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Expectations for Transition from Urban-Industrial Symbiosis to Green Innovation in Kawasaki
From Urban-Industrial Symbiosis to a Sustainable Future in Kawasaki City

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Theory and Practices for Industrial Symbiosis

Practices | Concept

1970

1972 Denmark Kalundborg

End-of Pipe Technology

1977 Cloud. "Industrial Ecosystem"

1980

LCA Research

1989 Frosh, R. A. "Industrial Ecosystem"

1990

Sustainable Development

1993 Ayres, Robert. "Industrial Metabolism"

1994 UNU Pauli, Gunter."Zero-emission"

1995

Industrial Ecology

1994 ・Allenby, Graedel "Industrial Ecology"

1995 US PCSD Eco-Industrial Park

Cleaner Production,D f E

1997 Japan Eco Town Projects

2000

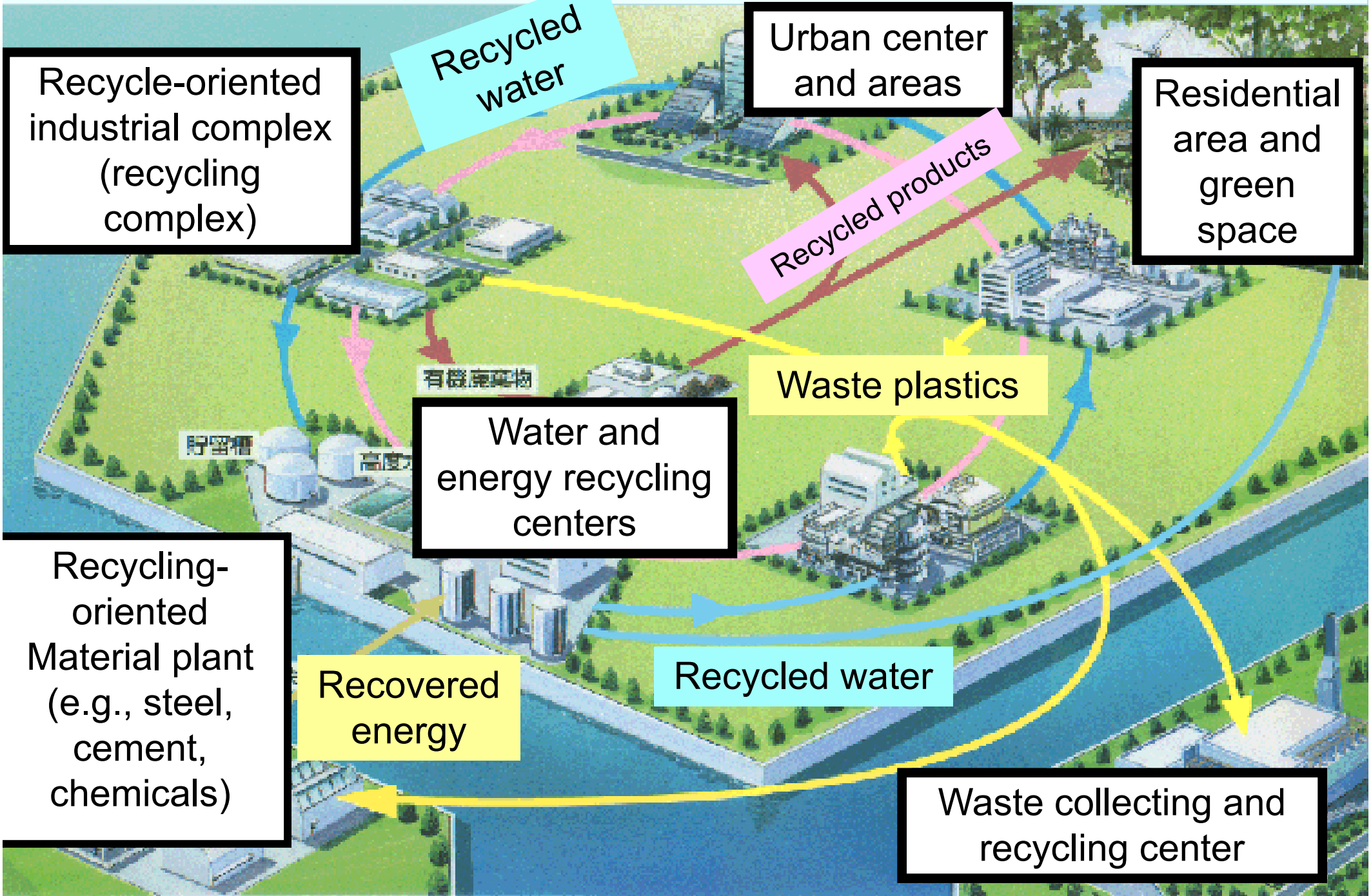
2005 Korea National Cleaner Production Centers

2009 China Circular Economy Law

2010

Tsinghua Univ. Seminar, Aug. 2013

Kawasaki Urban-Industrial Symbiosis Vision
Kawasaki Eco-Town in the 1990s and later

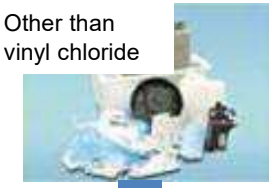


Arterial industry-linked resource centers are integrated in Kawasaki Eco-Town

For example, many resource recycling technologies have already been implemented as a part of the environmental technology field.

Plastics (domestic waste)

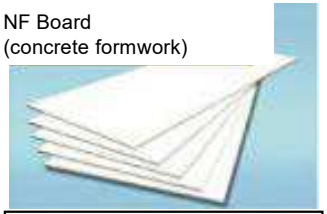
Plastics (industrial waste)



Waste appliances

Waste PET

NF Board
(concrete formwork)



NF Board

Steel material
plastics

Iron scraps

Recycled PET flakes

Construction sites

Steel plant

Merchandise

Recycling system that enables urban-industrial symbiosis in Kawasaki

Resource input process

Manufacturing or converting process

Commodification process

Limestone

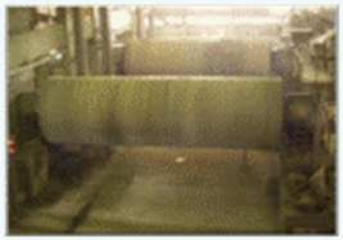
Clay

Coal

Crush materials

Revolving furnace

Cement pulverization



Cement products

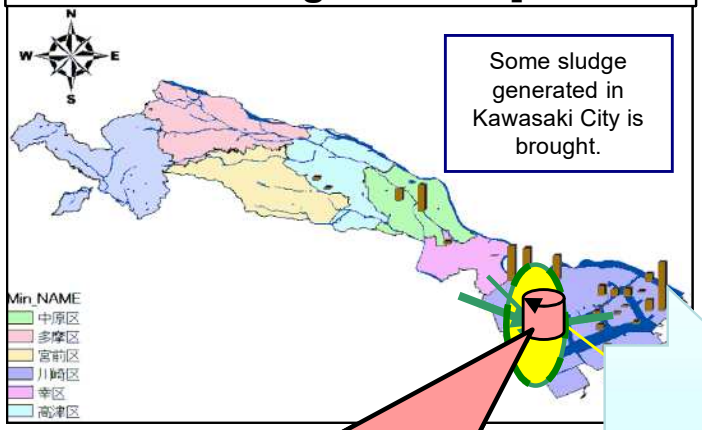
Pretreatment

Replacement with waste •Industrial waste etc.

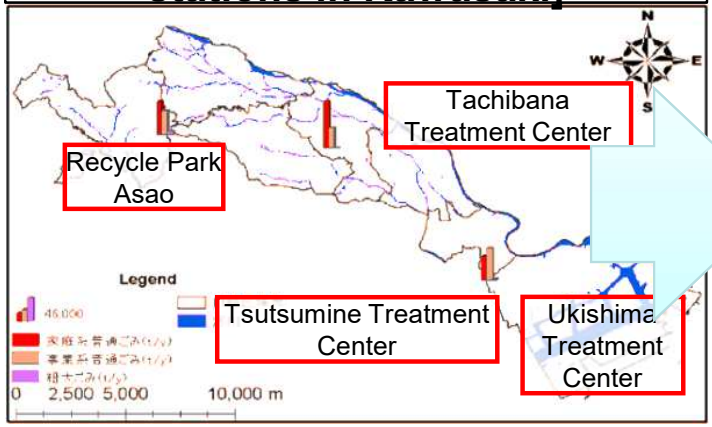
Replace clay and coal with waste materials to produce recycled material-based cement

Estimated effects of circular economy technologies (i): Recycling domestic waste as raw materials for cement production

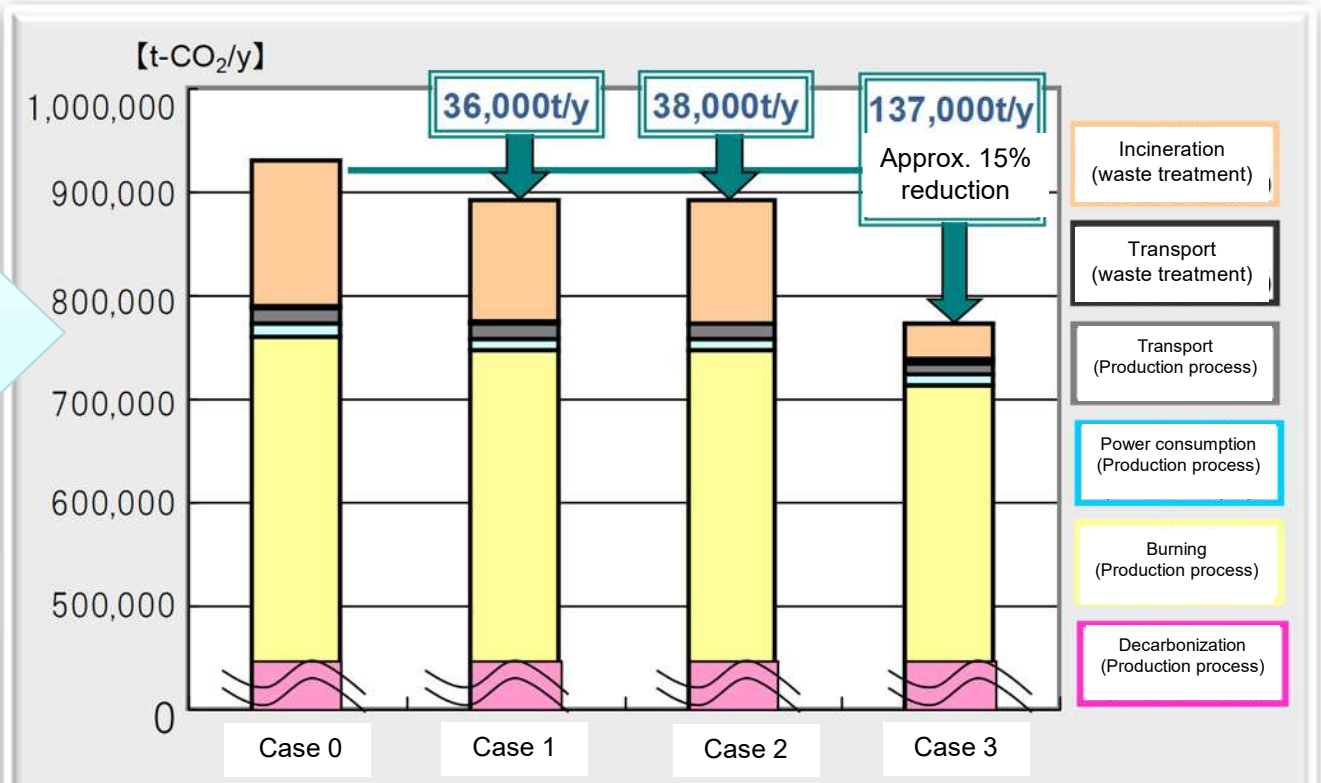
[Geographical distribution of waste generation]



[Waste generation treatment stations in Kawasaki]



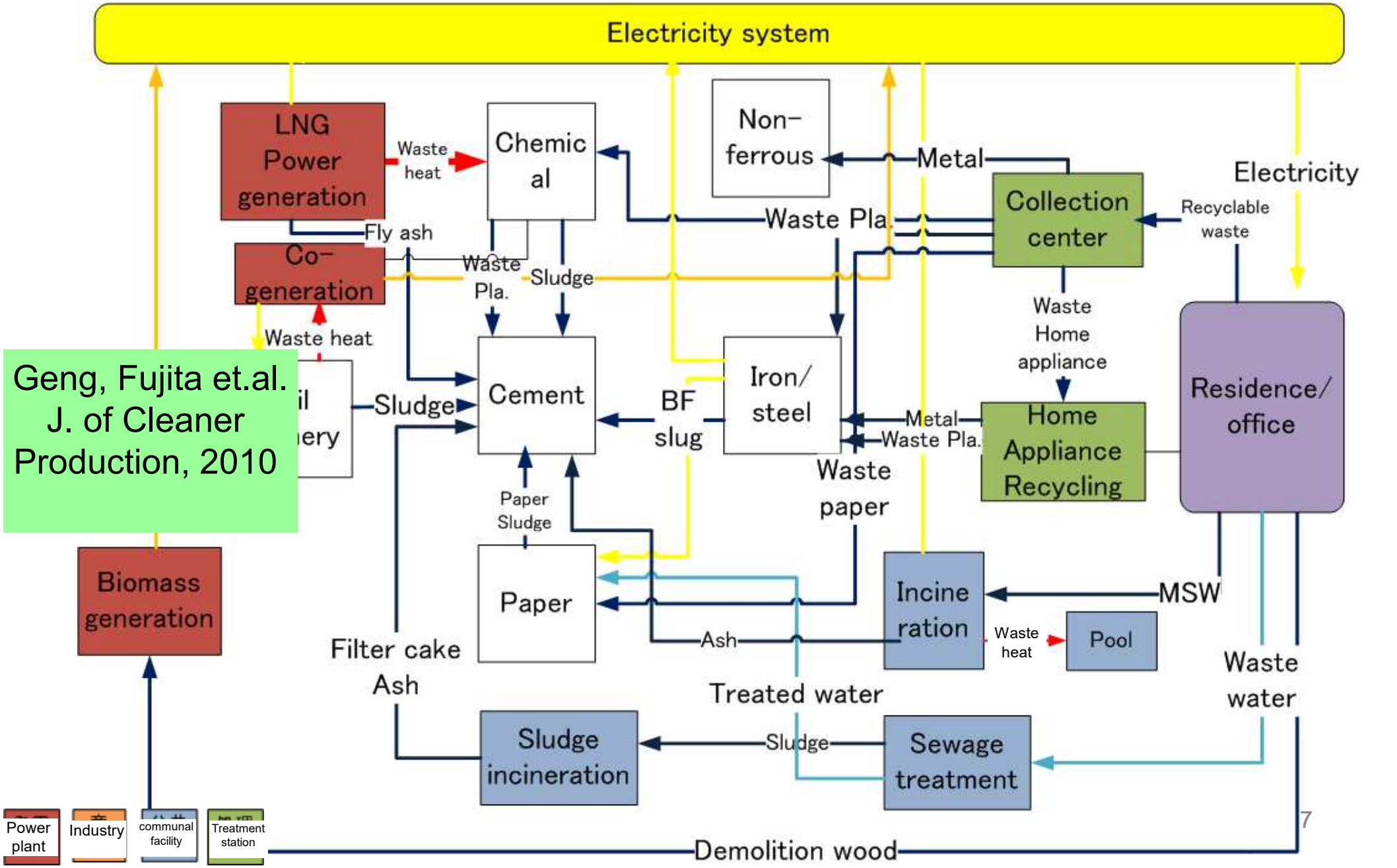
Example of estimated CO_2 emission reduction that a recycled material-based cement industry would achieve through the use of local resources.



		Waste (t/y)			Transport distance (km)	Waste-raw material conversion percentage (wt%)	Maximum waste-raw material conversion percentage (wt %)		Treatment of general waste (t/y)	Transport distance (km)	Treatment of general waste (t/y)	Transport distance (km)
		Kawasaki City	Kanagawa Pref.	Kanto Region	Other regions							
Industrial waste replacing clay-based raw materials	Case 1	0	0	0	0	0	0%	Waste to be treated	490000	52	0	0
	Case 2	28,000	54,000	50,000	113,000	52	100%		245,000	52	0	0
	Case 3	245,000	0	0	0	1.5	100%		245,000	52	0	0
	Case 4	245,000	0	0	0	1.5	100%		245,000	52	0	0
Industrial waste replacing fuel raw materials	Case 1	0	0	0	0	0	0%		19380	50	18620	5.4
	Case 2	0	0	0	12,000	50	10%		7360	50	18620	5
	Case 3	7,360	0	0	12,000	31	14.60%		0	0	18620	5
	Case 4	18,620 (general waste) 19,380 (Industrial waste)	0	0	0	5	40%		0	0	0	0

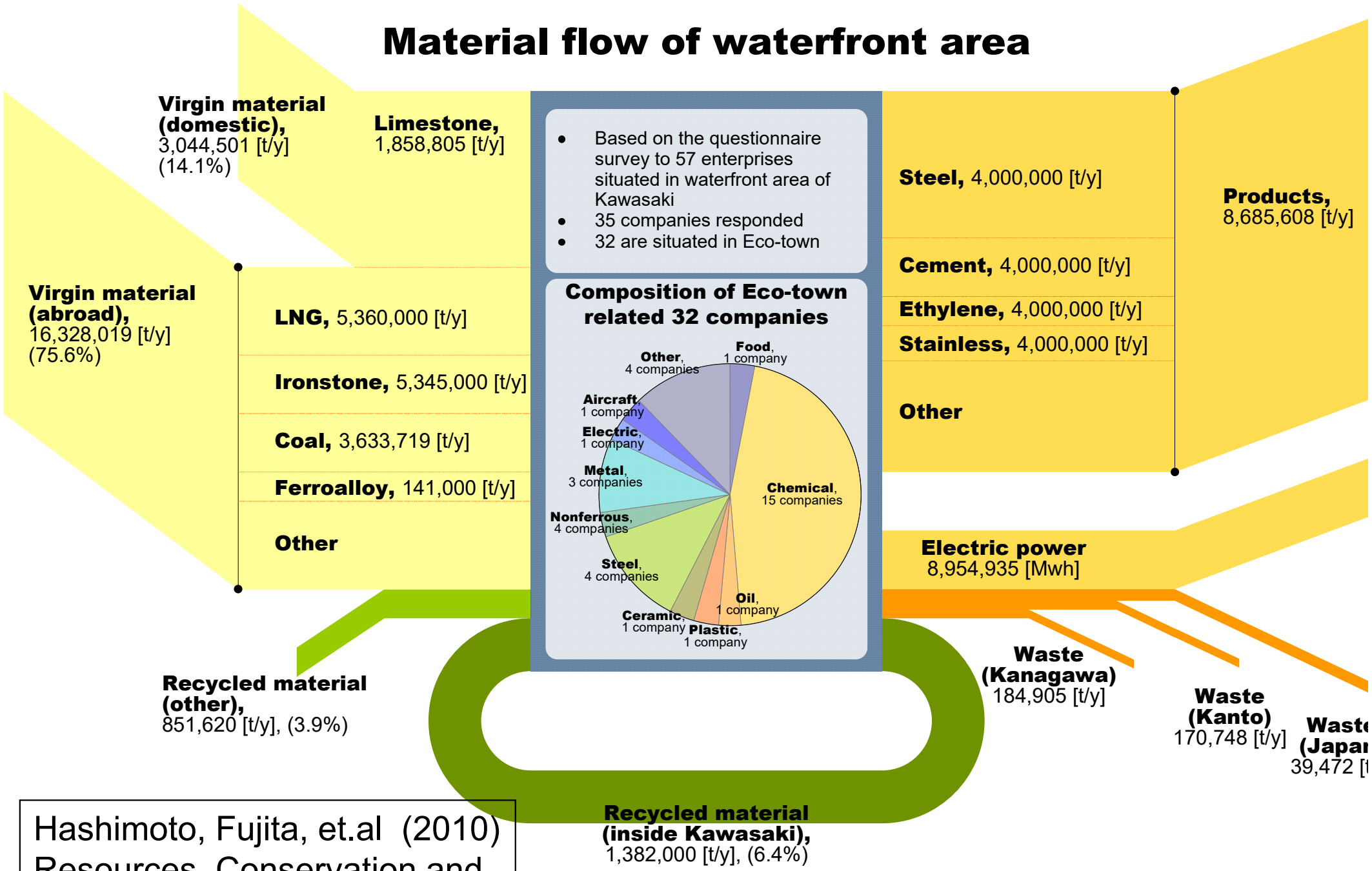
Kawasaki Synergy Network（current situation）

Bio/life science | Power generation & material industry | Treatment or recycling facility | City



Geng, Fujita et.al. J. of Cleaner Production, 2010

Material Flow Analysis for Kawasaki Eco-town

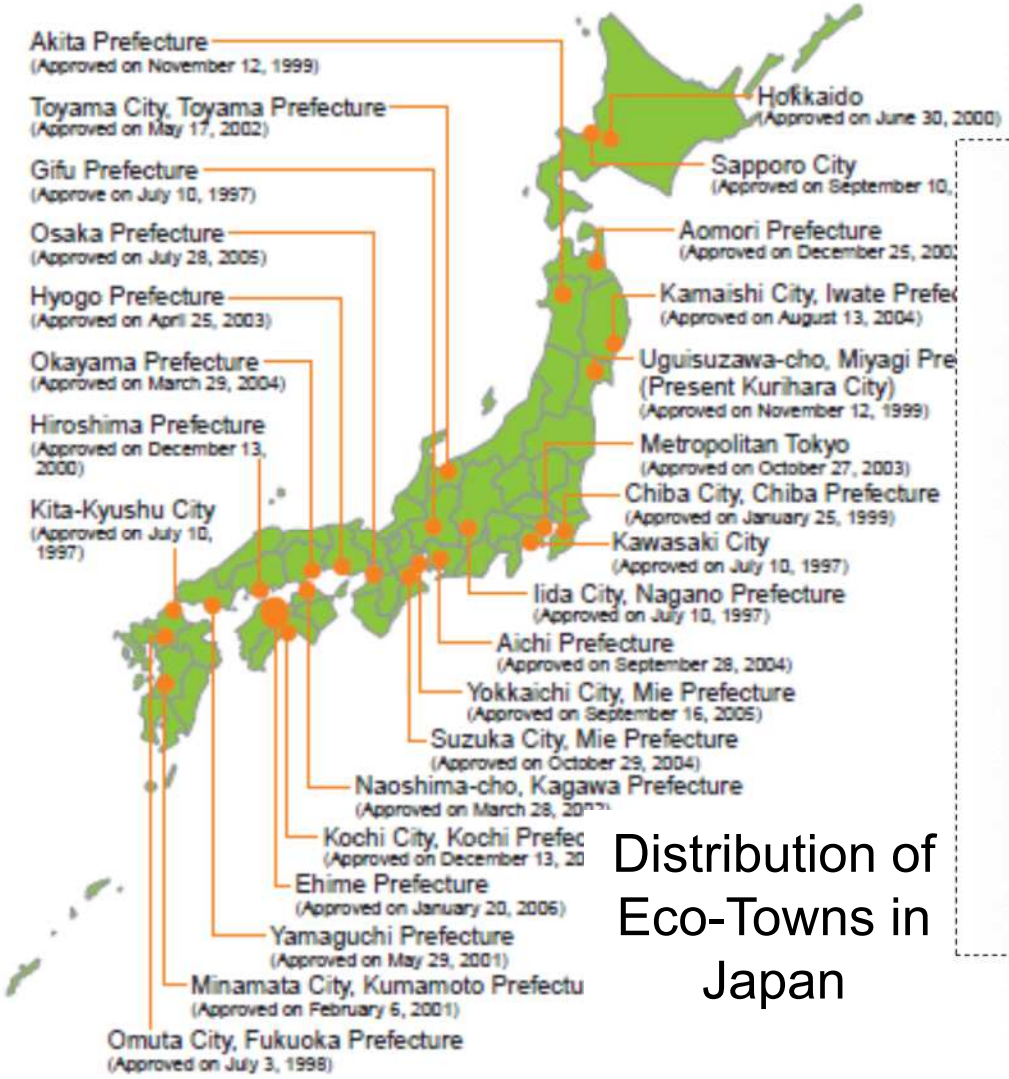


Hashimoto, Fujita, et.al (2010) Resources, Conservation and Recycling, 54(10),

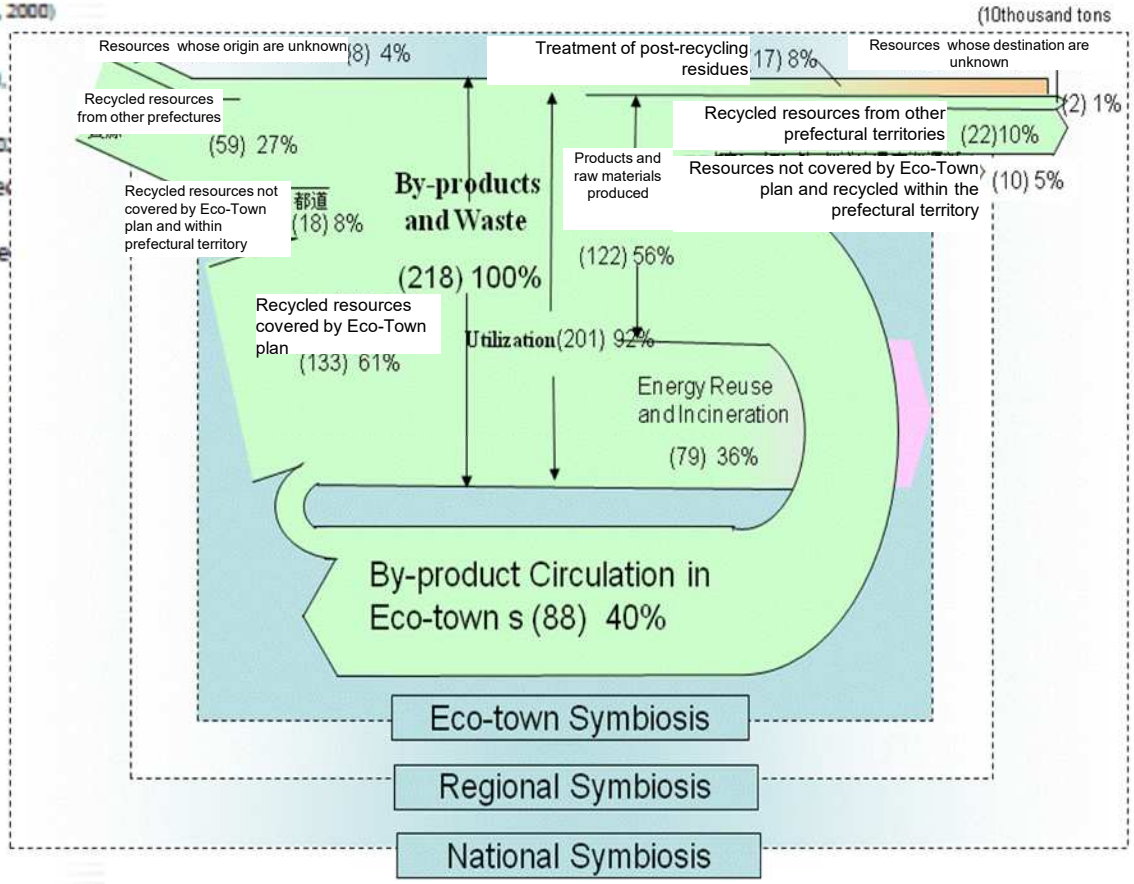
The Eco-Town project serves as a driving force for urban-industrial symbiosis in Japan

The Ministry of Economy, Trade and Industry and the Ministry of the Environment approved 26 Eco-Town areas and developed 62 facilities in ten years between 1997 and 2006

2008 Working Group for Further Enhancing Eco-Towns examined 26 Eco-Town municipalities and 170 recycling facilities



Distribution of Eco-Towns in Japan



Urban-Industrial Symbiotic Cities built in Japan

URBAN REDEVELOPMENT TYPE EIP

Kitakyushu

Recycle goods retail & sale*

Ecological consulting company*

Sustainable technology research company*

Ecological equipment manufacturing

Environmental Information Business Support CCR

EIP Center; Demonstration building*

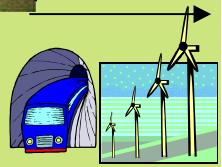
Environmental data bank

Collaborative marketing purchase

·Waste collection and recycling

-Eco-material, Recycled Material

-Design for environment



Clean Energy Supply System

Energy Storage System*

Environmental communication*

Environmental education*

Green Institute (Minneapolis) Cape Charles Sustainable Technology Park (Virginia) Rural Area

Farm

CITY-FARM COLLABORATION TYPE EIP

Hokkaido

Compost

Fuel Cell

Methane Fermentation

Residential Districts

Urban Area

Akita, Osaka

Plastic recycle center*

Organic waste Methane fermentation Composting

Collaboration reverse logistics District heat supply

Building material recycle center*

INDUSTRIAL SYMBIOSIS TYPE EIP

Fertilizer

Cement factory

Chemical factory

Heat

Fly ash

Heat

Power plant*

Heat

Oil

Petro chemical factory

Industrial symbiosis type

Kawasaki, Minamata

Brownfield Neighborhood

Industrial complex

PRODUCT REMANUFACTURING TYPE EIP

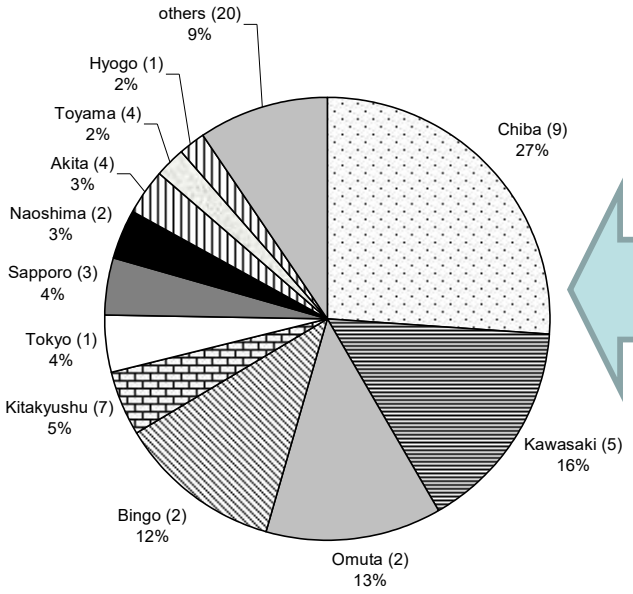
Chen and Fujita et. al., Euro. J. of Operation Research, 2013

Water Front

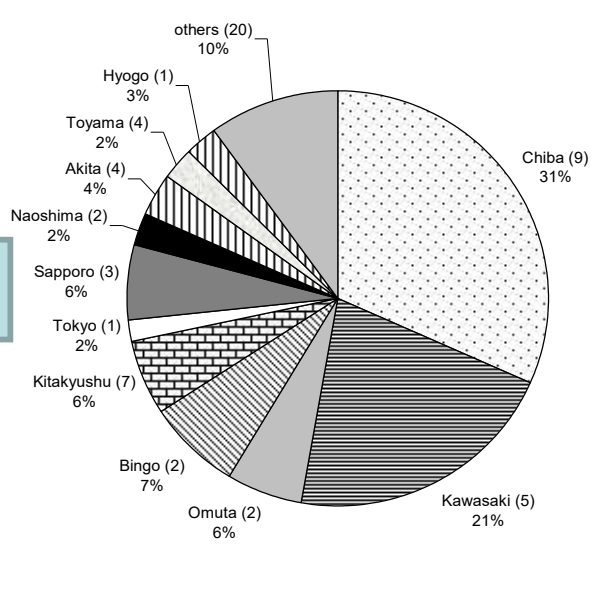
Eco-town Areas as demonstration projects of circular technologies; Berkel and Fujita et. al (2009)

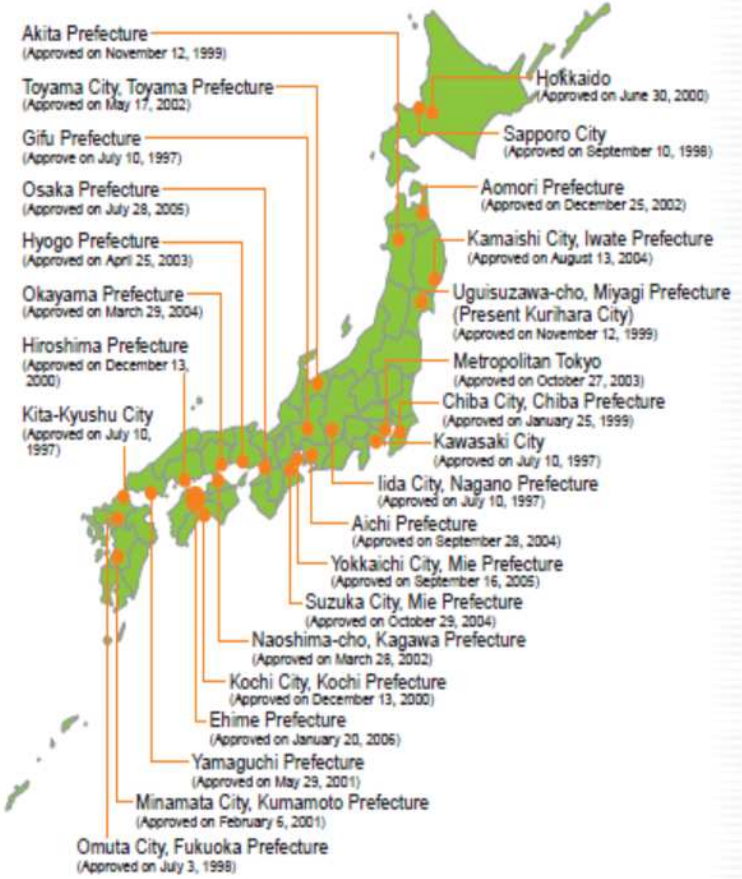
The Ministry of Economy, Trade and Industry and the Ministry of Environment approved Eco-Town Plans for 26 areas as of the end of January 2006, and they provided financial support to 62 facilities located within the appropriate areas.

Distribution of Total Investment
60 projects in 24 Eco-Towns
165 billion JPY or **1.6 bil. US$**



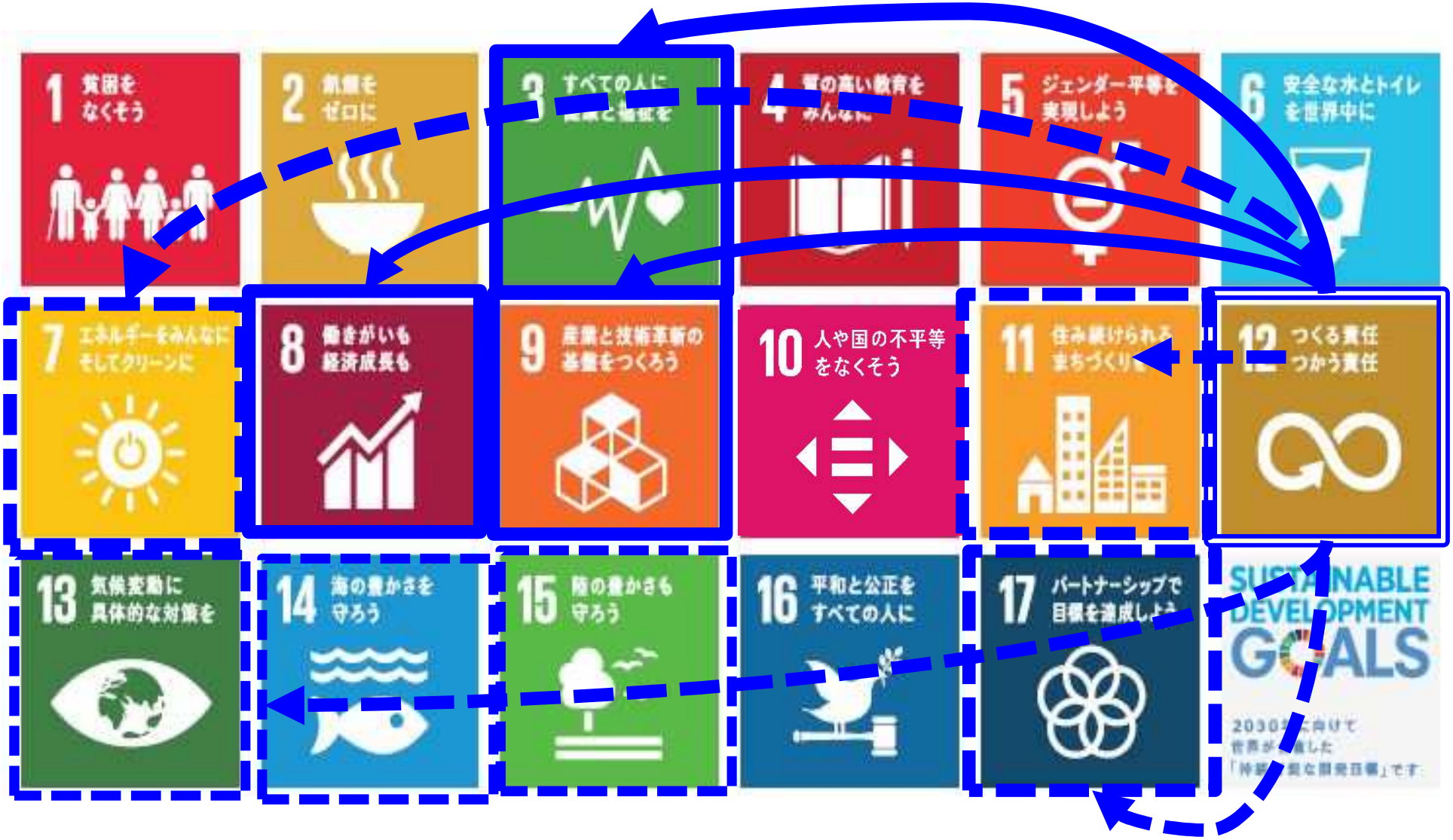
Distribution of Total Investment
Subsidy projects in 24 Eco-Towns
60 billion JPY or **600mil. US$**





Resource recycling enables SDGs-oriented future cities

- A system for locally circulating resources helps create a value-adding, high-efficiency, and competitive circular economic zone.
- The system integrates resource recycling, energy circulation, and nature conservation areas of the natural environment.



Transition from Urban-Industrial Symbiosis to Green Innovation

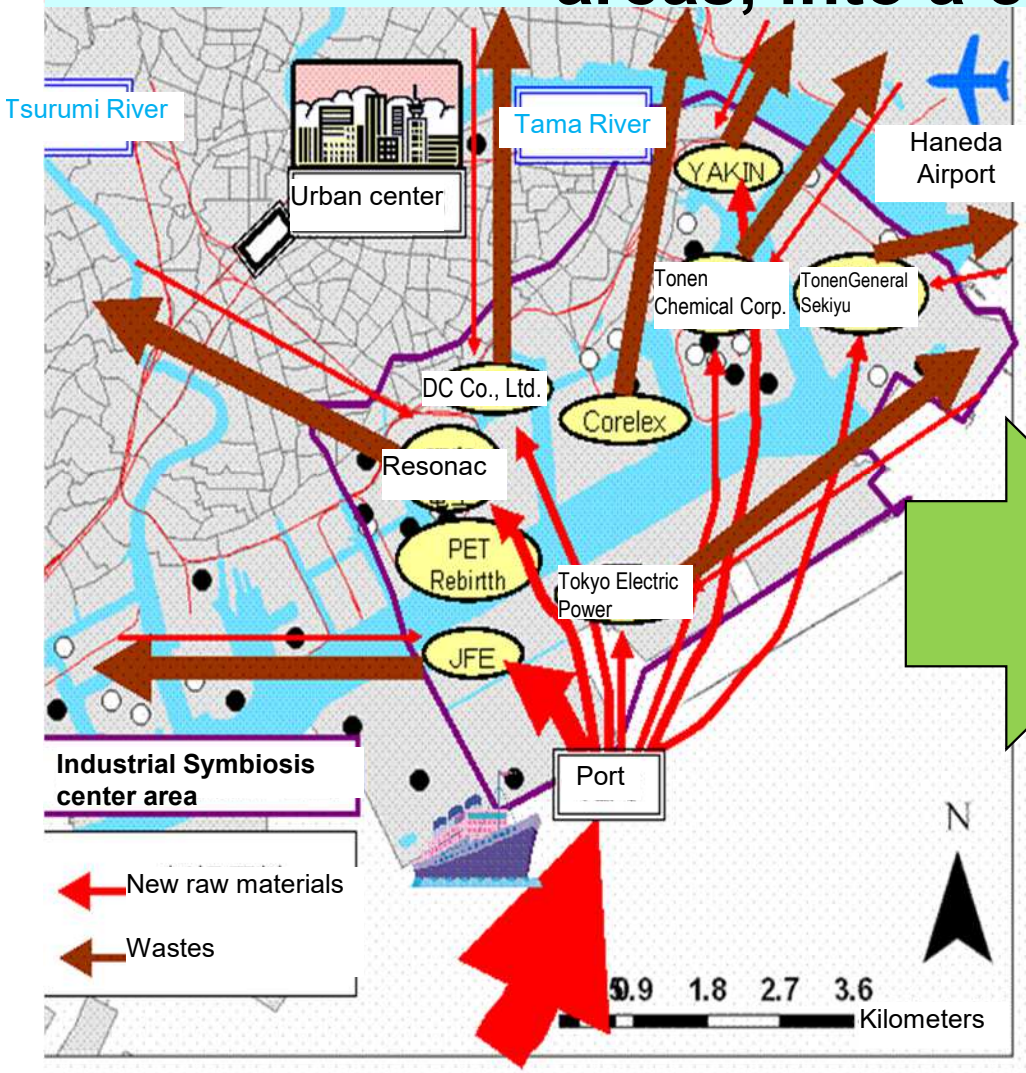
Step 1 Create a center for supplying decarbonized resources to cities and industries

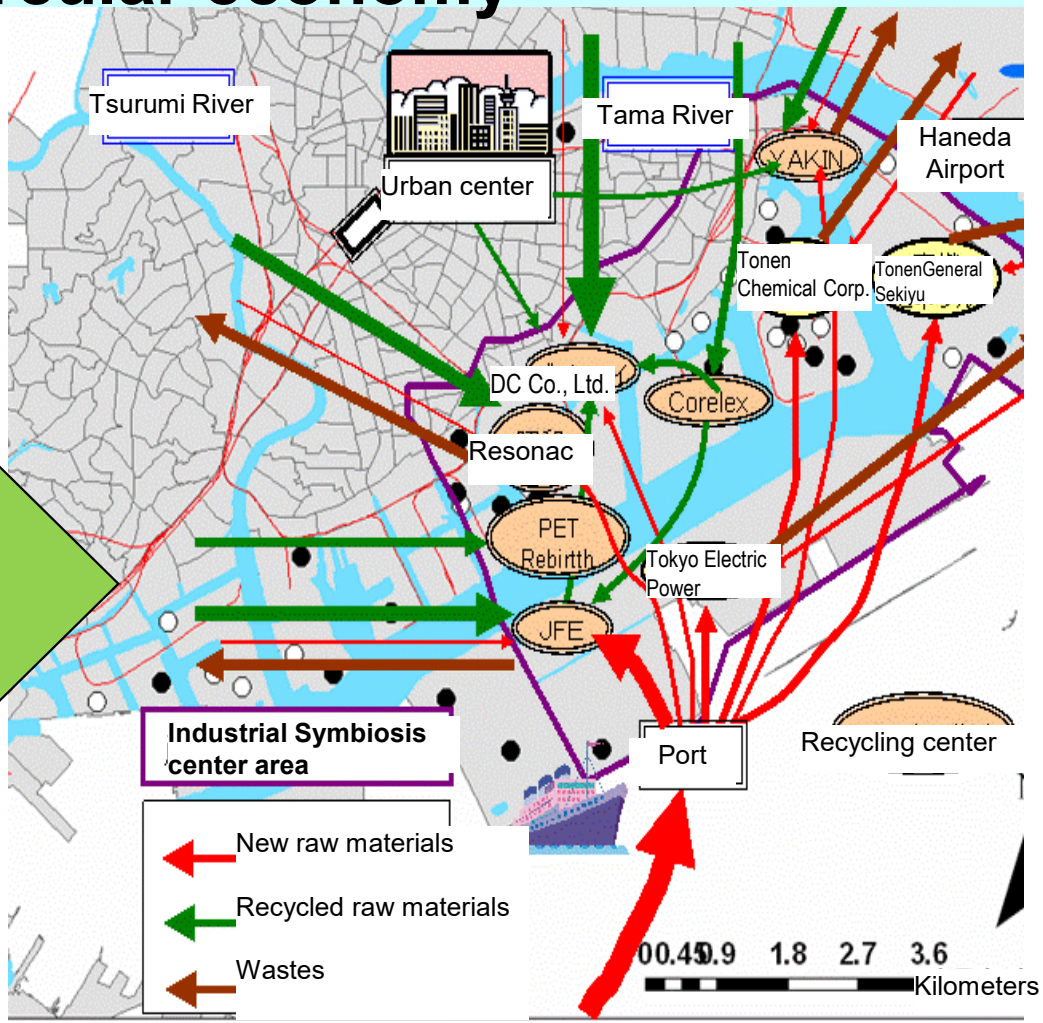
Add energy circulation loops to resource circulation loops to double zero emissions

Transform industrial symbiosis centers into regional revitalization centers

Step 2 Leverage the circular symbiosis system to create a hub for a global decarbonized regional network

Transform industrial activities, the core function of urban areas, into a circular economy





Non-circular flow of materials

- Industrial waste: Overstretched capacity of final disposal sites and illegal dumping
- Manufacturing industry: Dependence on natural resources from overseas
- A circular economy is not viable

Material flow in a carbon-neutral, circular economy

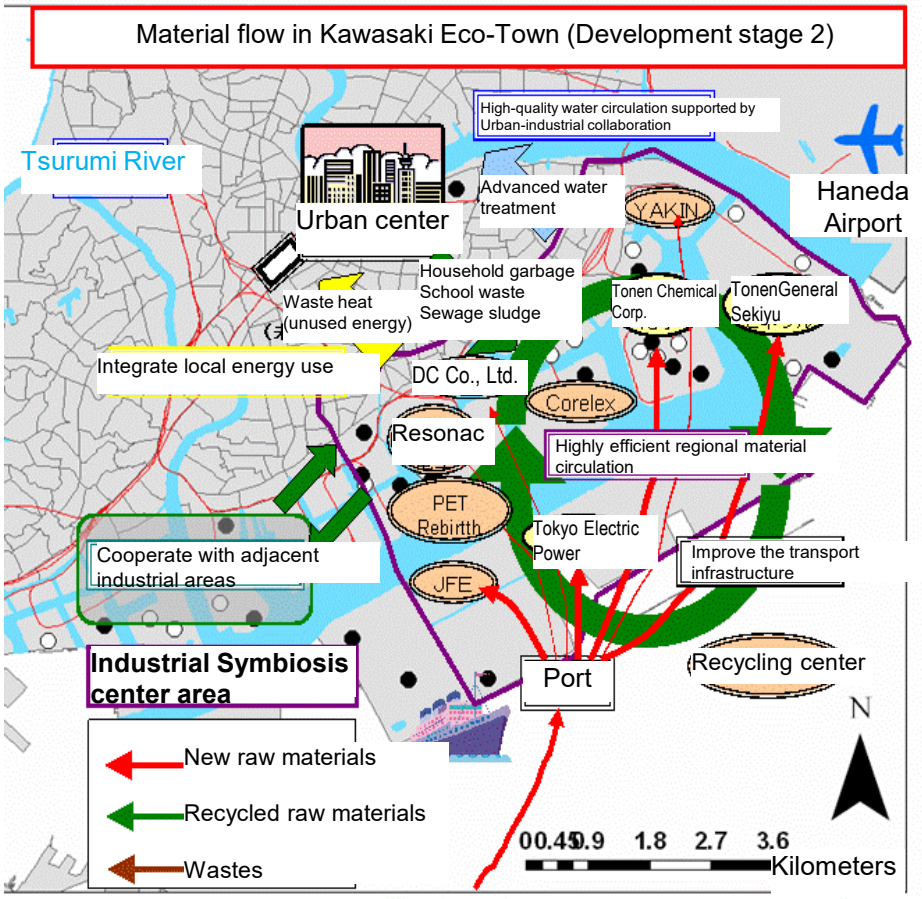
- Recycle industrial waste extensively
- Manufacturing industry: Replace resources with recycled materials
- Demonstrate a carbon-neutral, circular economy

Decarbonization of the existing Kombinat through linkage between urban areas and industrial centers

Create a pioneering integrated area for carbon-neutral urban-industrial symbiosis where material circulation and energy consumption are coordinated among the Eco-Town and urban areas (residences, businesses, and commercial facilities) and the local primary sector (agriculture, forestry, and fisheries facilities).

[An example of model project]
A social experiment model project for a local circular economy that locally circulates resources and carbon within a limited area. It involves locally collecting and recycling general, industrial, and agricultural waste in circulation-friendly conditions in a combined manner.

[An example of policy]
Industrial and environmental policies are integrated with urban policies involving urban development, roads, sewage systems, and infrastructure construction and port policies to develop a circular economy infrastructure in urban areas.

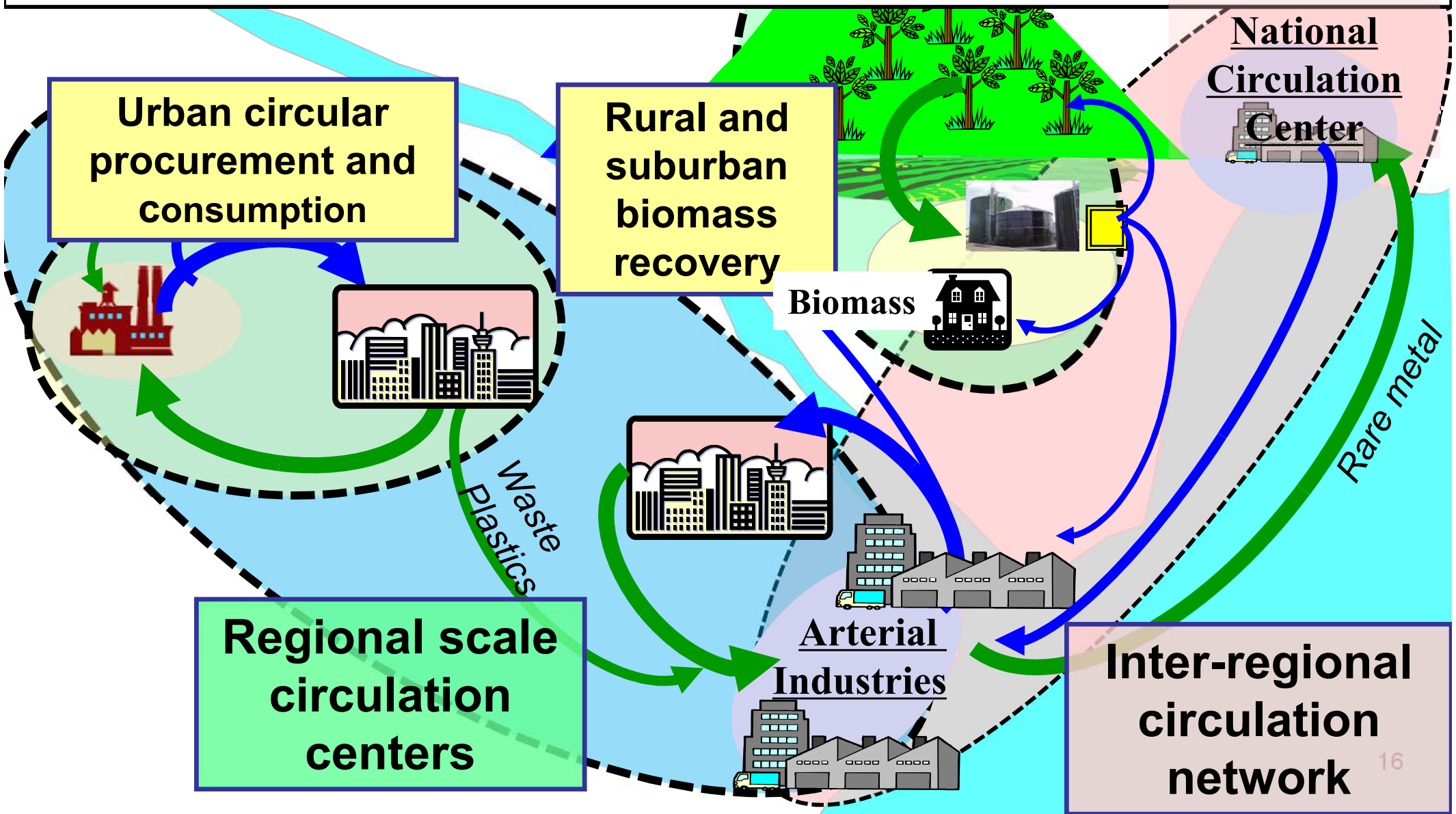


Carbon-Free Industrial Symbiosis Zone (proposed)

The vision has the objective to develop an integrated hub zone or area where the recycling and industrial infrastructures are mobilized to enhance resource efficiency and decarbonization.

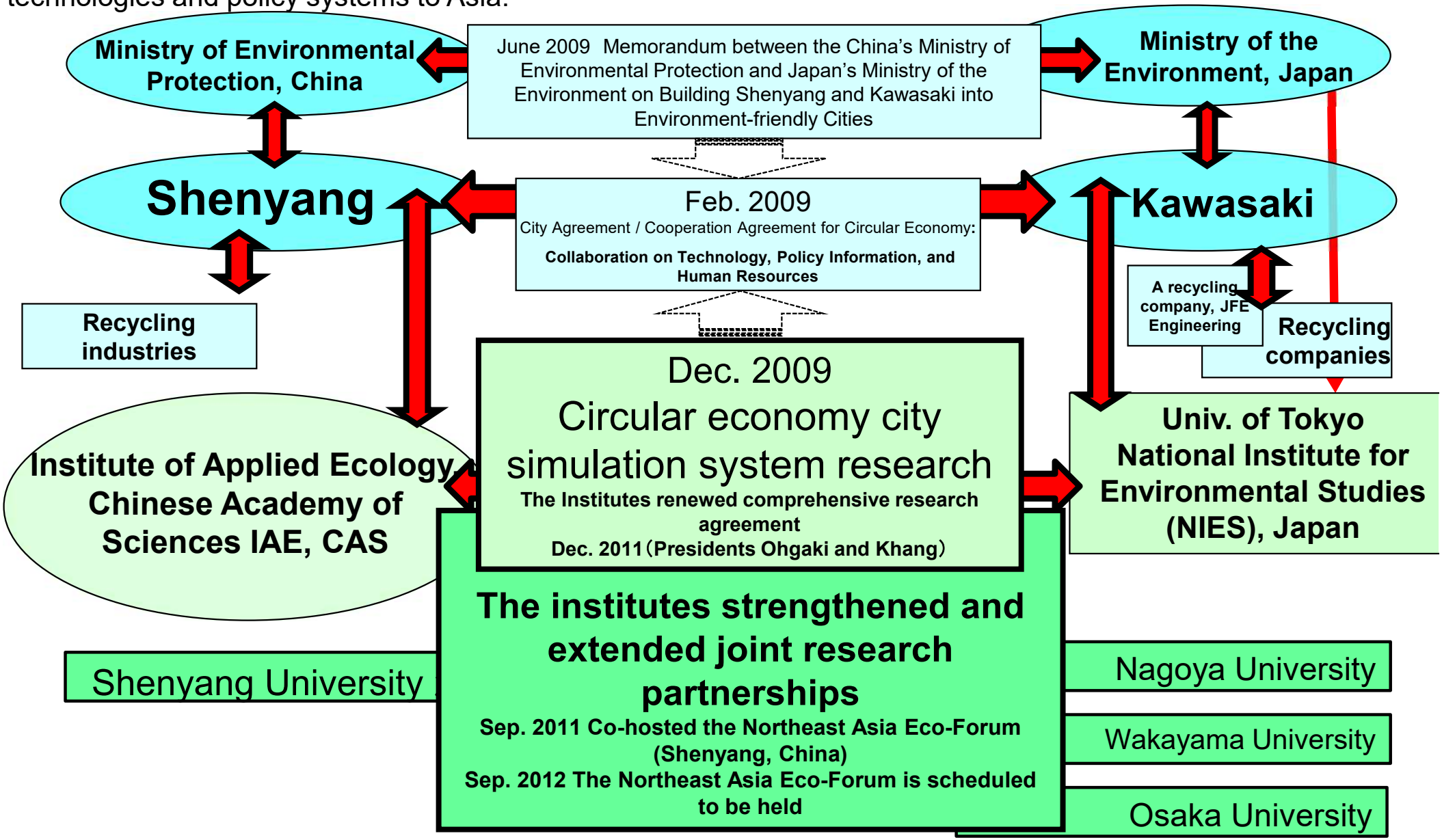
Strategies to Promote Eco-town Development

-Establishment of multi scale circulation system considering appropriate social waste transportation cost and environmental value of recycle products
-Social multi-stakeholder collaboration scheme for such separation, collection and green purchase
-Development of regional circulation center for multi-layered circulation areas

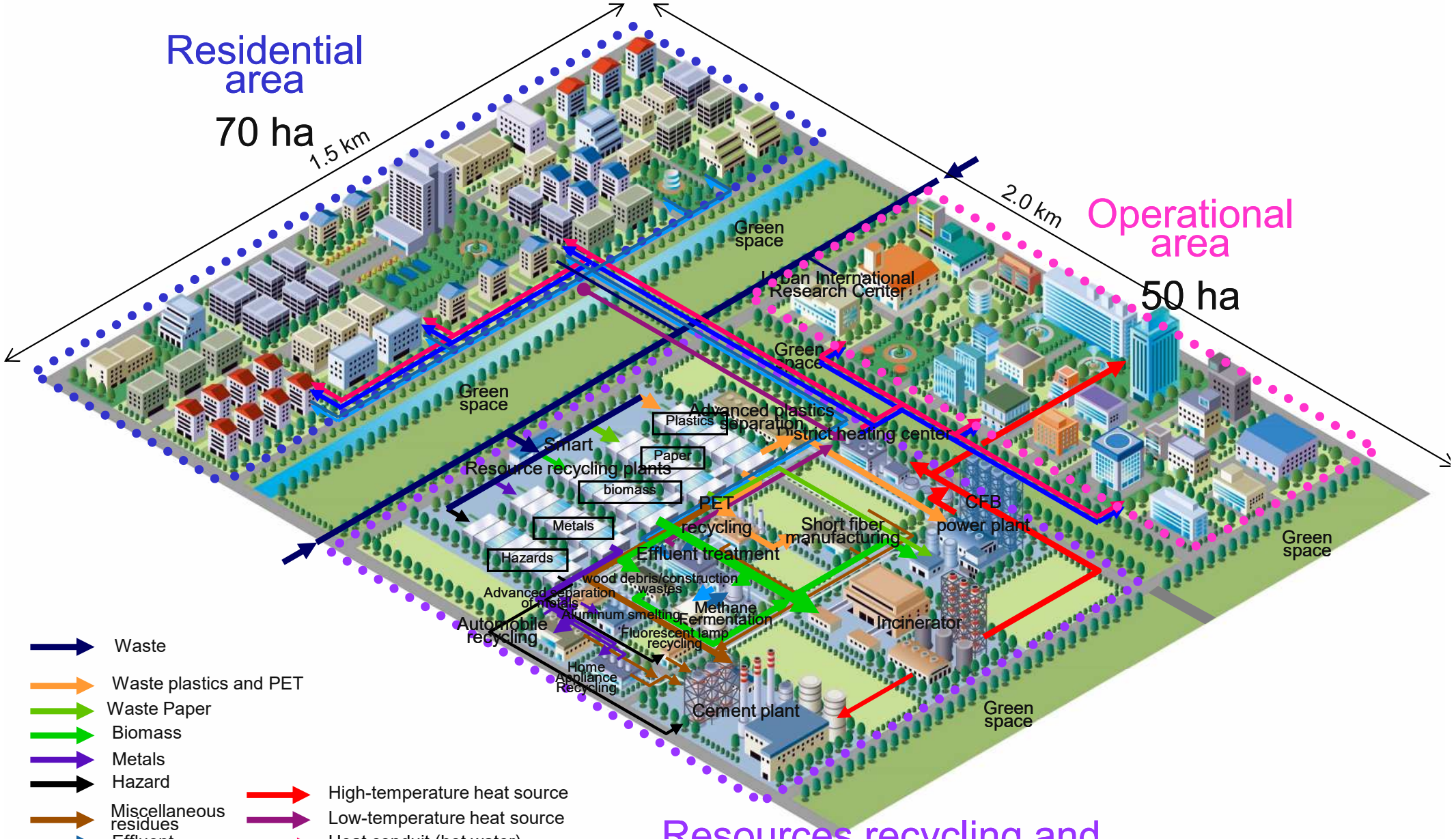


Research cooperation with Shenyang, a Chinese environmentally friendly city

Under the framework of the Promotion of Environmental Business Cooperation between Kawasaki and Shenyang by the Japanese and Chinese Ministries of the Environment, which serves as a pioneering example of a major venous business project, a research collaboration system was established to deploy Japanese-developed technologies and policy systems to Asia.



Proposed plan for a circular, low-carbon industrial ecosystem park (Kawasaki experiences transposed to other Asian cities)



From initiatives for urban-industrial symbiosis to the mainstream in an international green economy

1990− Theories and studies on a circular economy and industrial symbiosis achieve major progress.

1995− Countries set out concepts and plans for industrial symbiosis and eco-industrial development.

1997− Kawasaki City launched the Eco-Town project, one of the earliest recycling center initiatives in the world.

2005− Eco-industrial development was envisaged in China and South Korea.

Japanese Eco-Town projects (Kitakyushu and Kawasaki) served as leading cases.

2010− Eco-industrial development was deployed in Europe.

UK National Industrial Symbiosis Programme (NISP)

Eco-Town advancement projects (research and demonstration projects)

2015− G7 Summit addressed Industrial Symbiosis.

Expectations for green innovation in the 21st century, driven by urban-industrial symbiosis in Kawasaki

From the stronghold of a 20th-century industrial society to a leading model of green innovation supported by collaboration with the urban area.

- Supply of industrial products through the massive consumption of fossil fuels
- Global spread of industrial functions and visible signs indicating that the Earth's capacity to bear environmental burdens has been exhausted
- The impact of industrial bases reliant on imported resources and industrial pollution

⇓

- Reduce environmental impact through environmental measures and development of environmental monitoring technologies and enhance urban-industrial symbiosis.
- Shift industrial functions towards use of recycled resources and create regional circular economy zones.