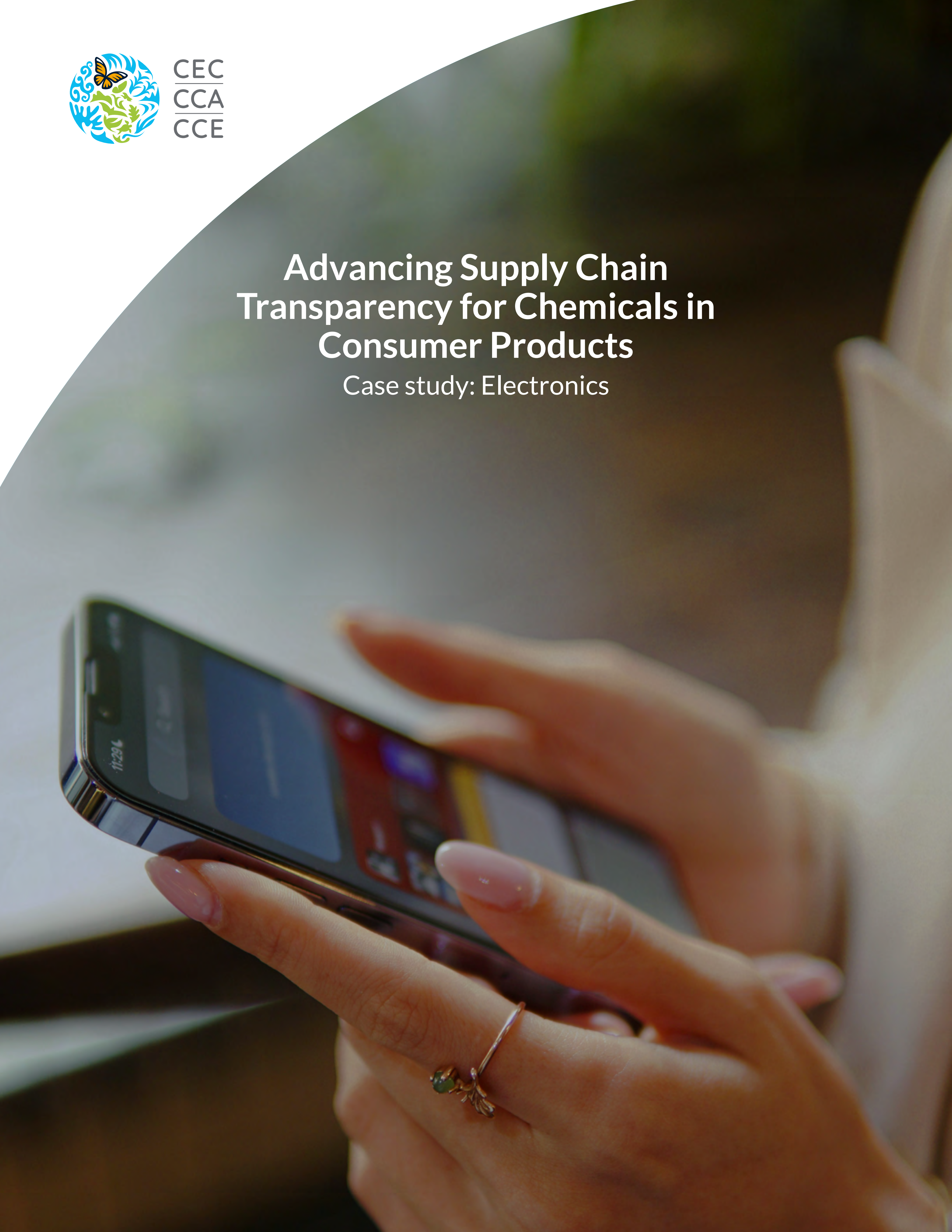
Advancing Supply Chain Transparency for Chemicals in Consumer Products

Case study: Electronics



Please cite as

CEC. 2025. *Advancing Supply Chain Transparency for Chemicals in Consumer Products. Case study: Electronics*. Montreal, Canada: Commission for Environmental Cooperation, 25 pp.

About the author(s)

This publication was prepared by WSP and the Lowell Center for Sustainable Production, for the Secretariat of the Commission for Environmental Cooperation. The information contained herein is the responsibility of the author and does not necessarily reflect the views of the CEC, nor the governments of Canada, Mexico or the United States of America.

ISBN: 978-2-89700-398-2
Disponible en français
ISBN: 978-2-89700-400-2
Disponible en español
ISBN: 978-2-89700-399-9

Photo credits

Cover: Image by Kamran Abdullayev at Unsplash
Page 3: Image by Manuel at Unsplash
Page 4-5: Image by Umberto at Unsplash
Page 6: Image by Steve Johnson at Unsplash
Page 7: Image by Michel Didier Joomun at Unsplash
Page 8: Sytnik
Page 11: FactoryTh
Page 12: Jelena83
Page 14: Image by Umberto at Unsplash
Page 15: Jelena83
Page 16: Image by Kier in Sight Archives at Unsplash
Page 18: Image by Jonathan Borba at Unsplash
Page 21: Image by Alejandro Escamilla at Unsplash
Page 22: Image by Lana Codes at Unsplash
Page 23: Image by Zoshua Colah at Unsplash
Page 24: Image by Brian Wangenheim at Unsplash
Page 25-26: Image by Tstudio at Unsplash

Publication Details

Document category: Report
Publication date: October 2025
Original language: English
Review and quality assurance procedures:
Final Party review: July, 2025
QA 407
Project: Operational Plan 2021–2022 / Advancing Supply Chain Transparency for Chemicals in Consumer Products

For more information

Commission for Environmental Cooperation
1001 Robert-Bourassa Boulevard, bureau 1620 Montreal, Quebec, Canada H3B 4L4
Phone: +1 (514) 350-4300
Fax: +1 (438) 701-1434
Email: info@cec.org / www.cec.org

Table of Contents

List of Tables

List of Abbreviations and Acronyms

CCPSA	Canada Consumer Product Safety Act
CEPA	Canadian Environment Protection Act 1999
CEC	Commission for Environmental Cooperation
CEPN	Clean Electronics Production Network
DSL	Declarable substance list
EPA	Environmental Protection Agency (United States)
EPEAT	Electronic product environmental assessment tool
FMD	Full material declaration
GEC	Global Electronics Council
GSE	General Specification for the Environment
IEC	International Electrotechnical Commission
Inegi	*Instituto Nacional de Estadística y Geografía* (National Institute for Statistics and Geography) (Mexico)
IMDS	International Material Data System (online database used by the automotive industry to manage information on materials and substances used in vehicles)
IPC	Institute of Printed Circuits (now Global Electronics Association for Interconnecting and Packaging Electronic Circuits, an association connecting electronics industries)
IEC	International Electrotechnical Commission

ISO	International Organization for Standardization
IT	Information technology
JIG	Joint Industry Guide
NGO	Nongovernmental organization
NAICS	North American Industry Classification System
OECD	Organization for Economic Cooperation and Development
PCB	Printed circuit board
PCDC Tool	Process Chemicals Data Collection Tool
PFAS	Per- and polyfluoroalkyl substances
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (EU)
RoHS	Restriction of Hazardous Substances Directive (EU)
RSL	Restricted substances list
SPARC	Supplier Program to Accelerate Responsibility and Commitment
SDS	Safety data sheet
SCT	Supply chain transparency
Semarnat	*Secretaría de Medio Ambiente y Recursos Naturales* (Ministry of the Environment and Natural Resources) (Mexico)
SAICM	Strategic Approach to International Chemicals Management (United Nations initiative)
TSCA	Toxics Substances Control Act (1976, amended 2016) (United States)
UNEP	United Nations Environment Programme

1. Introduction

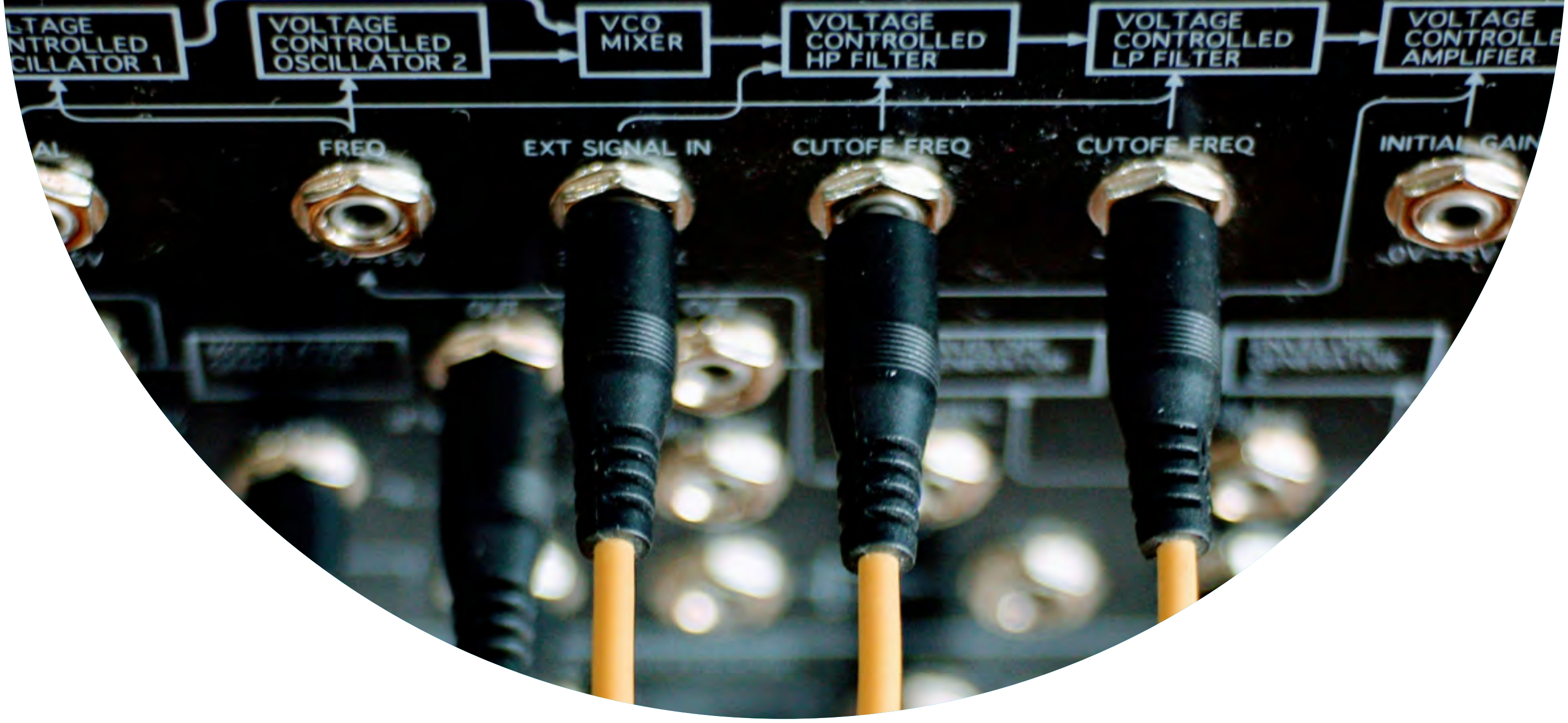
The Commission for Environmental Cooperation (CEC) initiated the project entitled "*Advancing Supply Chain Transparency (SCT) for Chemicals in Products*" with the purpose of fostering collaboration among the North American countries to improve SCT and enhancing governments' ability to identify and prevent products containing chemicals of concern or chemical substitutes of concern from entering or re-entering the economy.

In documenting chemicals of concern, Canada, Mexico and the United States implement risk-based approaches that consider exposure and relevant uses of chemicals in consumer products, based on risk determinations made through domestic, science-based and regulatory processes. This may result in risk determinations that differ among the three governments. For example, for any given chemical, the three governments may make different determinations as to whether and to what extent the chemical should be subject to regulatory action, based on its level of exposure and the specific uses in each country. The CEC recognizes such differences and underscores that not all the materials or examples within this report may be applicable to all three countries.

The information derived from this project is intended to:

- i) Support the development of resilient supply chains that respond to industry and other stakeholder requests for information on the chemical compositions of products,
- ii) respond to consumer demand for safer products and information on their chemical compositions,
- iii) inform trade and procurement decisions for raw materials, recycled materials, product components, and final goods at various points within value chains, and
- iv) improve industry's ability to comply with chemical reporting requirements and other regulations.

[1] The UN Strategic Approach to International Chemicals Management (SAICM) definition of "chemicals of concern" includes "chemicals for which evidence for risk to human health or the environment is currently emerging from scientific research, but which are not yet regulated." The term has therefore been used deliberately to include not only chemicals for which domestic risk assessment and regulation have already been completed, but also additional chemicals where concern is emerging but there may not yet be sufficient scientific evidence for or consensus on the need for regulatory action (SAIC N.d.).



The main activities of this project included assessing global and regional SCT practices and tools and developing case studies highlighting SCT best practices and associated drivers of and barriers to their implementation. The present case study is based on a literature review and input received from engaged experts and interested parties. This engagement included an online survey consultation and a virtual workshop. The online survey consultation, which invited input from 170 relevant organizations during the period of September–October 2023, was undertaken to help identify common SCT practices in industry in general, along with best SCT practices and the sectors leading in their implementation. On the basis of the 65 responses received during this online consultation, as well as on a sector prioritization by the government experts on the project steering committee, the electronics sector was selected for the development of a case study on SCT practices.

The first draft of this case study was reviewed during a virtual consultation workshop held on 10 October 2024, where 38 experts and interested participants from Canada, Mexico, and the United States had the opportunity to provide feedback and discuss possible drivers of and barriers to the implementation of best practices in the electronic sector. Subject matter experts from different types of organizations—including companies (21%, of participants), industry associations (5%), nongovernmental organizations (NGOs, 7%), and government (18%)—shared ideas on how to increase the uptake of these practices and tools within and across sectors in Canada, Mexico, and the United States.

2. Sector overview

The North American electronics sector comprises establishments that manufacture a wide array of electronic products that use integrated circuits—such as computers, communications equipment, and navigational, measuring and control instruments—and peripheral components. This sector is identified within the North American Industry Classification System (NAICS) as NAICS code 334: Computer and electronic product manufacturing. Table 1 summarizes key facts about the electronics sector in Canada, Mexico, and the United States.

On the basis of the literature review and expert engagement, this analysis three main types of SCT best practices were identified in the electronics sector. These best practices, along with their main implementation barriers and drivers, are discussed in more detail in the following sub-sections. The SCT best practices are:

- Corporate chemicals policies and industry initiatives to enhance SCT,
- standardization of the scope and format of chemical ingredient disclosure information, and
- the use of digital tools to communicate chemical ingredient information.

[2] El código SCIAN 334 se divide a su vez en seis subsectores que cada uno de los tres países define con ciertas diferencias, pero que en general se consideran comparables.

Table 1. Electronics sector overview, by country

	Canada	Mexico	United States
Employment	Computer and electronic product manufacturing (NAICS code 334): **55,568 persons** **3.6% of total manufacturing employment** (2022 data) [1]	Computer and electronic product manufacturing (NAICS code 334): **377,625 persons** **5.8% of total manufacturing employment** (2019 data) [3]	Computer and electronic product manufacturing (NAICS code 334): **1,088,100 persons** **8.5% of total manufacturing employment** (2022 data) [4]
Output	Computer and electronic product manufacturing (NAICS code 334): **CA$15,911 million (US$12,226)** **2.3% of total manufacturing output** (2022 data) [2]	Computer and electronic product manufacturing (NAICS code 334): **MX$70,138 million (US$3,486)** **0.7% of total manufacturing output** (2019 data, "Valor de los productos elaborados con materias primas propias") [3]	Computer and electronic product manufacturing (NAICS code 334): **US$441,400 million** **7.8% of total manufacturing output** (2022 data, dollars in 2012 prices) [4]
Description	Canada's electronics industry is largely concentrated in Ontario and Quebec, and to a lesser extent British Columbia and Alberta. [5] Canada is a net importer of electronics, but because of its highly developed communications infrastructures, the country boasts significant players in the global telecommunications sector. [6]	Mexico is a one of the world's largest exporters of TVs, computers, and other electronics. Many global players have manufacturing facilities in Mexico. Key clusters are located in Baja California, Jalisco (Guadalajara) and the Bajío region. [7]	Electronics manufacturing is largely concentrated in California and Texas, and to a lesser extent in Massachusetts, New York, Florida and Oregon. The United States is home to a number of world-leading electronics brands. Navigational, measuring, electromedical, and control instruments, as well as semiconductor and other electronic components, account for more than half of the employment in the U.S. electronics manufacturing sector. [8]

Sources

[1] Statistics Canada. Table 14-10-0202-01 Employment by industry, annual.
[2] Statistics Canada. Table 36-10-0488-01 Output, by sector and industry, provincial and territorial.
[3] INEGI. Censos Económicos 2019.
[4] Employment Projections program, U.S. Bureau of Labor Statistics.
[5] Innovation, Science and Economic Development Canada. https://ised-isde.canada.ca/app/ixb/cis/businesses-entreprises/334. Accessed 21 December 2023.
[6] Leyton. https://leyton.com/ca/insights/articles/the-electric-electronic-industry-ee-and-its-global-influence/. Accessed 21 December 2023.
[7] Ivesma. www.ivemsa.com/industries/electronics-manufacturing-in-mexico/. Accessed 21 December 2023.
[8] IPC (2020). Interconnecting America's economy: The economic impacts of the U.S. electronics manufacturing sector. Accessed 05 April 2025.

Note: NAICS: North American Industry Classification System. Currency conversions based on US Federal Reserve 2022 annual exchange rates: CA$1.3014=MX$20.1208=US$1. www.federalreserve.gov/releases/g5a/current/default.htm. Accessed 6 August 2024.

Table 1 (continued). Electronics sector overview, by country

	Canada	Mexico	United States
Key regulations	Canada Consumer Product Safety Act (CCPSA) Canadian Environmental Protection Act (CEPA) Canadian companies also reported to adhere to EU and U.S. regulations (e.g., EU Restriction of Hazardous Substances [RoHS] Directive; EU Registration, Evaluation, Authorization and Restriction of Chemicals [REACH] Regulation). Several relevant standards of the IPC (IPC-1752B) and the Canadian Standards Association (Canadian Electrical Code)	No specific regulations have been identified that govern the disclosure of chemical ingredients in electronics, but NOM-018-STPS-2015 regulates the use of chemicals in the workplace, which includes requirements to pass on safety data sheets (SDS) through supply chains in any sector. There are also several regulations governing the import and export of hazardous substances, which can trigger reporting requirements, including the Plafest regulation and international conventions (Montreal, Rotterdam, Stockholm, Minamata, Basel). Given Mexico's position as an exporter, it is likely that companies operating in Mexico also comply with other countries' regulations, although no specific information to confirm this has been received.	Toxic Substances Control Act (TSCA) California Proposition 65 Washington State Chapter 173-337 WAC Maine Title 38 Illinois Electronic Products Recycling and Reuse Act Other regulations in Indiana, Minnesota, New York, Rhode Island and Wisconsin [9] Standard IPC-1752B U.S. companies that sell products globally often also adhere to EU RoHS and REACH regulations, and several states have implemented regulations that follow the EU RoHS model. [10]
Future trends	Electronics is one of the world's fastest-growing industries, with hybrid electronics considered to be a particular opportunity for Canada. Due to the sector's growth and need for valuable resources, reduction of electronics waste and increased repair and recycling are a key focus for the sector. [6]	Electronics manufacturing is one of the fastest-growing industries in Mexico, and it is expected that the country will increasingly establish itself as a key player in the industry. [7]	Investment in digital technologies and artificial intelligence, as well as reshoring to improve supply chain resilience, could drive electronics manufacturing in the United States. Due to increasing interest of end-users, sustainability of electronics is becoming increasingly important. [11]

Sources

[9] UNEP. 2020. Chemicals of Concern in Electronics – Review of Legislative and Regulatory Approaches. https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/35362/CoCE.pdf (accessed 2 January 2024).

[10] UL. N.d. Restriction of Hazardous Substances Directive (RoHS) Compliance Services. www.ul.com/services/restriction-hazardous-substances-directive-rohs-compliance-services. Accessed 20 March 2024.

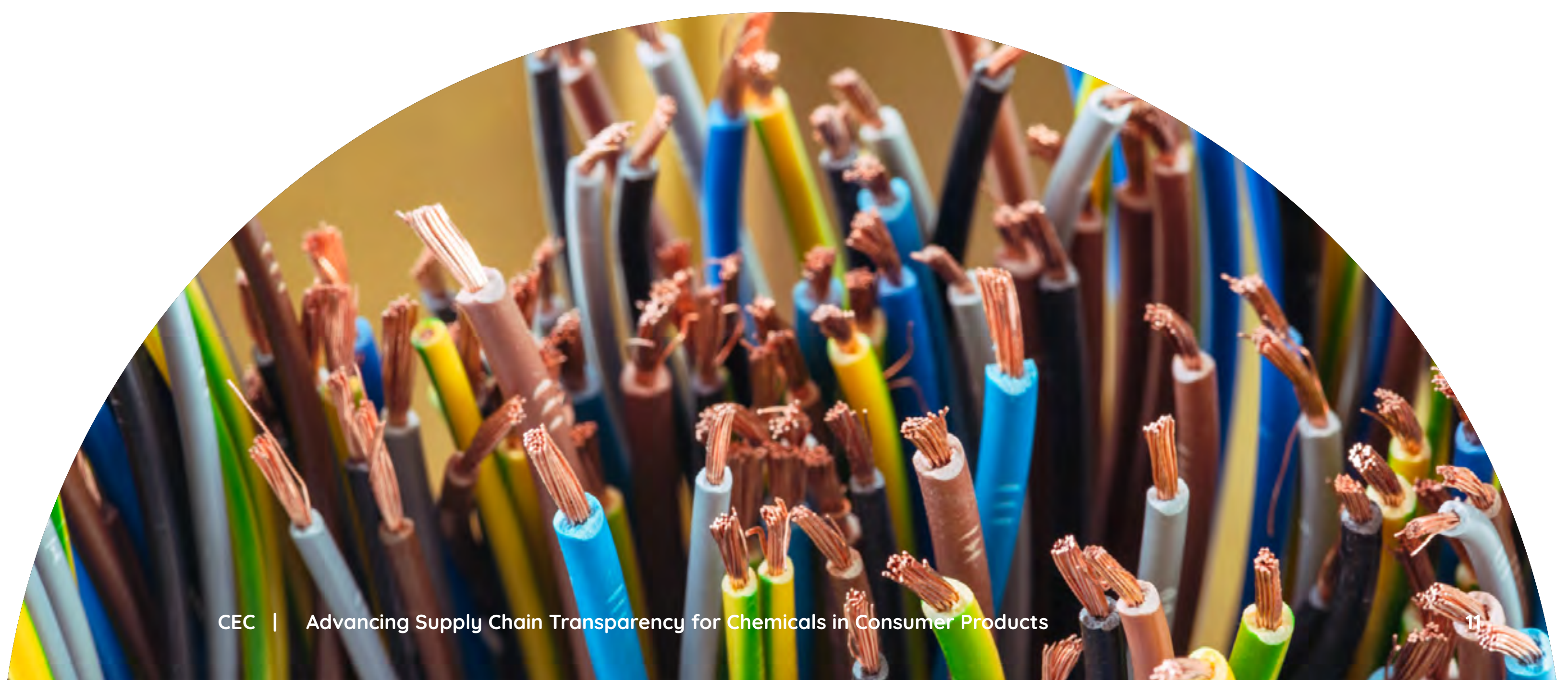
[11] Macrofab Blog. www.macrofab.com/blog/changes-us-electronics-manufacturing/. Accessed 21 December 2023.

Note: NAICS: North American Industry Classification System. Currency conversions based on US Federal Reserve 2022 annual exchange rates: CA$1.3014=MX$20.1208=US$1. www.federalreserve.gov/releases/g5a/current/default.htm. Accessed 6 August 2024.

3. Consideration of potential impacts on human health or the environment

The production of electronics involves the use of over 500 chemicals, and approximately 1,000 different chemicals can be found in electronics waste (e-waste) (GEC, 2022). The understanding of human health and environmental concerns associated with these chemicals throughout electronics supply chains continues to evolve (GEC, 2022). Electronics contain several substances that one or more of the three North American countries considers to be hazardous, including heavy metals (e.g., lead, mercury, cadmium), flame retardants (especially chlorinated and brominated), phthalates, dioxins and furans, PFAS, and solvents (SAICM Knowledge n.d.; GEC, 2022). These substances can be found in many different electronics components, including batteries, ceramics, hardware plating, insulator resins, integrated circuits or microchips, paints or pigments, plasticizers, printed circuit board (PCB) finishes, solders, and plastic parts (GEC, 2022).

[3] Each of the three governments takes into consideration available information on chemicals used in electronic products, along with information on levels of exposure and specific uses in its country, when making risk determinations on safe levels of chemicals in those products.

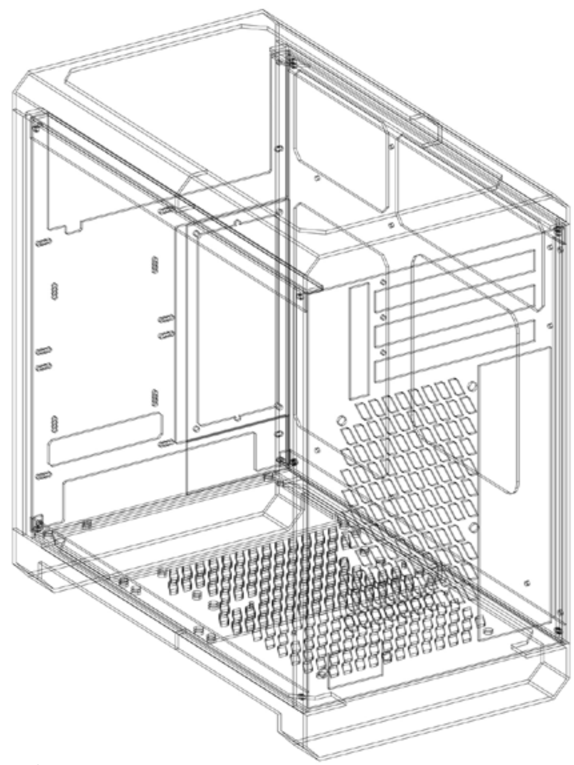


4. Main barriers to and drivers of supply chain transparency

Key barriers to and drivers of SCT identified across North American sectors in general (e.g., drivers such as regulatory compliance and demand from downstream purchasers and consumers; and barriers such as the complexity of international supply chains and inconsistent regulations) are also relevant to the electronics sector. Sector-specific examples and particularities are provided in the following sections.

Barriers

The consultation workshop and interviews with industry and government representatives revealed the following main barriers to the adoption of SCT practices in the electronics sector:



- **Costs and a lack of resources.** This includes a lack of specialized staff to support SCT practices, and the costs of digital tools or third-party service providers for supply chain communication, especially for smaller companies (Bellamy, 2024; IPC, 2024; Sweeney, n.d.; consultation workshop). For example, certain digital information standards, such as the widely used IPC-1752, are not human-readable and require a digital tool to be used, which some smaller companies do not have (IPC, 2024). Another example is the cost related to meeting the criteria of ecolabels (e.g., Electronic Product Environmental Assessment Tool—EPEAT) that require disclosure of chemical ingredients (U.S. EPA, 2024).

- **The electronics supply chain is global in nature**, which makes it particularly complex because of the variety of jurisdiction and regulations and large number of parties involved, as noted in the consultation workshop.

- **Reluctance to disclose.** There is a reluctance among some parts of the industry to disclose chemical ingredient information. For example, a distributor of electronics in the United States reported a reluctance of their overseas suppliers to respond to inquiries about chemical ingredients (Bellamy, 2024). Possible reasons could be that companies do not want to expose themselves to potential liabilities associated with chemical risks in their supply chains (U.S. EPA, 2024; consultation workshop), or that they do not want to disclose confidential business information (Sweeney, n.d.).

- **Limited regulation.** A comprehensive regulatory driver for the disclosure of chemical ingredients in electronics does not exist (Sweeney, n.d.). In Mexico, it was mentioned that specific regulations requiring disclosure of chemicals in electronics are lacking. There are regulations for disposing of hazardous waste, but these are not specific to electronic waste; and the resources to properly enforce them are also insufficient (Armenta, 2024). Participants of the consultation workshop confirmed the lack of a consistent regulatory framework for this sector, in all three countries (although it was mentioned more often in relation to Mexico).

- **Lack of inclusivity of SCT best practices.** Workshop participants stated that industry standards are often developed by large companies, without the involvement of smaller companies and civil society, which can limit the usefulness of the outcome for different stakeholders (e.g., smaller companies, consumers). However, participants also noted that IPC and other standards development organizations follow processes that are accredited by official government entities, such as the American National Standards Institute (ANSI), which set requirements for the involvement of different stakeholders in the development of standards.

- **An additional challenge for Mexico** is that the country receives a great deal of electronics waste from other countries, whose specific contents are unknown. Compounding this issue is that informal recycling, which observes neither regulations nor best practices, is widespread in the country.

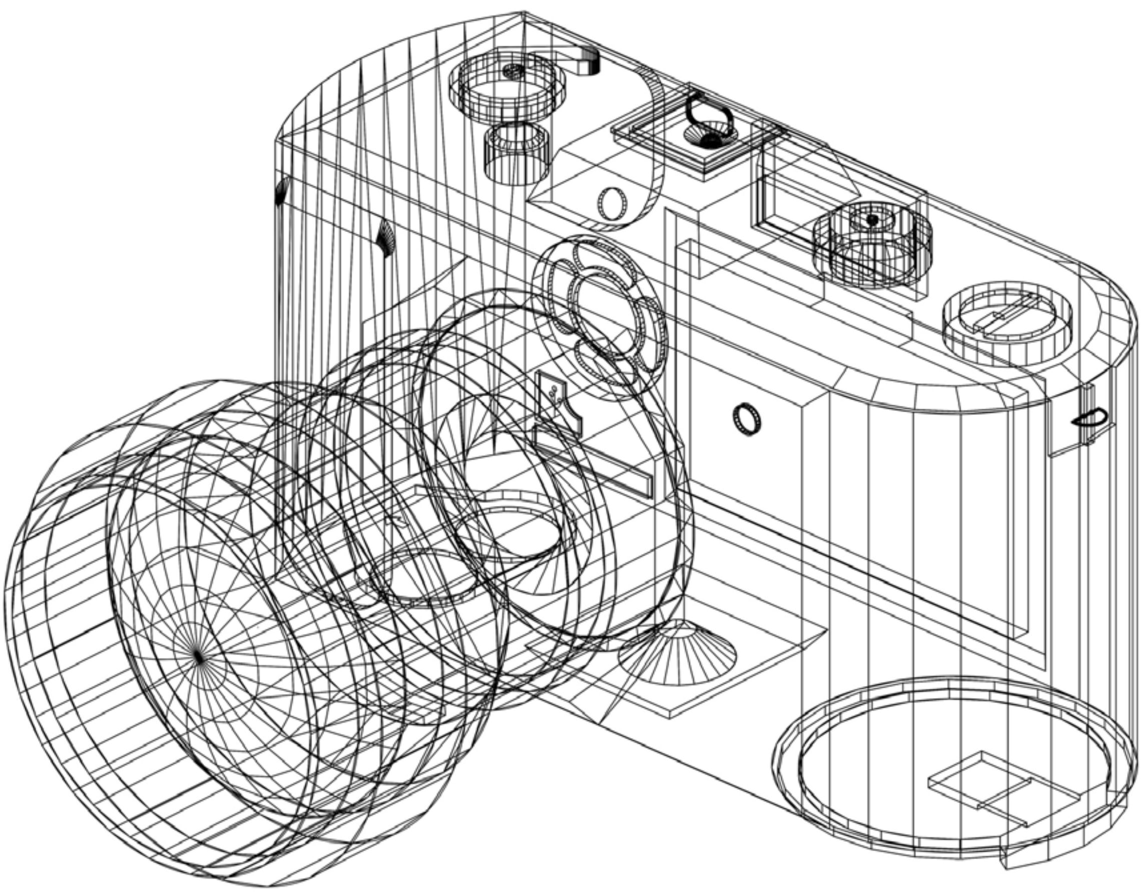
Drivers

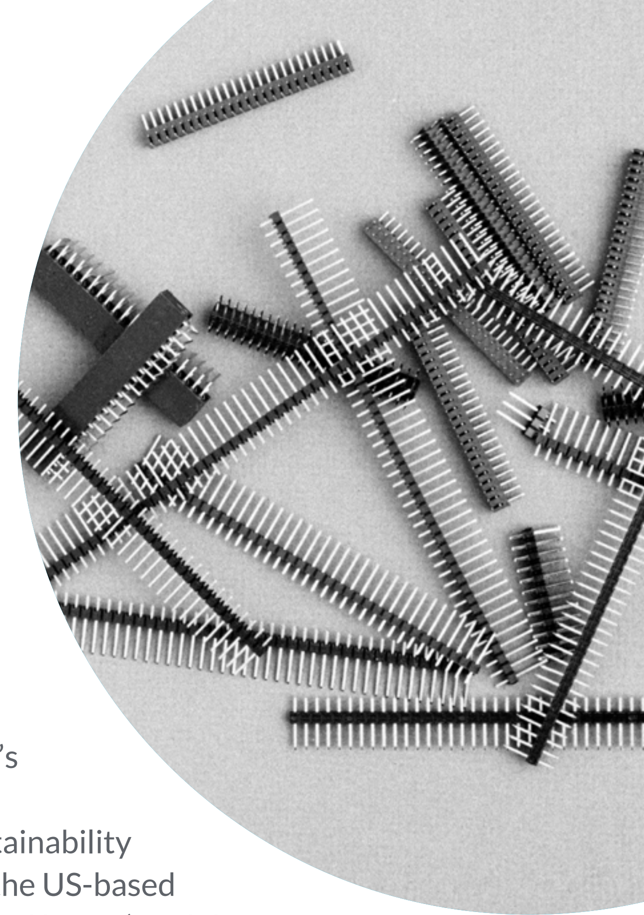
The online survey identified key drivers of SCT within the electronics sector, including demand from downstream purchasers (brands, retailers, and large institutions); the opportunity or need for more efficient and effective regulatory compliance; and businesses' own sustainability, health, and environmental goals. Workshop participants also confirmed that government regulations and customer demand (from both downstream supply chain purchasers and consumers) were important drivers of SCT, in the three countries.

The key regulations relative to SCT in Canada, Mexico and the United States are listed in Section 1 and Table 1, above. As mentioned, these are likely drivers of SCT in the electronics sector. It was also suggested that other regulations, including the EPA's PFAS disclosure rules, U.S. State-level PFAS regulations, Environment and Climate Change Canada's mandatory surveys on (toxic) chemicals, and Washington State's flame-retardant regulation, are also drivers of SCT (Bellamy, 2024). Many of these regulations apply to a wide range of products that include electronics but are not specifically tailored to them. Responses to the online survey indicate that the EU's Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive (among other international regulations) also impacts North American companies. Several U.S. states have implemented regulations that follow the RoHS model (UL n.d.). Some workshop participants noted that international agreements also drive SCT. It was also mentioned that producers exporting electronics to other regions must follow the importing countries' regulations.

In terms of corporate sustainability, health, and environmental goals driving SCT, survey respondents mentioned HP's General Specification for the Environment (GSE) as a good example, while Intel's Supplier Program to Accelerate Responsibility and Commitment (SPARC) was identified in the literature review as another. However, information about whether these initiatives are applied equally in all three North American countries (where these companies are active) was not available. Nevertheless, through such progressive initiatives, companies such as HP and Intel, as well as downstream retailers with similar progressive policies, can create a demand for their suppliers to apply SCT practices. This was confirmed in an interview with an electronics distributor, who stated that the need to comply with retailers' chemicals policies, which are often ahead of regulations, is a key driver for collecting chemical ingredient information from the supply chain (Bellamy, 2024).

Public-sector procurement requirements, (e.g., requiring EPEAT ecolabels on electronics purchased for the U.S. Government) also drive SCT in this sector. These requirements appear to have a direct impact on the willingness of industry to participate in EPEAT and similar initiatives (U.S. EPA, 2024). Ecolabels were also mentioned in the consultation workshop as being an important driver of SCT.





5. Supply chain transparency best practices

Industry initiatives and corporate policies

Leading electronics brands have created chemicals management policies that require transparency from their supply chains; they also participate regularly in initiatives to enhance SCT. One survey respondent considered the electronics sector to be a role model in terms of best practices for SCT because of the industry's chemical disclosure standards and initiatives, efforts to develop safer alternatives for chemicals, and other sustainability efforts. Notable SCT initiatives in the industry include the US-based Clean Electronics Production Network (CEPN) (discussed below) and the IPC Materials and Supplier Declarations Committee (discussed in section 5). Businesses in the electronics industry are also active in initiatives that promote SCT across sectors, such as the Responsible Business Alliance's Chemical Management Workgroup and BizNGO.

CEPN provides a forum for electronics brands and suppliers, as well as other stakeholders (e.g., NGOs, academics, labor organizations), to discuss and collaborate on issues related to toxic chemicals in the electronics supply chain (CEPN, n.d.). While the focus of the organization is on worker exposure and process chemicals that may not be present in the components or products that are passed down the supply chain, its activities have important impacts for SCT (Swanson, 2024; U.S. EPA, 2024). By encouraging a dialogue about SCT and the shift to safer chemicals within the electronics industry, particularly the IT sector, CEPN allows the industry and other stakeholders to jointly explore potential actions (US EPA, 2024). CEPN members have also developed the Process Chemicals Data Collection (PCDC) Tool, which is a publicly available spreadsheet template to help collect and manage process chemicals data in a standardized way. As part of CEPN's Toward Zero Exposure Program, which aims to help protect workers from chemical hazards in the electronics supply chain, participating companies make six commitments. One of these is to collect and map data on the use of process chemicals across the supply chain, which includes a target to have a certain number of facilities complete the PCDC Tool (CEPN, n.d.; Swanson, 2024).

As mentioned above, examples of individual corporate SCT policies such as those of Intel and HP are recognized as best practices. Intel's Supplier Program to Accelerate Responsibility and Commitment (SPARC) involves partnering with suppliers on initiatives to foster green chemistry and safer alternatives; developing sustainable chemistry screening criteria for suppliers and an innovative chemical footprint methodology; and hosting webinars and otherwise building capacity among tier 1 suppliers, related to transparency and compliance (Intel, 2021). HP has developed the Standard 011 General Specification for the Environment (GSE), which sets out restrictions, prohibitions and other requirements for certain chemical compounds or materials with which suppliers have to comply. These companies are based in the United States and operate internationally, including in Canada and Mexico. However, information about whether and to what extent their best practices are applied in all three countries was not available. Nevertheless, since electronics supply chains are highly interlinked across countries, it is expected that these practices are applied to some extent across North America.

Standards for the disclosure of chemical ingredient information

The online survey consultation, interviews (U.S. EPA, 2024; IPC, 2024) and a review of the literature (UNEP, 2015; Sweeney, n.d.) highlighted two standards in particular as key elements of SCT best practice in the electronics sector: IPC-1752 and IEC 62474. Participants of the consultation workshop also confirmed that the IPC and IEC standards for materials declaration and data exchange are widely used in the electronics sector.

The IPC-1752 standard was developed by members of IPC, the global association of electronics industries, to standardize the format and content of declarations about materials in electronic products (Sweeney, n.d.). It uses an XML file format that can be read by digital tools such as compliance and supply chain management software packages (see, e.g., Assent, n.d.). Each of the four classes of the IPC-1752 standard reflects a different level of detail required in the material declaration, as shown in Table 2, below.

Table 2. Classes of material declarations, according to the IPC-1752 standard

Class	Description / level of detail
A	Supplier statement about whether its product meets a defined query list
B	Substances that are intentionally added to the product, and substances that are known to be present above certain threshold levels
C	Product-level material declaration based on the JIG-101 material list (discussed below this table) and a substance list based on the EU REACH regulation
D	Full material disclosure (FMD) of all substances in each homogeneous material within the product

Source: Sweeney, n.d.; Assent, n.d.

Class C of the IPC-1752 standard is based on the Joint Industry Guide (JIG) for material composition declaration for electronics products, which establishes the substances to be reported, as well as the associated reporting thresholds that have been agreed to by the industry, based on regulatory or market requirements (Consumer Electronics Association et al., 2011; UNEP, 2015). According to the IPC members consulted, IPC-1752 has been widely adopted by the electronics supply chain and the brands that trade within North America and globally. Although to date this standard is only used in the electronics industry, it could be applied to other sectors by changing the list of product categories in the standard to those relevant to other sectors (IPC, 2024).

Survey respondents also consider the Switzerland-based International Electrotechnical Commission (IEC) 62474 Declarable Substance Llist (DSL) to be a best practice for determining the scope of information disclosure on chemicals in electronics. Similar to IPC-1752, IEC 62474 establishes an international standard and protocol for declaring the substances and materials in electronic products, which can be easily transferred and processed throughout the supply chain. It specifies the substances, substance groups and material classes to be declared, with a data format that can be used in relevant software packages (Sweeney, n.d.). It also has a wide application —i.e., to substances that are currently regulated, those that are expected to be regulated soon, as well as some that are not yet in process of being regulated (U.S. EPA, 2024). Participants of the consultation workshop mentioned that the IPC and IEC standards can also be used in other sectors—for example, aerospace and defense. IPC is working on making its data exchange standards more flexible or modular in order to make them easier to use as a generic reporting standard for any industry. And IEC 62474 is already being expanded for use by other sectors, through a partnership with ISO (IEC/ISO 82474).

Notwithstanding the usefulness of these standards for enhancing SCT throughout the supply chain, other stakeholders (e.g., academia, civil society) are often excluded from their development. In contrast, certain ecolabels, such as EPEAT, which is managed by the US-based Global Electronics Council and is currently being modified to include additional chemicals-related criteria, provide an opportunity for the electronics industry, NGOs, academia, recyclers and other stakeholders to participate in technical committees (U.S. EPA, 2024).

Digital tools to communicate chemical ingredient information

Due to the complexity of the information required to ensure compliance of the many different components of electronic products with different international regulations, using a digital system to communicate chemical ingredient information in the electronics supply chain is considered a best practice (IPC, 2024). Related to this is the fact that the standards discussed above cannot be used without such digital tools, many of which have been developed specifically to process data based on IPC-1752 and IEC 62474 (US EPA, 2024). The digital tools that are being used or developed in the electronics sector include the following:

- ChemSHERPA: developed in Japan as a harmonized data management system for communicating chemical ingredient information through international electronics and electrical equipment supply chains (OECD, 2021). Online survey respondents and an interview with IPC indicate that it is a particularly advanced tool that is commonly utilized in the North American electronics industry.

- Supply chain management and compliance systems offered by service providers—e.g., U.S.-based BOMcheck and Assent (with offices in Canada and other countries outside of North America) (IPC, 2024; Assent, n.d.).

- Internal corporate systems, especially those developed by large electronics brands and suppliers (IPC, 2024).

- CEPN’s PCDC Tool (discussed above): currently being implemented as an online platform by the Responsible Business Alliance (RBA) (Swanson, 2024).

6. Impacts of Supply Chain Transparency Best Practices

One of the main aims of the best practices described above (and in particular, the standards and digital tools) is to increase the efficiency of communicating chemical ingredient information through the supply chain. By creating common requirements and formats, chemical ingredient information can be collected, transferred and processed in a consistent, automated, and efficient manner across different systems and suppliers (Sweeney, n.d.; CEPN n.d.; IPC, 2024). Businesses have reported that this more efficient automated data transfer frees up employees to spend their time on other tasks (IPC 2024).

The ability to proactively ensure regulatory compliance is seen as another key benefit of enhanced SCT in the electronics sector. International electronics supply chains are regulated by different laws in different jurisdictions, restricting various chemicals. Moreover, the regulatory landscape for this sector continues to evolve. For example, the U.S. EPA has recently promulgated a rule restricting PIP (3:1), a chemical used in the production of many electronic devices. PIP (3:1) has persistent, bioaccumulative and toxic attributes, including aquatic toxicity (U.S. EPA, 2024). SCT best practices can give the electronics industry detailed knowledge of chemicals in their supply chains and products, which prevents the need to contact suppliers each time regulations change, reduces the risk of non-compliance penalties and reputational damage, and helps the industry to prepare for future regulatory changes (Sweeney, n.d.; IPC, 2024; CEPN, n.d.).

Lastly, SCT can reduce risks to human health and the environment by encouraging and enabling the electronics industry to better manage or substitute hazardous chemicals in their supply chains and products (CEPN, n.d.; Sweeney, n.d.)

7. Outlook

The SCT best practices described above are already used by many global suppliers in the electronics sector in North America, especially larger companies. However, certain barriers to a wider uptake of such practices remain, especially for smaller companies. As mentioned earlier, these best practices often require digital tools and/or specialized staff, and a lack of a comprehensive regulatory driver may mean that many companies are not willing or able to dedicate additional resources or disclose a wider scope of information about chemicals in their products. Furthermore, there is an ongoing debate in the industry about which data exchange formats to use and how to best protect confidential business information (Sweeney, n.d.).

A combination of stricter regulations, industry collaboration, increased demand for transparency from consumers, retailers and brands, and advancements in technology (including blockchain) could lead to a wider uptake of SCT best practices in a growing electronics industry in North America (Sweeney, n.d.). Workshop participants' recommendations for actions to increase the uptake of SCT best practices in the electronics sector included the following:

- Regulations specifically requiring chemical ingredient disclosure, with clear scope, criteria and timelines for the information needing to be disclosed and communicated, as well as clear steps to take when information is not provided by the upstream supply chain.

- Encouragement and support from leading companies to other companies in the sector to adopt and share their best practices, particularly with smaller companies.

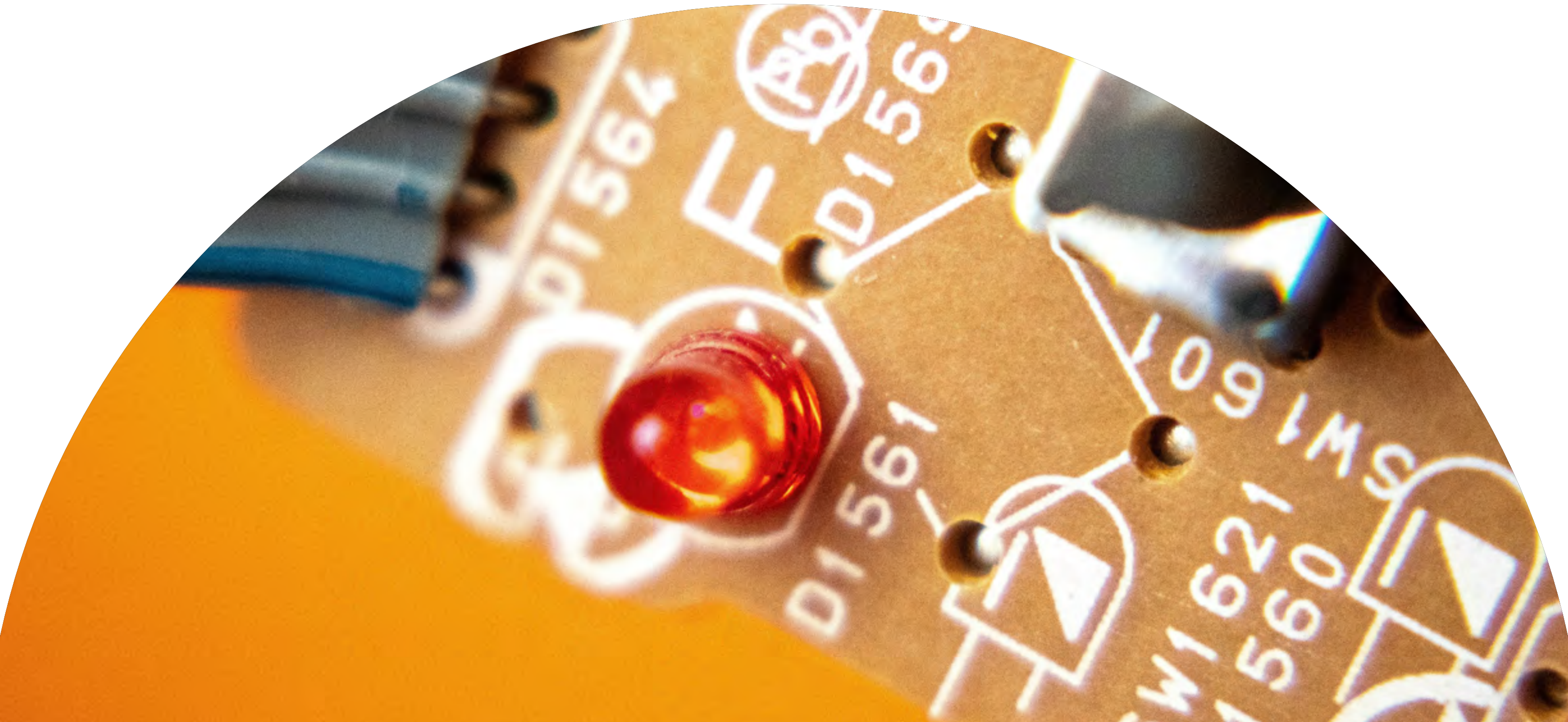
- Awareness-raising and education among consumers to increase consumer pressure on the industry to adopt SCT best practices. This could include a freely accessible database of companies applying best practices, to help inform consumers' purchasing decisions.

- Accessible tools to enhance the efficiency of supply chain communication. For instance, in the United States, the Responsible Business Alliance (RBA) is developing a new digital platform to upload chemical

inventory information. This tool would enable screening for chemicals of concern (negative lists) and safer chemicals, if known (positive lists), and sending the information to customers. The use of machine learning to automate the frequently manual handling of information in different digital formats (e.g., PDF SDS vs spreadsheets) was also suggested.

- A database, similar to the automotive industry's International Material Data System (IMDS), where suppliers are required to proactively report chemical ingredients to help decrease the burden on downstream parties such as manufacturers and importers.

- Expansion of the standards for the declaration of chemical ingredients, which currently mainly cover regulated or restricted lists of chemicals (RSLs), to include brand/company-specific RSLs, which may cover chemicals of concern that are not yet regulated.



References

Armenta, Melissa. Semarnat. 2024. Personal communication, 23 February.

Assent. N.d. What Is the IPC-1752A Standard? https://www.assent.com/resources/knowledge-article/what-is-the-ipc-1752a-standard/. Accessed March 2024.

Bellamy, Pat. Danby. 2024. Personal communication, 15 February.

California Department of Food and Agriculture. 2019. California Business and Professions Code Division 5 – Weights And Measures, Chapter 6. Fair Packaging and Labeling Act. January 2019. https://www.cdfa.ca.gov/dms/programs/Publications/BPC/2019/6.0-BPC_2019_Chapter_6_FairPackagingandLabelingAct_12601-12615.5.pdf. Accessed 25 March 2024.

CEPN. N.d. Clean Electronics Production Network website. https://cleanelectronicsproduction.org/. Accessed March 2024.

Consumer Electronics Association, Digital Europe, Japan Green Procurement Survey Standardization Initiative, IPC, Information Technology Industry Council, EIA Standards, JEDEC, TIA. 2011. Joint industry guide (JIG) Material Composition Declaration for Electrotechnical Products – JIG-101 Ed. 4.0. https://materion.com/-/media/files/alloy/cube-facts/jig-101-ed-4-110310_final.pdf. Accessed April 2025.

Global Electronics Council (GEC). 2022. State of sustainability research – Chemicals of concern. https://globalelectronicscouncil.org/wp-content/uploads/state-of-sustainability-research-chemicals-of-concern.pdf. Accessed January 2024.

Health Canada. 2024. Personal communication, 6 February.

IPC members Stephen Sweeney (IBM), Nikki Johnson (Source Intelligence), and Mark Frimann (Wolfspeed). 2024. Personal communication, 21 February.

Maine Legislature. 2021. Products containing PFAS. Maine. 38 MRS Ch 16, Sec 1614. https://legislature.maine.gov/legis/statutes/38/title38sec1614.html.

OECD. 2021. Labelling and information schemes for the circular economy. https://one.oecd.org/document/ENV/WKP(2021)15/En/pdf. Accessed July 2023.

SAICM Knowledge. N.d. Hazardous chemicals in electronics. https://saicmknowledge.org/epi/hazardous-chemicals-electronics. Accessed January 2024.

SAICM. N.d. 1.1 Guidance – Understanding chemicals of concern. https://saicmknowledge.org/sites/default/files/1_1_guidance_understanding_cocs.pdf. Accessed 1 April 2025.

Swanson, Mary. 2024. Green America / Clean Electronics Production Network (CEPN). Personal communication, 12 February.

Sweeney, Stephen. N.d. Full material disclosure in the electronics industry: An overview. IPC Thought Leaders Program. https://emails.ipc.org/links/IPCsweeney-full-material-thought-leadership.pdf. Accessed March 2024.

UL. N.d. Restriction of Hazardous Substances Directive (RoHS) Compliance Services website. https://www.ul.com/services/restriction-hazardous-substances-directive-rohs-compliance-services. Accessed March 2024.

UN Environment Programme (UNEP). 2015. The Chemicals in Products Programme: Guidance for stakeholders on exchanging chemicals in products information. http://www.saicm.org/Portals/12/Documents/EPI/Guidance%20for%20Stakeholder%20in%20Exchanging%20CiP%20Information_October2015.pdf. Accessed July 2023.

UN Environment Programme (UNEP). 2020. Chemicals of concern in electronics: Review of legislative and regulatory approaches. https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/35362/CoCE.pdf. Accessed January 2024.

U.S. EPA. 2024. Personal communication with Zoe Emdur, Melanie Adams, Johnathan Rifkin, Megan Kalsman, and Holly Elwood, 14 February.

U.S. EPA. 2024. Decabromodiphenyl ether and phenol, isopropylated phosphate (3:1); Revision to the Regulation of Persistent, Bioaccumulative, and Toxic Chemicals under the Toxic Substances Control Act (TSCA). https://www.federalregister.gov/documents/2024/11/19/2024-25758/decabromodiphenyl-ether-and-phenol-isopropylated-phosphate-31-revision-to-the-regulation-of. Accessed April 2025.

CEC CCA CCE