

“How to Construct Energy/GHG Reduction Database in Semiconductor, Display, Electric & Electronic Industries”

[Korean Case Studies]



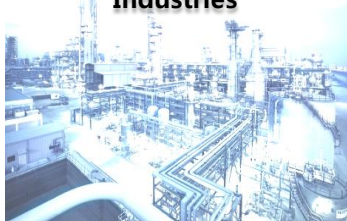
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ecosian Your Green Partner

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How to Construct Energy/GHG Reduction Database in Semiconductor, Display, Electric & Electronic Industries



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Contents



Database Overview

1. Coverage
2. Procedures



Constructing Energy/GHG Database

1. Semiconductor Industry
2. Display Industry
3. Electric & Electronic Industry

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1. Coverage(1)

I. Database Overview

- The Database Under Each Industry Covers 4 Topics like below.
 - New Technology either substitute Existing Process Technology or Reduce Energy Consumption or GHG Emission.

1 Process Technologies

- Industry Segmentation Analysis**
 - 9th Standard Industrial Classification
- Existing Technologies**
 - Technical & Cost Characteristics
 - Supply Status, etc.

2 Energy/GHG Reduction Technologies

- New Technologies**
 - Technical & Cost Characteristics
 - Expected Supply According to the Technical Characteristics

3 Energy/Mass Index

- Energy/Mass Index Development**
 - Corporate GHG Statements
 - Mass Balance
- Representative Indicators by Industry**
 - Selection of Representative Process
 - Industrial Characteristics

4 Utilities

- Possession Status**
 - Technical Classification Code
 - Transformers, Pumps, Motors, Compressors, etc

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1. Coverage(2)

I. Database Overview

- The Database Consists of 3 Types of Technologies and Each Contains Items like below.
 - The Contents of Database is filled through the steps below.

[Step 1]
"Selection of Technology Research"

- Existing Technologies**
 - Process/Product Research
 - Establishing Representative Process
- Utilities**
 - Boiler
 - Furnace/Kiln
 - Motor
 - Dryer
- New Technologies**
 - Foreign Advanced Technologies
 - Best Available Technology
 - Domestic R&D Technologies

[Step 2]
"Technology-Specific Research Items"

Research Items
Utilization Rate
Energy/Emissions Information
Production Information
Investment Costs
Maintenance Costs
Domestic Supply Capacity
Supply Levels & Expectations

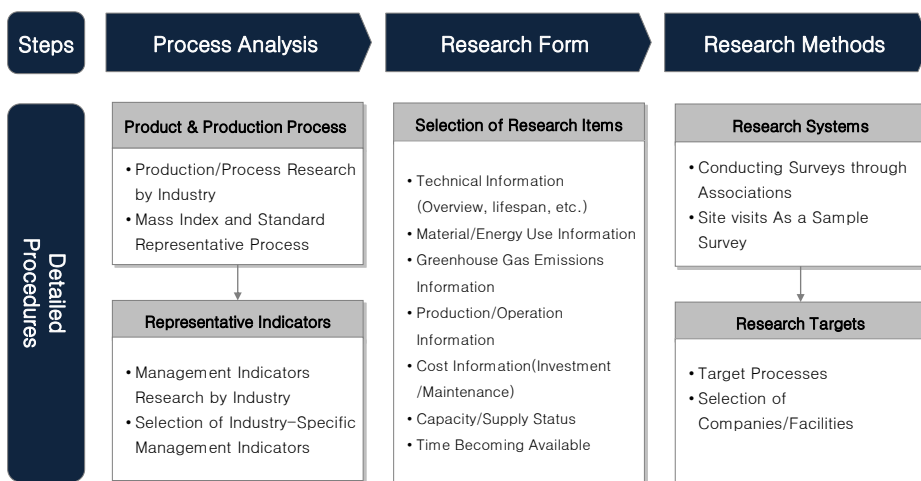
Establishing Research Process

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2. Procedures(1)

II. Constructing Energy/GHG Database

- The Following Procedures Represents Overall Processes of Constructing Database.
- This Shows How Research Procedures are Set Up.

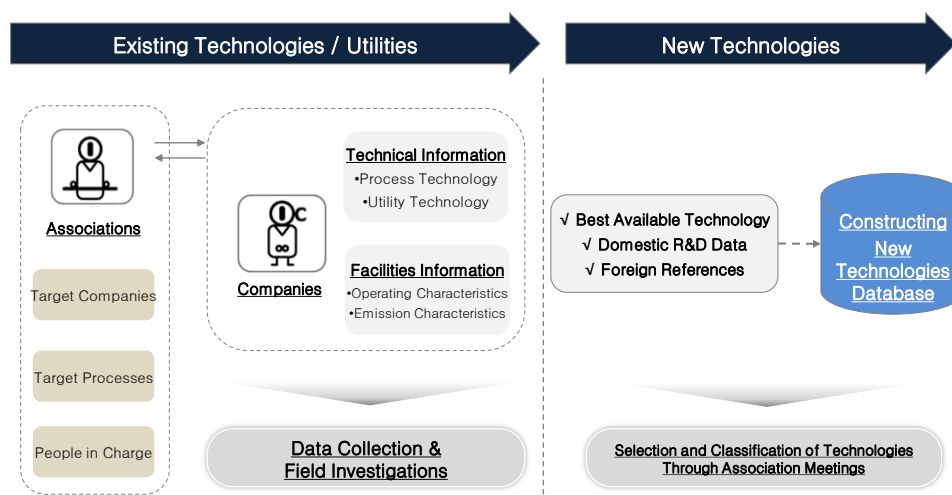


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2. Procedures(2)

II. Constructing Energy/GHG Database

- The Following Procedures Represents Overall Processes of Constructing Database.
- This Shows How Research Procedures are Set Up.



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How to Construct Energy/GHG Reduction Database in Semiconductor, Display, Electric & Electronic Industries



Contents



Database Overview

1. Coverage
2. Procedures



Constructing Energy/GHG Database

1. Semiconductor Industry
2. Display Industry
3. Electric & Electronic Industry

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1. Semiconductor Industry

II. Constructing Energy/GHG Database

◆ Products in Semiconductor Industry are classified as below.

Category	Sub-Category	Type	Detail
Memory	RAM(Volatile)	D RAM	▷ Mainly used for PC's primary storage ▷ According to information processing speed & graphics processing power, there are SD RAM, Rambus D-RAM, DDR, DDR2, etc.
		S RAM	▷ Because of low power consumption and fast processing speed, it is used for Cache of a computer, entertainment electronic equipment, etc.
		V RAM	▷ Only used to remember image information
	ROM(Non-Volatile)	Mask ROM	▷ It stores the information that customers want during a manufacturing process, and it is used for electronic game software storages, electronic musical instruments, electronic dictionaries etc.
		EP ROM	▷ Using ultraviolet light in order to erase or store the information
		EEP ROM	▷ Having both Features of the ROM and RAM(input and output characteristics)
		Flash Memory	▷ Low power consumption, high-speed programming, and high-capacity storage are available, and it can replace the HDD of a computer (separated by NOR(code storage) type and NAND(data storage) type)
Non-Memory	System IC	Micro Component	▷ As key components of controlling a computer, there are Micro Processor Unit, Micro Controller Unit, Digital Signal Processor, etc.
		Logic(ASIC)	▷ It is a specific circuit semiconductor designed by the needs of users, and suitable for small quantity batch production as a custom IC
		Analog IC	▷ It is a IC that recognizes various signal expression by continuous signal conversion, and used for the Audio/Video, communication, signal transformation
		LDI	▷ LCD driver IC as essential to drive or control IC
		Discrete Device	▷ Diodes, transistors as integrated circuit (IC) as a single function, unlike individual item means a product, it becomes packed IC.
	Others		▷ Opto(Optical Semiconductor), semiconductor sensors, etc.

✓ For Energy/GHG Database in Semiconductor Industry, Memory Products and Non-Memory Products are combined into Memory/Non-Memory
 - Because dividing products into 2 categories was not necessary in energy/GHG perspective.

1. Semiconductor Industry

II. Constructing Energy/GHG Database

• Process Technologies in Semiconductor Industry are classified as below.

Matching Processes with Products

Measuring, Reporting, & Verification Manuals

- Studying on Standardized Manual of MRV Procedures for Semiconductor Industry
- Analyzing relevant Processes and Technologies

Companies Under Target Management Scheme

- Researched Product Types of Companies Under Target Management Scheme
- Companies were Divided into 2 Categories According to the Product Types

Korea Semiconductor Industry Association

- Consulted with Process Experts about Structuring Technology Lists
- Determined the Finalized Structure of Process Lists with Product Types

Process	Product	Detail
Wafer-Producing	Wafer	Crystal Growing
		Shaping
		Polishing
		Circuit Design
		Mask-making
		Chemical Mechanical Planarization & Cleaning
Wafer-Manufacturing & Assembly	Wafer-Manufacturing	Inspection
		Oxidation
		Spreading Photo-Resist
		Light Exposure
		Development
		Etching Process
		Ion Implantation
		Chemical Vapor Deposition Process
		Metallization
	Wafer-Assembly	Automatic Sorting Wafer
		Cutting Wafer
		Die Attachment
		Linking Gold Thread
		Molding
		Chemical Mechanical Planarization & Cleaning
		Final Inspection

1. Semiconductor Industry

II. Constructing Energy/GHG Database

• Selection of Representative Indicators and Research Samples in Semiconductor Industry is shown below.

Selection of Representative Indicators

Semiconductor Industry

- Wafer Unit Area Production → Amount & Type of Raw Materials and Energy
- Wafer Production Volume/Capacity → Investment/Fixed/Variable Costs
- Emission: kg GHG / wafer m²

Designed Research Form

Research Samples in Semiconductor Industry

Item	Value	Unit	Item	Value	Unit
Utilization Rate		%	Byproduct Energy	:	:
Raw Material	Raw Material 1	m ² /production-m ²	Technology Life Span		year
	:	:	Economic Life Span		year
Main Product			Investment Costs		1,000won/capacity-m ²
Production Amount of Main Product		m ² /year	Fixed Maintenance Costs		1,000won/capacity-m ² year
Other Product	:		Variable Maintenance Costs		1,000won/capacity-m ² year
Energy Consumption	Electricity	GJ/production-m ²	GHG Emission	Fuel Combustion	kgCO ₂ eq/production-m ²
	Steam	GJ/production-m ²		Industrial Process	kgCO ₂ eq/production-m ²
	Total	GJ/production-m ²		Total GHG	kgCO ₂ eq/production-m ²

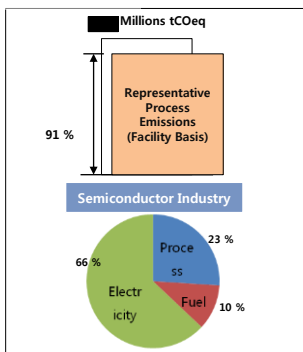
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1. Semiconductor Industry

II. Constructing Energy/GHG Database

- Representative Process & Target Products were Selected by Energy Consumption/GHG Emissions, and Products' Industrial Representation Criteria.

• 2010 Data



Representative Process	Memory, Non-Memory Production Process
Target Products	Memory, Non-Memory
Process/Fuel/Electricity	23% / 10% / 66%

Research Steps of Existing Technologies/Utilities

Research Format

- Writing Out Process Concepts Per Each Semiconductor Product
- Updating Supply Status and Characteristic Data

Target Companies

- Distributing Surveys to Top 8 Companies Which Account For 91% of Total Greenhouse Gas Emissions in Semiconductor Industry

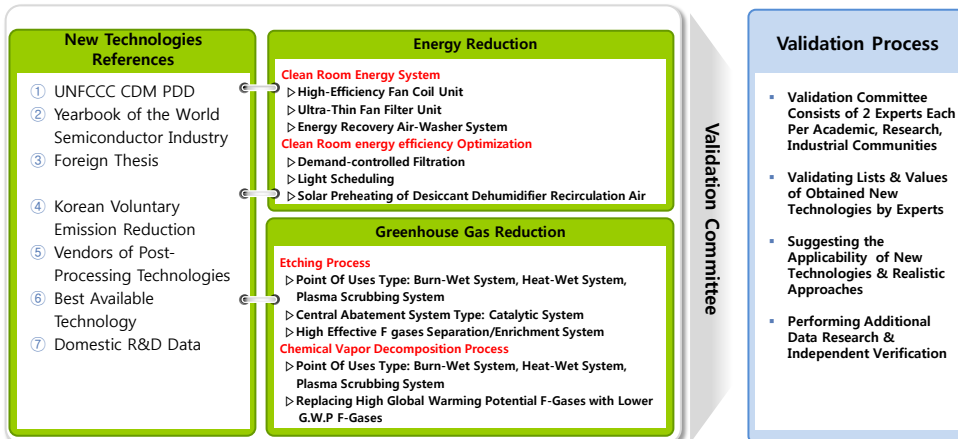
Consulted with Association

- < Korea Semiconductor Industry Association >
 - Clarifying Target Products
 - Correcting Companies' Information
 - Discussing Trends of GHG Reduction Technologies in Semiconductor Industry
 - Sorting Companies According to the Process Emissions
 - Revising Research Items

1. Semiconductor Industry

II. Constructing Energy/GHG Database

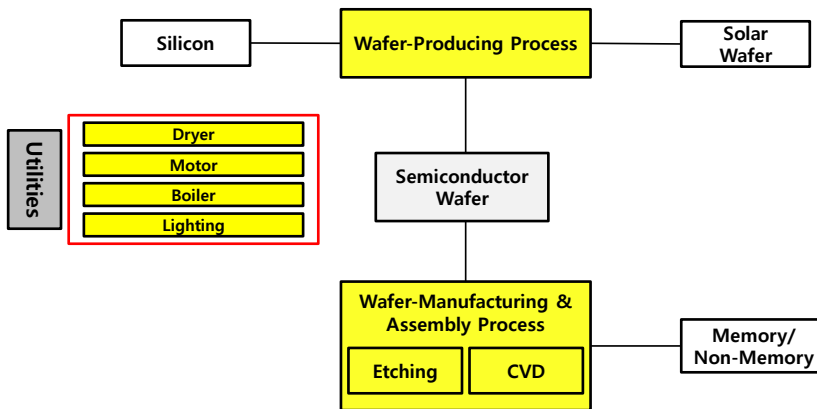
- References & Contents of New Technologies in Semiconductor Industry are Listed Below.
- These Technologies were Reviewed by Validation Committee.



1. Semiconductor Industry

II. Constructing Energy/GHG Database

Below is the Finalized Processes Representing Existing Technologies in Semiconductor Industry.



1. Semiconductor Industry

II. Constructing Energy/GHG Database

Below is the Finalized Energy/GHG Reduction Technologies by Corresponding Existing Technologies.

Energy Sector

NO	Energy Reduction Technologies	Corresponding Existing Technologies	GHG Reduction(%)	Adopting Time(Year)
1	High-Efficient Fan Coil Unit	Wafer-Making Process	██████	██████
2	Ultra-Thin Fan Filter Unit		██████	██████
3	Energy-Recovery Air-Washer System		██████	██████
4	High-Efficient Fan Coil Unit	Wafer-Manufacturing & Assembly Process	██████	██████
5	Ultra-Thin Fan Filter Unit		██████	██████
6	Energy-Recovery Air-Washer System		██████	██████
7	Optimization of Clean Room Energy Efficiency (Demand-controlled Filtration, Light scheduling, Solar Preheating)		Wafer-Making Process /Wafer-Manufacturing & Assembly Process	██████

Industrial Process Sector

NO	GHG Reduction Technologies	Corresponding Existing Technologies	GHG Reduction(%)	Adopting Time(Year)
1	Burn-Wet System for PFCs, SF6 Abatement - POU Type	Etching Process	██████	██████
2	Heat-Wet System for SF6 Abatement - POU Type		██████	██████
3	Plasma Scrubbing System for PFCs, SF6 Abatement - POU Type		██████	██████
4	Catalytic System for PFCs, SF6 Abatement - CAS Type		██████	██████
5	High Effective F gases Separation/Enrichment System		██████	██████
6	Replacing High G.W.P. F-Gases with Lower G.W.P F-Gases	Chemical Vapor Decomposition Process	██████	██████
7	Burn-Wet System for PFCs, SF6 Abatement - POU Type		██████	██████
8	Heat-Wet System for SF6 Abatement - POU Type		██████	██████
9	Plasma Scrubbing System for PFCs, SF6 Abatement - POU Type		██████	██████

2. Display Industry

II. Constructing Energy/GHG Database

- **Products in Display Industry are classified as below.**

Category	Product	Explanation
Display	LCD	▷ LCD stands for Liquid Crystal Display, and it is a device that displays information using state changes of liquid crystals which has middle characteristics between liquid and solid state. It is commonly used for Cathode-Ray Tube TV, PC monitor, small and medium-sized consumer electronics(cell phones, digital cameras, camcorders, etc.)
	PDP	▷ PDP stands for Plasma Display Panel, and it is a flat panel display using characteristics of plasma(gas discharge). It is suitable for very large TV, and used as a core part of Wall TV.
	OLED	▷ OLED stands for Organic Light-Emitting Diode, and it is organic material using glowing light-emitting phenomena when currents flow through fluorescent organic compounds. Compared with Thin Film Transistor-Liquid Crystal Display(TFT-LCD), its image quality reaction rate is more than 1,000 times faster, so it is a next-generation flat-panel display which afterimage is rarely appeared on.
	FED	▷ FED stands for Field Emission Display, and it display videos by the way that electrons emitted from a large number of very small-sized electron guns hit on the front of phosphors so that they can be light-emitting. It is called a next-generation flat-screen CRT because its operating mechanism is similar with existing CRT(Cathode-Ray Tube) and it is a flat panel

- ✓ For Energy/GHG Database in Display Industry, FED is not included.
- Because portion of FED industry in national display industry is very small.

2. Display Industry

II. Constructing Energy/GHG Database

- **Process Technologies in Display Industry are classified as below.**

Matching Processes with Products

Measuring, Reporting, & Verification Manuals

- Studying on Standardized Manual of MRV Procedures for Display Industry
- Analyzing relevant Processes and Technologies

Companies Under Target Management Scheme

- Researched Product Types of Companies Under Target Management Scheme
- Companies were Divided into 3 Categories According to the Product Types

Korea Display Industry Association

- Consulted with Process Experts about Structuring Technology Lists
- Determined the Finalized Structure of Process Lists with Product Types

Process	Product	Detail	
LCD-Producing	LCD	TFT(Thin Film Transistor) Process	Chemical Vapor Deposition Process
			Etching Process
			Other Processes
		CF(Color-Filter) Process	
		Cell(L/C)	
		Module	
OLED-Producing	OLED	TFT(Thin Film Transistor) Process	Chemical Vapor Deposition Process
			Etching Process
			Other Processes
		Evaporation	
		Encapsulation	
PDP-Producing	PDP	PDP-Producing Process	

2. Display Industry

II. Constructing Energy/GHG Database

- Selection of Representative Indicators and Research Samples in Display Industry is shown below.

Selection of Representative Indicators

Display Industry

- LCD/OLED/PDP Unit Area Production → Amount & Type of Raw Materials and Energy
- LCD/OLED/PDP Production Volume/Capacity → Investment/Fixed/Variable Costs
- Emission: (kg GHG) / (LCD/OLED/PDP m²)

Designed Research Form

Research Samples in Display Industry

Item	Value	Unit	Item	Value	Unit
Utilization Rate		%	Byproduct Energy	:	:
Raw Material	Raw Material 1	m ² /production-m ²	Technology Life Span		year
	:	:	Economic Life Span		year
Main Product			Investment Costs		1,000won/capacity-m ²
Production Amount of Main Product		m ² /year	Fixed Maintenance Costs		1,000won/capacity-m ² -year
Other Product	:		Variable Maintenance Costs		1,000won/capacity-m ² -year
Energy Consumption	Electricity	GJ/production-m ²	GHG Emission	Fuel Combustion	kgCO ₂ e/production-m ²
	Steam	GJ/production-m ²		Industrial Process	kgCO ₂ e/production-m ²
	Total	GJ/production-m ²		Total GHG	kgCO ₂ e/production-m ²

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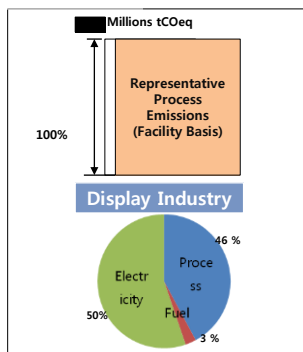
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2. Display Industry

II. Constructing Energy/GHG Database

- Representative Process & Target Products were Selected by Energy Consumption/GHG Emissions, and Products' Industrial Representation Criteria.

- 2010 Data



Representative Process	LCD, OLED, PDP Producing Process
Target Products	LCD, OLED, PDP
Process/Fuel/Electricity	46% / 3% / 50%

Research Steps of Existing Technologies/Utilities

Research Format

- Writing Out Process Concepts Per Each Display Product
- Updating Supply Status and Characteristic Data

Target Companies

- Distributing Surveys to All 4 Companies Which Account For Total Greenhouse Gas Emissions in Display Industry

Consulted with Association

- < Korea Display Industry Association >
 - Clarifying Target Products
 - Correcting Companies' Information
 - Discussing Trends of GHG Reduction Technologies in Display Industry
 - Sorting Companies According to the Process Emissions
 - Revising Research Items

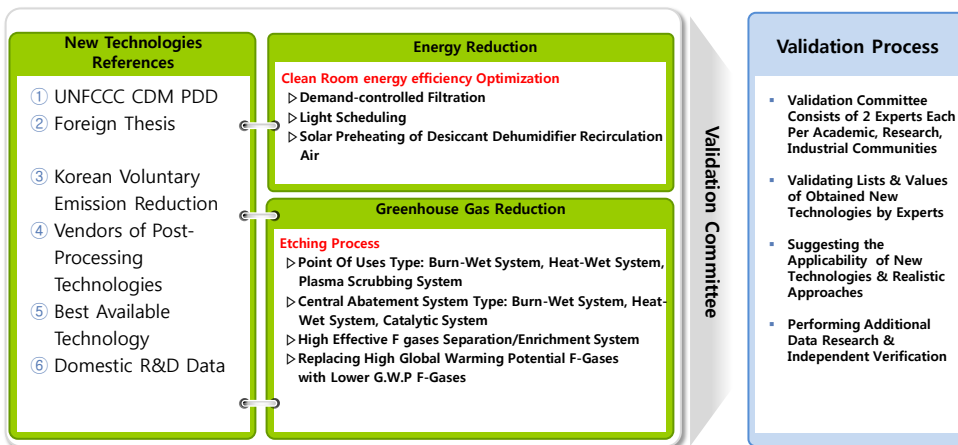
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2. Display Industry

II. Constructing Energy/GHG Database

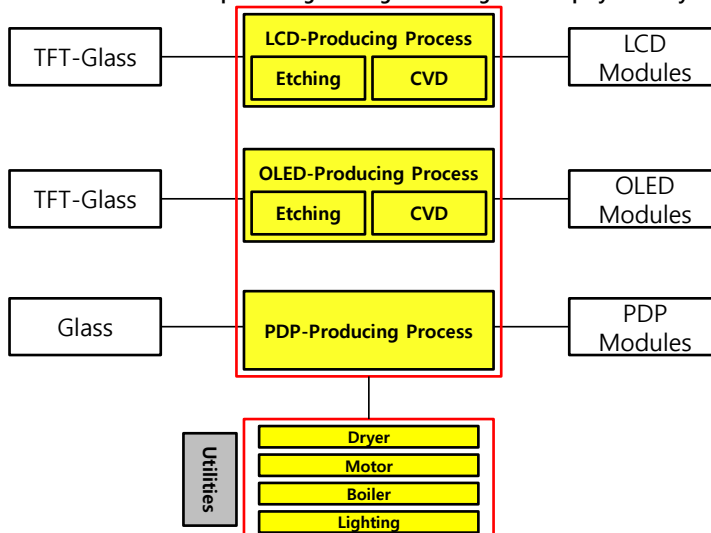
- References & Contents of New Technologies in Display Industry are Listed Below.
 - These Technologies were Reviewed by Validation Committee.



2. Display Industry

II. Constructing Energy/GHG Database

- Below is the Finalized Processes Representing Existing Technologies in Display Industry.



2. Display Industry

II. Constructing Energy/GHG Database

Below is the Finalized Energy/GHG Reduction Technologies by Corresponding Existing Technologies.

✓ Energy & Industrial Process Sector

NO	Energy/GHG Reduction Technologies	Corresponding Existing Technologies	GHG Reduction(%)	Adopting Time(Year)
1	Burn-Wet System for PFCs, SF6 Abatement - POU Type	LCD Etching Process	████	████
2	Heat-Wet System for SF6 Abatement - POU Type	LCD Etching Process	████	████
3	Plasma Scrubbing System for PFCs, SF6 Abatement - POU Type	LCD Etching Process	████	████
4	Burn-Wet System for PFCs, SF6 Abatement - CAS Type	LCD Etching Process	████	████
5	Heat-Wet System for SF6 Abatement - CAS Type	LCD Etching Process	████	████
6	Plasma Scrubbing System for PFCs, SF6 Abatement - CAS Type	LCD Etching Process	████	████
7	High-Effective F gases Separation/Enrichment System	LCD Etching Process	████	████
8	Replacing High G.W.P. F-Gases with Lower G.W.P F-Gases	LCD Etching Process	████	████
9	Optimization of Clean Room Energy Efficiency (Demand-controlled Filtration, Light scheduling, Solar Preheating)	LCD-Producing Process /OLED-Producing Process	████	████

3. Electric & Electronic Industry

II. Constructing Energy/GHG Database

Products & Products' Classification Table in Electric & Electronic Industry are written as below.

✓ Products' Classification Table

Category	Division	Section
Electrical and Electronic Equipment (13)	Electronic Machinery and Equipment (42)	Generators, Motors & Transformers (096)
		Other Electrical Equipment (097)
	Electronic parts (43)	Electronic Display Devices (098)
		Semiconductor (099)
		Other Electronic Parts (100)
	Video, sound and communication equipment (44)	Video and Sound Equipment (101)
		Communication and Broadcasting Equipment (102)
	Computers and Office Equipment (45)	Computer and Peripherals (103)
		Office Equipment (104)
	Consumer Electrical Equipment (46)	Electric Household Appliances (105)

✓ General Products

Category	Product	Explanation
Electric & Electronic	PCB	▷ PCB stands for Printed Circuit Board ▷ Type: PCB for mobile phone, Module/Other, BGA(Ball Grid Array), HDI(High Density Interconnect)
	Battery	▷ Type: Battery for cars, Secondary Battery, Storage Battery
	Capacitor	▷ Type: Electronic Capacitors/Aluminum Electrolytic Capacitor, MLCC(Multi-Layer Ceramic Capacitor)
	Other Electronics	▷ Type: TV SET, Microwave, Refrigerator Compressor, Refrigerator, Air Conditioner, Washing Machine, Air Conditioner Compressor, Mobile Phone, Optical Storage(DVD, NAS), Home Entertainment(Security/Car/TV/AV), Cellular Phone, Vacuum Cleaner, Compressor etc

✓ Gas Insulated Switchgear

Category	Product	Explanation
GIS	GIS Above 30kV	▷ Type: 765kV, 345kV, 154kV, 66kV GIS
	GIS Below 30kV	▷ Type: 22kV GIS Overhead Line, 22kV GIS Underground Line

① For Energy/GHG Database in Electric & Electronic Industry, General Products are Divided into 4 Types.

② Additionally, Gas Insulated Switchgear is Researched for F-Gas Uses.

3. Electric & Electronic Industry

II. Constructing Energy/GHG Database

- Process Technologies in Electric & Electronic Industry are classified as below.

Matching Processes with Products

Measuring, Reporting, & Verification Manuals

- Studying on Standardized Manual of MRV Procedures for Electric & Electronic Industry
- Analyzing relevant Processes and Technologies

Companies Under Target Management Scheme

- Researched Product Types of Companies Under Target Management Scheme
- Companies were Divided into 4 & 2 Categories According to the Product Types

Korea Electronics Association

- Consulted with Process Experts about Structuring Technology Lists
- Determined the Finalized Structure of Process Lists with Product Types

General Products

Process	Product	Detail
PCB-Producing	PCB	▷ Drill, Photo, Plating, PSR(Photo Imageable Solder Resist), Print, Marking Print, Surface treatment, External Processing, Inspection ▷ Associated with Clean Room Process
Battery-Producing	Battery	▷ Mixing process, Coating process, ROLL Pressing process, Slitting process, Punching process, Vacuum dry process, Assembly process, Folding & lot no. marking system, Discharge (Formation) & Grading process, Packaging and Shipment
Capacitor-Producing	Capacitor	▷ Aluminum etching foil, Forming, Foil slitter, Winding, Lead wire, separator, Foaming and carbonization, immersion & assembly, Polymerized conducting polymer, AL-case, rubber, Aging & inspection
Other Electronics-Producing	Other Electronics	▷ TV SET, Microwave, Refrigerator Compressor, Refrigerator, Air Conditioner, Washing Machine, Air Conditioner Compressor, Mobile Phone, Optical Storage(DVD, NAS), Home Entertainment(Security/Car/TV/AV), Cellular Phone, Vacuum Cleaner, Compressor etc Producing Process

Gas Insulated Switchgear

Process	Product	Detail
GIS Above 30kV -Producing	GIS Above 30kV	▷ 765kV, 345kV, 154kV, 66kV GIS-Producing Process
GIS Below 30kV -Producing	GIS Below 30kV	▷ 22kV GIS Overhead Line, 22kV GIS Underground Line-Producing Process

3. Electric & Electronic Industry

II. Constructing Energy/GHG Database

- Selection of Representative Indicators and Research Samples in Electric & Electronic Industry is shown below.

Selection of Representative Indicators

Electric & Electronic Industry

- PCB Unit Area Production/Battery Unit Production/Capacitor 1,000 Unit Production /Other Electronics Unit Production → Amount & Type of Raw Materials and Energy
- PCB/Battery/Capacitor/Other Electronics Production Volume/Capacity → Investment/Fixed/Variable Costs
- Emission: (kg GHG) / (PCB m²/Batter Unit/Capacitor 1,000 Unit/Other Electronics Unit)

Designed Research Form

Research Samples in Electric & Electronic Industry

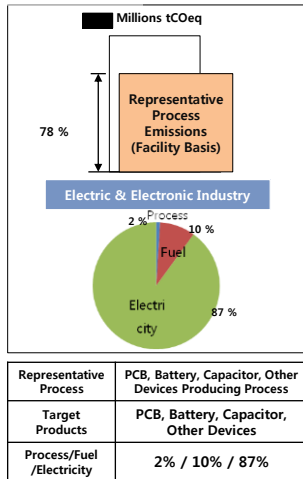
Item	Value	Unit	Item	Value	Unit
Utilization Rate		%	Byproduct Energy	:	:
Raw Material	Raw Material 1	m ² /production-unit	Technology Life Span		year
	:	:	Economic Life Span		year
Main Product			Investment Costs		1,000won/capacity-unit
Production Amount of Main Product		m ² /year	Fixed Maintenance Costs		1,000won/capacity-unit-year
Other Product	:		Variable Maintenance Costs		1,000won/capacity-unit-year
Energy Consumption	Electricity	GJ/production-unit	GHG Emission	Fuel Combustion	kgCO ₂ eq/production-unit
	Steam	GJ/production-unit		Industrial Process	kgCO ₂ eq/production-unit
	Total	GJ/production-unit		Total GHG	kgCO ₂ eq/production-unit

3. Electric & Electronic Industry

II. Constructing Energy/GHG Database

- Representative Process & Target Products were Selected by Energy Consumption/GHG Emissions, and Products' Industrial Representation Criteria.

• 2010 Data



Research Steps of Existing Technologies/Utilities

Research Format

- Writing Out Process Concepts Per Each Electric & Electronic Product
- Updating Supply Status and Characteristic Data

Target Companies

- Distributing Surveys to Top 5 Companies Which Account For 78% of Total Greenhouse Gas Emissions in Electric & Electronic Industry

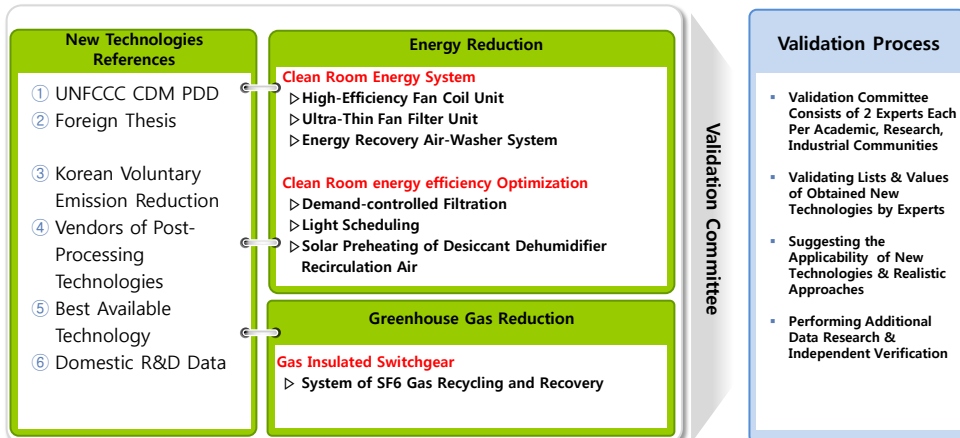
Consulted with Association

- < Korea Electronics Association >
 - Clarifying Target Products
 - Correcting Companies' Information
 - Discussing Trends of GHG Reduction Technologies in Semiconductor Industry
 - Sorting Companies According to the Process Emissions
 - Revising Research Items

3. Electric & Electronic Industry

II. Constructing Energy/GHG Database

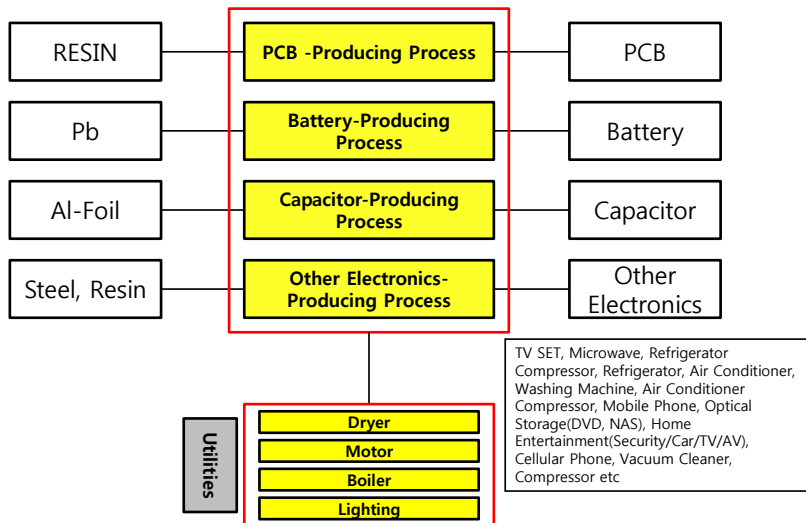
- References & Contents of New Technologies in Electric & Electronic Industry are Listed Below.
- These Technologies were Reviewed by Validation Committee.



3. Electric & Electronic Industry

II. Constructing Energy/GHG Database

Below is the Finalized Processes Representing Existing Technologies in Electric & Electronic Industry.



3. Electric & Electronic Industry

II. Constructing Energy/GHG Database

Below is the Finalized Energy/GHG Reduction Technologies by Corresponding Existing Technologies.

NO	Energy/GHG Reduction Technologies	Corresponding Existing Technologies	GHG Reduction(%)	Adopting Time(Year)
1	System of SF6 Gas Recycling and Recovery	GIS Above 30kV	████	████
2	System of SF6 Gas Recycling and Recovery	GIS Below 30kV	████	████
3	High-Efficient Fan Coil Unit	PCB-Producing Process	████	████
4	Ultra-Thin Fan Filter Unit	PCB-Producing Process	████	████
5	Energy-Recovery Air-Washer System	PCB-Producing Process	████	████
6	Optimization of Clean Room Energy Efficiency (Demand-controlled Filtration, Light scheduling, Solar Preheating)	PCB-Producing Process	████	████

