GEOSPATIAL SIMULATION FOR WIDE-AREA WASTE TRANSPORTATION TO DRIVE LCCN IMPLEMENTATION

~MSW for Life-Cycle Carbon Neutral ~

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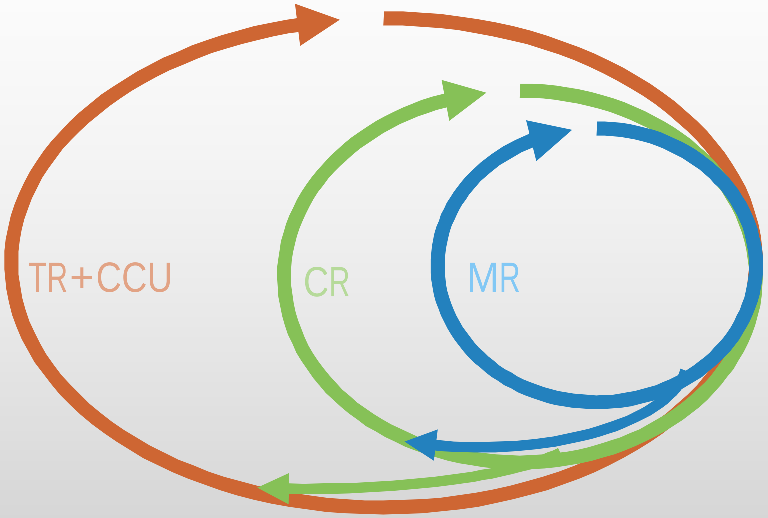
1. INTRODUCTION

Our Concerns and Scope

- Optimize relationally, not locally
  We are committed to recycling with great effort.
  Material and chemical recycling still leave some waste.
  So, we need an inclusive approach to manage carbon.

- Rethinking our stance
  We shouldn't burn waste just because we can't recycle it.
  We should burn it only when heat recovery is the best option.

- Implementation sequence
  For now, we should focus on consolidating incinerator.
  and improving heat efficiency through collaboration with Manufactures (Waste to Steam).
  By doing this, it will be easier to partly shift to CCU in the next step.



LCCN* concept by NIES, M. Fujii
*Life Cycle Carbon Neutral

Scale Gap in “WtE” plant Capacity

Incineration facilities in JP

app.1,000 sites

—WtE app.400 sites

—Non-WtE app.600 sites

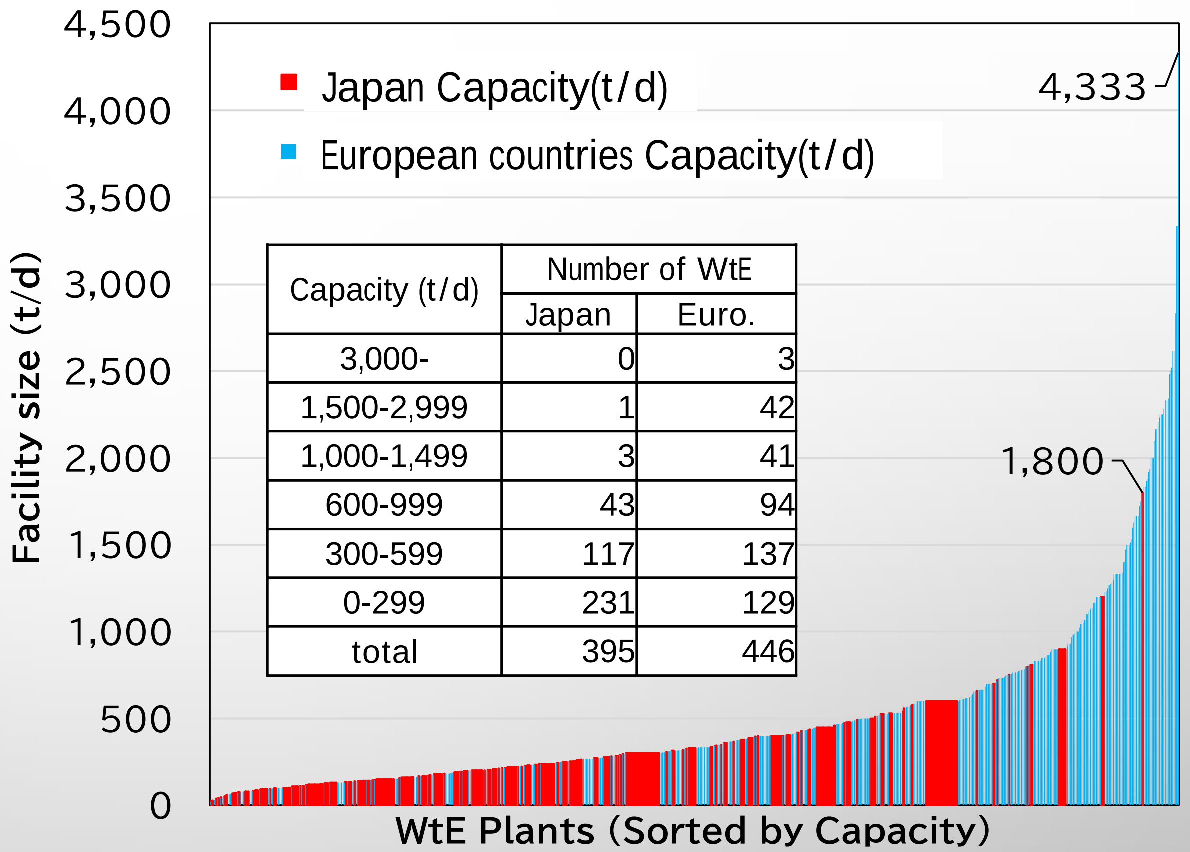
Comparison of WtE plant Capacity

—Japan 302 t/d

—Euro 665 t/d

Japan: distributed and small-scale WtE

Euro: centralized and bigger than JP

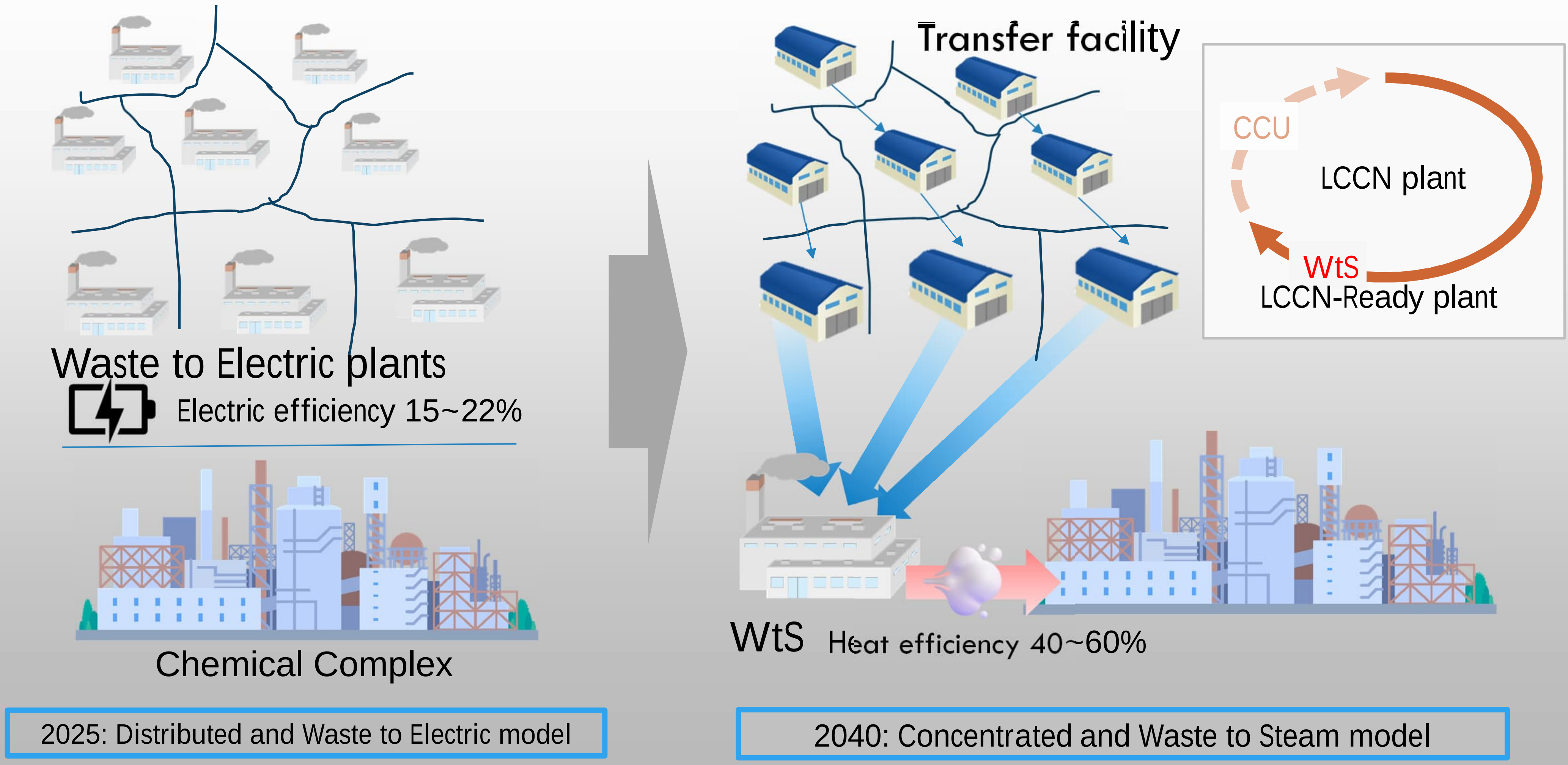


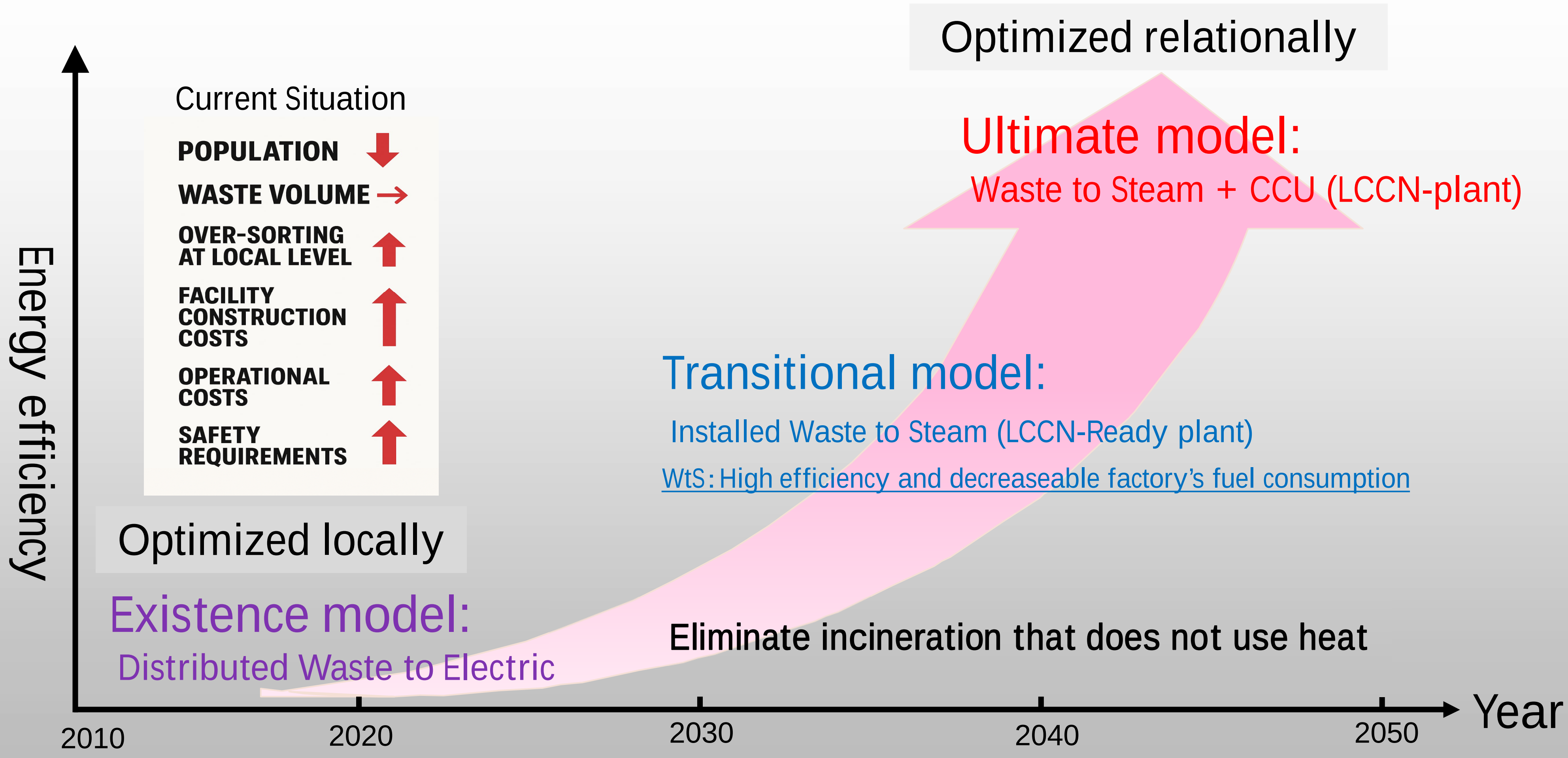
Capacity (t/d)	Number of WtE	
	Japan	Euro.
3,000-	0	3
1,500-2,999	1	42
1,000-1,499	3	41
600-999	43	94
300-599	117	137
0-299	231	129
total	395	446

Fig. Comparison of Waste-to-Energy (WtE) Plant Capacities between Europe and Japan(2021)

- ✓ *Japanese incineration facilities (in red) are based on data from the Ministry of the Environment's FY2021 Municipal Solid Waste Survey, including only operational plants with power generation capabilities.*
- ✓ *European WtE facilities (in blue) are compiled from CEWEP maps and national databases where available, with data standardized and verified across countries.*

TRANSITION SCENARIO FOR ACHIEVING LCCN





Model for Transition toward System-wide Optimization

2.PURPOSE

WE ESTIMATE THE COST AND CO_2 IMPACT OF:

- Consolidating waste treatment facilities
- Promoting wide-area waste transport

THEN, WE PROPOSE:

- A redesign of the waste infrastructure
- Based on the concept of *relational optimization*

3.METHOD

Environmental and Economic Assessment of WtS Transition

(1) Setting of Transportation Method and Packaging through site visit.

(2) Estimated the number of incinerator and waste volume.

(3) Estimation of Transportation Costs

(1)Setting of Packaging Forms

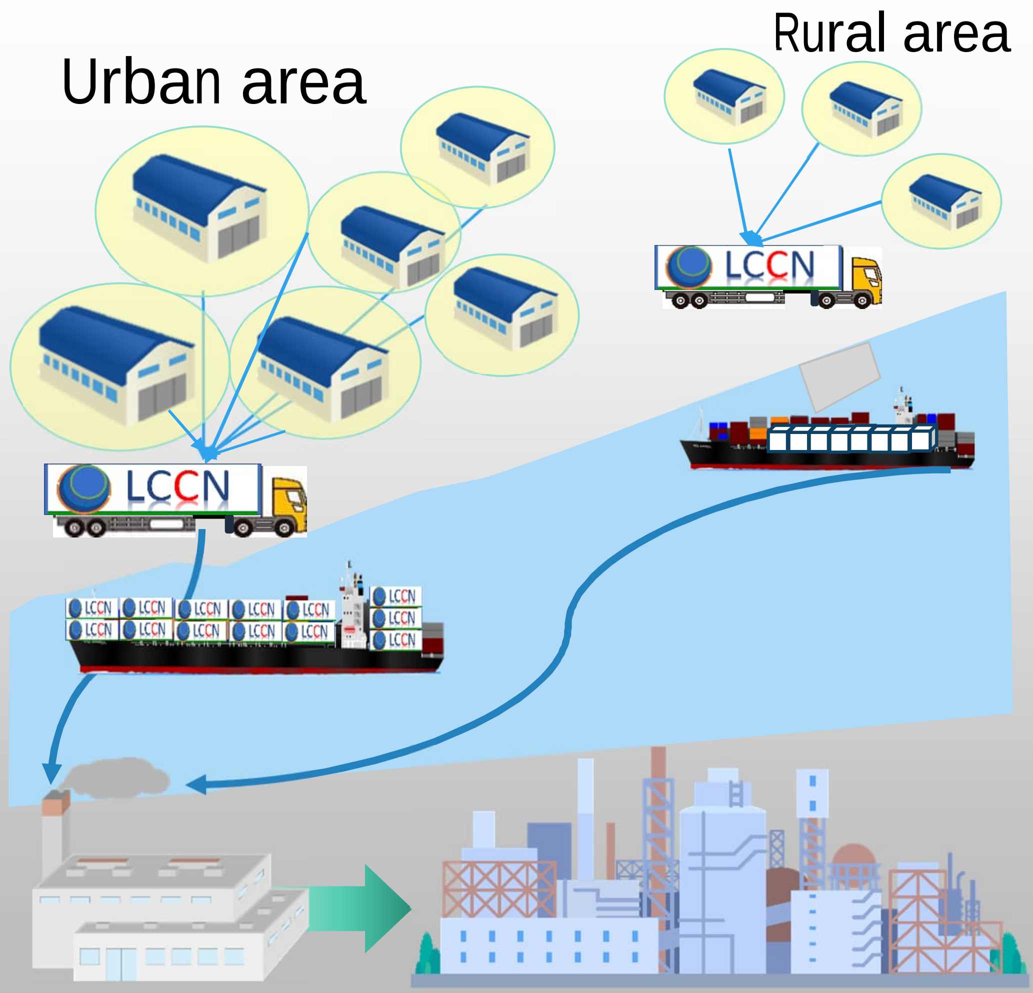


Fig. Packaging and Transport Forms

Bale Storage - Land and Sea Transportation

(2) Estimated the number of incinerator and waste volume.

◆ Facility and Waste volume Scenario Setup

- Created a Database of MSW Incineration Facilities
- Projected Future Waste Generation Volumes
- Identified Facility Decommissioning Timelines Based on Projection
- Selected Half of the Existing Facilities as Future Consolidation Targets

◆ Demand Center and Routing Design

- Defined 9 Demand Centers
  (Maximum processing capacity per site: 7,000 tons/day)
- Assigned Transport Destinations for Each Service Area
- Identified Optimal Transport Routes

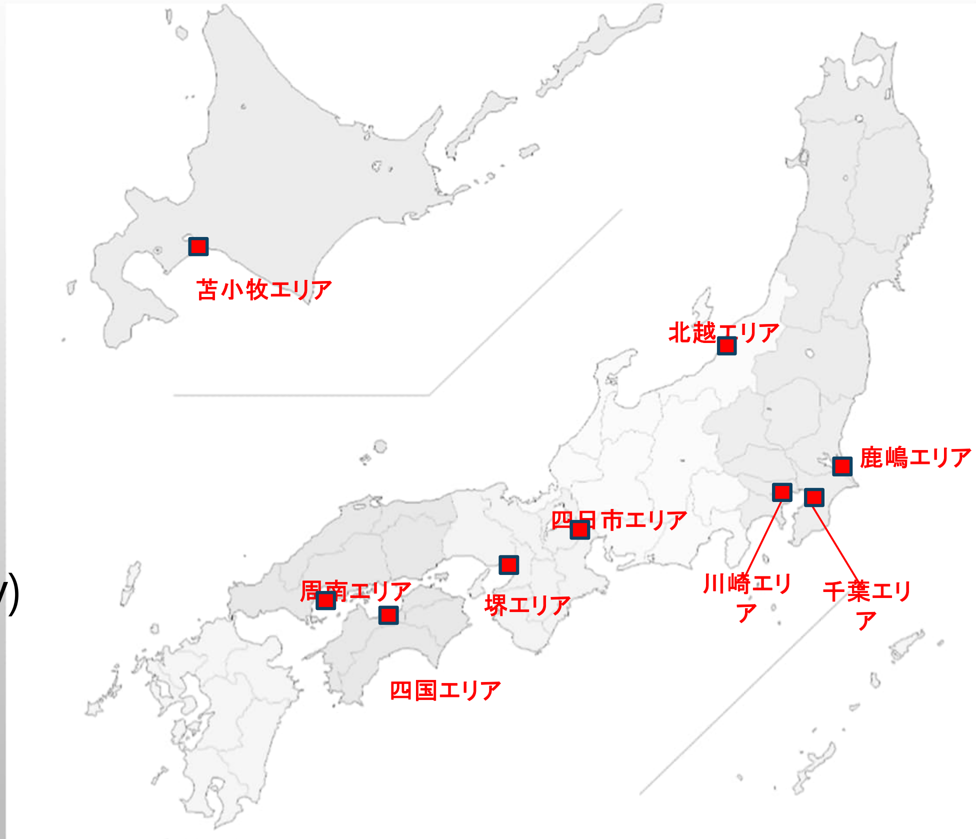


Fig. Heat demand area settings

(3) Estimation of Transportation Costs

- Calculated Transport Distances Between Points
- Estimated Transport Costs and fuel consumption

  ・Maritime: Based on operational scenario planning

  ・Land: Using NX One-Stop Navi (logistics estimation tool)

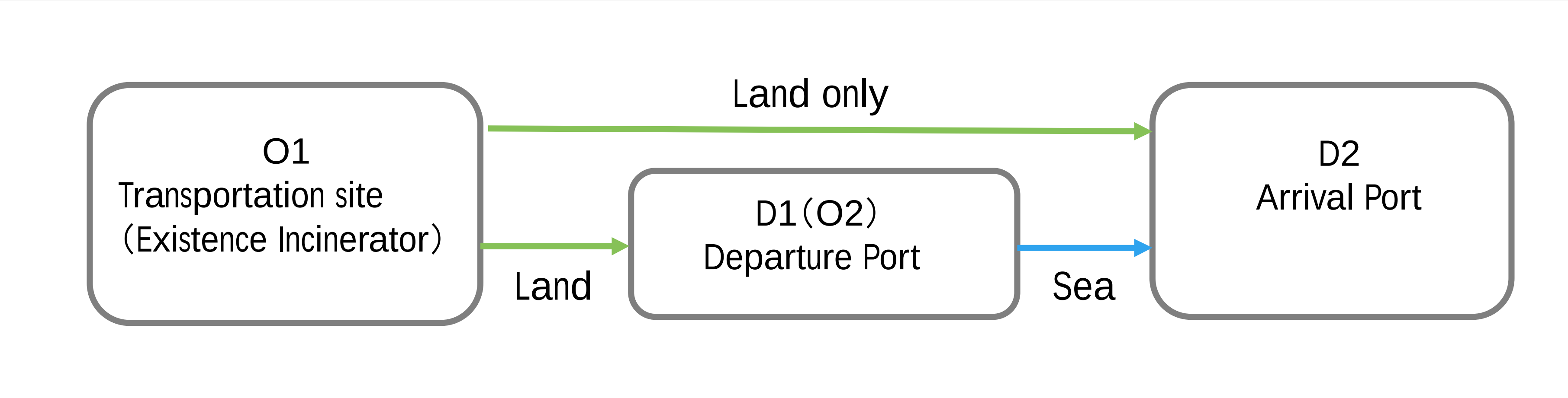


Fig. Comparison of two Transportation Options (OD)

4. RESULTS AND DISCUSSION

The number of incinerators will naturally decrease as they reach the end of their life.

The number of municipal waste incinerator by size and their lifespans (simulation)

Capacity ton/day		Number of facility			Treated Volume		
		2021	2040	2050	2021	2040	2050
0~100	Existing ●	391	106	67	10,004	2,809	1,743
~300	Existing ●	374	106	67	36,671	11,362	6,443
~600	Existing ●	119	41	25	32,265	10,551	5,992
~1000	Existing ●	15	3	3	6,736	1,202	1,091
~2000	Existing ●	4	0	0	2,961	0	0
2000~	New non LCCN ●	0	10	11	0	22,460	26,158
2000~	New Waste to Steam ▲	0	8	8	0	36,870	36,645
Total		903	274	181	98,014	85,255	78,072
Total t/year					33,194,724	29,912,108	27,385,409

Estimated emission and costs

- By 2040, operational improvements could reduce CO_2 emissions by approx. 5.89 million tons/year and save operation cost approx. ¥1.5 trillion/year. (15B DUS/year)
- In terms of facility construction, cumulative savings by 2050 could reach approx. ¥4.4 trillion.

Operation cost					
Type of facilities		CO2 Emission (k t-CO_2/year)		Business potential (Billion yen/year)	
		2040	2050	2040	2050
Conc. WtS	1) Fuel fee	-6930	-689	-152.8	-151.9
	2) Operation fee	-	-	-138.8	-138.0
Methane gas recovery		-	-	0.18	0.19
Transfer facility	1) Packing	933	928	63.1	65.4
	2) Transport	112	107	77.4	75.5
Total		-5,890	-5,850	-151.0	-148.8

Initial cost until 2050			
Type of facilities	Business potential (Trillion yen)		
	Distr. WtE	Conc. WtS	WtS-WtE
WtS	4.77	0.00	-4.77
Methane gas recovery	-	0.29	0.29
Transfer facility	-	0.06	0.06
Total	4.77	0.35	-4.41

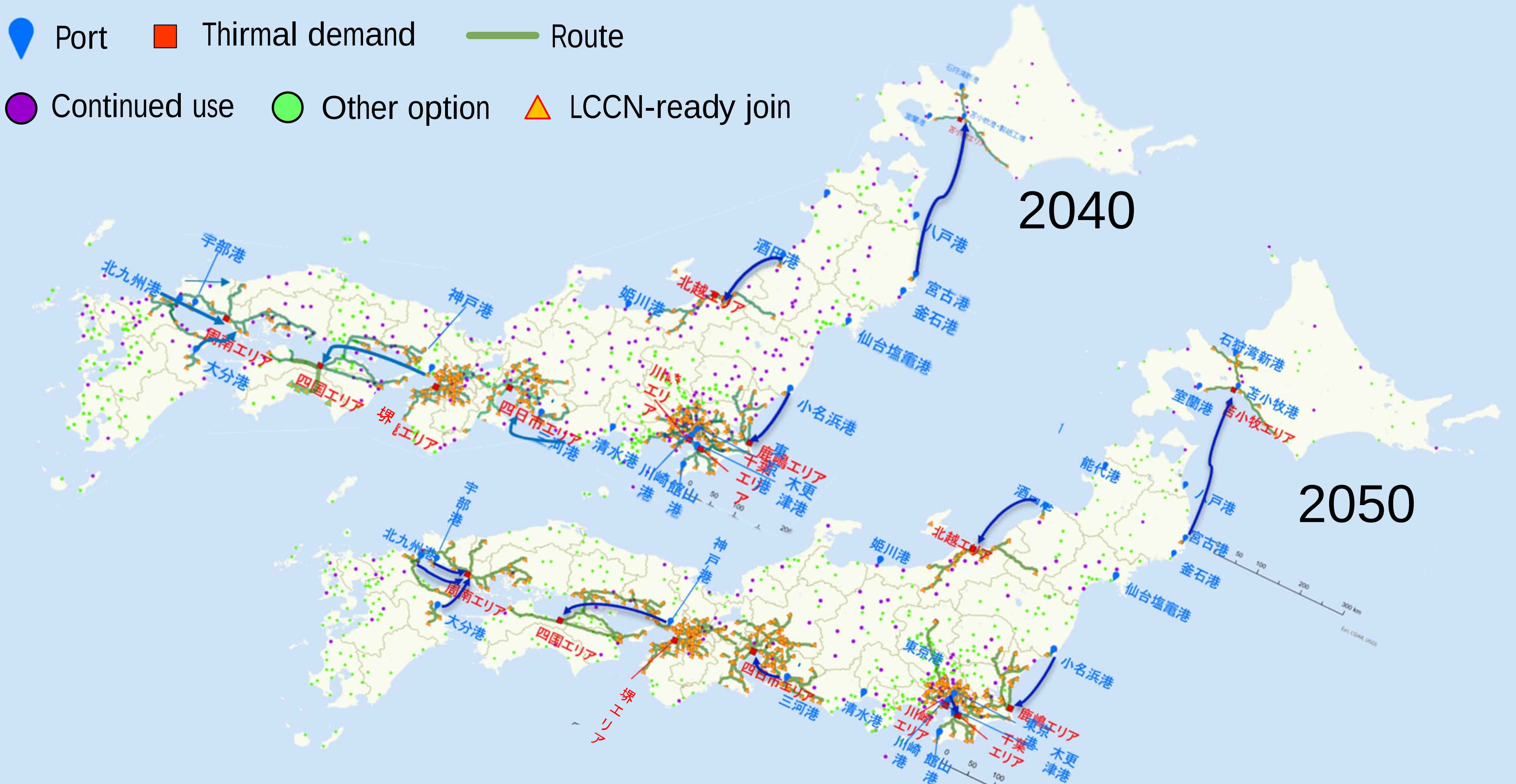


Fig. Waste Transport Route Map Covering 50% of Total Waste Volume

"If we set the main collection points, the transport routes and block areas will naturally take shape.

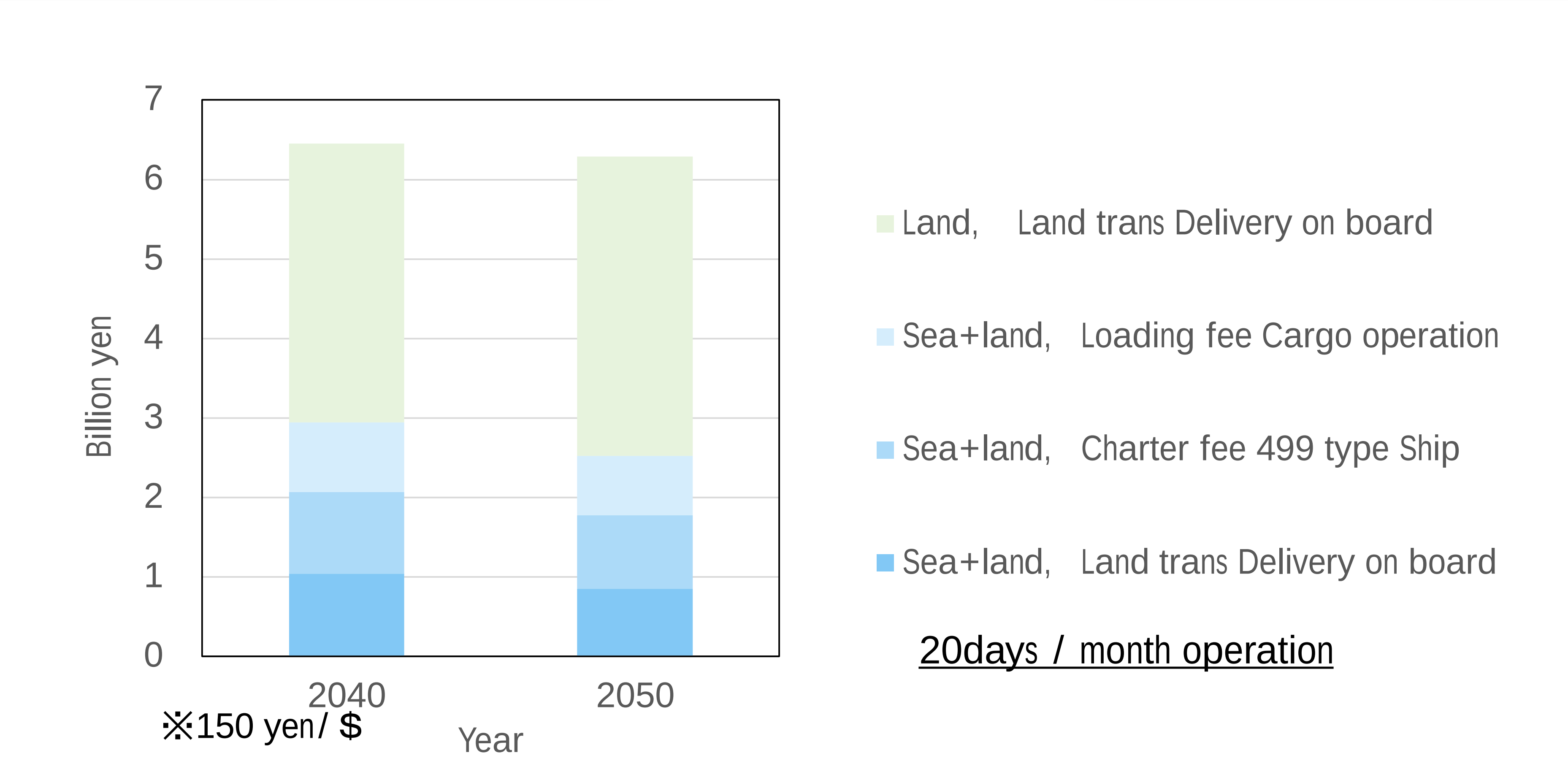
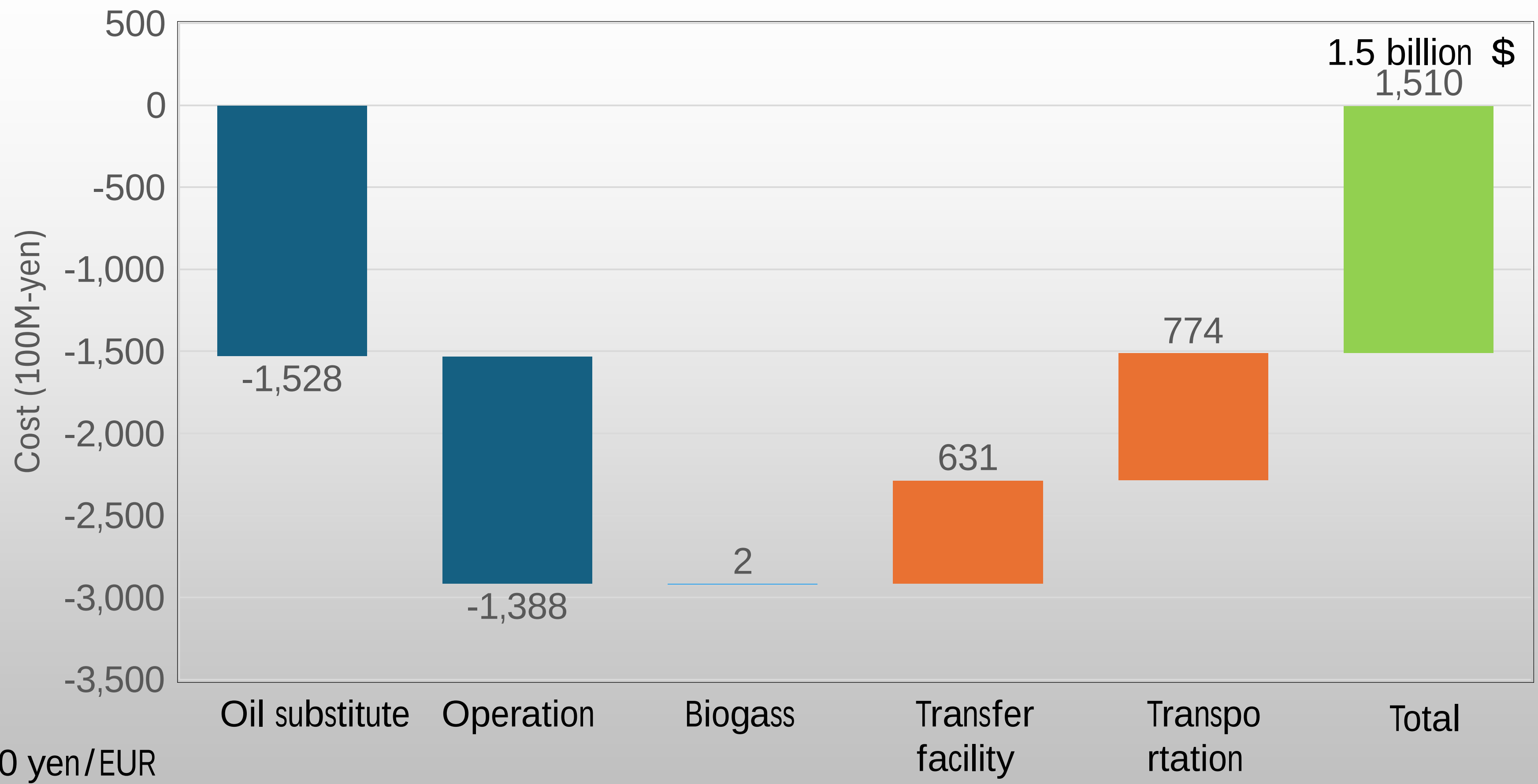


Fig. Waste transportation fee accumulation volume in one month (20days operation)



※170 yen/EUR

※150 yen/USD

Fig. Estimated Operational Costs for WtS (LCCN-Ready Plants) by 2040

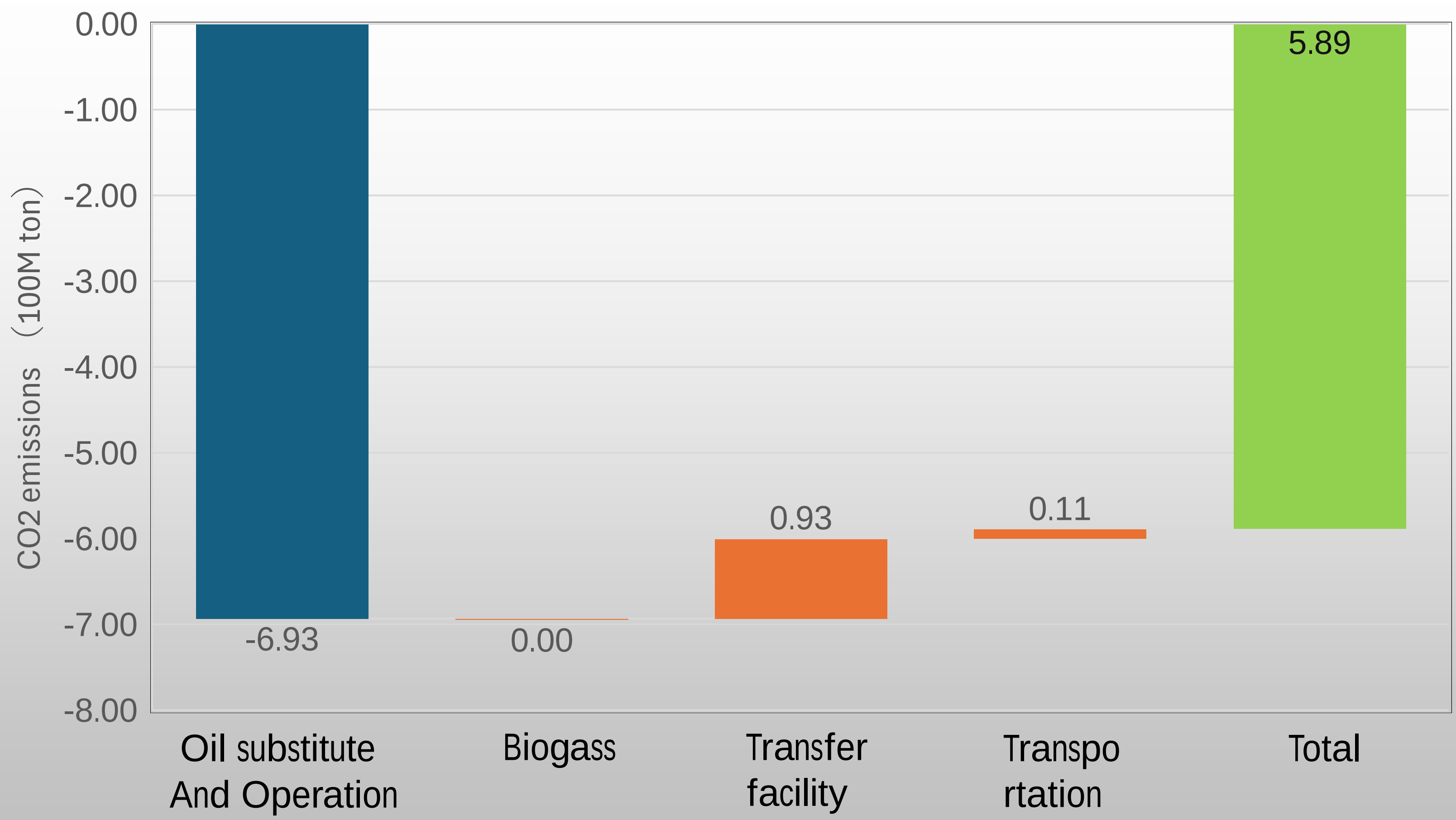


Fig. Estimated CO_2 Emissions Breakdown from WtS (LCCN-Ready Plants) in 2040

Economic and Environmental Benefits of LCCN-Ready Plants

- Cost of CO_2 reduction with LCCN plants saves money—about ¥25,500 per ton (149.79 EUR).
- LCCN-Ready plants are more effective than many other climate actions.
- These plants (Waste-to-Steam + CCU) are not just about technology—they can also drive big changes in policy and infrastructure.

Basic unit (Rebate from Accumulation, average of both years)			
Facility and fee contents		CO2 emission kg-CO2/t	Business potential Yen /t （EUR/t）
WtS in CC	1) Fuel fee	-570	-12,561 (73.4)
	2) Operation fee		-11,411 (67.0)
Methane gas recovery		-	468 (2.75)
Transfer facility	1) Packing fee	76.7	5,295 (31.10)
	2) Transport fee	9.17	6,362 (37.37)

Cost of CO2 reduction	2040	2050	Average
Yen /t-CO2	-25,651	-25,419	-25,500 (149.79)

How to decrease the incinerator for Optimize Relationally?

- Overview

This presentation introduces a large-scale idea: consolidating incineration facilities in industrial areas.
We intentionally set aside local constraints to offer a trigger for rethinking the current system.

- Current Challenges

Even cooperation between neighboring municipalities takes great effort.
Scaling this up for wider coordination faces serious limits.

- What This Scenario Shows

With existing technology and logistics, CO_2 and cost reductions can both be achieved.
But technical feasibility alone won't move society.

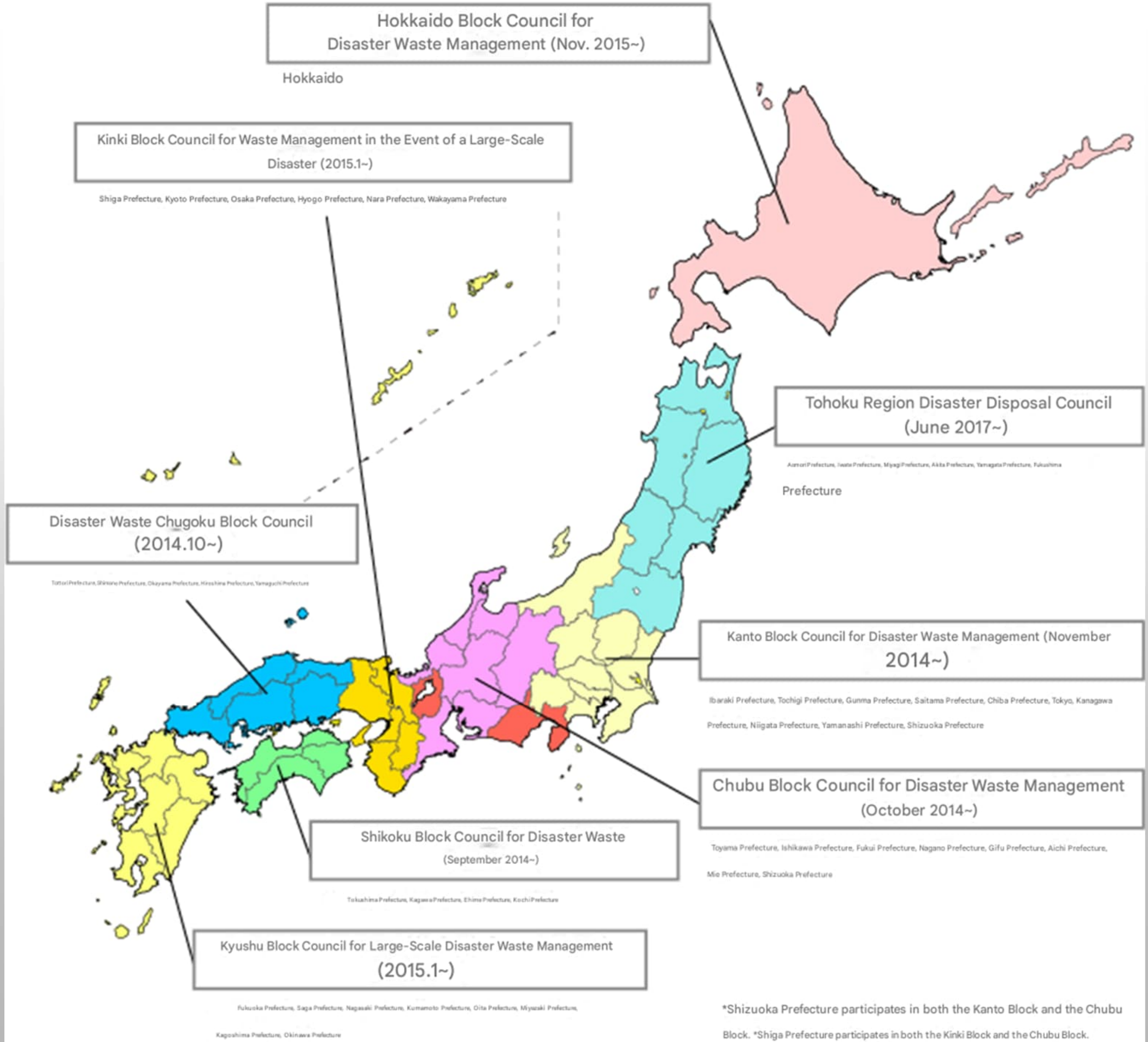
- Why It Matters

By discussing bold scenarios, we may discover new solutions.
Public interest—not just local officials—is essential.

This is
Japan's wide-area disaster waste transport map

“Block-level secretariats already exist.”
Originally for crisis,
It is good idea for using it during normal times as well.

It’s not disruptive
—but collaborative innovation.



6. CHALLENGES AHEAD

- Visualize policy options clearly
- Compare environmental and economic impacts simply
- Link local practices to national discussions
- Put these options on the public agenda

Thank you very much for your attention.

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