TAIPEI TECH 國立臺北科技大學 National Taipei University of Technology

Life Cycle Assessment for ATM Control Board Product

NTUT IEEM

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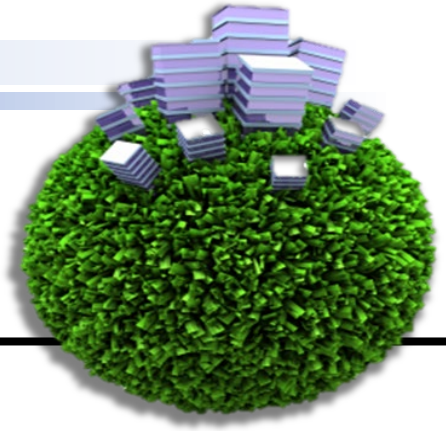
永續創新與評估中心

Sustainability, Innovation and Assessment Center (SIAC)



Project Description

Project Description

- **Project Objectives**

  USI Green Product Lifecycle Assessment and Counseling – ATM Control Board Study

- **Project Implementation Framework**

  The Green Product Lifecycle Assessment and Counseling Project is planned for one year, with the goal of promoting the establishment of product LCA, and at the same time, through counseling and training, strengthening the ability to implement product LCA, to fulfill the corporate social responsibility, to give full play to the influence of the semiconductor industry, and to improve the performance of international sustainability questionnaires (e.g., DJSI, CDP, etc.).

- **Anticipated Benefits**

  1) Perform life cycle assessment on the target product to assist the investment control subsidiary to more comprehensively identify the environmental impacts associated with the product production process, as well as to identify improvement hotspots in the production process, and to fulfill its corporate social responsibility.
  2) Through this year's project work program, not only can we achieve further exchanges between the industry and the academia, but we can also combine academic theories to meet the needs of the commissioning unit.

ATM Control Board Environmental impact implementation process

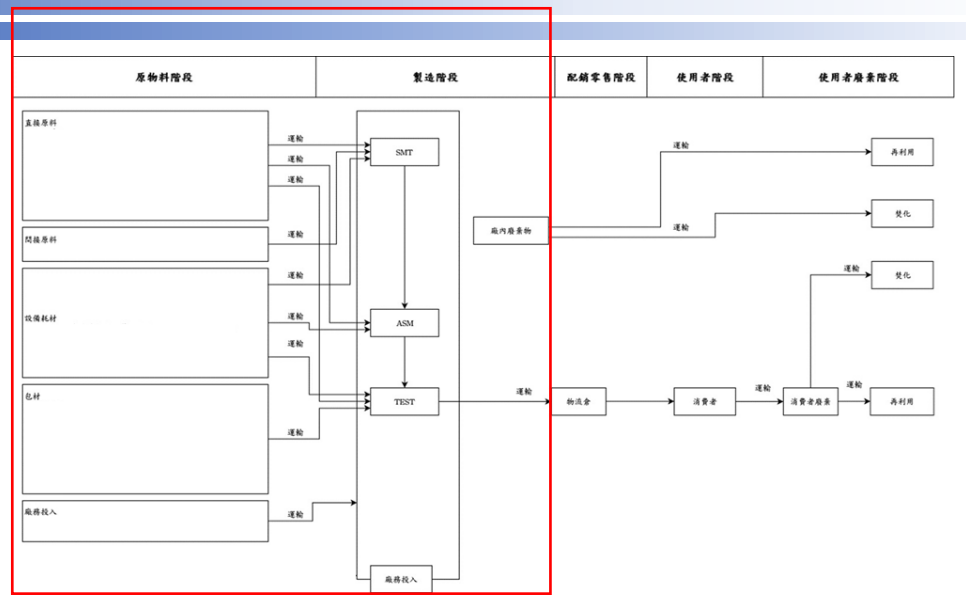
Research Target

Target Product	**ATM Control Board**
Functional unit	**The production of one ATM Control Board product**
System Boundary	B2B(Raw materials, manufacturing, waste)
Software	SimaPro 9.5.0.2
Database Use	Ecoinvent 3.9
Inventory Data	USI provides data on energy inputs, and the data collection period is one year.
Carbon Footprint	IPCC 2021 GWP100a
Environmental impact	ReCiPe Midpoint & Endpoint

ATM Control Board Environmental Impact Implementation Process

System Boundary

- Includes wastes from the raw material stage, the manufacturing stage, and the production stage.



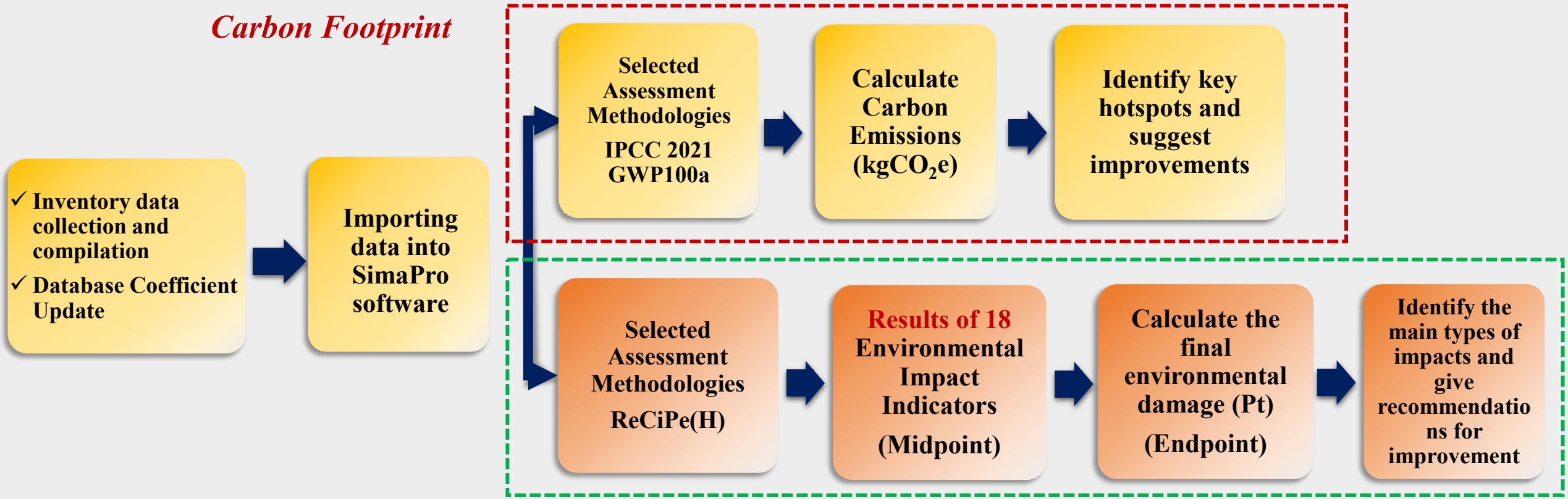
Inventory Data

- **2023/01/01~2023/12/31**

Stages	Use of Information	Source	Allocation
Raw material stage	Raw Material Activity Data	SAP、OA、Replacement of Records	1.Unallocated 2. Allocation by production volume 3. Allocation by workshop production volume 4. Allocation by factory production volume
	Transportation Distance, Vehicle Type	Supplier Information、Google Map、ELCD、ICAO	
Manufacturing stage	Resources	Electricity Bills, Greenhouse Gas Inventory Data, Meter Reading Records	Product output/Total output of factory
Waste Stage	Waste	Statistical Tables, Weigh Bills, Coupons	Product quantity allocation
	Transportation Distance, Vehicle Type	Supplier Information、Google Map	

ATM Control Board Impact Assessment Execution Process

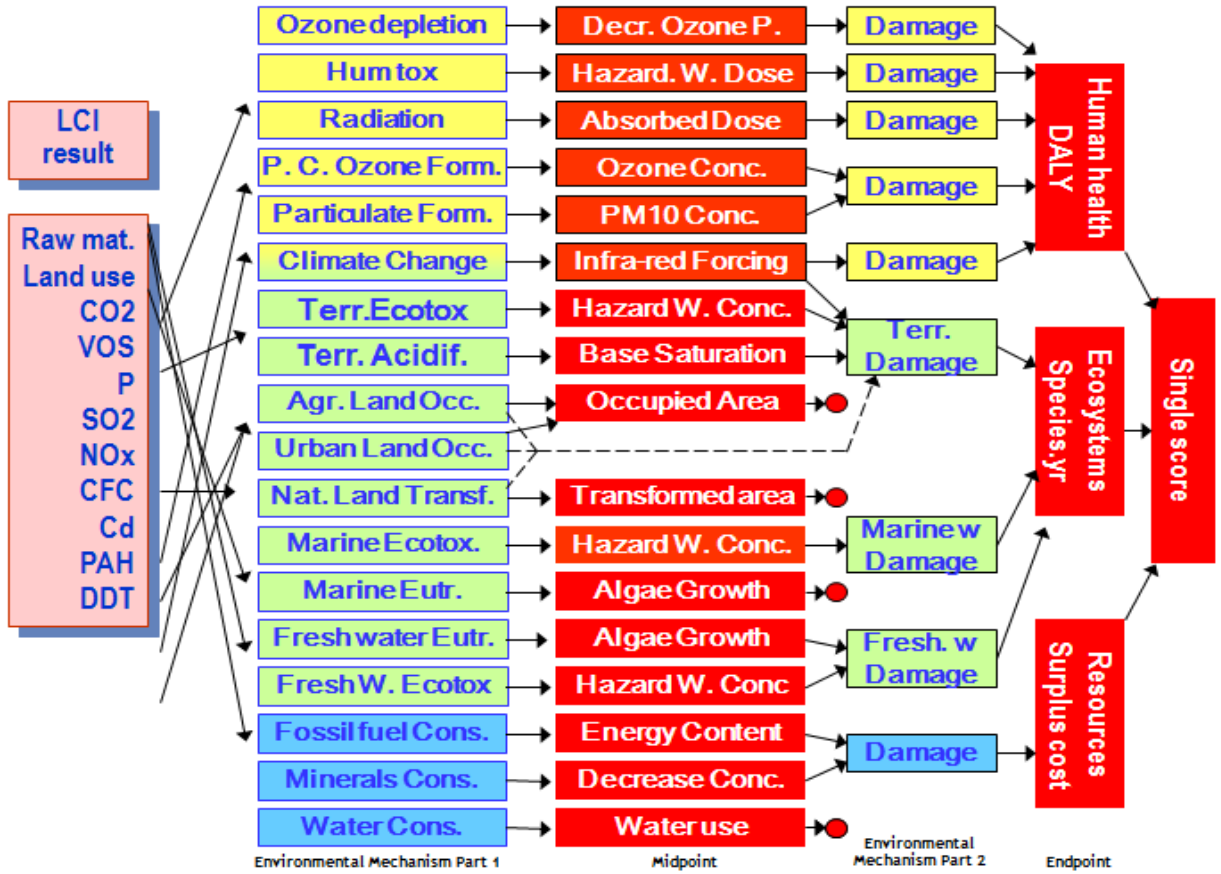
Carbon Footprint＆Environmental Impact

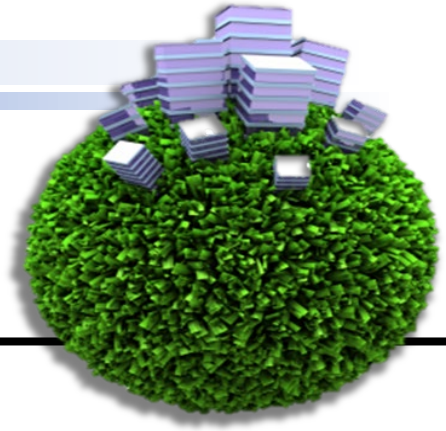


ATM Control Board Selection of Environmental Impact Methods

ReCiPe methodologies

- ReCiPe is a methodology developed based on two existing methods, CML 2001 and Eco-indicator 99, making it one of the relatively newer environmental impact assessment methods (Goedkoop et al., 2013). ReCiPe encompasses the most extensive range of environmental impact categories among current existing methods (Heinonen et al., 2016) and can be used for comparative analyses of various environmental impact and damage categories (Korol et al., 2016).
- A significant feature of the ReCiPe methodology is that the normalization factors between midpoint and endpoint methods are consistent. Therefore, when evaluating damage results, the ReCiPe life cycle impact assessment method is recommended for use (Dong and Ng, 2014).



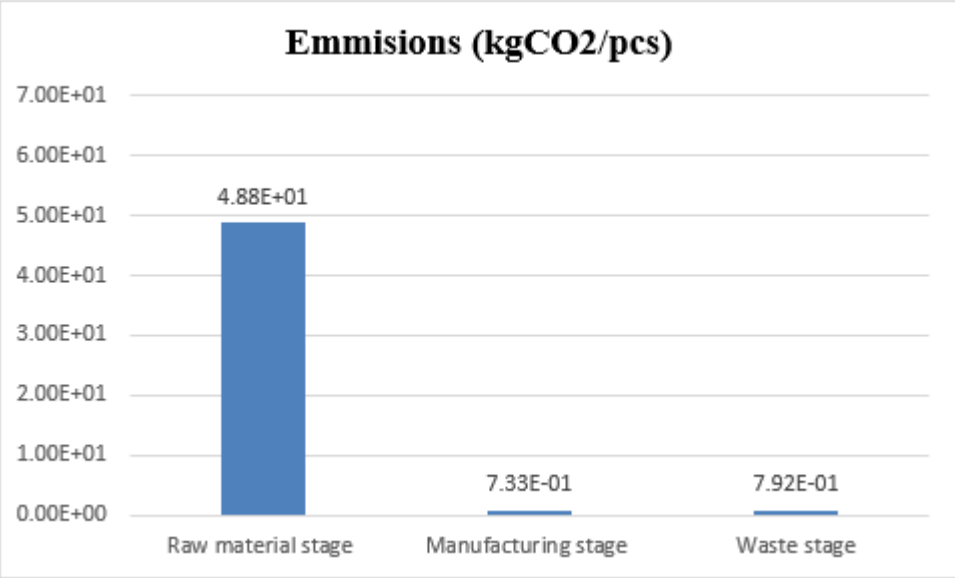


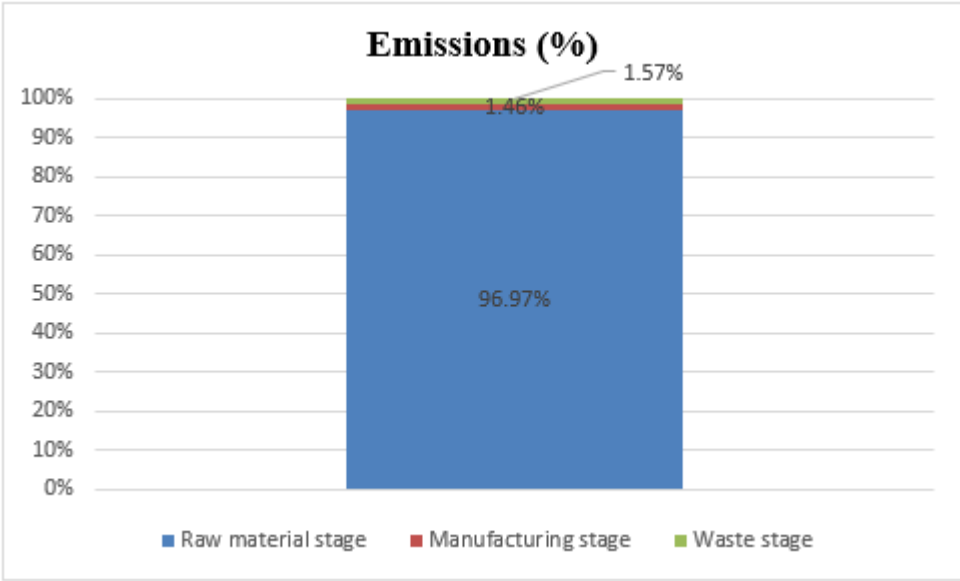
ATM Control Board Carbon Footprint Assessment Results

ATM Control Board Carbon Footprint Assessment Results

Carbon Footprint Assessment Results

- ✓ Using the life cycle assessment software SimaPro and the IPCC 2021 100a methodology, we examined the carbon emissions of ATM Control Board products and found that the total carbon emissions were 50.3 kgCO2e/pcs.
- ✓ The raw material stage (48.8 kgCO2e/pcs) has a higher carbon footprint than the manufacturing stage (0.733 kgCO2e/pcs).





ATM Control Board Carbon Footprint Assessment Results

Critical Material

✓ Connector used in Raw materials processes is a major hotspot for carbon emissions.

➢ **Top five hot spots for products**

Categorization	Name	Carbon footprint ($kgCO_2e$/pcs)
Manufacturing	Electricity	6.30E-01
Manufacturing	Nitrogen	1.03E-01
Raw materials	PCB	4.33E+00
Raw materials	Connector	4.54E+00
Raw materials	Connector	2.27E+00

➢ **Raw materials**

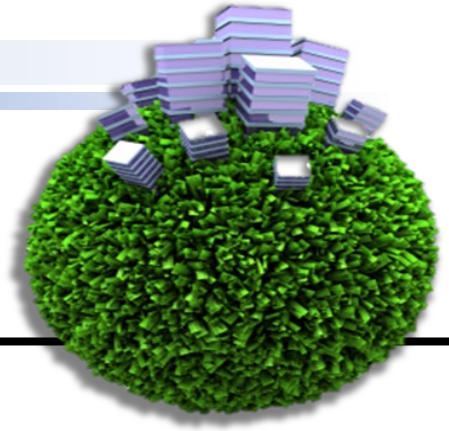
Categorization	Name	Carbon footprint ($kgCO_2e$/pcs)
Raw materials	PCB	4.33E+00
Raw materials	Connector	4.54E+00
Raw materials	Connector	2.27E+00

➢ **Manufacturing**

Categorization	Name	Carbon footprint ($kgCO_2e$/pcs)
Manufacturing	Electricity	6.30E-01
Manufacturing	Nitrogen	1.03E-01
Manufacturing	Use water	4.06E-06

➢ **Waste**

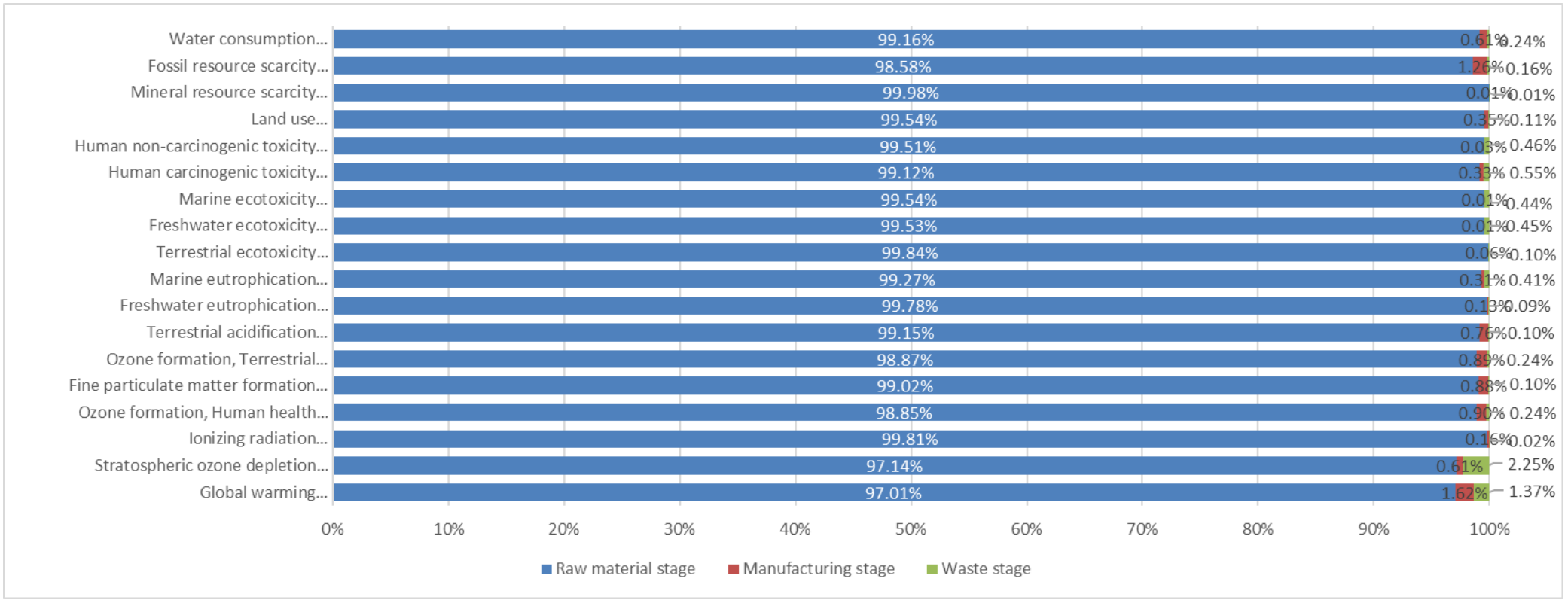
Categorization	Name	Carbon footprint ($kgCO_2e$/pcs)
Waste	"ESD Anti-static Gloves F02-01-05-0000131"	9.35E-03
Waste	"Steel mesh wiping paper (F04-01-13-0000251)"	5.08E-01
Waste	"Stencil Wiping Paper (F04-01-01-0002351)"	2.27E-01



ATM Control Board
Environmental damage assessment results

ATM Control Board -Midpoint

ATM Control BoardLife cycle assessment results (Midpoint)



ATM Control Board -Endpoint

Midpoint			Normalization			Weighting				Endpoint	
Impact category	Unit	Characterization	Unit	Weight	standardization	Unit	Weight	Damage	Proportion		
Global warming, Human health	DALY	5.38E-05	Pt	41.7	2.24E-03	Pt	300	6.73E-01	9.90%	Human health	Single score
Stratospheric ozone depletion	DALY	1.86E-08	Pt	41.7	7.75E-07	Pt	300	2.33E-04	0.00%		
Ionizing radiation	DALY	5.13E-08	Pt	41.7	2.14E-06	Pt	300	6.42E-04	0.01%		
Ozone formation, Human health	DALY	2.56E-07	Pt	41.7	1.07E-05	Pt	300	3.20E-03	0.05%	6.61E+00	
Fine particulate matter formation	DALY	9.96E-05	Pt	41.7	4.15E-03	Pt	300	1.25E+00	18.32%		
Human carcinogenic toxicity	DALY	2.95E-05	Pt	41.7	1.23E-03	Pt	300	3.69E-01	5.43%		
Human non-carcinogenic toxicity	DALY	3.45E-04	Pt	41.7	1.44E-02	Pt	300	4.31E+00	63.40%		
Water consumption, Human health	DALY	9.91E-07	Pt	41.7	4.13E-05	Pt	300	1.24E-02	0.18%		
Global warming, Terrestrial ecosystems	species.yr	1.62E-07	Pt	676	1.10E-04	Pt	400	4.39E-02	0.65%		
Global warming, Freshwater ecosystems	species.yr	4.44E-12	Pt	676	3.00E-09	Pt	400	1.20E-06	0.00%		
Ozone formation, Terrestrial ecosystems	species.yr	3.71E-08	Pt	676	2.51E-05	Pt	400	1.00E-02	0.15%		
Terrestrial acidification	species.yr	8.18E-08	Pt	676	5.53E-05	Pt	400	2.21E-02	0.33%		
Freshwater eutrophication	species.yr	9.90E-08	Pt	676	6.69E-05	Pt	400	2.68E-02	0.39%	Ecosystems	
Marine eutrophication	species.yr	6.88E-12	Pt	676	4.65E-09	Pt	400	1.86E-06	0.00%	1.36E-01	
Terrestrial ecotoxicity	species.yr	1.34E-08	Pt	676	9.04E-06	Pt	400	3.61E-03	0.05%		
Freshwater ecotoxicity	species.yr	6.04E-08	Pt	676	4.09E-05	Pt	400	1.63E-02	0.24%		
Marine ecotoxicity	species.yr	1.21E-08	Pt	676	8.21E-06	Pt	400	3.29E-03	0.05%		
Land use	species.yr	2.85E-08	Pt	676	1.92E-05	Pt	400	7.70E-03	0.11%		
Water consumption, Terrestrial ecosystem	species.yr	6.59E-09	Pt	676	4.46E-06	Pt	400	1.78E-03	0.03%		
Water consumption, Aquatic ecosystems	species.yr	6.58E-13	Pt	676	4.45E-10	Pt	400	1.78E-07	0.00%		
Mineral resource scarcity	$	1.13E+00	Pt	3.57E-05	4.03E-05	Pt	300	1.21E-02	0.18%	Resources	
Fossil resource scarcity	$	3.37E+00	Pt	3.57E-05	1.20E-04	Pt	300	3.60E-02	0.53%	4.81E-02	

ATM Control Board Environmental impact sequence & key raw material sequence at each stage

➢ Environmental impact sequence

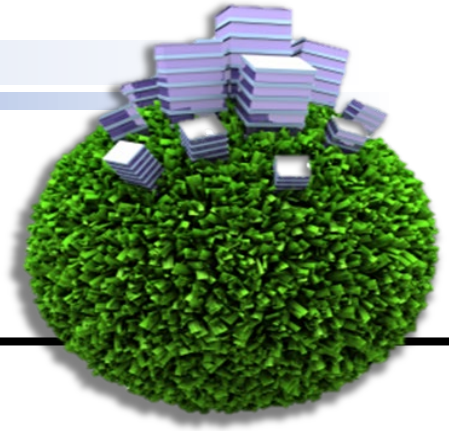
ReCiPe(H)-Full life cycle stage	
Environmental impact (Percentage of damage)	Priority
	ATM Control Board
Fine particulate matter formation	2 1.25E+00 Pt (18.32%)
Global warming, Human health	3 6.73E-01 Pt (9.90%)
Human non-carcinogenic toxicity	1 4.31E+00 Pt (63.40%)
Human carcinogenic toxicity	4 3.69E-01 Pt (5.43%)

➢ Sequencing of key raw materials at each stage

ATM Control Board

Raw material number	Raw material classification	Raw material name	Final damage value	Proportion
Process	Process investment	Electricity	2.34E+00	99.85%
M58	Direct raw materials	FUSE	1.83E+00	21.39%
M257	Direct raw materials	Connector	5.71E-02	6.67%

✓ The key raw materials of ATM Control Board are mainly FUSE and the electricity used in the process.



Conclusion and Recommendation

Conclusion and Recommendation

➢ **Carbon Footprint**

✓ From the results of ATM Control Board Carbon Footprint Critical Raw Materials, power input in the manufacturing process is one of the hotspots.

✓ →It is recommended to reduce the proportion of traditional electricity input and increase the use of electricity (purchased green energy) in the manufacturing process to improve the damaging effects.

✓ In the ranking of critical raw materials (except for the process stage), PCB, Connector used in the raw material stage are the hotspots that affect carbon emissions.

✓ →It is recommended to optimize the ratio of inputs of these critical raw materials to strengthen raw material management and avoid unnecessary consumption, thus improving the environmental impact.

Conclusion and Recommendation

➢ **Environmental damage assessment**

✓ The results show that FUSE is the reason for the high environmental hazard value, so we can consider whether there are alternative materials to effectively reduce the environmental impact.

✓ Secondly, during the manufacturing stage of the production of packaged products, it is observed that the power supply has a soft multi-faceted environmental impact, and power supply optimization should be carried out step by step. Energy-saving technologies or equipment can be adopted, as well as green power policies.

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Thank you for your attention

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