Eco-Industrial Park

Korean EIP Development Initiatives: Progresses, Outcomes, and Lessons

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Contents

I. Introduction

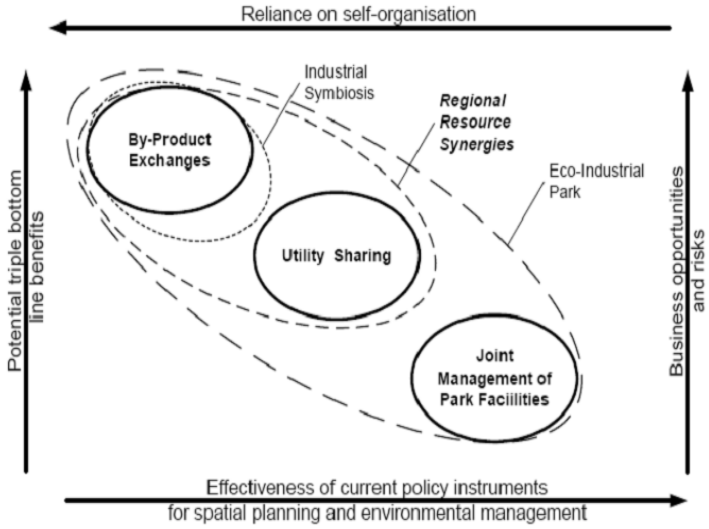
1. Introduction

EIP (Eco-Industrial Park) Concept

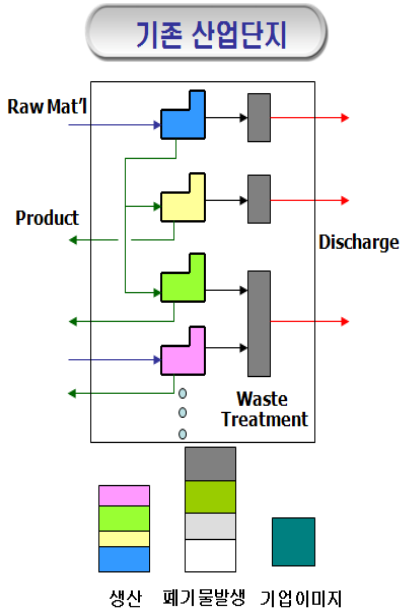
• In narrow sense, EIP Means waste-by-product circulation between companies, so called Industrial symbiosis network.

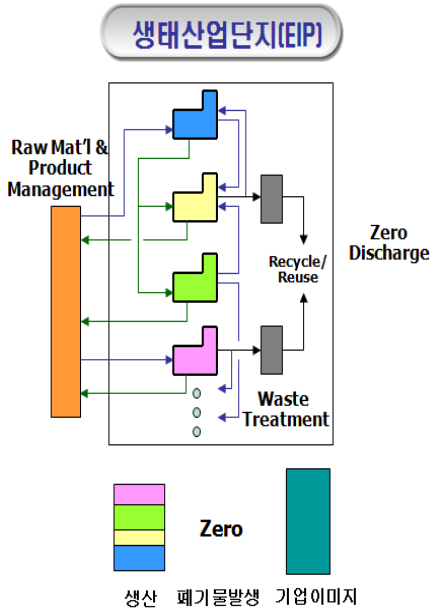
-Nowadays the concept has included ecologically spatial planning and regional development based on sustainable development

- EIP has been originated from Circular and Sharing economy..



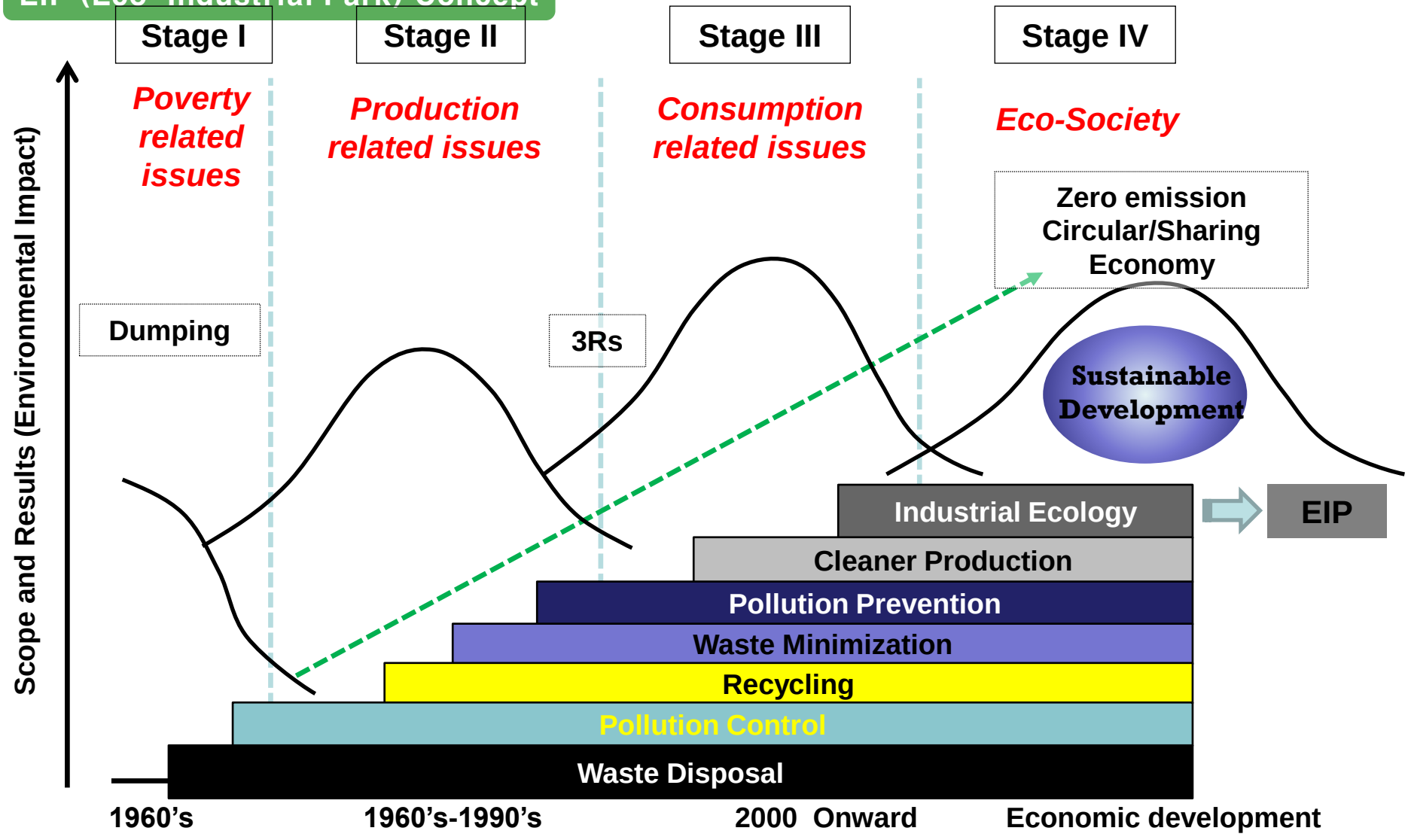
Regional Resource Synergies for Sustainable Development In Heavy Industrial Areas: An Overview of opportunities and experiences, Centre of Excellence in Cleaner Production, Curtin Univ of Technology, 2007





1. Introduction

EIP (Eco-Industrial Park) Concept



1. Introduction

Process of continuous improvement: Going beyond the minimum EIP requirements

Core EIP Categories and Topics

	Park management performance	Environmental performance	Social performance	Economic performance
Minimum EIP Requirements	▶ **Park management services** ▶ **Monitoring** ▶ **Planning and zoning**	▶ Environmental management and monitoring ▶ Energy management ▶ Water management ▶ Waste and material use ▶ Natural environment and climate resilience	▶ Social management and monitoring ▶ Social infrastructure ▶ Community outreach and dialogue ▶ Employment generation	▶ Local business and SME promotion ▶ Economic value creation – New revenue and Cost savings

Compliance with local and national regulations and alignment with international standards

Circumstances in Korea

- Relatively high proportion of manufacturing in GDP

Field Name	1970	1975	1980	1985	1990	1995	2000	2005
Agriculture, Forestry and Fishing	29.2	27.1	16.2	13.5	8.9	6.3	4.9	3.4
Mining, Quarrying and Manufacturing	19.6	23.5	26.4	28.7	28.1	28.2	29.8	28.7
(Manufacturing)	17.8	21.6	24.4	27.3	27.3	27.6	29.4	28.4
Electricity, Gas and Water	1.4	1.1	2.2	3.0	2.1	2.0	2.6	2.3
Construction	5.1	4.6	8.0	7.3	11.3	11.6	8.4	9.2
Services	44.7	43.6	47.3	47.4	49.5	51.8	54.4	56.3

Circumstances in Korea

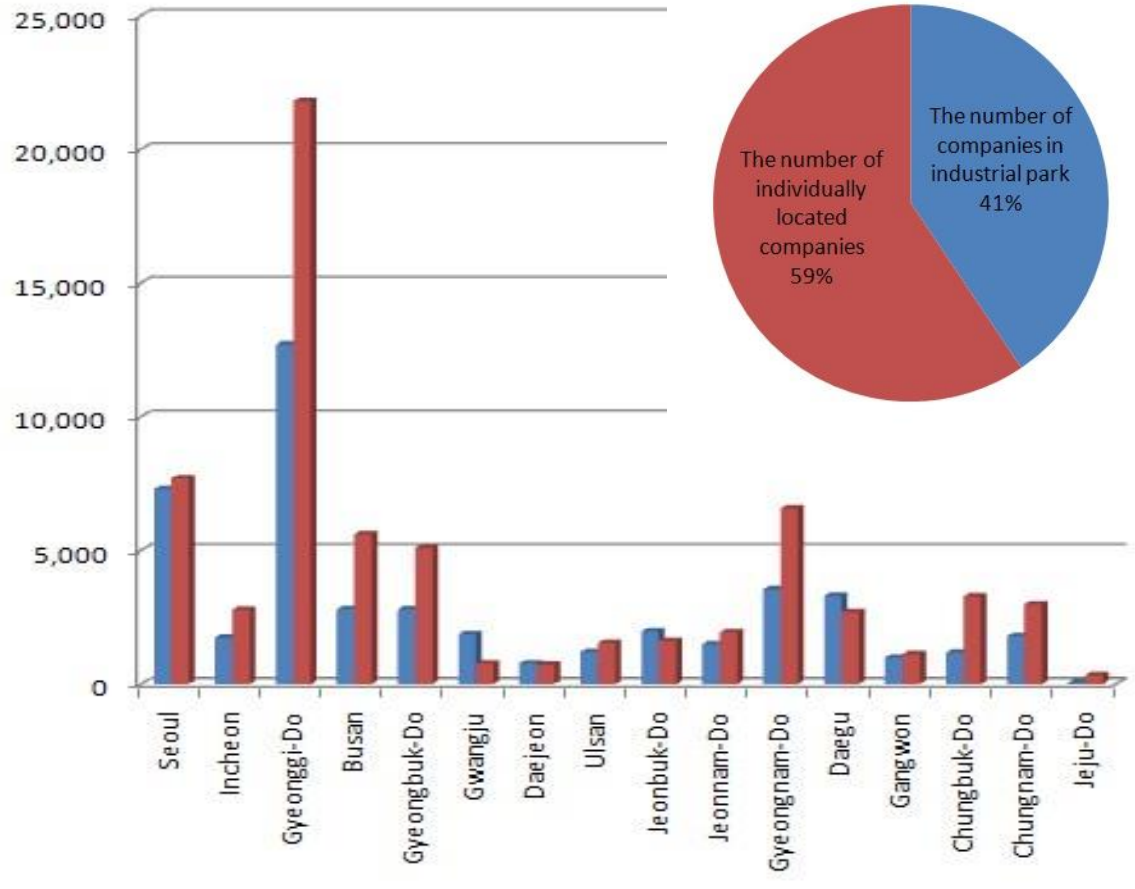
- Industrial parks take 32.3% of GDP and 20% of employees

	Production (KRW billion)	Export(KRW million)	employment(1000)
Industrial Park(A)	190,116	71,278	518
Whole manufacturing (B)	583,793	162,800	2,648
(A/B, %)	32.2	43.8	19.6

Aggregation of Diverse Industries in Korea

- Industrial parks in Korea : 1,000 Parks composed of diverse companies with high density – High Potential to develop Eco-Industrial Networks

구분	The number of companies in industrial park	The number of individually located companies
Seoul	7,296	7,687
Incheon	1,729	2,786
Gyeonggi-Do	12,694	21,800
Busan	2,801	5,598
Gyeongbuk-Do	2,787	5,089
Gwangju	1,862	764
Daejeon	770	723
Ulsan	1,203	1,535
Jeonbuk-Do	1,972	1,608
Jeonnam-Do	1,484	1,939
Gyeongnam-Do	3,544	6,575
Daegu	3,291	2,691
Gangwon	984	1,115
Chungbuk-Do	1,177	3,272
Chungnam-Do	1,791	2,982
Jeju-Do	53	328
Total	45,438	66,492



Ⅱ. Analysis of EIP Development Projects in Korea

2. Progresses of EIP Development Projects in Korea

Environmental Policies to Stimulate EIP Development

Rio Earth Summit (1992) – Adoption of cleaner production and industrial ecology concepts by Korean industries to improve their environmental, social and business performance.

APEFIS - Act to Promote Environmental Friendly Industrial Structure (MKE, 1995) (Based on article 4.2 of Korean law)

Establishment of Korean National Cleaner Production Center (KNCPC)

- Streamlining the supporting system,
-Cleaner production transfer and dissemination
(technology transfer, international collaborative projects, supply chain environmental management, environmental management system and EIPs),
-Promoting environmental industry

2. Progresses of EIP Development Projects in Korea

Brief History of Korean EIP Development Project

Establishment of EIPs through resource recirculation network development for environmental pollution reduction and energy efficiency maximization in industrial complexes.

'03.10	Establishment of national EIP demonstration project plan (MKE)
'05.10	Selection of demonstration sites: Pohang, Yeosu, Ulsan mipo-onsan
'06.02	Additional selection of demonstration sites: Banwol-sihwa, Cheongju
'06.12	Change of EIP ownership (KNCPC → KICOX)
'10.06	Beginning of 2nd phase EIP project
'15.01	Beginning of 3d phase EIP project

2. Progresses of EIP Development Projects in Korea

Legal Background of Korean EIP Development Project

10th amendment (2005.12.23) Law No. 7750 『Inclusion of EIP article』	12th amendment (2008.2.29) Law No. 8852 『Change of Governing Body』	13th amendment (2008.3.28) Law No. 9013 『Content amendment』
Sub paragraph 5, article 2 of the industrial sites and development act: Eco-industrial park means industrial complexes that are designed to minimize the environmental burden and maximize the resources and energy efficiency through the utilization of by- and waste products generated during the manufacture of products utilizing virgin raw materials and energy.		
Article 4-2	**Article 4-2 (Construction of Eco-Industrial Park)**	**Article 4-2 (Designation of Eco-Industrial Park)**

2. Continued…

Article 4-2 1. The MKE may promote projects prescribed in the following subparagraphs with regard to an EIP. i. Development and promulgation of technology for the shared utilization of resources and energy among enterprises within an EIP. ii. Construction of comprehensive management system for resources and energy within an EIP. iii. Nurturing and educating specialists related with construction of EIP. iv. Cooperation with local communities for construction of EIP v. Other projects prescribed by Presidential decision for construction of EIP 2. The government may support the funds to promote the project according to section 1. 3. Promoting the project according to section 1 and matters related to promotion of projects, the methodology etc. according to section 2 shall be prescribed by ordinances of the MKE in consultation with the MOE.	Article 4-2 (Construction of Eco-Industrial Park) 1. same as No.1 (Law No.7750) 2. same as No.1 (Law No.7750) 3. same as No.1 (Law No.7750)	Article 4-2 (Designation of Eco-Industrial Park) 1. The MKE shall designate an EIP in consultation with the MOE under Article 8-2-1 of the Industrial Sites and Development Act. 2. same as No.1 (Law No.8852) 3. The MKE may designate a special organization prescribed by Presidential decision to take charge of the duties, such as an operation of an EIP. 4. Where ever necessary, for the efficient establishment of an EIP, the MKE may set its plans for industrial complex development under Articles 6, 7 and 7-2 of the Industrial Sites and Development Act, request the concerned authority to designate an industrial complex to the main Project and can be included by the industrial complex concerned, planning for land use, major infrastructure, etc. in order to maximize the resources and energy efficiency in the industries. 5. Matters related to promotion of projects, the methodology etc. according to section 2 shall be prescribed by ordinances of the MIE in consultation with the MOE.

Assessment of benefits of Korean EIP Projects

1) Finding → Commercialization Ratio (EIP: 66% > other R&Ds: 42%)

Item finding	Completion	Commercialization	Commercialization(%)	Company No.
655	355	235	66.2%	1,831

★ Budget('05–' 16): 81 Million $ → 30 fold economic achievement compared to budget expenditure

Economic Effect

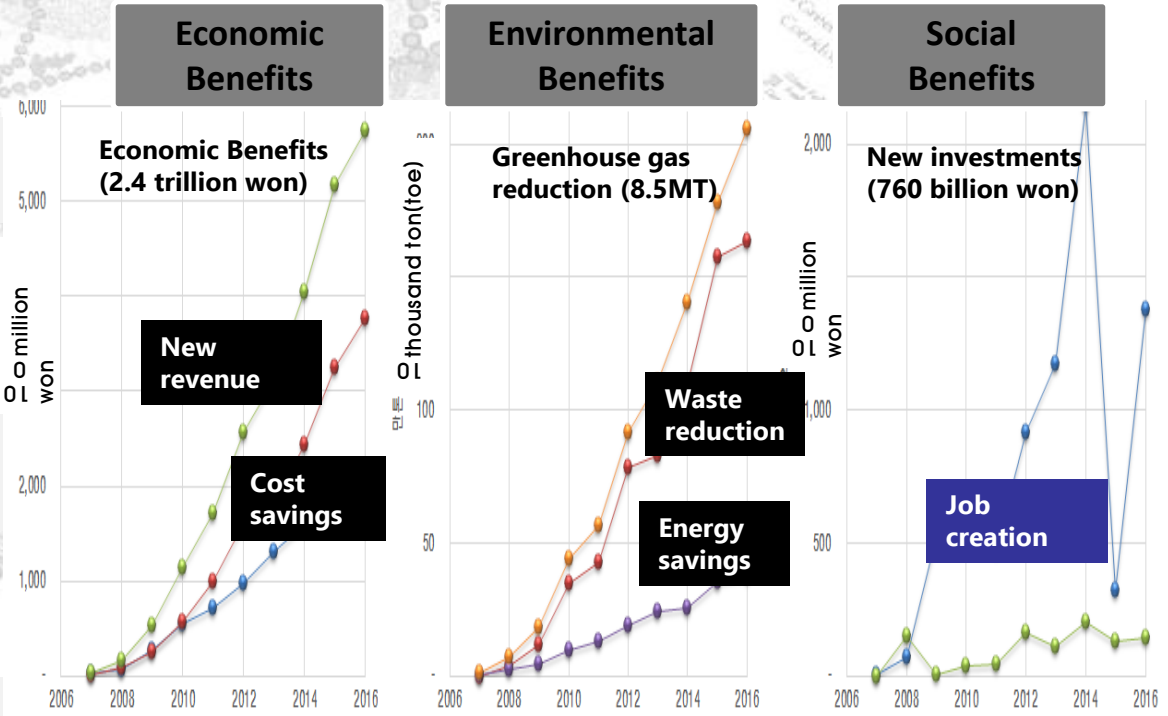
Cost savings, New revenue : 2.2 B $

Environmental Effect

Energy savings 1,730 thousand toe
GHGs 8,540 thousand ton ↓
Waste 6,850 thousand ton ↓

Social Effect

New investment 0.7b$
Direct Job creation 992 persons



Phases of Korean EIP Development Projects

3 Phases of Korean EIP Development Projects

1st phase EIP with 5 industrial complexes

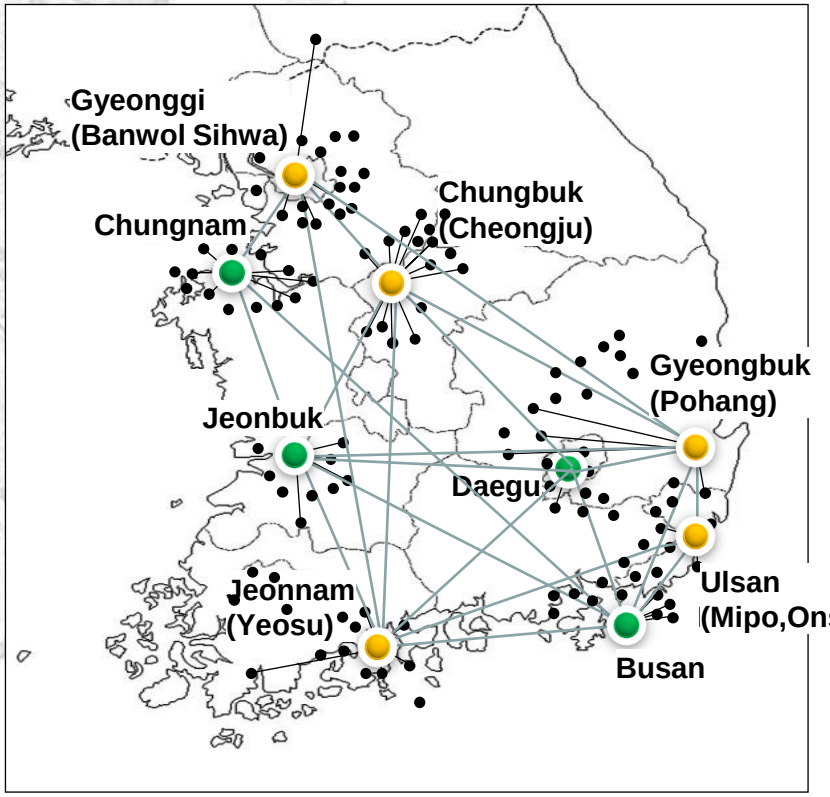
- 2005.11~2010.5
- 5 demonstration industrial complexes

2nd phase Diffusion on 46 Industrial Parks

- 2010.6~2014.12
- Diffusion on 46 industrial Parks
- 9 Hub Industrial Parks – 37 Spoke IPs

3rd phase 105 Industrial Parks Networked

- 2015.1~2016.12.
- Central Government Stopped the Funding

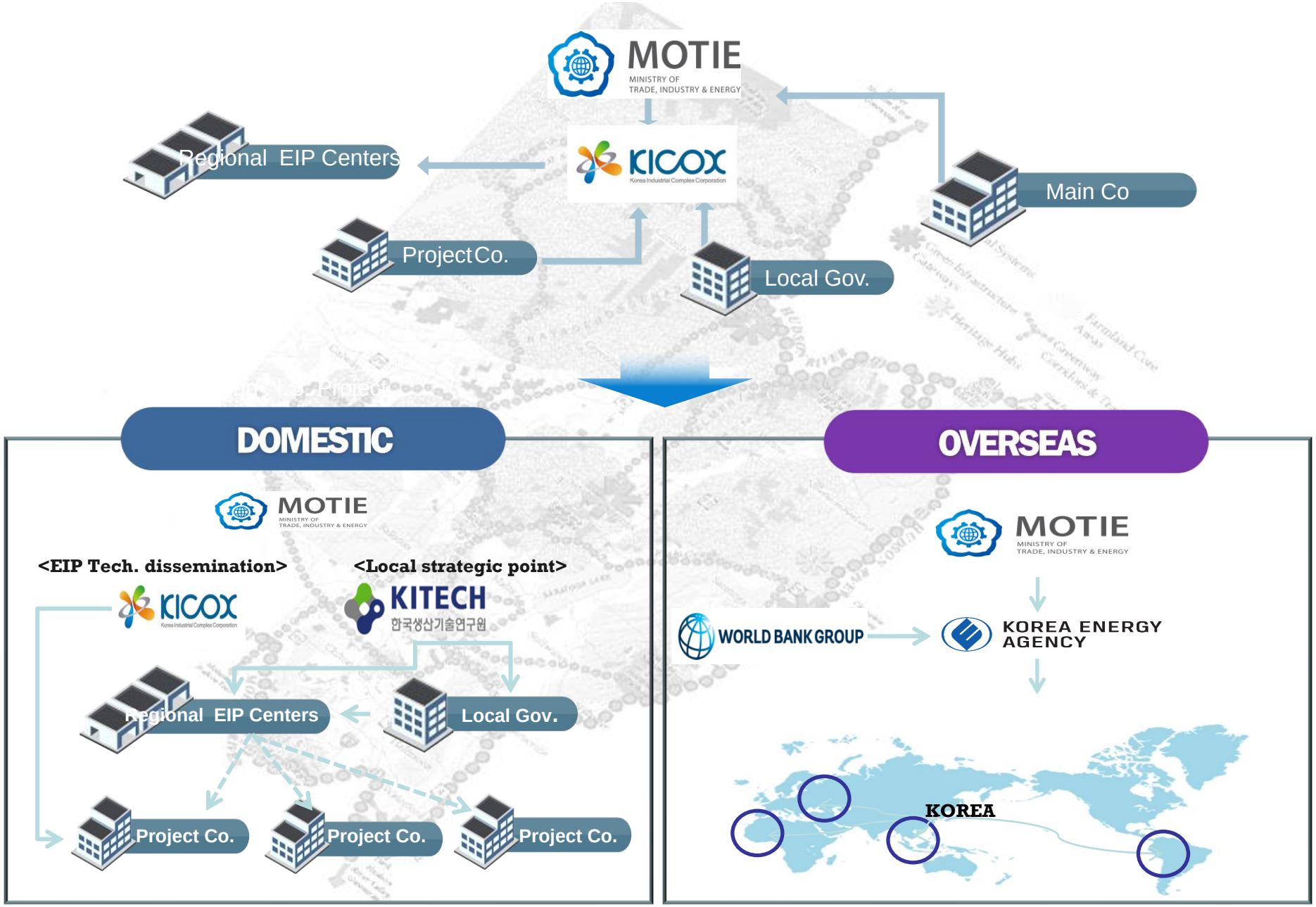


Post EIP : Eco-Industrial Development

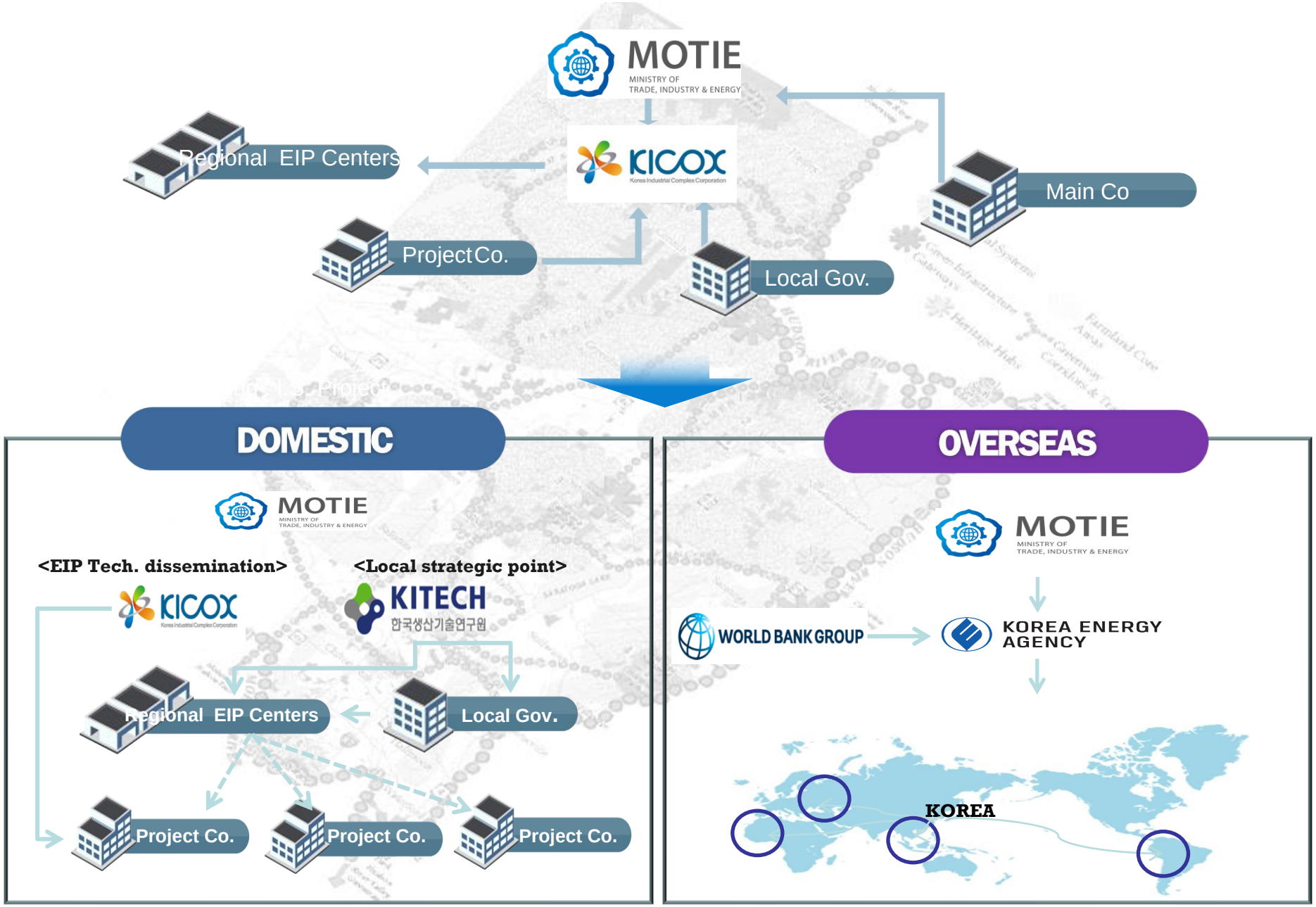
Building National Eco-Industrial Networks
-Regionwide Industrial Symbiosis Networks

- 2018.5 ~ Present, Restart Funding EID projects

Operation System of Korean EIP Projects



Operation System of Korean EIP Projects

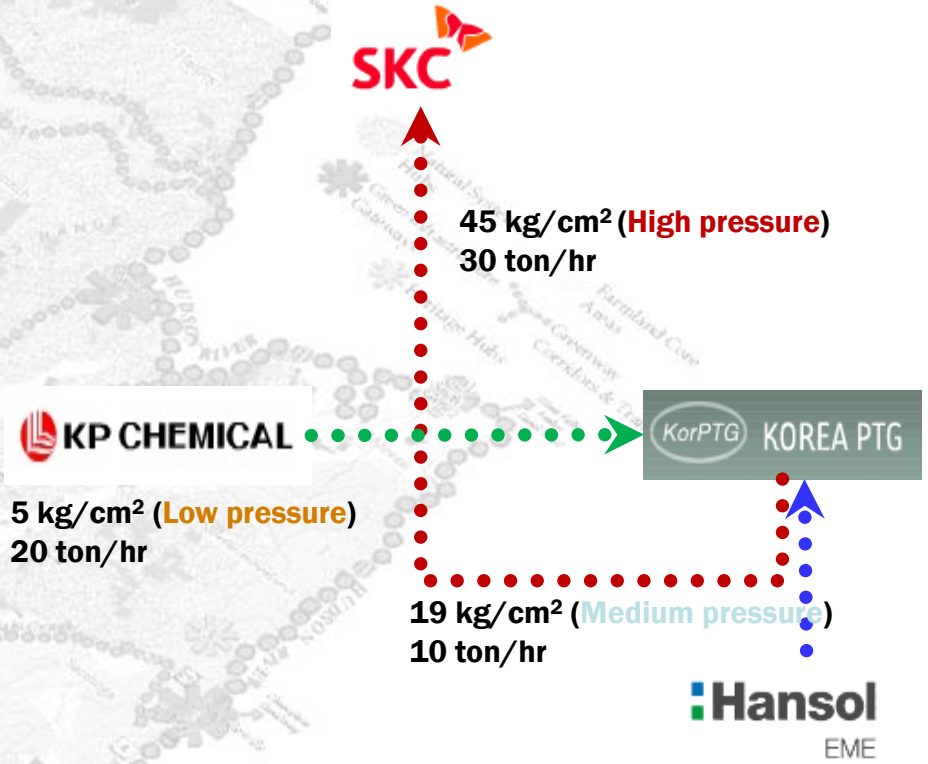


Case Study 1 : Ulsan Steam Highway

Ulsan Steam Highway

Surplus Steam Supply Surplus Steam Demand

2nd Stage Steam Network



5 stage Steam Network

- 1st('08) : SungAm Incinerator ▶ Hyosung Factory
- 2nd('09) : KP Chemical ▶ Korea PTG ▶ SKC
- 3rd('13) : SK Chemical ▶ Hansol EME ▶ SK Energy
- 4th('13) : Sungam Incinerator ▶ Hyosung 1 Factory
- 5th('14) : Hyosung Factory ▶ KP Chemical ▶ Istman

< Total Effects >

- ☞ **Total $90m investment → $25m payback/y**
- ☞ **Energy 49thousand toe/y**
- ☞ **GHGs 135 thousand ton/y**

Case Study 2 : Recycling technology development of the waste mock marble

LG Hausys,
Hanhwa L&C

Waste Mock Marble → Raw Material

Raw Material

Crushing, Grinding

Dry

Pyrolysis → Condensation → Oil-Water Separation → Storage

Oil-Water Separation

Wastewater

Storage

Distillation

Distillation

MMA(product)

Pyrolysis

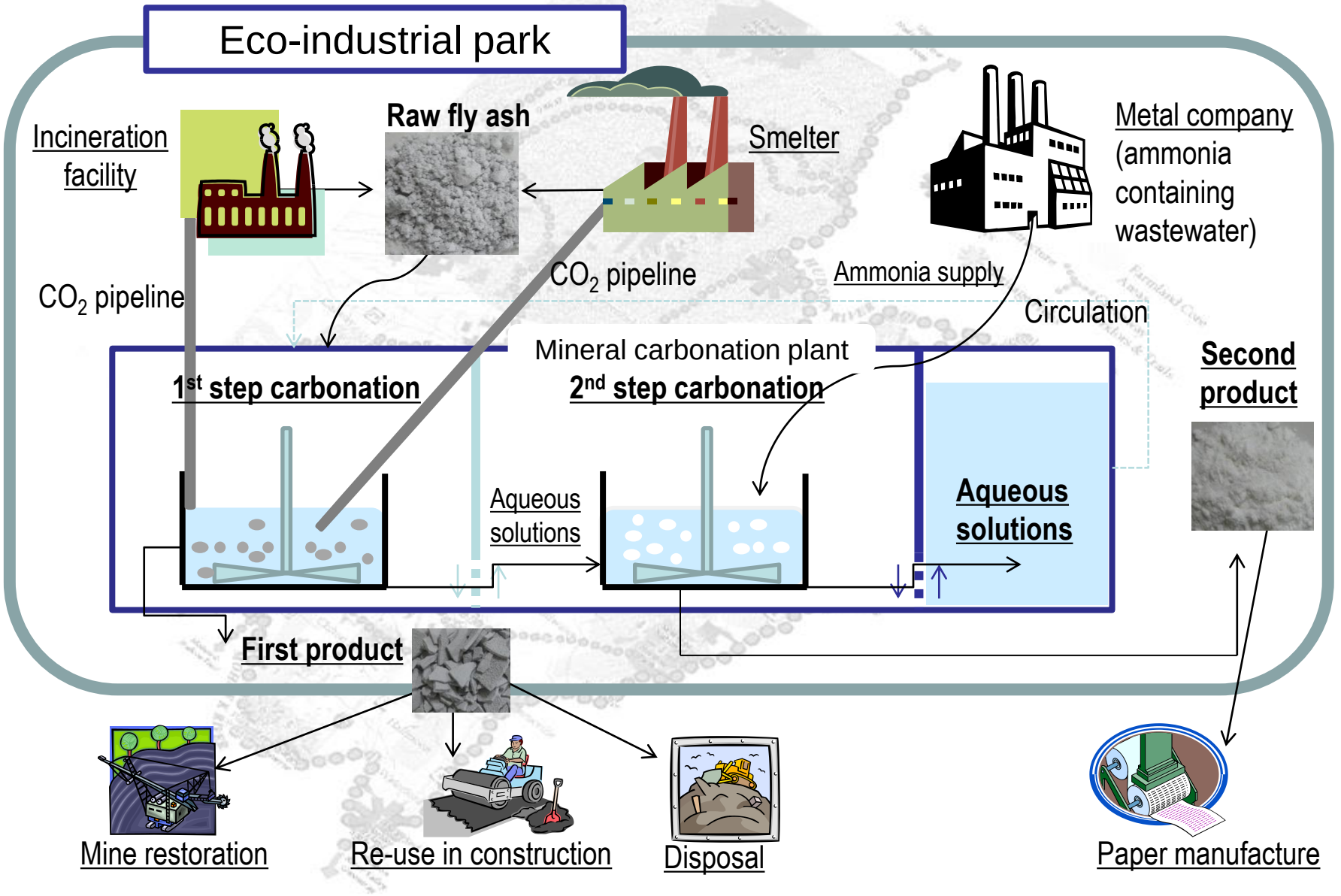
Calcination

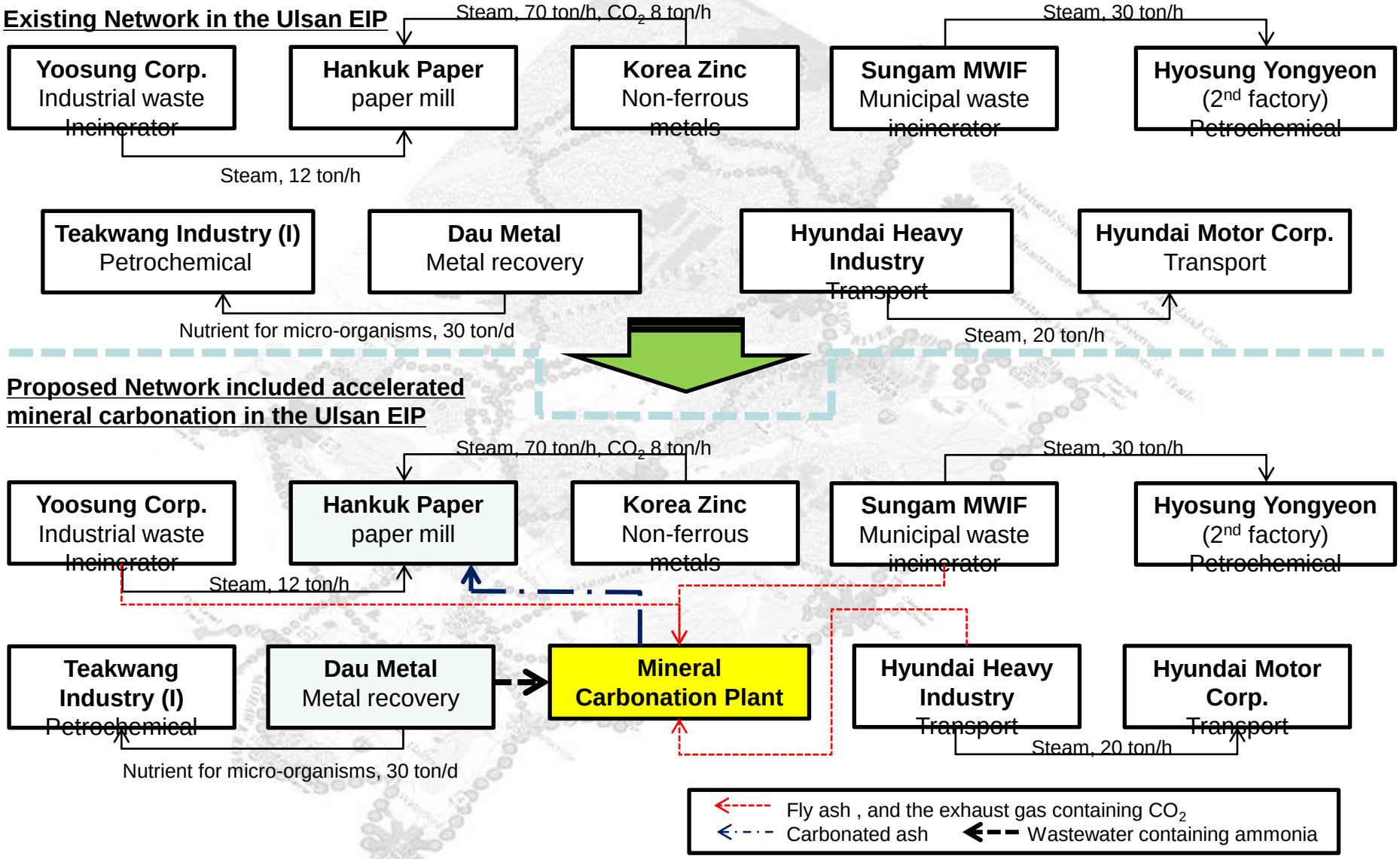
Alumina (product)

〈 Expectation Effect 〉

- ☞ Cost savings & New Revenue $6m/y
- ☞ GHGs 13thousand ton/y
- ☞ 18 job creation through new investment

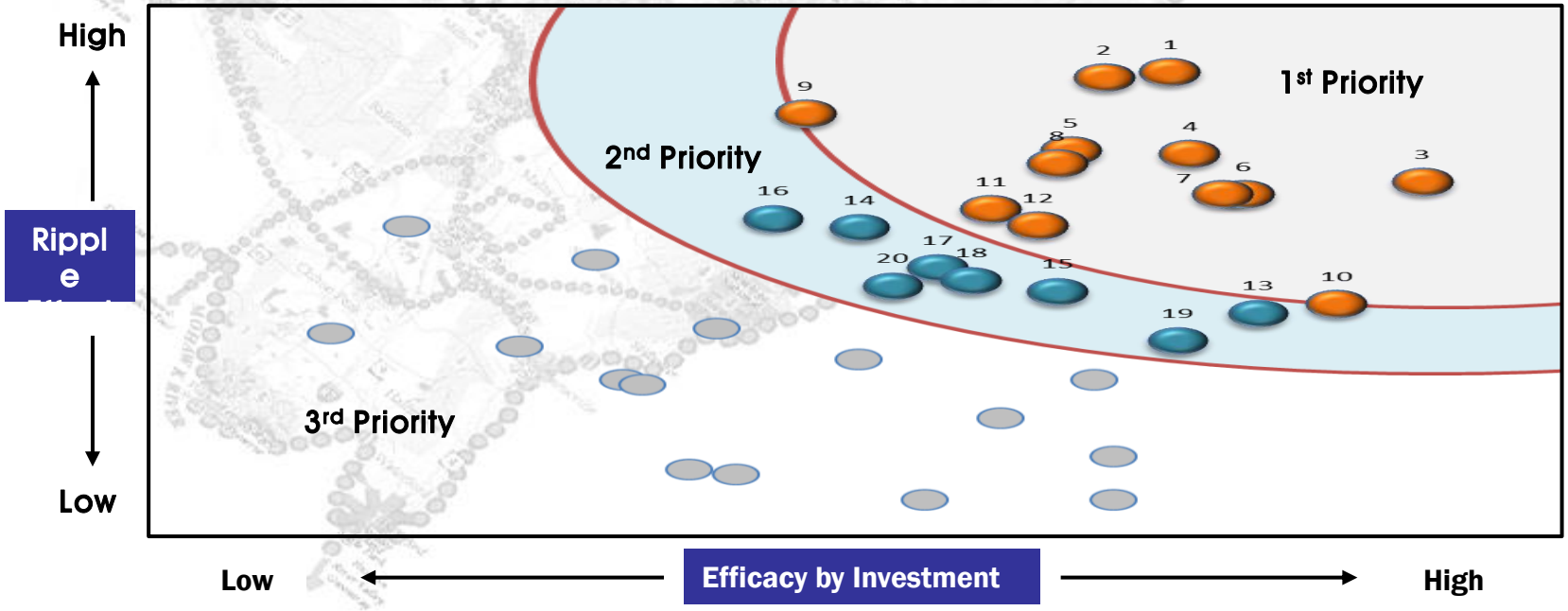
Potential project : CCU Techniques for the mitigation of CO2 Emissions




Existing Network in the Ulsan EIP
Steam, 70 ton/h, CO_2 8 ton/h
Steam, 30 ton/h
Yoosung Corp.
Industrial waste Incinerator
Hankuk Paper
paper mill
Korea Zinc
Non-ferrous metals
Sungam MWIF
Municipal waste incinerator
Hyosung Yongyeon
(2nd factory)
Petrochemical
Steam, 12 ton/h
Teakwang Industry (I)
Petrochemical
Dau Metal
Metal recovery
Hyundai Heavy Industry
Transport
Hyundai Motor Corp.
Transport
Nutrient for micro-organisms, 30 ton/d
Steam, 20 ton/h
Proposed Network included accelerated mineral carbonation in the Ulsan EIP
Steam, 70 ton/h, CO_2 8 ton/h
Steam, 30 ton/h
Yoosung Corp.
Industrial waste Incinerator
Hankuk Paper
paper mill
Korea Zinc
Non-ferrous metals
Sungam MWIF
Municipal waste incinerator
Hyosung Yongyeon
(2nd factory)
Petrochemical
Steam, 12 ton/h
Teakwang Industry (I)
Petrochemical
Dau Metal
Metal recovery
Mineral Carbonation Plant
Hyundai Heavy Industry
Transport
Hyundai Motor Corp.
Transport
Steam, 20 ton/h
Nutrient for micro-organisms, 30 ton/d
Fly ash , and the exhaust gas containing CO_2
Carbonated ash
Wastewater containing ammonia

Representative 37 EIP technologies

Ranking	Name of Representative technologies
1	Energy optimization using heat of incineration and process
2	Recovery of valuable metals from process wastewater
3	Recycling technology for non-ferrous metal scrap
4	Solid fuel technology using waste wood
5	Recycling technology of waste acid, alkali and organic solvent
6	Extraction of waste synthetic resin into feedstock
7	Extraction of waste synthetic resin into raw material
8	Alternative fuel production using oil mist recovery and waste oil
9	Fertilizer production using by-products of fish and meat processing
10	Construction material production using slag and ash



Representative 37 EIP technologies

Priority	Ranking	Name of Representative technologies
1st	1	Energy optimization using heat of incineration and process
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	6	Extraction of waste synthetic resin into feedstock
	7	Extraction of waste synthetic resin into raw material
	8	Alternative fuel production using oil mist recovery and waste oil
	9	Fertilizer production using by-products of fish and meat processing
	10	Construction material production using slag and ash
2nd	11	Recovery of valuable metals from process wastewater and sludge
	12	Application and extraction of process sludge into raw material
	13	Construction material production using inorganic sludge
	14	Recovery of valuable metals from waste metals
	15	Industrial water production using sewage treatment plant effluent
	16	Recycling technology for ferrous metal scrap
	17	Technology of bio-energy production using organic wastewater and by-products
	18	Extraction of waste synthetic rubber into raw material
	19	Recycling technology for organic by-product in ceramic industry
	20	Production of Industrial gas using by-product gas
3rd	21	Application and extraction of process sludge into raw material (Silicon recovery in wastewater
	22	Solid refuse fuel technology using sludge
	23	Recovery of organic solvent and reclaimed oil from wastewater and sludge
	24	Production of the chemical raw materials using by-product gas
	25	Manufacturing of refractory materials using silicon sludge
	26	Regeneration technology of waste adsorbent
	27	Production of microbial preparation using by-products, such as food processes and probiotics
	28	Fertilizer production using waste refractory materials
	29	Recovery of valuable metals in waste oil
	30	Production of adsorbent using sludge
	31	Fertilizer production using organic sludge
	32	Fuel production using waste wood
	33	Production of reducing agents for steel making using coke particle
	34	Application and extraction of ash into rubber product filler
	35	Application and extraction of process sludge into floor filler
	36	Construction material production using inorganic by-product
	37	Hydrotalcite production using fly ash

International Cooperation on Korean EIP models

Bangladesh

2013, Chittagong Industrial Park
(Received Performance Award from World Bank)

Vietnam

2015, Hoa Khanh Industrial Park
(Request on best practice in Korean EIP models)

Egypt

2016, EIP Cooperation MOU
(Proposals for introducing Korean EIP models)

Turkey

2018, EIP Cooperation MOU
(Request for Korean EIP experts)

To begin joint project with WB for EIPs in developing countries

WORLD BANK GROUP
Finance, Competitiveness & Innovation

Diagnosis	→	Analysis	→	Master Plan	→	Promotion
Energy consumption Waste generation		Resource efficiency Regulation and finance		Roadmap		Target countries Investors

☞ **Potential EIP partners : Mexico, Malaysia, Peru, Myanmar, Morocco, etc.**

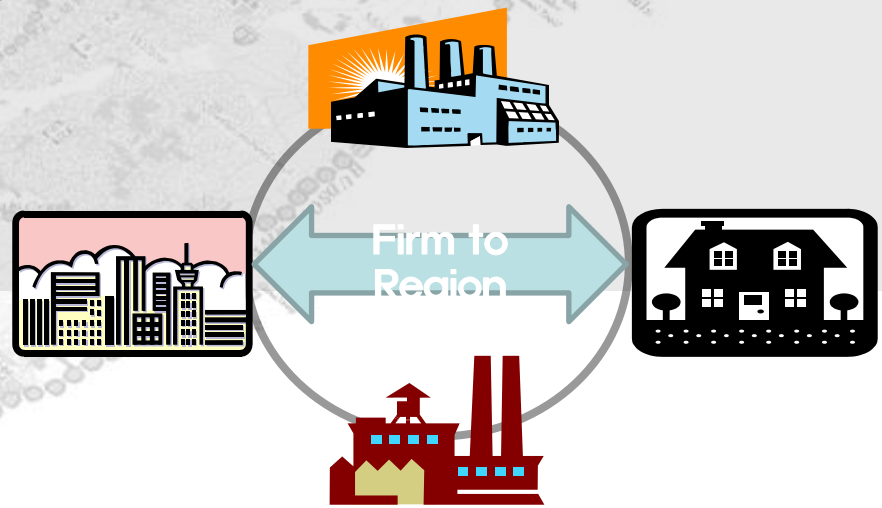
Post-EIP: Eco-Industrial Development (EID) Projects

Now

1 Eco-Industrial Park

Future

2 Eco-Industrial Development



Building Smart -EID Networks

: Big data/AI/IoT Technologies

Future : Smart EID Platform: an Integrated IS Matching System

Information

- Building Register
- Building Energy
- Petroleum Consumption
- Transportation Information
- Green Information
- Local Information
- Policy Information

Potential Matching of Industrial Symbiosis Networks

Collection

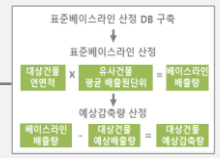
- ETL
- Open API
- FTP/SFTP
- Streaming
- Crawling

Data Base

- Extraction, Transformation, Loading
- Processing
- Storage

Analysis

- Analysis Algorithm
- R Program
- Toolkit



Service

- Characteristic analysis of local areas
- Fluctuating analysis of local energy
- Finding business model
- Emissions coefficient
- Monitoring

Visualization

- Chart
- Estimation
- GIS
- Scatter Diagram

III. Lessons from Korean EIP Development Initiative

3. Lessons from the Korean EIP Development Initiative

Lessons from the EIP Development Projects in Korea: Barriers and Drivers and Enablers

Barriers:

- Co-ordination among governmental departments
- Rigidity of regulatory framework
- Difficulty to attract investment for commercialization due to financing (especially SMEs)
- Difficulty to access to resource circulation data due to privacy policy of sensitive data due to rigid legal enforcement
- Difficulty to coordinate the departments of central and local governments

3. Lessons from the Korean EIP Development Initiative

Lessons from the EIP Development Projects in Korea: Barriers and Drivers and Enablers

Drivers:

- Economic incentives from governments (Central and Local governments)
- National policy based on regulations
- Technological support from governmental funding (Cleaner Production–related R&D fund)
- Institutional support from KICOX as a governing institution

3. Lessons from the Korean EIP Development Initiative

Lessons from the EIP Development Projects in Korea: Barriers and Drivers and Enablers

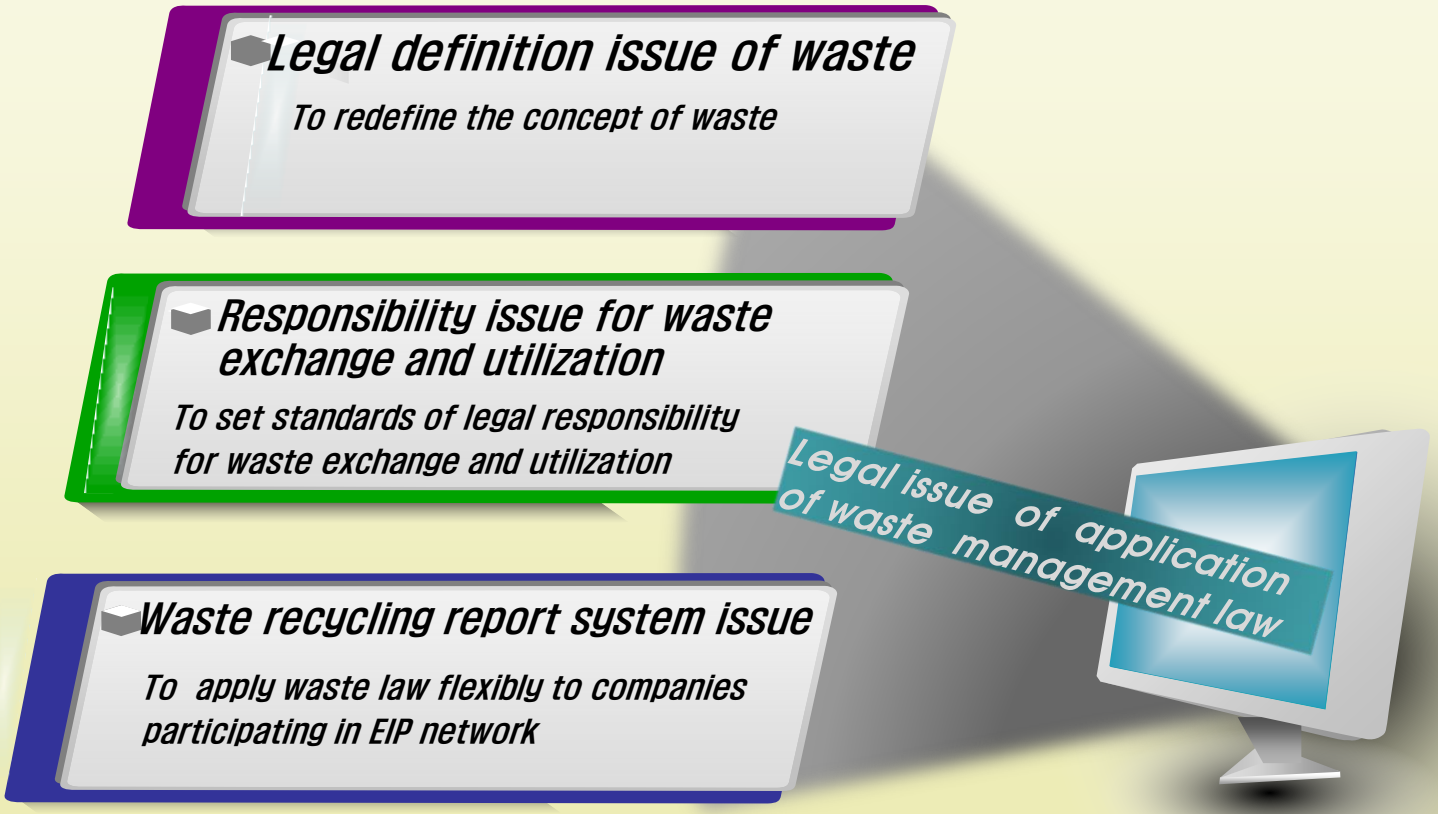
Enablers:

- Brain storming during symbiotic identification
- Heart storming during project implementation
- Business model need to be developed to attract stakeholders to participate in the synergy networks
- Step by step approach from low to high hanging fruits
- Legal improvement to solve the problems, facing during the process of EIP development

3. Lessons from Korean EIP Development Initiative

To Improve Legal/institutional System

- Waste management system



3. Lessons from Korean EIP Development Initiative

To Improve Legal/institutional System

Restrictions on location of waste treatment company in industrial parks	To approve exception
Restrictions on waste treatment facilities in factory	To approve mixed use
Restrictions on waste treatment facilities in industrial facility area	To approve change of management plan of industrial parks
Low costs for landfill and incineration	To raise up tipping fees

3. Lessons from Korean EIP Development Initiative

Some Progresses Seen on Legal/Institutional System

-Improvement of EIP Management System : Revision of the Act on the Promotion of the Conversion into Environment-Friendly Industrial Structure(08.03)

- Designation of the organization in charge of EIP project management(Article 3).
- Specification of time and method of Industrial-Environmental Statistical Research related to EIP management(Article 4).
- Founding Base of Cooperation between Ministries for Industrial-Environmental Statistical Research related to EIP management(Article 4).

3. Lessons from Korean EIP Development Initiative

Some Progresses Seen on Legal/Institutional System

Relaxation of Restrictions on location of recycling company and facilities: Revision of Act on Stimulation of Industrial Integration and Plant Foundation(August, 2009)

- Manufacturer in industrial parks can provide waste steam to other businesses in industrial parks(Article 43).
- Decomposer /Scavenger company can be installed in newly designated special areas in industrial parks(Article 43)

3. Lessons from Korean EIP Development Initiative

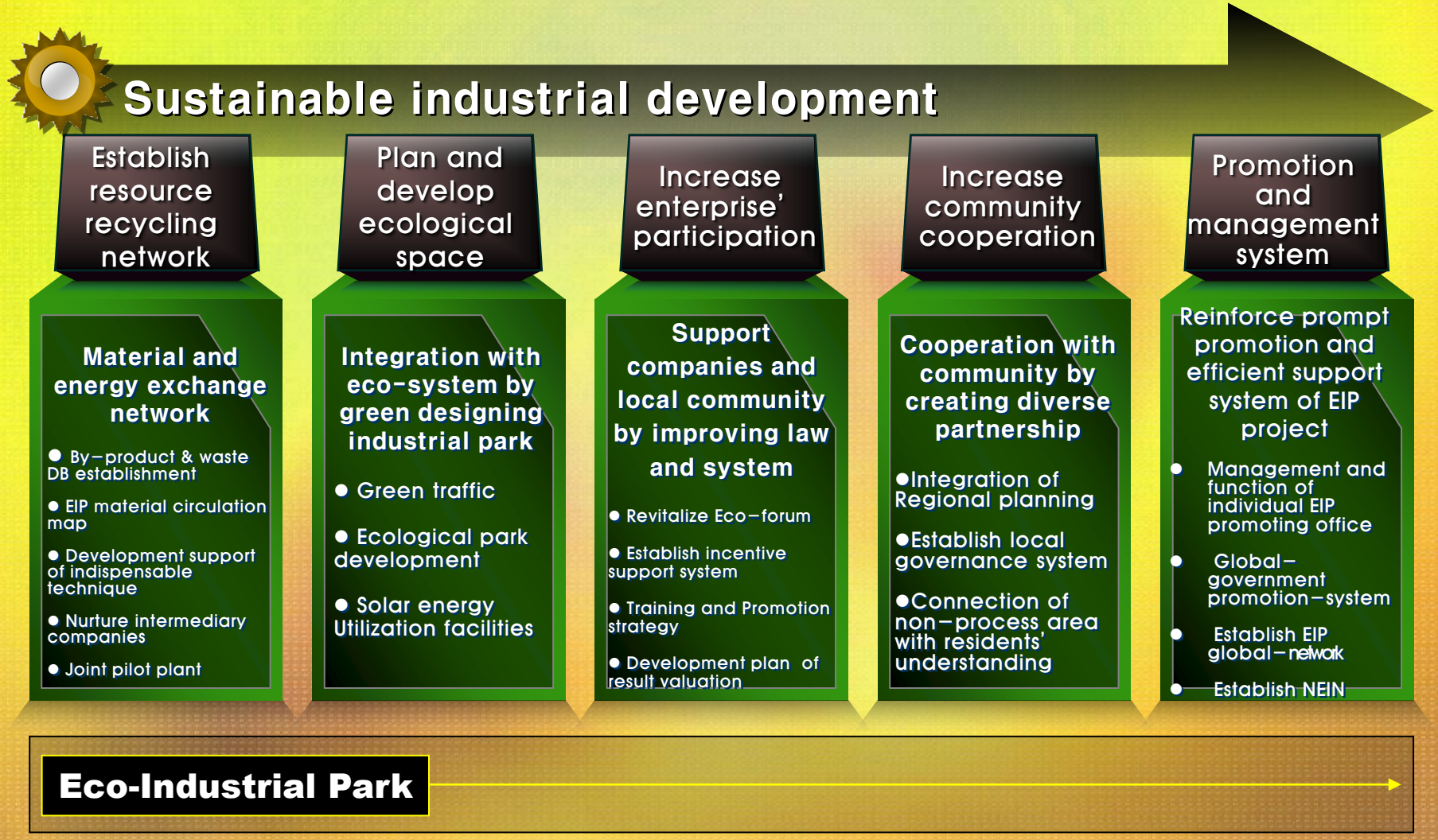
On-going efforts to improve Legal/Institutional System

Relaxation of Restrictions on Treatment of Some Wastes to Stimulate Recycling: Revision of Act on Waste Management

- To widen sewage sludge recycle such as fuel of thermal power plant, soil conditioner, and land reclamation material.
- To use carbonized non-organic sludge as a catalyst

IV. Conclusions

Conclusion


Sustainable industrial development
Establish resource recycling network
Material and energy exchange network
● By-product & waste DB establishment
● EIP material circulation map
● Development support of indispensable technique
● Nurture intermediary companies
● Joint pilot plant
Plan and develop ecological space
Integration with eco-system by green designing industrial park
● Green traffic
● Ecological park development
● Solar energy Utilization facilities
Increase enterprise' participation
Support companies and local community by improving law and system
● Revitalize Eco-forum
● Establish incentive support system
● Training and Promotion strategy
● Development plan of result valuation
Increase community cooperation
Cooperation with community by creating diverse partnership
●Integration of Regional planning
●Establish local governance system
●Connection of non-process area with residents' understanding
Promotion and management system
Reinforce prompt promotion and efficient support system of EIP project
● Management and function of individual EIP promoting office
● Global-government promotion-system
● Establish EIP global-network
● Establish NEIN
Eco-Industrial Park

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