

A Study on Saving Energy Costs in Container Terminal

Aug. 23, 2012

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Table of Contents

I

Necessity and Purpose of Study

II

Energy Consumption of Container Terminal

III

Energy Cost Saving Alternative and Effect of Container Terminal

IV

Case Analysis

V

Conclusion

I

Necessity and Purpose of Study

1. Necessity of Study

❑ Continued increase in global oil price puts burden on container terminal industry.

○ Trend in Dubai oil price(\$/BL) : [Jan. 4] \$91.59 → [Mar. 7] \$111.18 → [Mar. 21] \$108.75
 – **439.4 billion won of oil expenses occurred additionally in 2010 compared to 2005.**

※ Oil consumption by emission source : Cargo-handling (114,418kL), Ship (188,863kL),
 Tugboat (59,866kL), External Tractor (126,283kL)

[Comparison of Oil Expenses in Container Terminal Industry]

Year	Diesel Consumption (kL)	Oil Price(L)	Annual Oil Expenses	Remarks
2005	489,430	1,200	587.3 billion	–
2010	641,696	1,600	1.0267 trillion	Spend additionally 439.4 billion
2020	836,920	1,600	1.3391 trillion	Spend additionally 751.8 billion

1. Necessity of Study

❑ Increase in energy cost reduces rate of operating profits of domestic container terminal companies significantly.

○ As the global oil price exceeded \$100 as of June 2011, increased energy cost weakens competitiveness

– Energy cost 6% in 2005 → 8% in 2010

※ Dongbu Shingamman port used 0.7 million liters of diesel oil(900 million) and 3.7 million KWh of electricity(300 million) in 2010.

[Cost Structure of Container Terminal Industry]

Items	Ratio	Items	Ratio
Labor Cost	29%	Wharfage	1%
Welfare Cost	5%	Other Direct Cost	10%
Energy Cost	6%	Depreciation Cost	6%
Equipment Maintenance Cost	4%	Facility Rental Cost	35%
Repair and Maintenance	1%	Sales and Administration	3%
Insurance on Contents	1%	Total Cost	100%

1. Necessity of Study

❑ Need to establish green port by reducing energy consumption.

- Efforts to reduce greenhouse gas emissions as Kyoto Protocol took effect(Feb. 2005)
 - Korea needs to come up with measures to greenhouse gas emissions as **the 10th largest energy consumer and 7th largest greenhouse gas emitter** in the world.
 - ※ Korea is grouped into non-Annex 1 but expected to be Annex 1 country under the 2nd Protocol(2013~2017).
- Globally **low carbon, eco-friendly green ports are** established.
 - Major advanced ports established low carbon, ecofriendly port system (US Long Beach Port, Rotterdam in Netherlands, and green logistics policy in Japan, etc.)
- Pursue **policies to establish Green Port under the framework of low carbon green growth.**
 - Establish the goal to transition into green port which is low carbon and high energy efficient and come up with policies to implement low carbon, green growth.

1. Necessity of Study

❑ Concept of GREEN Port

- Gas Reducing Energy Efficiency & Nature-friendly Port
- Low carbon green growth port which is to increase resource and energy efficiency of port development and operation and achieve balanced development between the economy and environment.
 - Transition to low carbon port logistics system and inland transportation system.
 - Adoption of new and renewable energy to provide power to port and relevant facility on its own.
 - Recycle Port Complex to treat waste in an environment-friendly manner and increase efficiency of recycling.
 - Establishment of safety net for port and harbor district in response to climate change and disaster.



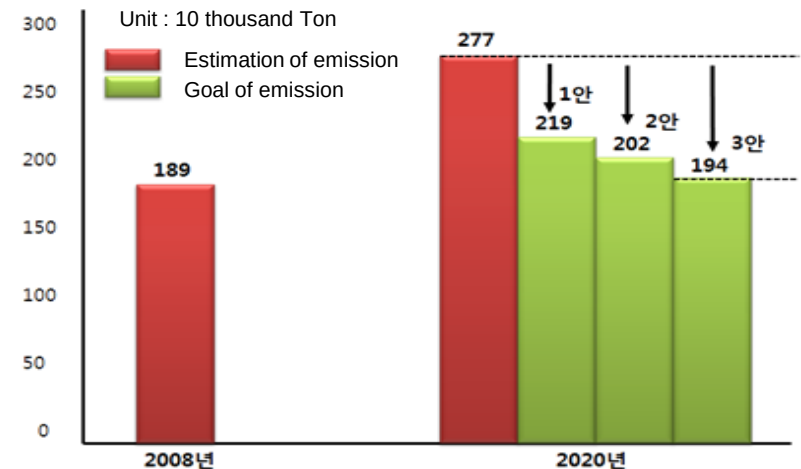
1. Necessity of Study

❑ Need to reduce greenhouse gas emissions by 30% in 2020 compared to the BAU level.

- About 2.77 million tons of CO₂ are expected to be emitted in 2020 and reduction volume will be 830,000 tons.
 - Despite continued increase in the quantity of goods transported through port is expected, the CO₂ emissions need to be decreased to the level of 2009.
 - ※ CO₂ emissions in 2009 was 1.97 million tons.

CO₂ Emission Reduction Volume Calculation for 2020

	Scenario 1 (Reduction by 21% in 2020 compared to the BAU level)	Scenario 2 (Reduction by 27% in 2020 compared to the BAU level)	Scenario 2 (Reduction by 30% in 2020 compared to the BAU level)
Estimation of emission in 2020 (A)	2,768,021(100%)		
Goal of emission in 2020 (B)	2,186,737(-21 %)	2,020,656(-2 7%)	1,937,615(- 30%)
Goal of reduction in 2020 (B)	581,284	747,366	830,406



2. Purpose of Study

□ Purpose

- Establish alternative measures to reduce energy consumption to pursue energy-saving green container terminal.
 - Oil price increase due to political instability worldwide (WTI \$100, Brent Oil \$115, Dubai Oil \$106)
 - Establish measures to respond to increased operating cost of container terminal.
 - Establish measures to reduce energy consumption in container terminal to reduce greenhouse gas emissions.

Research on Ways to Reduce Energy Cost of Cargo-Handling Industry

Measures from the Perspective of Equipment

- Analyze energy consumption amount of ports nationwide.
- Analyze ways to reduce berth, yard and transportation equipment.
- Analyze economic feasibility

Measures from the Perspective of Operation and Facility

- Analyze measures to reduce cost from operational perspective.
- Analyze measures to reduce cost from facility perspective.
- Analyze economic feasibility.

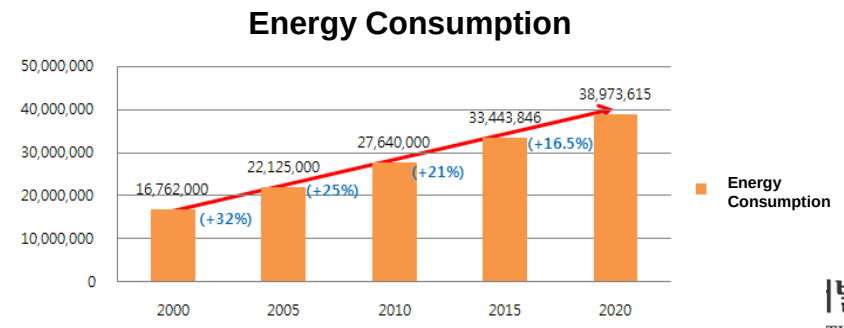
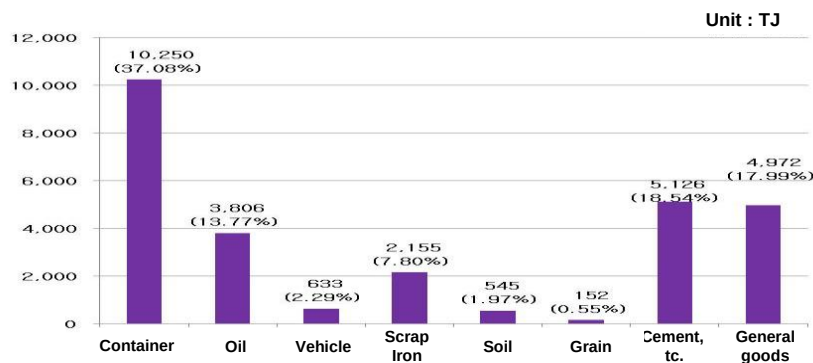
II

Energy Consumption of Container Terminal

1. Analysis on Energy Consumption of Ports in Korea

- Ports in Korea are expected to use 640 million liters of diesel and 1.8 trillion Kw of electricity in 2020.
- Container terminal accounts for 43.6% of total energy consumption in Korean ports in 2020.

Year		Container	Oil	Vehicle	Scrap Iron, Steel	Soil	Grain	Cement, Coal, Iron Ore	General Goods	Total
2010	Diesel(kl)	115,020	79,072	13,972	51,512	10,761	3,455	92,684	103,057	469,532
	Electricity (MWh)	686,485	111,880	15,429	36,815	18,281	3,310	204,954	147,114	1,224,269
	Subtotal(GJ)	10,250,000	3,806,000	633,000	2,155,000	545,000	152,000	5,126,000	4,972,000	27,640,000
2015	Diesel(kl)	148,386	87,736	14,657	54,269	18,750	4,168	108,060	123,377	559,403
	Electricity (MWh)	885,627	124,140	16,185	38,786	31,855	3,993	238,956	176,122	1,515,664
	Subtotal(GJ)	13,223,490	4,223,122	664,510	2,270,196	950,455	183,476	5,975,947	5,952,650	33,443,846
2020	Diesel(kl)	190,463	94,883	17,048	60,975	20,330	4,185	113,492	137,178	638,554
	Electricity (MWh)	1,136,764	134,252	18,826	43,579	34,539	4,009	250,966	195,822	1,818,757
	Subtotal(GJ)	16,973,269	4,567,126	772,953	2,550,720	1,030,523	184,234	6,276,296	6,618,494	38,973,615



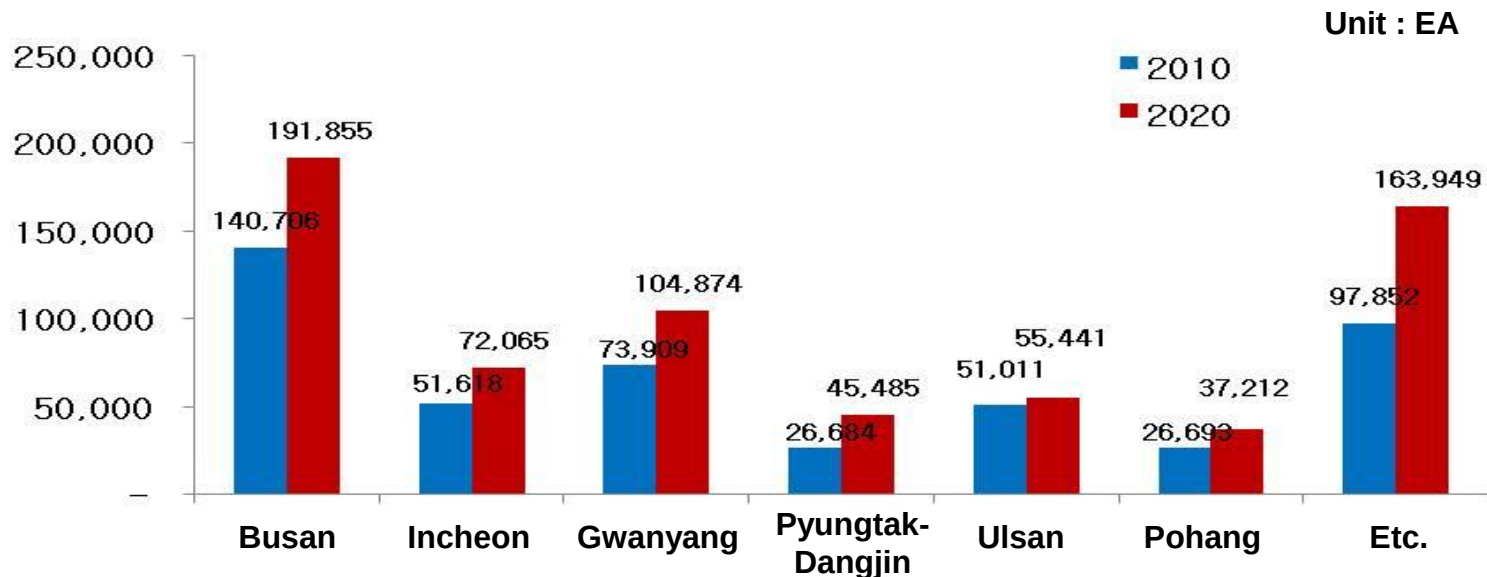
1. Analysis on Energy Consumption of Ports in Korea

○ As of 2010, energy consumption in Korean ports is equivalent to 466,472 vehicles a year.

- Gwangyang port used energy equivalent to 74,000 units in 2010 and 105,000 by 2020.
- By 2020, the annual energy consumption will be equivalent to 660,576 vehicles, an increase of 41.0% compared to the level of 2010.

※ Energy consumption of a vehicle a year is calculated on the assumption that the vehicle is a gasoline-driven vehicle with fuel economy of 12Km/L and annual driving distance is 20,000Km.

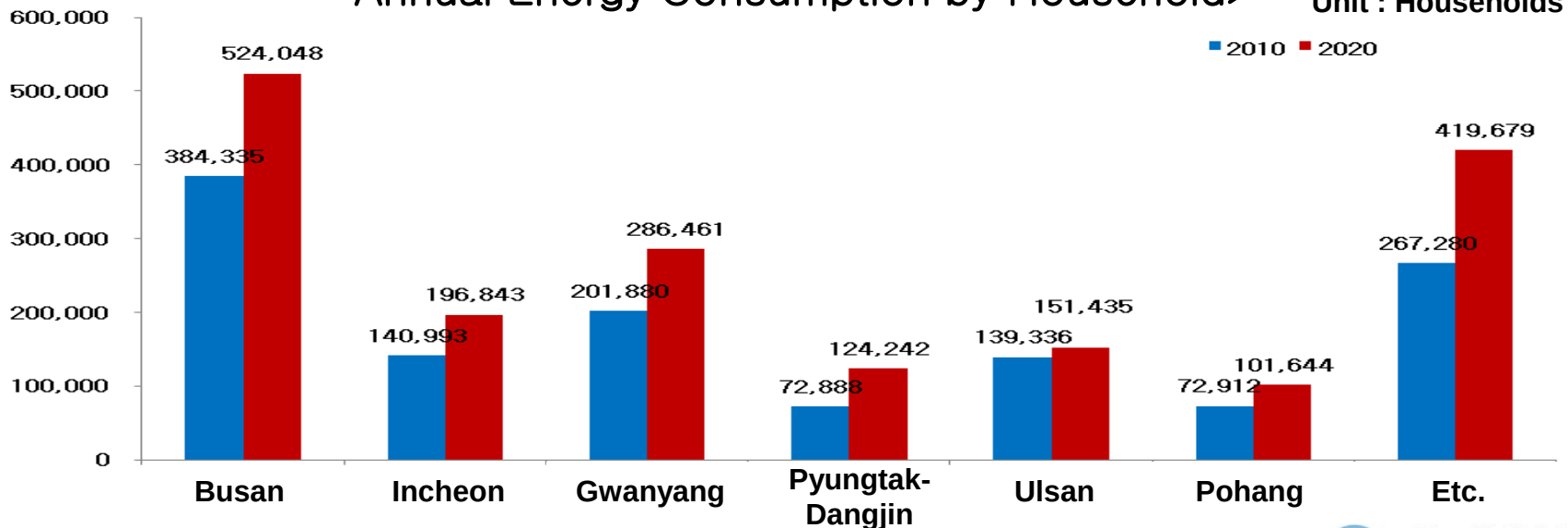
<Conversion of Energy Consumption of Korea's 6 Major Ports into Annual Energy Consumption by Vehicle>



1. Analysis on Energy Consumption of Ports in Korea

- If the energy consumption of 6 major ports in Korea in 2020 is converted into annual average energy consumption by a household and the energy consumption amount is equivalent to energy consumption by 1.8 million households.
 - The energy consumption by ports in Korea in 2010 was equivalent to amount used by 1.28 million households.
 - Gwangyang port consumes energy amount for 286,000 households in 2020.
- ※ The calculation of required energy per households is based on the assumption that a household consumes 200 KWH a year.

<Conversion of Energy Consumption of Korea's 6 Major Ports into Annual Energy Consumption by Household> Unit : Households



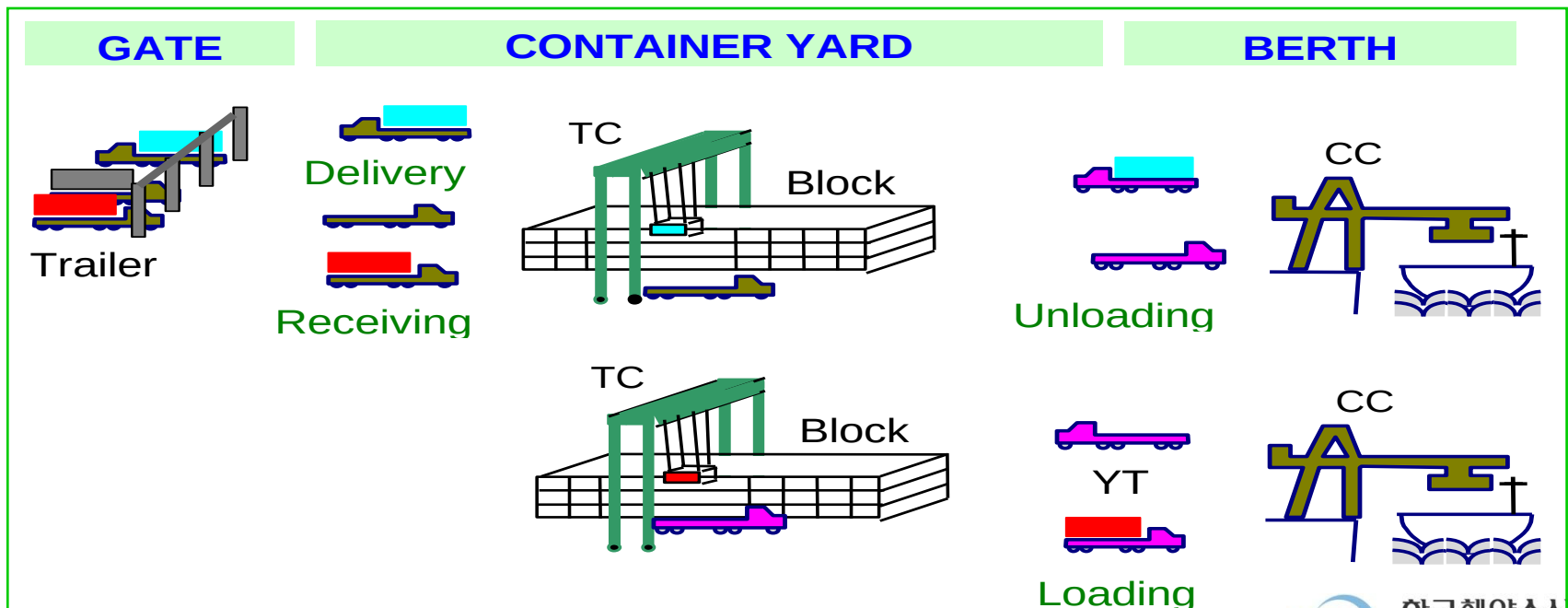
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Energy Cost Saving Alternative and Effect of Container Terminal

III. Energy Cost Saving Alternative and Effect of Container Terminal

1. Overview

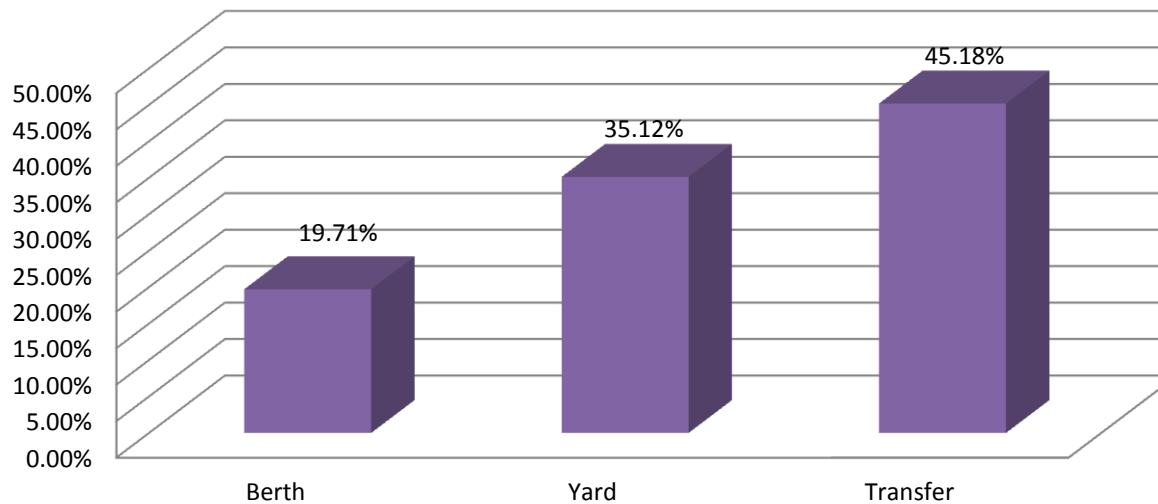
- Introduction to container terminal system
 - Composition : berth, yard, and gate
 - Unloading : ship → berth crane → yard tractor → yard crane → external truck → gate
 - Loading : gate → external truck → yard crane → yard tractor → berth crane → ship
- Scope of research
 - Equipment (berth equipment, yard equipment and transportation equipment), operation (minimization of moving line, Pooling System, etc.), and facility (main building, maintenance building)



2. Equipment

- Equipment is composed of berth, yard and transportation equipment[a total of 8 technologies]
 - Berth equipment uses Tandem technology(1 technology)
 - Yard equipment uses hybrid RTGC technology, super capacitor technology and E-RTGC (a total of 3 technologies)
 - Transportation equipment uses hybrid transportation vehicle technology, transportation vehicle for online power technology, no-load operation prevention technology and double loading technology (a total of 4 technologies)

Energy Consume Ratio



2. Equipment[berth equipment]

○ Tandem technology

- Container crane used to use twin spreader (1 unit of 40ft spreader or 2 units of 20ft spreader) but tandem technology increases operational efficiency by converting twin spreader into tandem spreader (2 units of 40ft or 4 units of 20ft)
- Yangsan port in Shanghai, Busan new port and Port of Algeciras applied this technology.

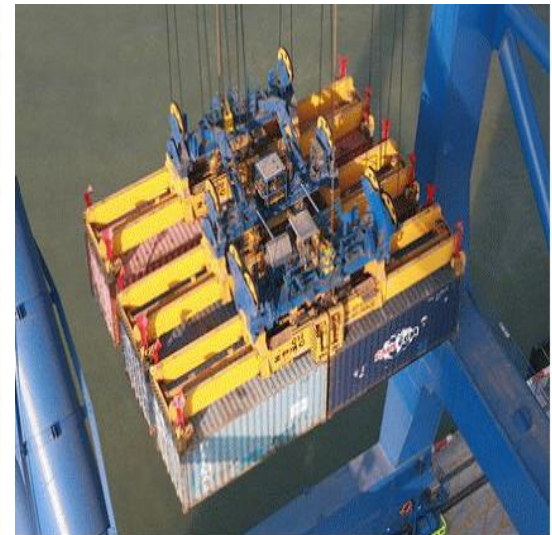
Twin



Tandem



Triple



2. Equipment(yard equipment)

- E-RTGC(Rubber Tyred Gantry Crane)
 - Technology to save fuel cost by making diesel driven RTGC at container terminal into electrical one.
 - Busan North Port applied this technology.



2. Equipment(yard equipment)

○ Hybrid RTGC

- Technology to save fuel cost by replacing diesel driven RTGC at container terminal by hybrid engine.

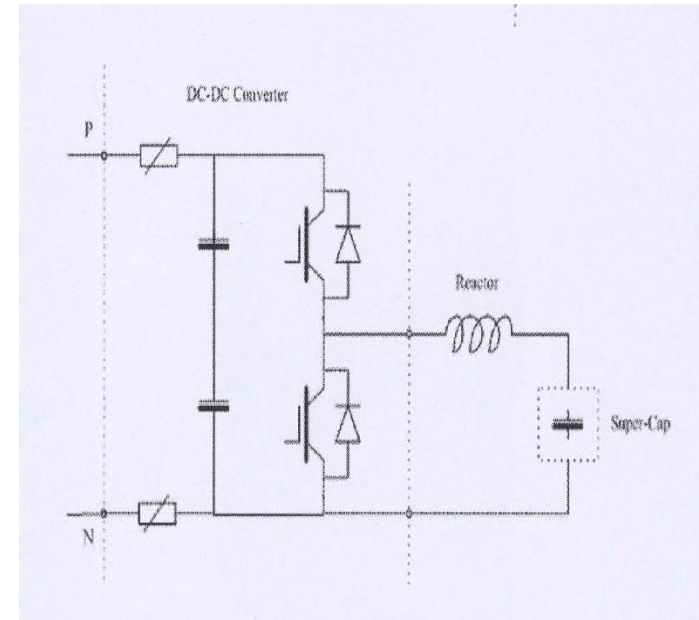
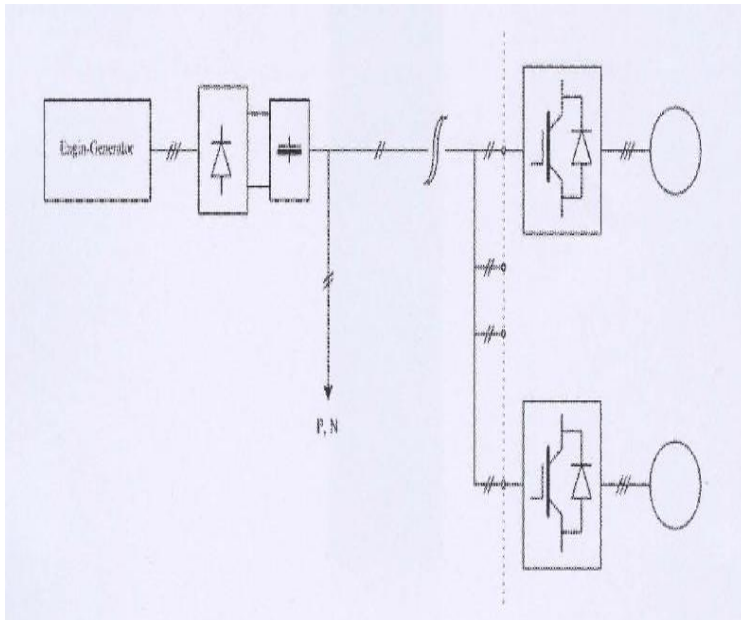


III. Energy Cost Saving Alternative and Effect of Container Terminal

2. Equipment(yard equipment)

○ Adoption of RTGC Super Capacitor

- RTGC uses energy to lift a container, but it generates electrical energy from cargo' s potential energy upon putting down the container.
- The electricity generated is converted into heat through resister and emitted into the atmosphere, but this technology increases energy efficiency by charging this electrical energy into capacitor to use the energy again.



III. Energy Cost Saving Alternative and Effect of Container Terminal

2. Equipment(transportation equipment)

○ Hybrid Y/T

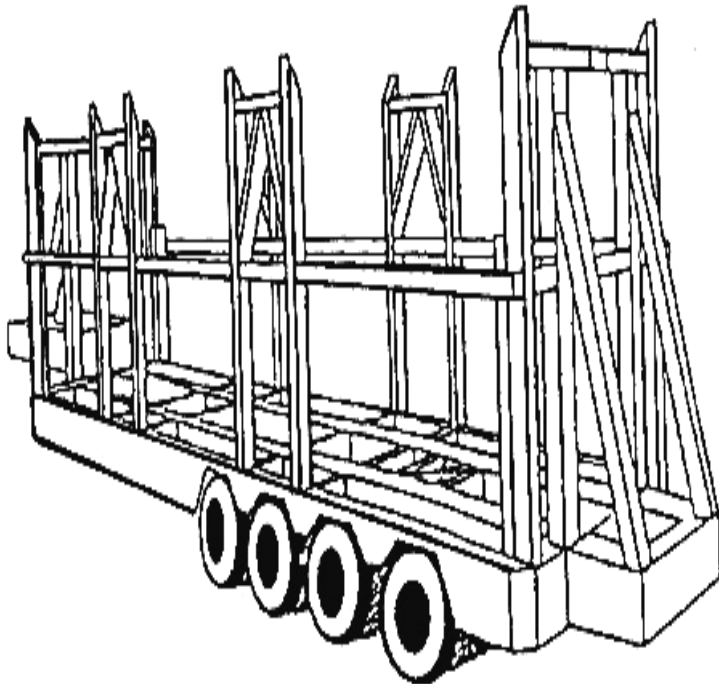
- Hybrid Y/T charges energy using engine during standby and operation and uses engine and electricity during driving and acceleration improving fuel efficiency and reducing energy consumption.



2. Equipment(transportation equipment)

○ Double Loading Y/T

- Usually transport 1 container using Y/T but energy efficiency can be increased by transporting 2 containers of 40ft[possible in the form of 4 units of 20ft] by adopting double loading chassis.
- This is uniquely developed by PSA, Singapore.

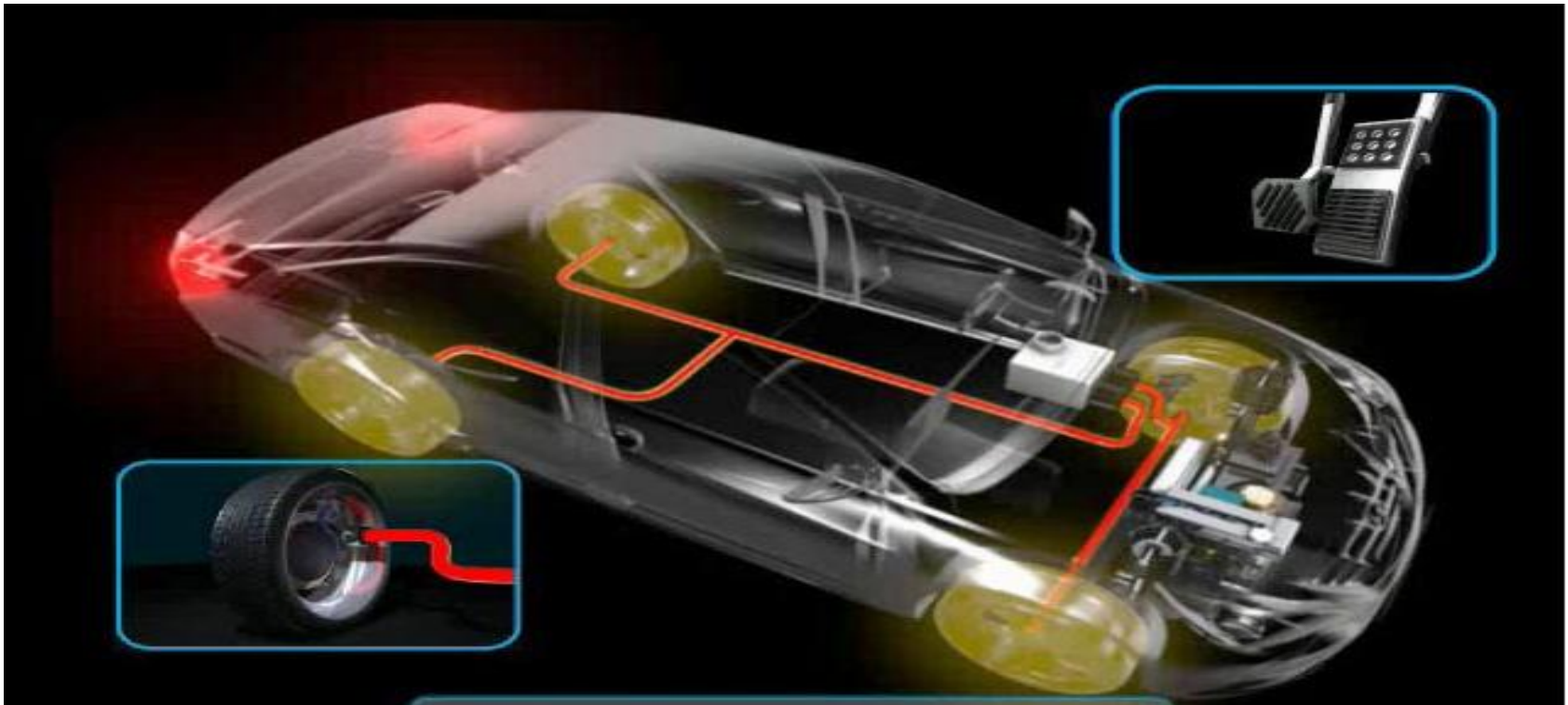


III. Energy Cost Saving Alternative and Effect of Container Terminal

2. Equipment(transportation equipment)

○ Y/T Anti-Idling Device

- At the port, 50% of the Y/T is idling time out of total working hours. To manage this efficiently this technology reduces fuel consumption amount by preventing no-load operation during Y/T stand-by.



III. Energy Cost Saving Alternative and Effect of Container Terminal

2. Equipment(transportation equipment)

○ Online power-driven Y/T

- This technology makes Y/T currently used at container terminal not use rail and battery. Instead, power supply rail and power collection device are used to deliver electricity with no rail.



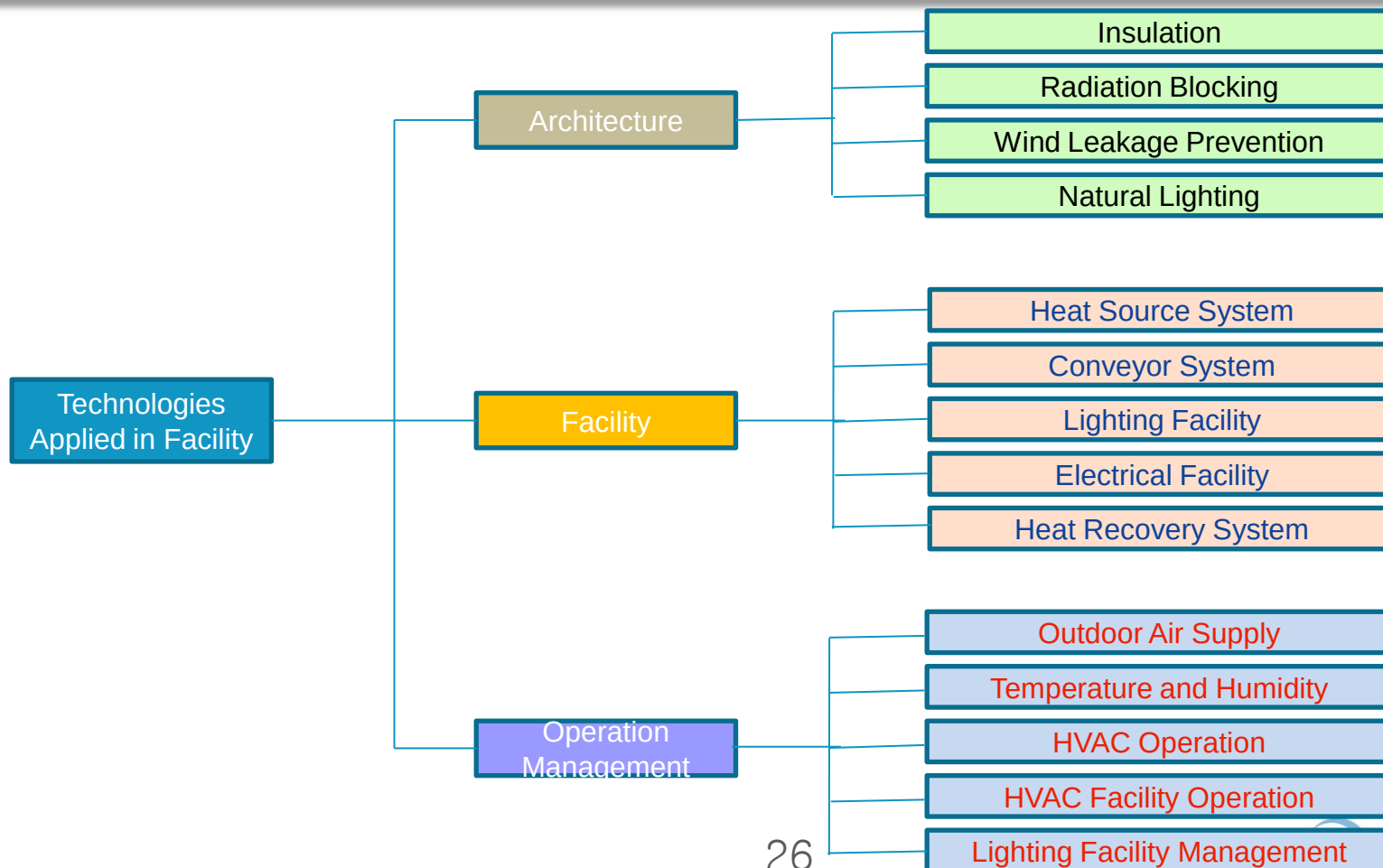
3. Equipment[reduction effect]

- Energy saving effect and cost required by the equipment
 - Online power Y/T technology is under test and other technologies excluding this can be applied immediately.
 - RTGC super capacitor technology can save energy cost up to 55% and Y/T no-load operation prevention technology is very cost effective.

Description	Technology	Effect	Cost	Development
Equipment	Tandem	20%	13billion won	Developed
	e-RTGC	27%	370 million won	Developed
	Hybrid RTGC	35%	1.5 times higher than diesel	Developed
	RTGC Super Capacitor	55%	50 million won	Developed
	Hybrid Y/T	35%	1.5 times higher than diesel	Developed
	Double Loading Y/T	–	50 million won	Developed
	Y/T No-load Operation Prevention	16.7%	1 million won	Developed
	Y/T Facility for Online Power	40~50%	To Be Determined	Under Development

4. Facility

- Technologies in the facility part are classified into architecture, facility and operation management.
 - Architecture (4 technologies), Facility(5 technologies), Operation and Management (5 technologies)



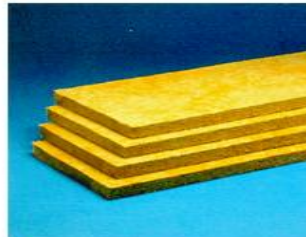
4. Facility(architecture technology)

○ Insulation Technology

- Save energy by blocking heat flow. It is divided into envelop insulation that forms warm environment with pleasant indoor condition and tight fitting insulation technology that maintains insulation function and indoor pleasant condition.



Glass-wool



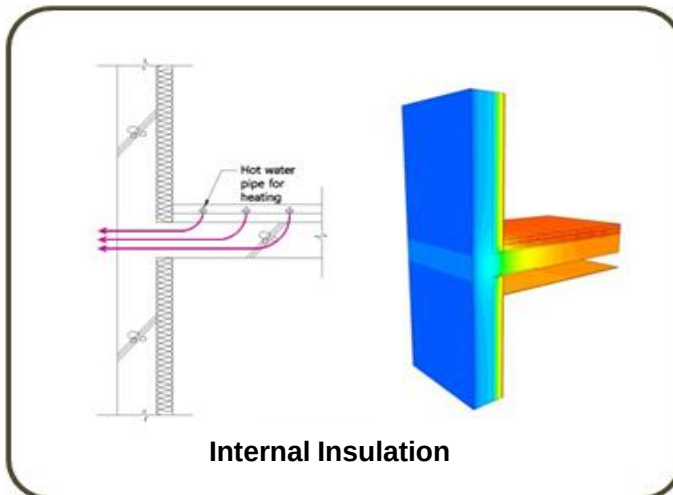
Rock-wool



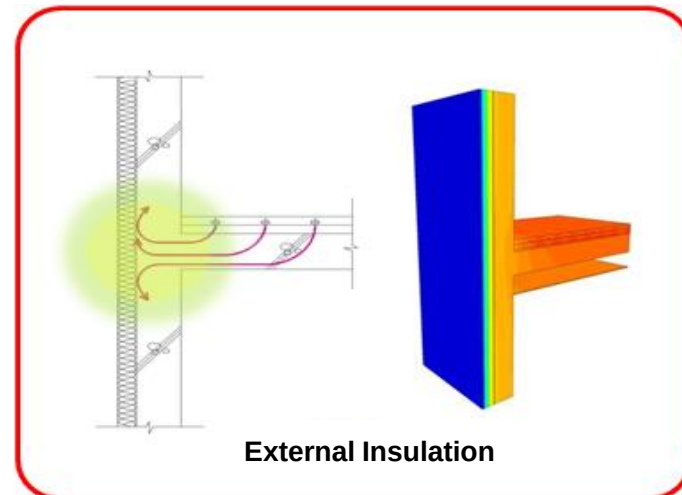
Rock-felt



Iso-pink



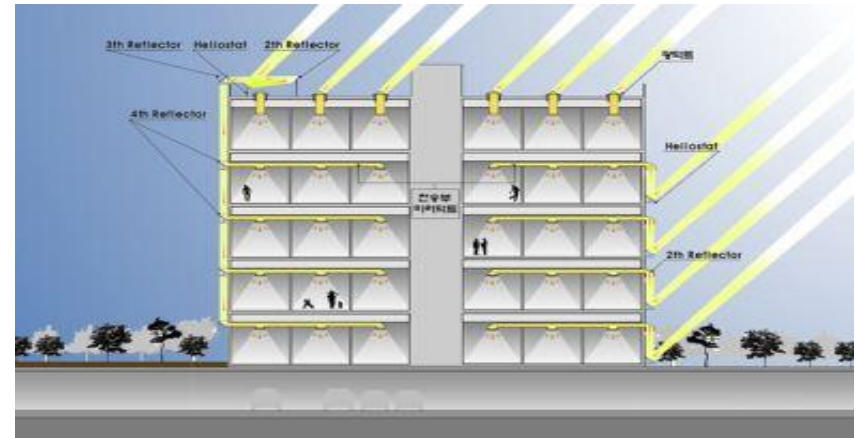
Internal Insulation



External Insulation

4. Facility(architecture technology)

- Radiation blocking technology
 - Technology to prevent massive heat from coming inside.
- Wind leakage prevention technology
 - Technology to prevent heat loss and noise due to wind.
- Natural lighting technology
 - Technology to make pleasant indoor atmosphere and save energy by deterring the use of electrical light energy during day time.

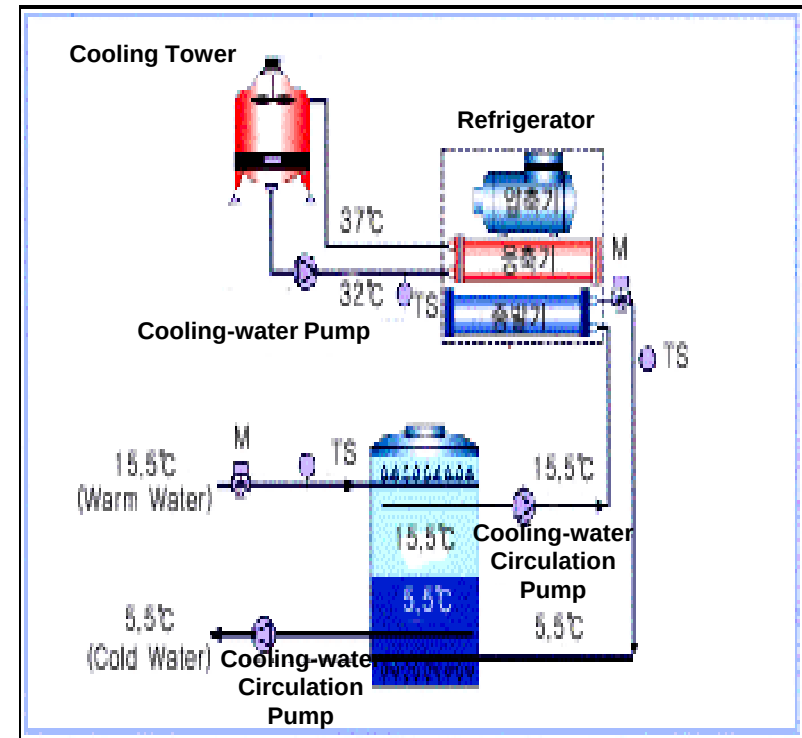
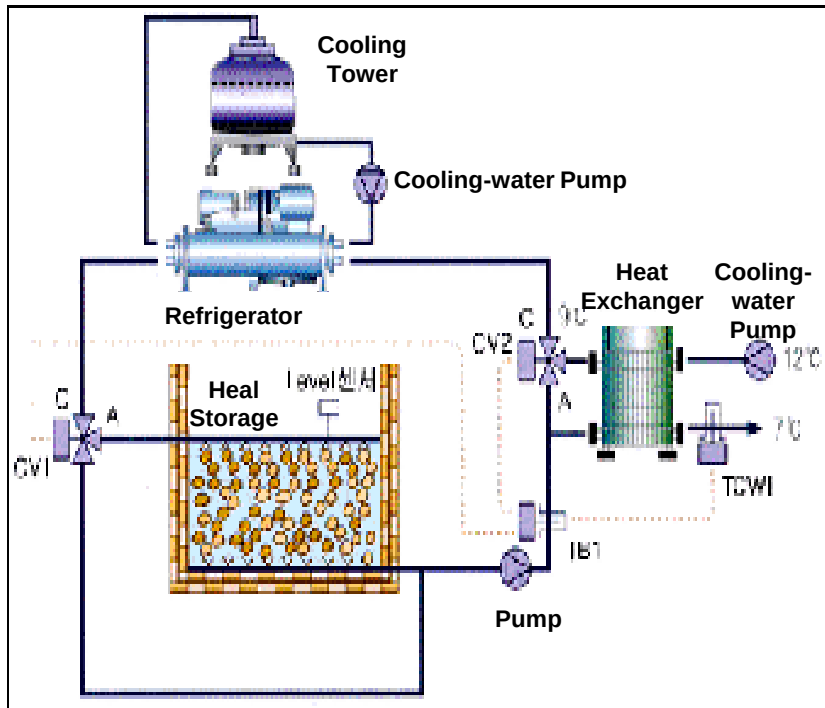


III. Energy Cost Saving Alternative and Effect of Container Terminal

4. Facility(technology related to facility)

○ Heat source system

- This is the core element of environment-friendly building that improves effective energy use efficiency in the overall system.



4. Facility(technology related to facility)

○ Conveyor system

- This technology adjusts the volume of air inflow, which is divided into variable air volume technology and variable air speed pumping technology.

○ Lighting facility technology

- This is divided into energy saving technology using equipment like sensor and energy saving technology by operation control.

○ Electrical Facility

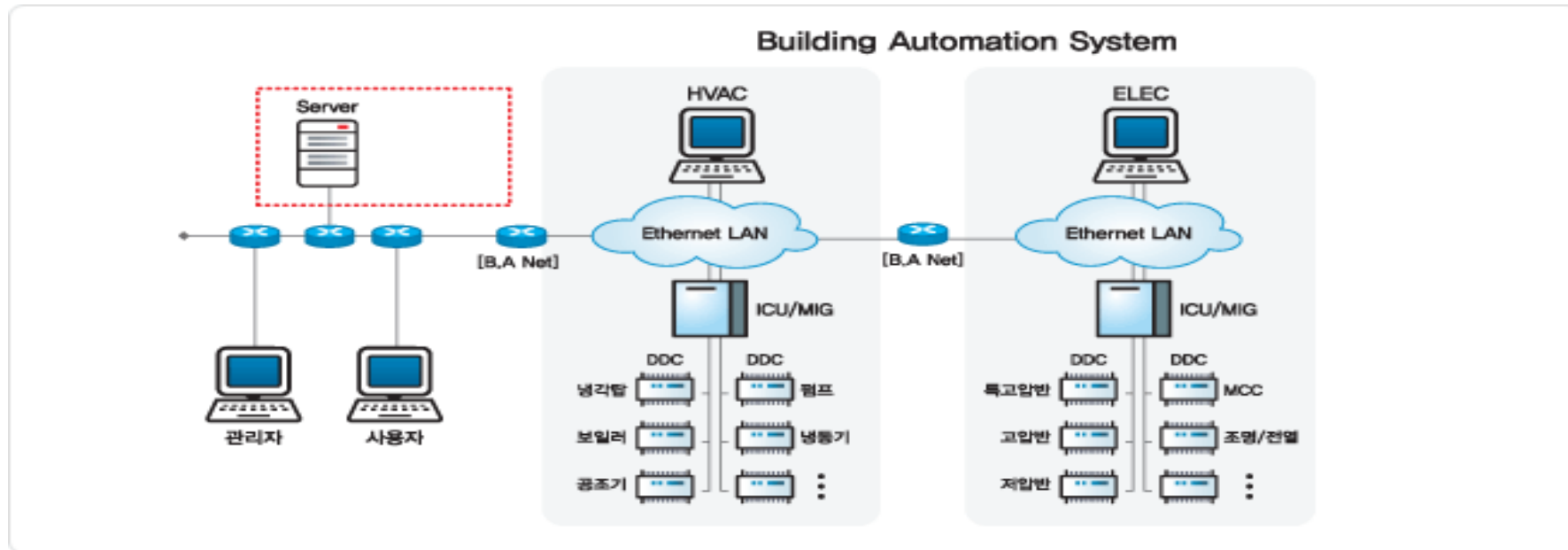
- Peak Demand Control technology that controls load temporarily to the extent that the control does not have negative impact on the facility.

○ Heat Recovery System

- This technology recovers excessive heat or discarded heat inside the building and convey the heat to the area where heat is in short supply inside the building. The heat is used as the source of heating.
- There are exhaust heats from lighting, human body, OA, mechanical, electrical and elevator machine room.

4. Facility[operation management technology]

- BEMS (Building Energy Management System) technology
 - Building management system that maintains pleasant indoor condition as well as improves energy efficiency.
 - Save energy by monitoring facility system operation status, conducting automatic control and collecting energy information.



4. Facility(Effect)

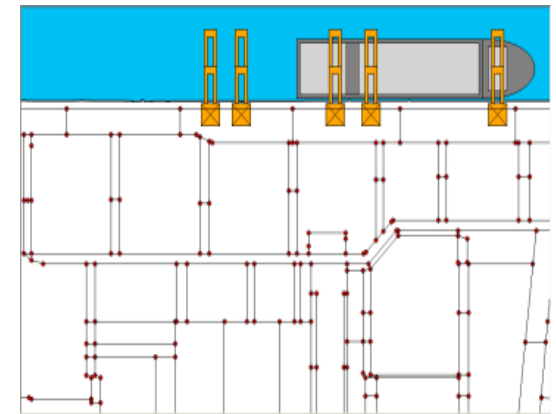
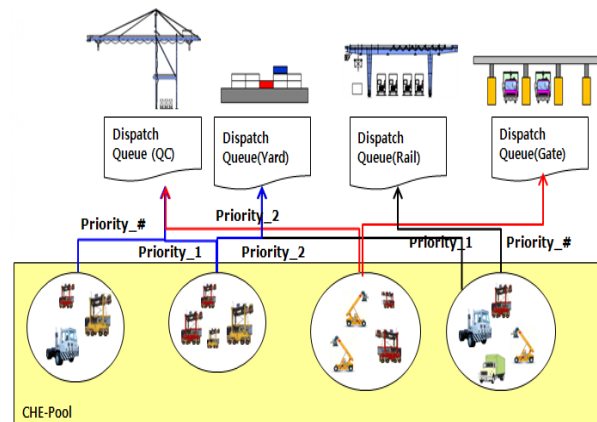
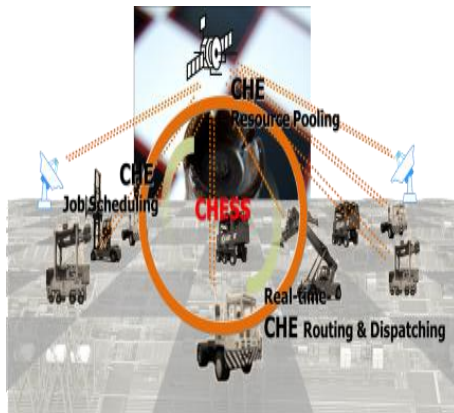
○ Cost saving effect in facility part

- Port operation building is included in relatively small building so large temperature differential system, low temperature HVAC system and automatic ventilation system are excluded.
- Optical duct system can save cost up to 11% and LED light can achieve 4% higher effect with relatively low cost.

System	Energy Saving Rate	Effect	Cost	Applicability to Existing Building	Development
Optical Cable Duct	– Save 85% of power for lighting	11%	6 million won	Applicable	Applicable
Variable Air Volume System	– Save 80% of power for pump	6%	0.4 million won(m ²)	Applicable	Applicable
Variable Air Speed Pumping System	– Save 70% of power for ventilator	4%	30 million won	Applicable	Applicable
LED Light	– Save 84~88% of power compared to light bulb	4%	30,000~70,000 won	Applicable	Applicable
Blind Control	– 9.8% save in case of auto blind.	3%	0.3 million won(m ²)	Applicable	Applicable
BEMS	– Large building : 2% saving – Small building : 4% saving	4%	1 billion won	Applicable	Applicable

4. Operation

- Intelligent No-Handling operation system
 - Technology to deter the handling of yard equipment again reducing transportation cost and saving energy.
- Container Handling Equipment Pooling System
 - A number of cranes uses multiple transportation equipment for effective use of transportation equipment.



4. Operation

- Yard equipment movement line minimization system
 - The yard equipment working time is composed of time for movement and container handling time. To minimize the time for movement, minimize the movement distance to reduce energy.
- Transportation equipment dual cycle system
 - In general, transportation equipment carries container to berth and goes back to the port with vacant vehicle.
 - Dual cycle system makes loading work and port work in parallel to reduce the rate of vacant vehicle movement reducing energy consumption.
- Intelligent operation planning system
 - Real-time planning system, multiple user planning system, automatic unloading system, safe operation and efficient unloading to meet the demands of diversified container terminal operation condition.
- Dual cycle system for loading
 - Operation system where loading and unloading are conducted simultaneously. If the loading and unloading container exist for the same bay in 1-bay on-board work condition, apply dual cycle to save energy.

III. Energy Cost Saving Alternative and Effect of Container Terminal

4. Operation(saving effect)

○ Dual cycle system for loading work

- Dual cycle system for loading, intelligent no-handling Operation system, intelligent operation planning system are under development.
- Pre-reservation system is the most effective by saving 25% of cost.

Classification	Technology	Effect	Cost	Development
Port Operation System	Dual Cycle System for Loading Work	20%	700 million won	Not developed
	System to minimize the movement distance of yard equipment	2%	500 million won	Developed
	Intelligent No-handling Operation System	20%	700 million won	Not developed
	CHE Pooling System	15%	500 million won	Developed
	Dual Cycle System for Transportation Equipment	20%	700 million won	Developed
	RYMS	15%	500 million won	Developed
	Pre-reservation System	25%	500 million won	Developed
	Intelligent Operation Planning System	15%	1 billion won	Not developed

IV

Case Analysis

1. Facility and Equipment Status

○ Facility and Equipment Status of Shingamman Quay and Hanjin New Port

<Facility Status>

Item	Shingamman Quay	Hanjin New Port
Quay Length(m)	826	1,100
Cargo Handling Capacity (1,000TEU)	610	1,140
Site Area (1,000 m ²)	294	688
CY Area (1,000 m ²)	153	346
Building Area (1,000 m ²)	12	15.7
CFS (1,000 m ²)	5.5	1.1

<Equipment Status>

Classification		Shingamman Quay (the no. of equipment using diesel)	Hanjin New Port
C/C	18 rows	4	-
	22 rows	3	-
	24 rows	-	12
	Subtotal	7	12
T/C		16(4)	42
TH		-	3
R/S		4	6
Y/T		36	96
F/L		1	-
Chassis		64	193

2. Cargo-handling Status

- Cargo-handling volume of Shingamman Quay and Hanjin New Port in 2010
 - Shingamman Quay 1,237,000 TEU, Hanjin New Port 1,626,000 TEU

< Cargo-handling Volume of Shingamman Quay and Hanjin New Port in 2010 >

Classification		Shigamman Quay	Hanjin New Port
2010 (TEU)	Jan.	96,572	95,385
	Feb.	86,214	95,061
	Mar.	106,858	103,303
	Apr.	107,142	127,316
	May	107,477	144,526
	June	107,380	159,035
	July	110,837	154,663
	Aug.	111,117	144,836
	Sept.	86,274	146,337
	Oct.	101,578	146,811
	Nov.	111,278	162,014
	Dec.	104,339	147,073
	Subtotal	1,237,066	1,626,360

3. Energy Consumption in 2010

- Survey on energy consumption of Shingamman Quay and Hanjin New Port
 - The electricity consumption was 123,252Gj, diesel consumption was 76,282Gj totaling 199,534Gj (Shingamman Quay)
 - The electricity consumption was 361,801Gj, , diesel consumption was 74,023Gj totaling 435,824Gj (Hanjin New Port)

<Energy Consumption for Each Component>

Component	Shingamman		Hanjin	
	Electricity(Gj)	Diesel(Gj)	Electricity(Gj)	Diesel(Gj)
Berth	37,486	-	80,819	-
Transportation	-	32,355	-	62,494
Yard	29,050	30,644	143,432	-
Other Equipment	-	11,858	-	6,677
Complex Building	6,060	-	19,680	-
Freezing Transformer Room	38,466	-	80,185	-
Lighting Tower	5,961	-	14,495	-
Others	6,229	1,425	3,510	4,852
Total	123,252	76,282	361,801	74,023

4. Application of Energy Saving Measures

- Summary of applicable measures for Shingamman Quay and Hanjin New Port
 - 22 alternatives are summarized using RTGC in case of Shingamman(save up to 73.42%)
 - 18 alternatives are summarized using RMGC in case of Hanjin(save up to 80.01%)

Case1: Shingamman

No.	Sum	Technology	Effect (gCO ₂ /RT) 73.42	Period (Yr)	Budget (0.1bilKRW) 1,177	Remark
1	F1	Daylight Duct System	0.28	1.00	30.30	
2	F2	Variable Speed Pumping System	0.49	1.00	19.66	
3	F3	Variable Air Volume System	0.09	1.00	0.30	
4	F4	LED	2.18	1.00	0.68	
5	F5	Blind Control System	0.06	1.00	12.77	
6	F6	BEMS	0.10	1.00	10.00	
7	H1	Tandem Berth Equipment	3.10	1.00	910.00	
8	H21	Hybrid-RTGC	2.80	1.00	8.00	Selection 1
9	H22	Super Capacitor	4.40	1.00	2.00	
10	H31	Hybrid Y/T	7.30	1.00	25.00	Selection 1
11	H32	Bio Diesel	12.30	1.00	23.00	
12	H33	Online Power Y/T	7.30	3.00	72.00	
13	H4	Y/T Anti-Idling Device	3.50	1.00	0.36	
14	H5	Dual Loading Y/T	1.50	1.00	18.00	
15	M1	Dual-cycle Ship Loading	3.10	2.00	7.00	
16	M2	Traffic-line Minimization System of Yard Equipment	0.66	1.00	5.00	
17	M3	AI No-handling	6.34	2.00	7.00	
18	M4	Pooling System for YT	3.12	1.00	2.00	
19	M5	Dual-cycle for YT	4.16	1.00	4.00	
20	M6	RYMS	3.12	1.00	5.00	
21	M7	Pre-reservation System	5.20	1.00	5.00	
22	M8	Intelligent Operation Planning System	2.32	3.00	10.00	

Case2: Hanjin

No.	Sum	Technology	Effect (gCO ₂ /RT) 80.01	Period (Yr)	Budget (0.1bilKRW) 434	Remark
1	F1	Daylight Duct System	0.47	1.00	22.71	
2	F2	Variable Speed Pumping System	0.26	1.00	32.63	
3	F3	Variable Air Volume System	0.15	1.00	0.30	
4	F4	LED	2.85	1.00	1.03	
5	F5	Blind Control System	0.11	1.00	2.18	
6	F6	BEMS	0.17	1.00	10.00	
7	H11	Hybrid Y/T	14.10	1.00	67.00	Selection 1
8	H12	Bio Diesel	11.90	1.00	22.00	
9	H13	Online Power Y/T	14.10	3.00	192.00	
10	H2	Dual Loading YT	2.80	1.00	48.00	
11	H3	Y/T Anti-Idling Device	6.70	1.00	0.96	
12	M1	Dual-cycle Ship Loading	3.54	2.00	7.00	
13	M2	Traffic-line Minimization System of Yard Equipment	0.65	1.00	5.00	
14	M3	AI No-handling	6.27	2.00	7.00	
15	M4	Pooling System for YT	3.19	1.00	2.00	
16	M5	Dual-cycle for YT	4.25	1.00	4.00	
17	M6	RYMS	3.19	1.00	5.00	
18	M7	Pre-reservation System	1.00	1.00	5.00	

5. Selection of Energy Saving Alternatives

- Select 30%, and 50% energy consumption reduction for Shingamman and Hanjin.
 - 30% reduction requires 2.604 billion and 50% reduction requires 7.104 billion won (Shingamman)
 - 30% reduction requires 2.499 billion and 50% reduction requires 10.199 billion won (Hanjin)

Case1	Shingamman					
Goal	List of Technology	Effect	Budget (0.1bilKRW)	Tech. No.	Year	
28.0%	4 9 13 17 18 19 21	28.90%	21.04	7	2	
29.0%	9 13 17 18 19 20 21	29.84%	25.36	7	2	
30.0%	4 9 13 17 18 19 20 21	32.02%	26.04	8	2	
31.0%	4 9 13 17 18 19 20 21	32.02%	26.04	8	2	
32.0%	4 9 13 17 18 19 20 21	32.02%	26.04	8	2	
.	.	.	.	.	.	
.	.	.	.	.	.	
.	.	.	.	.	.	
47.0%	4 9 11 13 15 17 18 19 20 21	47.42%	56.04	10	2	
48.0%	4 9 11 13 15 17 18 19 20 21	47.42%	56.04	10	2	
49.0%	4 9 11 13 15 17 18 19 20 21 22	49.74%	66.04	11	3	
50.0%	4 9 11 13 15 16 17 18 19 20 21 22	50.40%	71.04	12	3	
51.0%	4 9 11 13 14 15 17 18 19 20 21	48.92%	74.04	11	2	
52.0%	4 6 9 11 13 14 15 16 17 18 19 20 21 22	52.00%	99.04	14	3	

Case2	Hanjin					
Goal	List of Technology	Effect	Budget (0.1bilKRW)	Tech. No.	Year	
28.0%	4 11 14 15 16 18	28.57%	19.99	6	2	
29.0%	3 11 14 15 16 17 18	29.06%	24.26	7	2	
30.0%	4 11 14 15 16 17 18	31.76%	24.99	7	2	
31.0%	4 11 14 15 16 17 18	31.76%	24.99	7	2	
32.0%	4 11 12 14 15 16 18	32.11%	26.99	7	2	
.	.	.	.	.	.	
.	.	.	.	.	.	
.	.	.	.	.	.	
47.0%	4 8 11 12 14 15 16 17 18	47.20%	53.99	9	2	
48.0%	3 4 8 11 12 13 14 15 16 17 18	48.00%	59.29	11	2	
49.0%	4 7 11 12 14 15 16 17 18	49.40%	98.99	9	2	
50.0%	4 8 10 11 12 14 15 16 17 18	50.00%	101.99	10	2	
51.0%	3 4 5 6 8 10 11 12 13 14 15 16 17 18	51.08%	119.47	14	2	
52.0%	4 7 10 11 12 14 15 16 17 18	52.20%	146.99	10	2	

6. Economic Analysis of Measures to Save Energy

- Basic condition to conduct economic analysis
 - Discount rate of 5.5%, 30 years of application period, benefits(energy saving, carbon emission trading system)
- Result of the economic analysis
 - It is found to be economically feasible as the B/C of 32.02% reduction for Shingamman and 31.76% reduction for Hanjin is 2.29 and 5.39 respectively.
 - It is found to be not economically feasible as the B/C of 50% reduction for Shingamman and 50% reduction for Hanjin is 0.66 and 0.99 respectively.

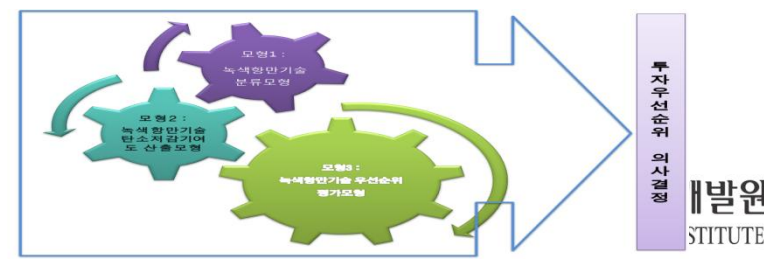
Description	Shingamman (32.02%)	Shingamman (50.40%)	Hanjin New Port (31.76%)	Hanjin New Port (50%)
Present value of cost	49	274	34	304
Present value of benefit	113	182	181	302
Net present value(NPV)	64	-92	147	-3
Cost-benefit ratio(B/C Ratio)	2.29	0.66	5.39	0.99
Internal return rate(IRR,%)	21.19	0.61	78.88	5.39

V

Conclusion

1. Conclusion

- Result of analysis on energy-saving port
 - RTGC terminals like Shingamman and RMGC terminals like Hanjin New Port can reduce 30%
 - If 50% is reduced, it is not economically feasible.
- Need to design energy-saving container terminal
 - Shingamman terminal needs 0.1637Gj of energy to treat 1TEU container.
 - Hanjin New Port terminal needs 0.2680Gj to treat 1TEU.
 - Hanjin New Port terminal consumes 1.6371 times more energy than Shingamman terminal.
- Policy Proposal
 - Need to have mid-to-long term plan to implement green port industry for green growth.
 - Need to conduct research on 2012 green technology certification system completion and technological level.
 - Need to consider greenhouse gas emission, energy target management system.
 - Actively pursue R&D for reducing energy consumption.
 - Use green technology analysis model upon determining priority of green investments by the government.



Thank You