 1,696 tons

CO₂ from hazardous waste incineration: 651 tons

Gaseous emission in wastewater treatment plant: 15,623 tons

Gaseous emission from landfill: 3,665 tons

Landfill: 1001 tons

Carbon in effluents to Hangzhou Bay: 720 tons

Carbon outputs in products: 85,530 tons 69 %

Carbon outputs in waste: 37,878 tons 31 %

Carbon inputs in raw chemicals: 123,408 tons

Carbon metabolism of chemicals production in a typical Chinese fine chemical park

Sankey diagram

Tian, Jinping; Guo, Qiuping; Chen, Ying; Li, Xing; Shi, Han; Chen, Lujun. 2012, Study on industrial metabolism of carbon in a Chinese fine chemical industrial park, Environmental Science & Technology, 47, 1048-1056
Sulphur Metabolism in Shangyu Park

Direct Material Input
120,749 tons
100%

Elemental sulfur: 97662 tons
81%

Chemicals: 19514 tons 16%
Coal: 3573 tons 3%

Sulphuric acid: 27022 tons
Inorganic sulfur chemicals: 37616 tons 31.2%
SO2 emissions in flue gas: 1169 tons 1.0%
Sulfate ion in effluent: 6254 tons 5.2%
WWTP sludge: 1126 tons 0.9%
Slag and desulfurization residue: 2606 tons 2.2%
Calcium sulfate (L&R): 16743 tons 11.7%
Solid waste (non-L&R): 14185 tons 13.9%

Pharmaceutical: 180 tons 0.15%
Dye: 1986 tons 1.6%
Other fine chemicals: 11862 tons 9.8%

Final products
78,666 tons 65%
Emissions to the environment
42,083 tons 35%

1. Calcium sulfate (L&R): refer to calcium sulfate produced by Group L and Group R
2. Solid waste (non-L&R): refer to solid waste produced by enterprises unaffiliated with Group L and Group R
3. All calculated as sulfur

HSEDA has diversified primary energy input, such as coal, natural gas, sulfur, biomass, MSW waste, and sludge.
Features of Eco-industrial development in Shangyu Park

**Infrastructure sharing**

**Food web**

**Energy infrastructure**
- Combined heat and power
- Clean/renewable energy

**Centralized wastewater treatment plant**
- Reclaimed water

**Risk Prevention and emergency response system**

**Products**

Green chemistry:
- PRODUCTIVELY

Green chemical engineering:
- IMPROVEMENTS

Cleaner production
End of pipe treatment

Inter-firm cooperation
- Vertical integration
- Horizontal integration
- Industrial symbiosis
Green Transition in Shangyu Park

Upgrading equipment and phasing out low-efficiency ones with clear negative list
装备制造、落后设备淘汰、负面清单

Employing green chemistry
Green chemical engineering
绿色工艺技术

Automatic control
生产自动化控制

High thresholds for new products
新产品准入控制

Green transition in HSEDA

Chemicals management
transportation, storage, in-plant transfer, and metering
化学品全过程精细化管理

Environmentally sensitive chemicals classification, ---into two categories
原料按环境敏感性分类

Environmental management
强化企业环境管理

Tailored guideline for different chemical reaction and separation, process
主反应单元分离单元的详细要求
THANK YOU

School of Environment
Tsinghua University