



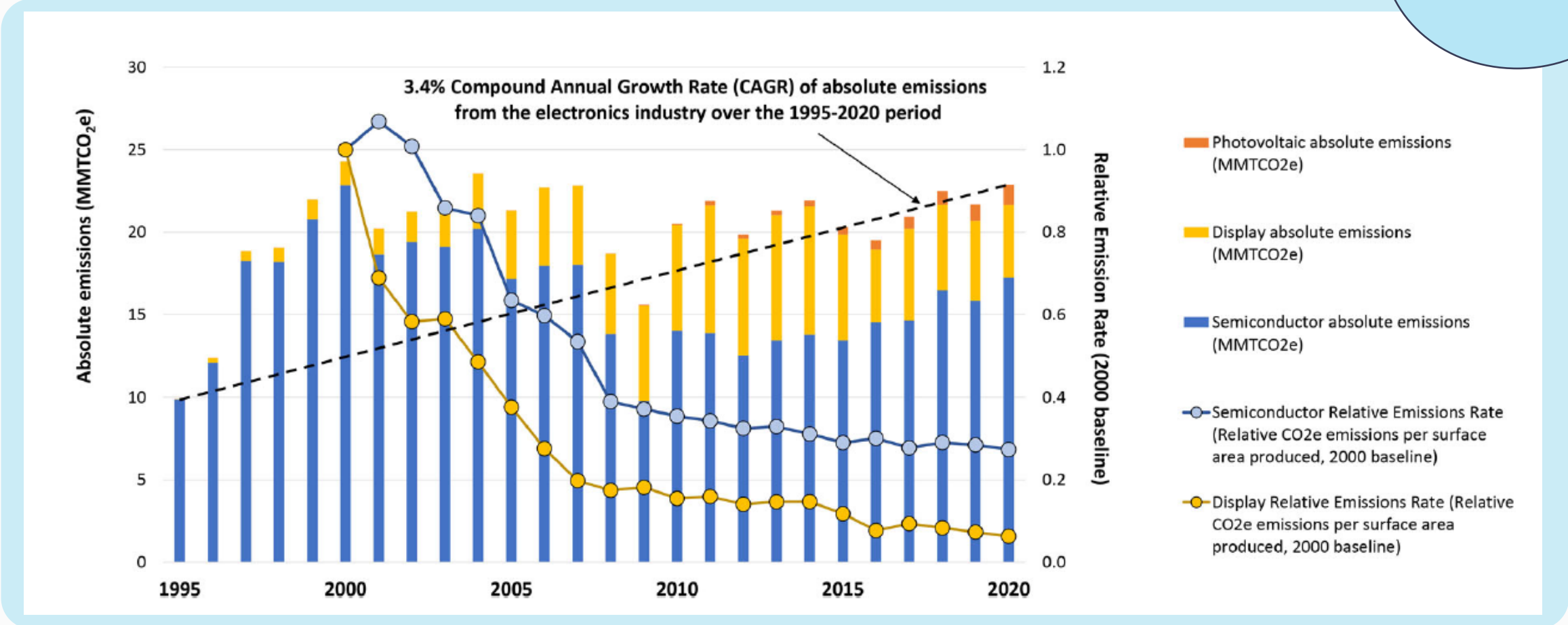
การจัดการคาร์บอนสำหรับอุตสาหกรรม
อิเล็กทรอนิกส์
Carbon management for the
electronics industry

BSI Thailand



Introduction – Carbon Management for the electronics industry

What is the impact of Net Zero?



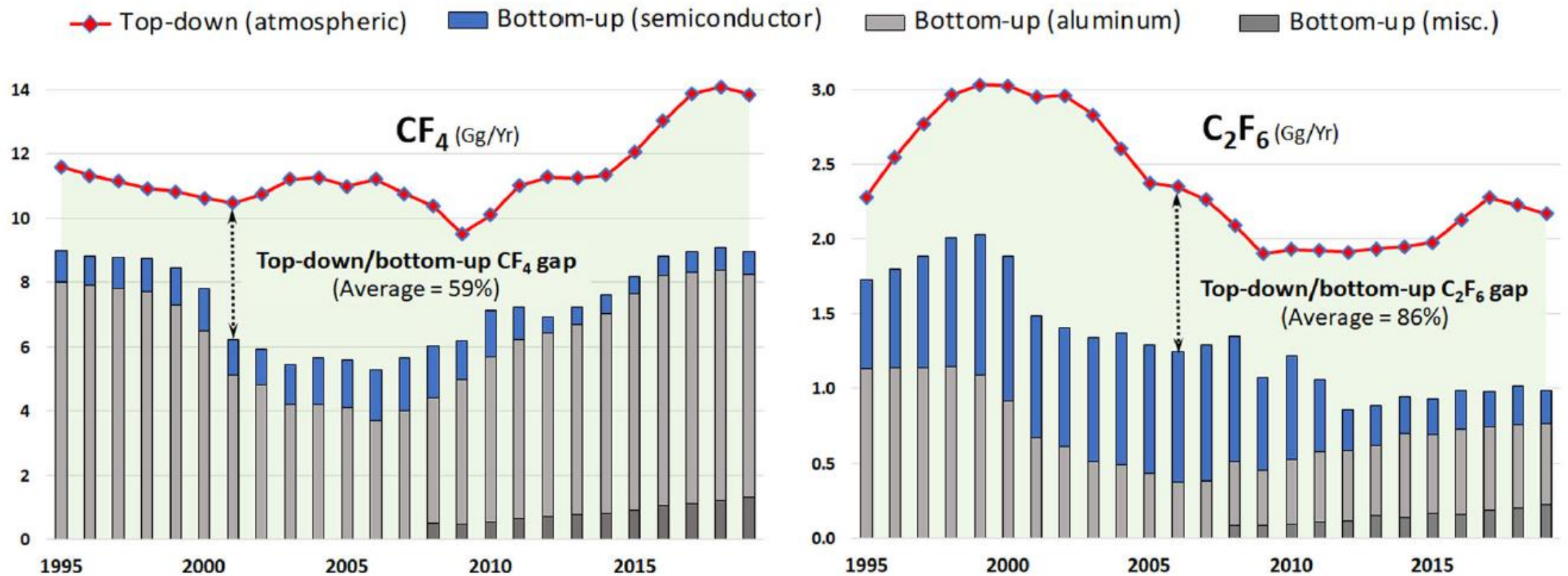
Source: Raoux, S. (2023). Fluorinated greenhouse gas and net-zero emissions from the electronics industry: the proof is in the pudding. Carbon management, 14(1), 2179941.



World Net Zero Target : 2050

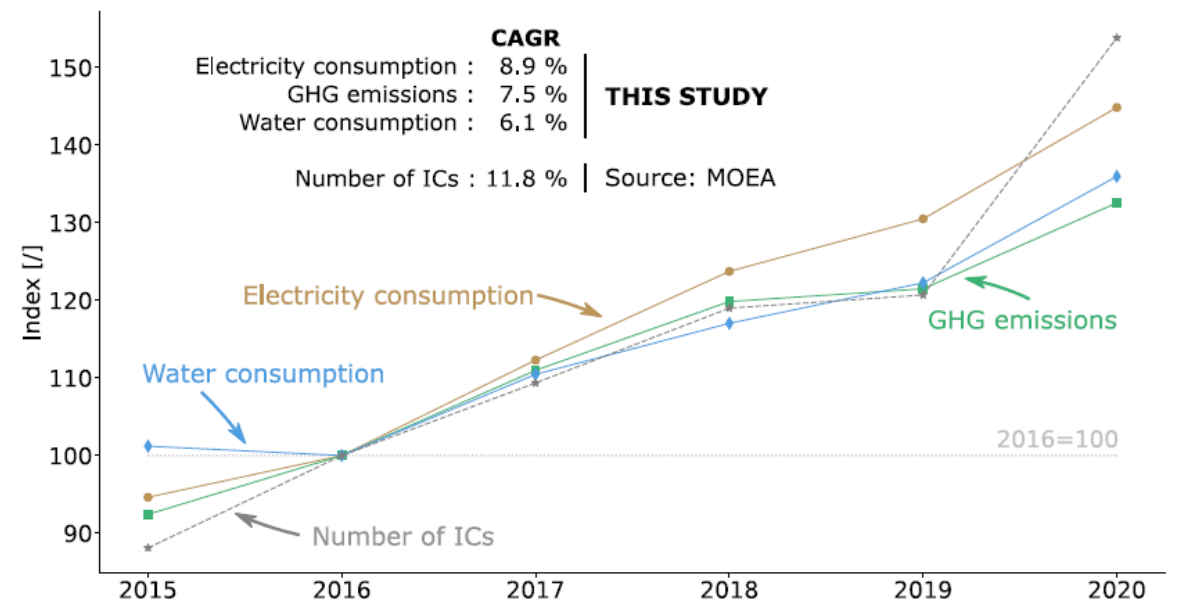
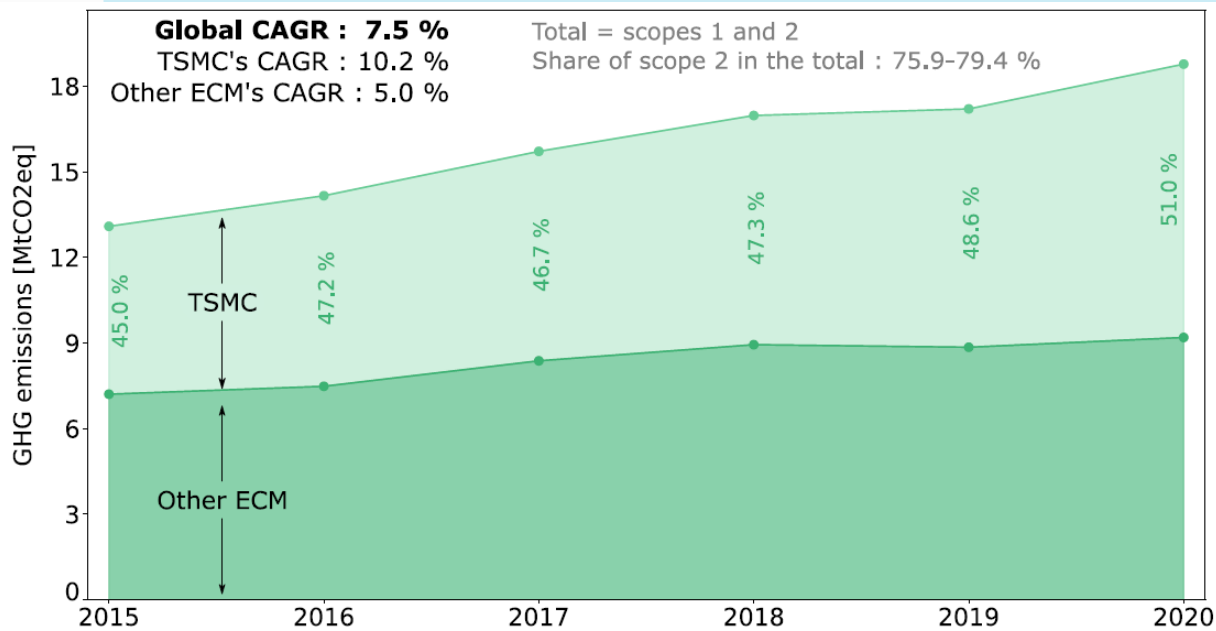
Thailand Net Zero Target : 2065

Introduction – Carbon Management for the electronics industry



Source: Raoux, S. (2023). Fluorinated greenhouse gas and net-zero emissions from the electronics industry: the proof is in the pudding. Carbon management, 14(1), 2179941.

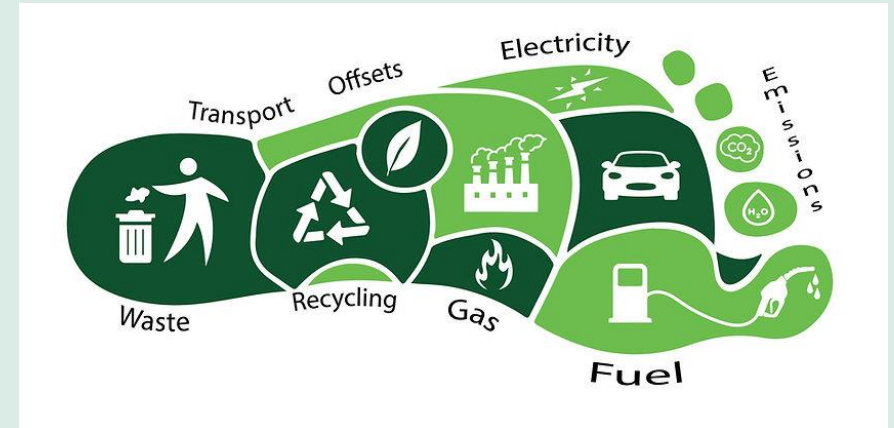
Introduction – Carbon Management for the electronics industry



Understanding Carbon Footprint

What is carbon footprint?

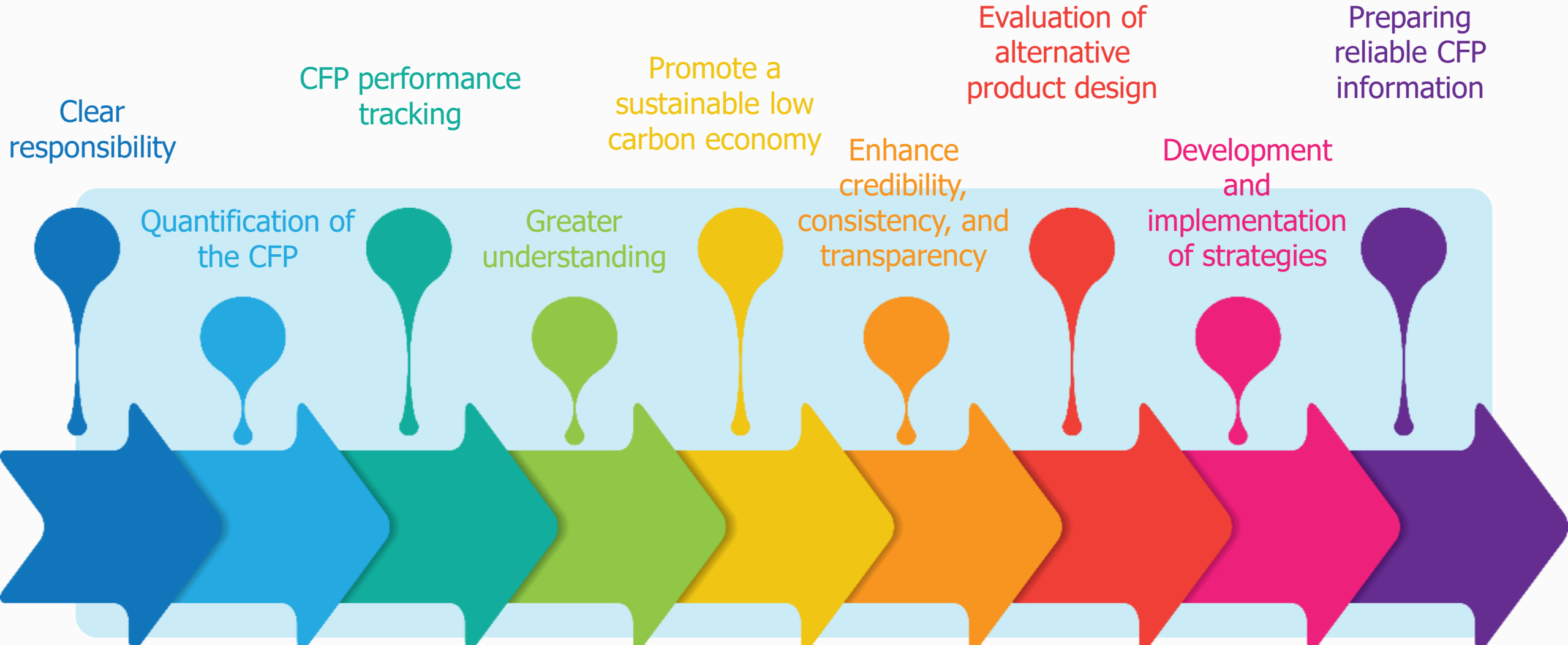
คาร์บอนฟุตพริ้นต์ คือ ผลรวมปริมาณการปล่อยก๊าซเรือนกระจกทั้งหมดที่กิจกรรม ผลิตภัณฑ์ องค์กร ปล่อยสู่ชั้นบรรยากาศ



[What Is A Carbon Footprint? \(plugitinsolar.com\)](https://plugitinsolar.com)

What is the important of carbon footprint ?

Understanding Carbon Footprint



Calculating the Carbon Footprint

ISO 14064-1



BSI Standards

Publication

Greenhouse gases
Part 1:
Specification with
guidance at the
organization level for
quantification and
reporting of greenhouse
gas emissions and
removals

bsi.

ISO 14067



BSI Standards

Publication

Greenhouse gases
Carbon footprint of
products –
Requirements and
guidelines for
quantification

bsi.



Examples specific to electronic industry

ประโยชน์

Environmental Impact Reduction:

Lower Emissions: Reducing the carbon footprint helps to minimize greenhouse gas (GHG) emissions associated with the production, use, and disposal of electronic products.

Resource Efficiency: Assessing the carbon footprint encourages the use of more sustainable materials and energy sources, leading to better resource efficiency and less environmental degradation.

Cost Savings:

Energy Efficiency: By focusing on reducing the carbon footprint, companies often find ways to improve energy efficiency, which can lead to substantial cost savings in manufacturing and operations.

Waste Reduction: Lowering the carbon footprint often involves optimizing processes to reduce waste, which can further decrease operational costs.

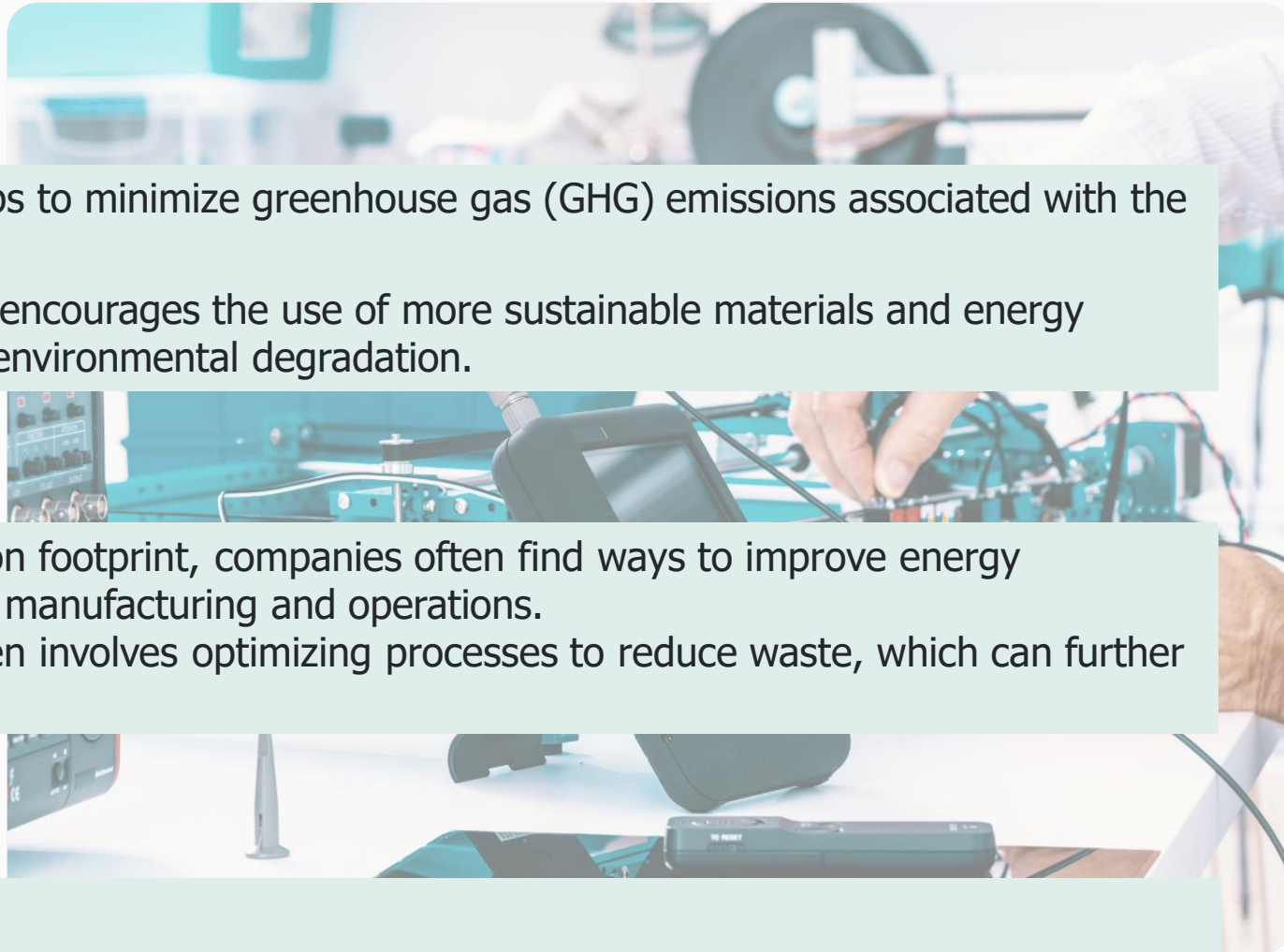
Regulatory Compliance:

Adherence to Standards:

Companies can ensure compliance with these regulations.

Preparedness for Future Legislation:

Having a low carbon footprint positions companies well to meet future regulatory requirements.



Examples specific to electronic industry

ประโยชน์

Market Advantage:

Consumer Preference: As consumers become more environmentally conscious, products with a lower carbon footprint can be more appealing. This can differentiate a company's products in a competitive market.

Brand Reputation: Companies that take proactive steps to reduce their carbon footprint can enhance their brand image and reputation, leading to increased customer loyalty.

Innovation and Competitiveness:

Driving Innovation: The challenge of reducing carbon emissions can spur innovation, leading to the development of new technologies, processes, and materials that are more sustainable.

Competitive Edge: Companies that lead in reducing their carbon footprint may gain a competitive edge by setting industry standards and attracting partnerships or investments focused on sustainability.

Supply Chain Optimization:

Sustainable Sourcing: Understanding the carbon footprint can lead to more sustainable supply chain practices, including sourcing materials from suppliers with lower carbon emissions.

Enhanced Collaboration: Companies can work with suppliers and partners to collectively reduce emissions, improving overall supply chain efficiency and sustainability.



Examples specific to electronic industry

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Long-term Sustainability:

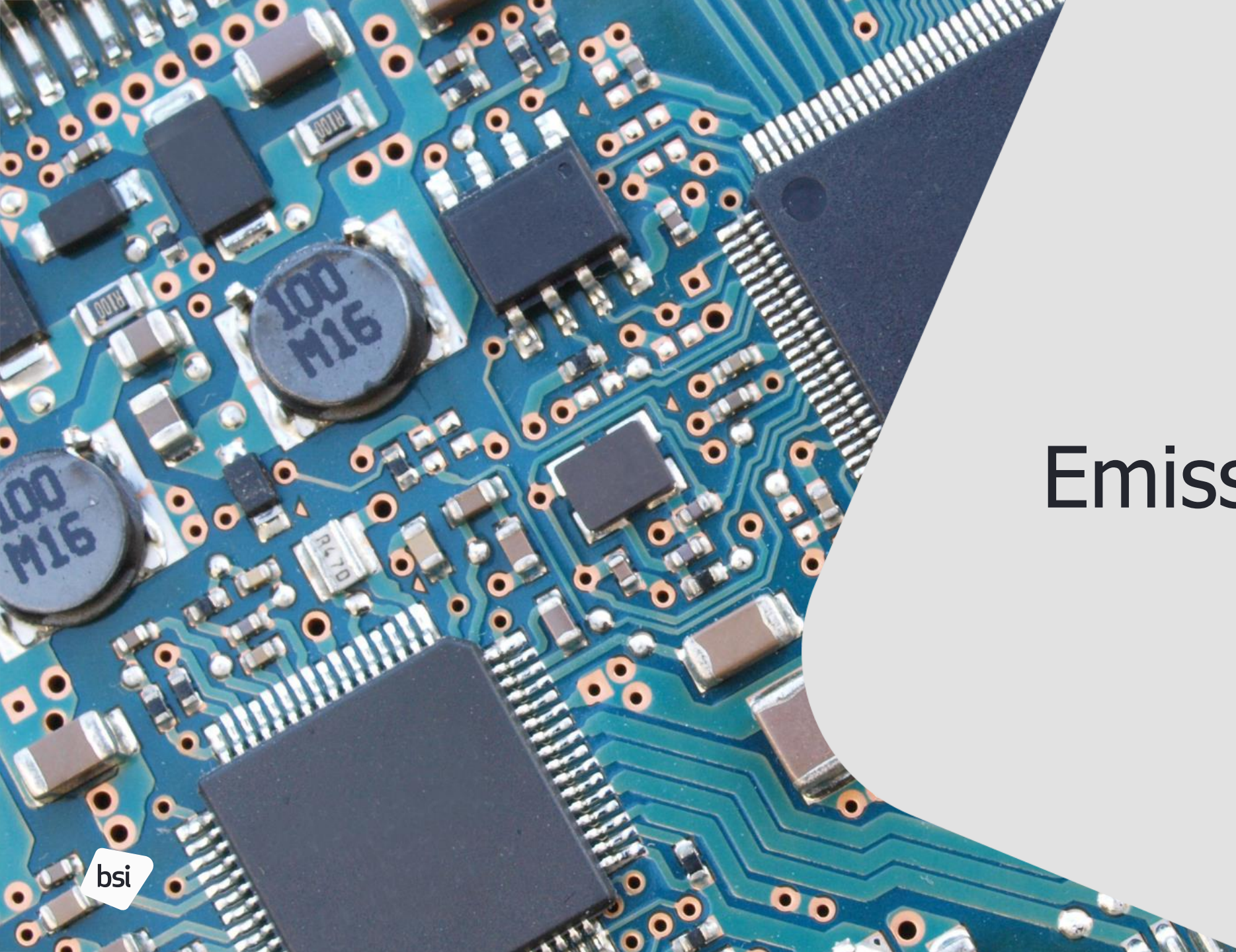
Future-proofing Business: Reducing carbon footprint contributes to the long-term sustainability of the electronic industry by mitigating the risks associated with climate change.

Corporate Social Responsibility (CSR): Demonstrating a commitment to reducing carbon emissions aligns with broader CSR goals, helping companies to build trust with stakeholders.

Financial Incentives:

Access to Green Funding: Companies that actively reduce their carbon footprint may have access to green bonds, grants, or other financial incentives designed to support environmentally friendly practices.

Carbon Credits: Companies can earn carbon credits by reducing their emissions, which can be traded or sold, providing an additional revenue stream.



Sources of Carbon Emissions in the Electronic Industry

Number of reporters and emissions in the electronics manufacturing sector (as of 8/18/2023), United States

GHG sources in electronic industry

This source category includes, but is not limited to, facilities that manufacture semiconductors (including light-emitting diodes), micro-electromechanical systems (MEMS), liquid crystal displays (LCDs), and photovoltaic cells (PV).

This subsector consists of electronics manufacturing facilities with production processes that use plasma-generated fluorine atoms and other reactive fluorine-containing fragments to etch thin films, clean chambers for depositing thin films, clean wafers, or remove residual material.

CO₂ emissions from the combustion of biomass are NOT included in emissions totals provided above.

Emissions of CO₂ and CH₄ are from stationary fuel combustion sources.

Total reported emissions are less than 0.05 million metric tons.



Electronics Manufacturing Sector - Greenhouse Gas Emissions Reported to the GHGRP												
(all emissions values presented in million metric tons CO ₂ e)												
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Number of facilities:	56	56	58	59	58	53	51	49	48	48	47	47
Total emissions (CO₂e):	7.0	6.4	5.2	6.2	6.3	6.2	6.1	6.5	6.0	6.0	6.4	6.2
Emissions by greenhouse gas (CO₂e)												
• Carbon dioxide (CO ₂):	1.6	1.5	0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.8	0.8	0.8
• Methane (CH ₄):	**	**	**	**	**	**	**	**	**	**	**	**
• Nitrous oxide (N ₂ O):	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.3
• Hydrofluorocarbons (HFCs):	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4
• Hydrofluoroethers (HFEs):	**	**	**	**	**	**	**	**	**	**	**	**
• Perfluorocarbons (PFCs):	3.2	2.8	2.7	3.0	3.0	2.9	2.9	3.1	2.7	2.7	2.8	2.9
• Sulfur hexafluoride (SF ₆):	0.3	0.3	0.3	0.7	0.7	0.8	0.7	0.8	0.7	0.7	0.9	0.7
• Nitrogen trifluoride (NF ₃):	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
• Other Fully Fluorinated GHGs:	0.7	0.8	0.6	0.8	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.4
• Very short-lived Compounds:	**	**	**	**	**	**	**	**	**	**	**	**



Main GHG types in electronic industry

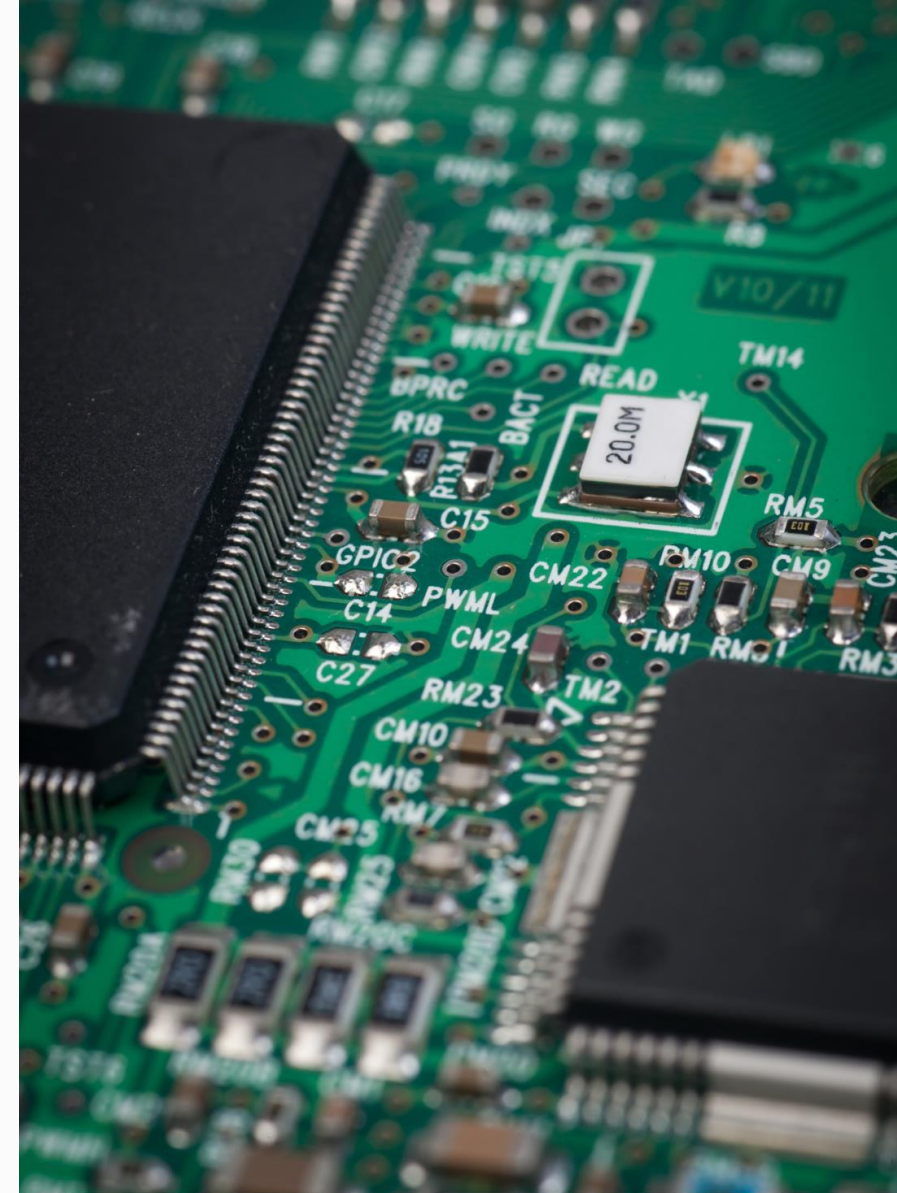
The electronics industry currently emits both FCs that are gases at room temperature and FCs that are liquids at room temperature.

- CF₄
- C₂F₆
- C₃F₈
- c-C₄F₈
- c-C₄F₈O
- C₄F₆
- C₅F₈
- CHF₃
- CH₂F₂
- nitrogen trifluoride (NF₃)
- sulfur hexafluoride (SF₆)

Two important steps of electronics manufacturing:

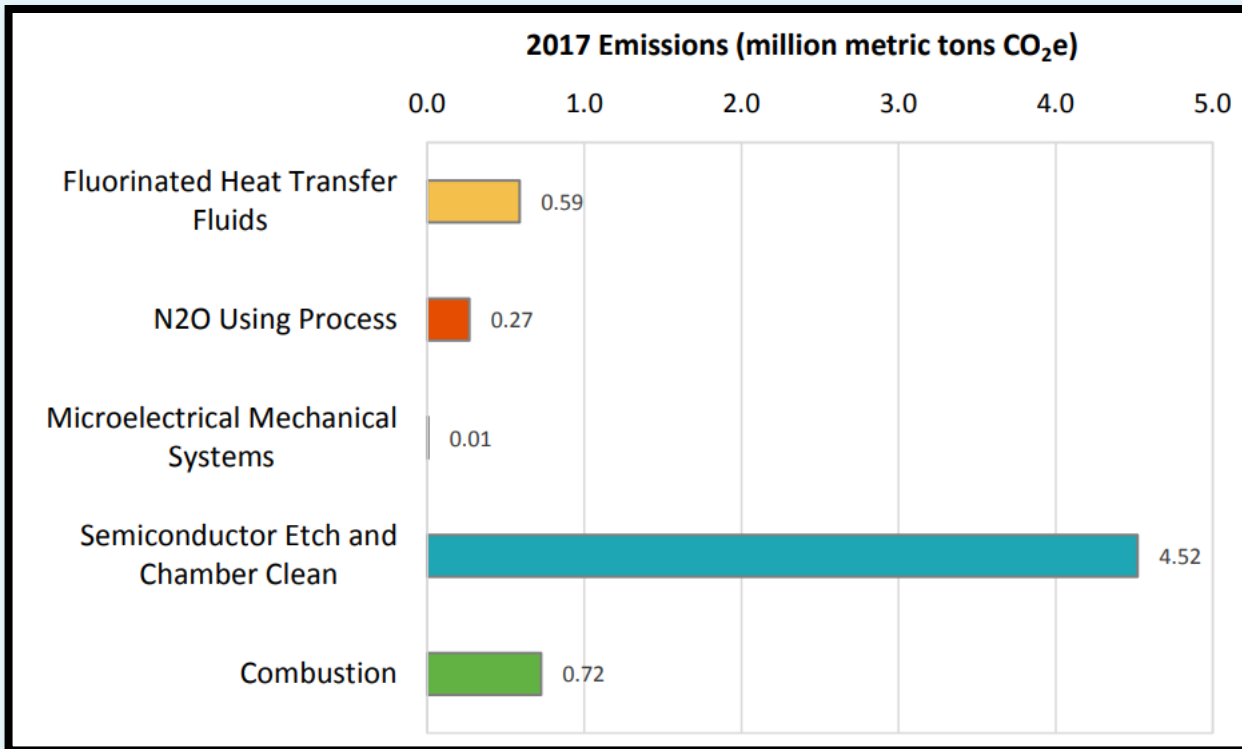
- (i) plasma etching silicon containing materials and
- (ii) cleaning chemical vapour deposition (CVD) tool chamber-walls where silicon has deposited

The majority of FC emissions results from limited utilisation efficiency (i.e., consumption) of the FC precursors during the etching or the cleaning process.



Red: Plasma Etching - Henniker Plasma (plasmatreatment.co.uk)

Electronics Manufacturing Sector 2017 Emissions by Process Type, United States



Emission range (MMT CO ₂ e)	Number of Reporter in electronic manufacturing sector
<0.025	9
0.025-0.05	10
0.05-0.1	15
0.1-0.25	10
0.25-1	7
>1	0



Source: https://www.epa.gov/sites/default/files/2018-10/documents/electronics_manufacturing_2017_industrial_profile.pdf

Strategies for Reducing Carbon Emissions

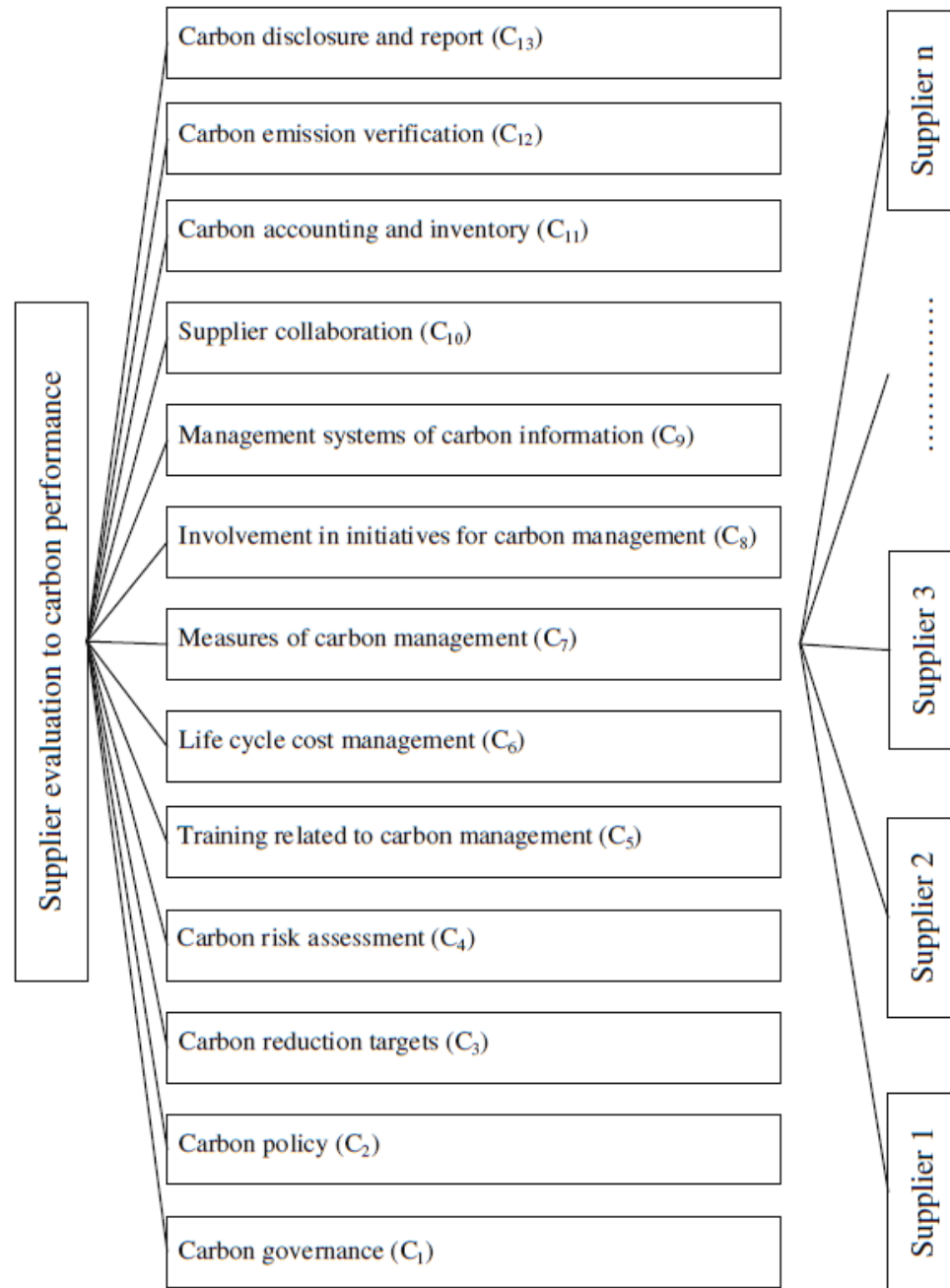
Steps to reduce PFC emissions

- Decommissioning fabrication plants manufacturing 150 millimeter or smaller wafers
- Installation of abatement equipment
- Process optimization
- Installation of endpoint detection for processes to minimize gas consumption
- Use of new and alternative clean chemistries
- Integration of low emissions chemical vapor deposition (CVD) tools
- Increasing wafer size and advanced process technology



The framework of supplier evaluation

Source: Hsu, C. W., Kuo, R. J., & Chiou, C. Y. (2014). A multi-criteria decision-making approach for evaluating carbon performance of suppliers in the electronics industry. *International Journal of Environmental Science and Technology*, 11, 775-784.



Criteria for supplier selection in carbon management

Dimensions	Criteria
Planning	Carbon governance
	Carbon policy
	Carbon reduction targets
	Carbon risk assessment
	Training related carbon management
	Life cycle cost management
Implementation	Measures of carbon management
	Involvement in initiatives for carbon management
	Management systems of carbon information
	Supplier collaboration
Management	Carbon accounting and inventory
	Carbon verification
	Carbon disclosure and report

Carbon Offset Programs

What are Carbon Offsets?

- Definition and types

How to Implement Carbon Offset Programs

- Selection of projects
- Verification and certification



Monitoring and Reporting

Establishing Baselines and Targets

- Initial assessments
- Setting realistic goals

Data Collection and Analysis

- Monitoring tools and software
- Reporting standards (e.g., GHG Protocol)

Regular Audits and Reviews

- Continuous improvement
- Transparency and accountability



Case Studies and Best Practices

Successful Examples from the Industry

- Company-specific initiatives
- Results and benefits

Lessons Learned

- Challenges faced
- Solutions and innovations



Policy and Regulatory Framework

International Agreements and Standards

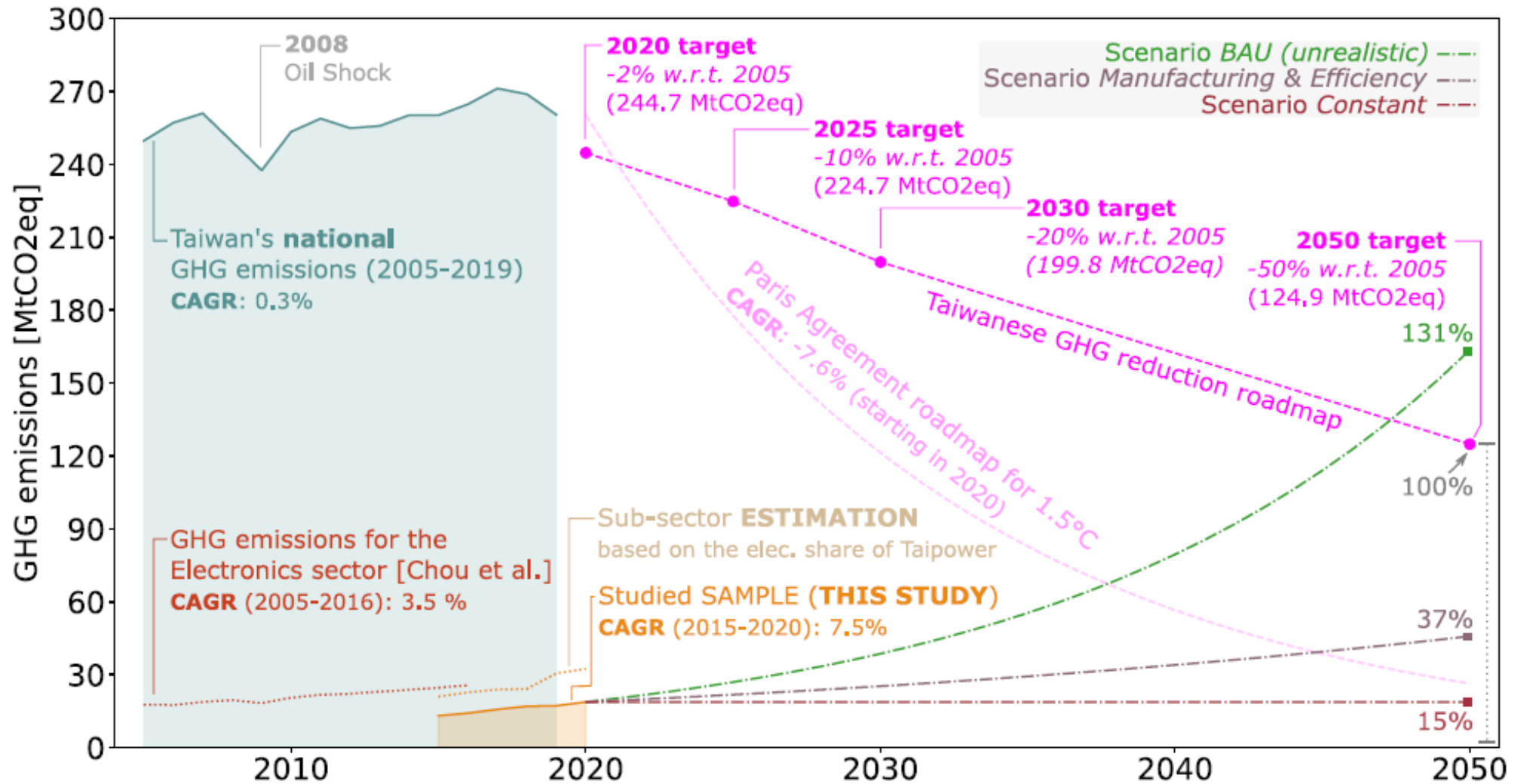
- Paris Agreement
- ISO 14001

National and Regional Regulations

- Compliance requirements
- Incentives and support programs



Conclusion



Source: Roussilhe, G., Pirson, T., Xhonneux, M., & Bol, D. (2022). From silicon shield to carbon lock-in? The environmental footprint of electronic components manufacturing in Taiwan (2015–2020). *Journal of Industrial Ecology*.

“ Q&A Time



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เพื่อไม่ให้พลาดข่าวสารข้อมูลที่เป็นประโยชน์ในสายอาชีพของท่าน

- Free webinars
- Tool และบทความดีๆ

