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The economic impacts of misalignment in the Canadian Electrical Code

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Executive summary

Introduction and scope

The Standards Council of Canada (SCC) along with Canadian Standards Association (CSA), Electro-Federation of Canada, and members of SCC's Provincial-Territorial Advisory Committee engaged PricewaterhouseCoopers, LLP ("PwC", "we" or "us") to assess the potential economic impacts of harmonization in the Canadian Electrical Code, Part I, Safety Standard for Electrical Installations ("CE Code", or "the Code") across Canadian jurisdictions. This assessment is also intended to facilitate an understanding by the SCC of the economic impacts, if any, experienced by various industries and stakeholders as a result of current misalignment of adoptions by the provinces and territories of the Canadian Electrical Code Part I.

The objective of this work is to understand whether harmonizing the CE Code across all Canadian jurisdictions will, among other things:

- Reduce costs for enterprises operating in more than one jurisdiction
- Enable or increase transferability of plans between jurisdictions
- Reduce time spent on regulatory adoption of the Code by jurisdictions
- Facilitate labour mobility and skill transferability between provinces and territories
- Create additional costs to organizations (as a result of transitioning away from the current system)

Lack of alignment of the CE Code across Canadian provinces and territories can be a technical barrier to trade. Regulatory inconsistencies, such as in the misalignment of electrical codes across provinces and territories, are a type of interprovincial trade barrier that can add costs for organizations operating in more than one province. In response to technical barriers to trade between provinces, the Canadian Free Trade Agreement (CFTA) was enacted in July 2017. Among other mutually agreed principles, the agreement recognizes that existing regulatory measures that create or reinforce technical barriers need to be reconciled.

The study approach includes the following elements:

- Primary research which consists of interviews with 26 organizations that are impacted by, or primary users of, the CE Code Part I
- A review of secondary research and data, including industry reports
- Assessment of potential economic impacts of a lack of harmonization across the Canadian economy

Background

The CE Code consists of five parts, with Part I being the safety standard for electrical installations at buildings, structures or premises. For the purpose of this report, C22.1, or Part I of the Canadian Electrical Code is referred to solely as the "CE Code," or "the Code." The CE Code uses a prescriptive regulation approach; that is, it specifies requirements that can be assessed visually or by measurement. A key feature of the CE Code with respect to this study appears on the title page of the Code, stating "The Canadian Electrical Code, Part I, is a voluntary Code for adoption and enforcement by regulatory authorities," allowing provinces and territories to adopt and enforce the Code using their respective regulatory authorities. This right is also enshrined in the Constitution.

The CE Code is developed by CSA through a process approved by SCC. It is revised every three years with the participation of volunteers across various industries and organizations. Changes to the Code can be made to improve safety, adopt a new technology, correlate with other standards, or clarify wording. CSA conducts impact assessments for

certain Code changes to evaluate the purpose of the change. These include a consultation process regarding the change, impact to key stakeholders and anticipated economic impact.

Affected organizations and their roles with respect to the Code

The sections below outline the groups that are affected by the CE Code and describe their interactions with the Code.

- **Authorities Having Jurisdiction (AHJs)**: An organization that has the authority to develop the electrical Code and regulate electrical safety in a region is often referred to as a legislated regulatory authority having jurisdiction ("Authority Having Jurisdiction" or "AHJ"). AHJs across Canada have the option to adopt the CSA CE Code "as-is," to adopt it with technical deviations, or to publish a different code based on the CE Code. In many cases, an AHJ may be responsible for both adoption and enforcement of the Code in a jurisdiction. The AHJ can also adjust or amend the CE Code in their jurisdiction as necessary. These options can lead to differences in requirements between jurisdictions.
- **Manufacturers**: Manufactured electrical products must be able to be installed according to the relevant electrical Code that is in place in the jurisdiction of installation. Therefore, manufacturers are required to design, manufacture, certify, and hold inventory (as applicable) of the products based on the requirements of the jurisdiction in which they plan to sell their products.
- **Construction**: Construction firms are responsible for ensuring that through the execution of engineering designs, they adhere to the CE Code. The Code governs their installations of electrical equipment and components, power systems, instrumentation and controls, wiring, cabling and other activities.
- **Design engineering**: These firms must design buildings and electrical systems in compliance with CE Code Parts I, and building codes in the local jurisdiction where the asset will be constructed. The designs must also ensure that all necessary electrical systems and equipment (e.g. electrical equipment and components, power systems, cabling, etc.) meet installation requirements, achieve necessary regulatory permits and align with other discipline-based codes and standards.
- **Certification organizations**: Under Part I of the Code, individuals or organizations are legally required to only install products that have been approved and certified by an accredited evaluation or certification organization. Certification organizations rely on Part II of the CE Code to conduct their business, and even though product standards in Part II are referenced within Part I of the CE Code, they are not typically impacted by any misalignment in Part I. Products governed by Part II of the CE Code include refrigeration equipment, electrical burner control systems, and electrical laboratory equipment.

Sources of misalignment in the CE Code

There are multiple reasons for CE Code misalignment between jurisdictions. Below, we outline these key drivers of misalignment.

Technical deviations

Provinces and territories have various tools they can use to tailor the CE Code for use in their jurisdiction, deviating from the national Code released by CSA. Technical deviations can be made by provinces and territories by adding, removing or adjusting individual rules within the Code prior to release of the jurisdictions' electrical Code. In contrast, some jurisdictions choose to automatically adopt the CE Code as provincial or territorial regulation, and deviate from the national Code only through the use of bulletins or published interpretations of the Code. Technical deviations therefore create differences between the national CE Code, the Code that is released and adopted in the jurisdiction, and other jurisdiction's Codes, which may not have the same technical deviations. Different interpretations of the Code released by AHJs through bulletins can also create differences in how the same Code section may be interpreted in different provinces.

Timing of Code adoption

The timing of adoption of the latest CE Code differs by AHJ, regardless of whether technical deviations are made. Some jurisdictions adopt the CE Code "as is," meaning that there are no technical deviations to the Code prior to its release and application in the jurisdiction. Due to differences in timing of adoption between jurisdictions, there is potential for time periods in which two or even three different Code versions are being used across the country. Therefore, misalignments may exist due to differences between these Code editions, creating impacts for different types of organizations. Our interviews indicate that timing in adoption, rather than technical deviations, is responsible for the majority of significant misalignments.

Regional and sub-provincial variations

Some provinces have multiple regulatory authorities responsible for administering the CE Code. Each regulatory authority has responsibility for administering the CE Code under the applicable Code in the jurisdiction, whether it is the CE Code adopted by the provincial or territorial AHJ, or a municipal by-law adopted by a municipal AHJ. For engineers or construction companies that are unfamiliar with conducting activity in a particular region, having multiple Codes and/or multiple regulatory authorities can cause confusion, especially if the Codes have differences. Our interviews with companies that conduct work in jurisdictions with multiple Codes indicate that there can be confusion as to whether the municipal or provincial Code applies, and which is the appropriate Code to use.

Enforcement

Electrical inspection authorities in provinces, territories and certain municipalities have the responsibility of enforcing the Code in their respective jurisdiction. These authorities may take the form of government, electrical utility providers or even private inspection agencies. Individual electrical inspectors under these authorities are responsible for ensuring adherence to the CE Code by reviewing designs and inspecting installations. Misalignment can come from differing interpretations of language used in the Code regarding inspections and enforcement, therefore allowing an inspector the ability to use his or her judgment during inspection. Beyond language in the Code, if a particular jurisdiction is behind in adoption of the most current Codes, the status of newer technologies that have since been introduced may be unclear to Code users. Inspectors sometimes will allow these technologies even if a jurisdiction is behind in adoption, and will look to engineering opinions or bulletins for potential approval for the use of the product and its installation. Ultimately, when it comes to new technologies or overall enforcement of the Code, decisions by individual inspectors can create inconsistencies for electrical inspections and the enforcement of the CE Code both across and within jurisdictions.

Impacts of CE Code misalignment

Our overall observation is that on an economy-wide basis, cost impacts resulting from misalignment in the CE Code are not causing material economic costs in most situations. However, in rare circumstances, misalignment has the potential to create material one-time costs for firms operating in certain industries, such as manufacturing and construction. The majority of costs resulting from CE Code misalignment are driven by timing in adoption of new versions of the Code, rather than technical deviations. The table below presents a summary of material impacts from CE Code misalignment gathered through stakeholder engagement.

Table I: Summary of material impacts from CE Code misalignment

Material impact	Description	Frequency
Manufacturing and management of additional stock-keeping units (SKUs)	**Significant costs for manufacturers most often occur when changes are made in the latest version of the Code and jurisdictions adopt it at different times.** In rare cases, a new version of the code can have implications for electrical products required. This means that there may be different product requirements across jurisdictions. Manufacturers are then forced to carry and manufacture two different SKUs or potentially modify existing equipment installations to be able to service multiple jurisdictions. Impacts from manufacturing and management of additional SKUs are normally absorbed by manufacturers, but can sometimes be passed on to consumers. Manufacturers interviewed described one example of this issue, which we estimate would have created costs of $800,000 to $900,000 across the entire Canadian economy. These impacts occur rarely: those in the manufacturing business for decades were able to point to one or two examples at most.	**Rare**
Jurisdictional regulatory adoption process	**CE Code misalignment can generate costs for the economy when jurisdictions dedicate time and labour resources to make technical deviations to the Code.** Depending on the jurisdiction, the time spent by regulatory authorities reviewing the Code, making technical deviations, and re-releasing the Code exclusively for one jurisdiction can be significant. In addition to the regulatory adoption process, some provinces expend resources to conduct their own impact assessments of CE Code changes, conduct additional stakeholder engagement, and revise the French translation, all beyond what is already completed by CSA. However, these impacts arise from the right for provinces and territories to develop and implement their own electrical Code which is embedded in the Canadian Constitution. As a result, these impacts will not necessarily be reduced or eliminated through harmonization. Jurisdictions absorb the cost impacts from the regulatory adoption process. However, these cost impacts may exist even in a harmonized system. These costs are only incurred by larger provinces that undertake large scale reviews, specifically Ontario, Quebec, and British Columbia. For each province and each code cycle, costs may range from $308,000 and $326,000 for in-house evaluation and an additional $50,000-$80,000 if external evaluators are involved. We note that addressing misalignment would not necessarily reduce these costs because provinces have a constitutional right to govern electrical safety in their jurisdictions.	**Recurring every code cycle**
Additional Code review for those working across jurisdictions	**Cost impacts occur when staff must spend time reviewing changes in the CE Code across jurisdictions.** This is a one-time cost that occurs when a firm undertakes a project in a jurisdiction with a Code they have not worked with before, and is paid for by the employer of those working across jurisdictions. The cost depends on the number of FTE hours and FTE hourly wage rates that are spent reviewing the Code used in the new jurisdiction. These impacts exist directly as a result of misalignment, and recur depending on changes in Code versions and project locations. However, the cost of these impacts are likely to be included in the initial project's budget, and are also one-time costs until the Code is updated in that jurisdiction. Cost impacts will depend on the number of times a firm requires additional Code review and the number of staff that need to undertake this review. Based on input from interviews, we estimate one-time costs between $600 and $15,000 each time a firm enters a jurisdiction with new Code requirements.	**Common**

Lack of clarity surrounding which Code applies in jurisdictions	**Cost impacts may occur if firms conduct work in a jurisdiction using the wrong Code.** This would apply in jurisdictions where there are two Codes in use and there is confusion or error surrounding which Code prevails, or lack of knowledge of both Codes**.** Jurisdictions with two Codes normally include a set of provincial standards and a municipal or city by-law relating to electrical installations. Cost impacts can vary depending on when a potential error is discovered. Costs can be negligible if the project doesn't progress significantly using the wrong Code, but can be large if the project progresses significantly before the error is discovered. These cost impacts are often generated by labour and materials needed to correct any errors and ensure adherence to the appropriate Code. Interviews indicate that this can happen even with experienced design engineers and construction contractors, and that costs can be material. These costs are absorbed by the firm that experiences the error. We were not able to quantify these potential costs; however, interviews indicated that costs can be material when a serious error occurs, which would be infrequently. One example cited cost approximately $50,000.	**Infrequent**

Current misalignments in the Code do not necessarily create clear or tangible costs for all organizations that use the Code in their day-to-day business. As a result, many participants in stakeholder consultation were not comfortable providing estimates of potential costs they incur as a result of misalignment, as many of these impacts are not easily tracked or fully quantifiable and/or happen unpredictably and rarely. It was evident that the magnitude of impacts can vary significantly across firms, instances, sectors and jurisdictions. Some also described any costs they experience as a result of misalignment as "manageable." We initially hypothesized other potential negative impacts of CE Code misalignment that may be experienced by organizations, such as limited innovation, transferability of electrical designs or labour mobility. However, through stakeholder engagement we learned that these impacts are less material and do not affect the majority of the stakeholders.

Potential impacts of CE Code harmonization

Interviews completed for this study revealed that stakeholders are supportive of harmonizing the CE Code across the Canadian provinces and territories. In fact, virtually all interviewees from industry were supportive of harmonization, while recognizing that there are practical barriers to it. The reasons for this support often depend on the industry in which a stakeholder operates, and the impacts they may experience as a result of misalignment. The size and extent of potential impacts also may depend on how harmonization is implemented. The size and extent of the potential impacts above depend on how harmonization is implemented. Therefore, in a future state with harmonization, these potential impacts are not guaranteed to be realized. Below we address what harmonization of the CE Code may look like, and potential impacts to any organizations or stakeholders.

What harmonization may look like

Provinces' and territories' right to govern electrical safety in their jurisdictions is protected by the Canadian Constitution. Provinces and territories will maintain the ability to make their own laws in relation to electrical energy in any harmonization structures explored. To ensure harmonization it would be necessary for provinces and territories to agree on any recommended approach to harmonize, and to implement such changes or structures in their jurisdictions. Each province and territory would have the right to not participate in such an agreement, and also to withdraw from any agreement at any time. Below, we describe options to reduce the economic costs of misalignment through harmonization. These options were proposed by stakeholders through our interviews. Our findings indicate that the output of these strategies would benefit all users of the Code who work across jurisdictions. The execution of these strategies are most likely to impact AHJs and inspection authorities.

- **Align timing of Code adoption:** There is currently a lag in adoption across all jurisdictions, meaning that the newest version of the CE Code is not adopted by any provinces immediately after being published by CSA Group. Without taking away jurisdictions' rights to adopt the Code how they wish, having jurisdictions align on the timing of Code adoption would reduce discrepancies in Code requirements between jurisdictions. This approach would ensure that at least the same version of the Code is being used across the country.
- **Remove municipal-provincial variations:** Merging municipal Code variations with the appropriate provincial or territorial Code in effect could eliminate the confusion that arises for organizations beginning work in a jurisdiction with two or more Codes.

Impact to organizations and stakeholders

The harmonization strategies above have potential to impact regulatory authorities, particularly AHJs that are most affected by time constraints related to the CE Code. Many AHJs use the time between Code release and adoption to review the new version of the Code, make technical deviations, conduct stakeholder engagement, and complete economic impact assessment of any changes. Industry stakeholders can also be affected, as many educational instructors and users of the Code use the time to get up to speed on the new Code. In a scenario where the CE Code has to be adopted by jurisdictions at the same time, the role of regulatory authorities is likely to remain the same, but has potential to affect the regulatory adoption process. These effects could differ based on each jurisdiction's adoption process. In a scenario where the potential for differences between municipal and provincial Codes is removed, the role of municipal AHJs would likely change. We understand based on interviews that with any change to how or when the CE Code is adopted in a province or a territory, AHJs would likely need to conduct additional consultation with stakeholders in their jurisdiction. Additional consultation with these stakeholders would generate transition costs for the AHJs across Canada. It is expected that apart from participating in consultation, there would be no additional transition costs for industry.

Future scenarios

There are other factors that should be considered in enhancing the effectiveness of a harmonized system in the future. These suggestions will occur outside any necessary legal adjustments that are required to implement a harmonized national system. The future scenarios discussed below were raised by stakeholders during the interview process.

- **Increased consideration of provincial and territorial input at national level:** If inputs from provinces and territories were taken more into consideration during the Code development process, there may be less need for them to amend the Code. This includes provinces and territories participating closely in the language and writing of the Code, as well as CSA Group's impact assessment process.
- **Streamlining French translation process**: At the national level, the French version of the CE Code is released after the English version. The French version released by CSA Group sometimes doesn't meet the same language standard of French documents that are released provincially. As a result, some provinces start the adoption process only when the French version is published, and sometimes must revise the translation completed by CSA. Streamlining the French translation process at the national level could reduce the need for language revisions by provinces and territories after the Code release, and potentially also facilitate the release of the French and English Codes at the same time.
- **Public review in French at the national level**: French consultation of the CE Code and any related changes could be a step that is taken at the national level to ensure consistent understanding and decrease duplication of French consultation efforts across jurisdictions. This therefore has the potential to increase the speed at which provinces and territories adopt the CE Code, enabling more harmonized adoption.

These factors have potential to speed up the regulatory adoption process and reduce the need for jurisdictions to make technical deviations. These suggestions will occur outside any necessary legal adjustments that are required to implement a harmonized national system.

Beyond the scope of this study, further research on Canada's alignment with international standards would determine whether exports from Canada or imports into Canada are significantly impacted by differences in standards, or any other factors. Stakeholder interviews informed us that differences between Canadian and international standards are often a result of infrastructure differences, in voltage for example, rather than misalignment between provinces. Therefore, this analysis would also help determine the extent to which CE Code harmonization at a national level could improve Canada's position in international markets. Some stakeholders also feel that the Code can be slow in keeping up with the latest technologies and doesn't often consider technologies until they become mainstream. Further research is warranted on whether changes to the overall Code adoption system could promote development and use of new technologies.

Section 1: Introduction and scope

1.1 Background

Currently, provinces, territories, and some municipalities have the authority to regulate electrical safety. These jurisdictions independently choose how to apply the Canadian Electrical Code Part I, resulting in differences in requirements between jurisdictions. The federal government is responsible for electrical safety in federally regulated facilities; however, this may be delegated to the local jurisdiction through an administrative agreement. These differences in requirements are perceived to create economic impacts for the Canadian economy.

The Standards Council of Canada ("SCC") along with Canadian Standards Association (CSA Group), Electro-Federation of Canada, and members of SCC's Provincial-Territorial advisory committee engaged PricewaterhouseCoopers, LLP ("PwC", "we" or "us") to assess the potential economic impacts of harmonization of the Canadian Electrical Code, Part I, Safety Standard for Electrical Installations ("CE Code", "the Code") across Canadian jurisdictions. This assessment is also intended to facilitate an understanding by the SCC of the economic impacts, if any, experienced by various industries and stakeholders as a result of current misalignment of adoptions by the provinces and territories of the Canadian Electrical Code Part I.

For the purpose of the study, alignment (or "harmonization") is defined as "universal adoption and recognition of the latest edition of the Canadian Electrical Standard (CSA C22.1), as the central electrical Code for use across all authorities and regions within Canada, including acceptance of any/all reference standards noted within each Code."

The objective of this work is to understand whether harmonizing the Canadian Electrical Code Part I ("CE Code", or "the Code") across all Canadian jurisdictions will, among other things:

- Reduce costs for enterprises operating in more than one jurisdiction
- Enable or increase transferability of plans between jurisdictions
- Reduce time spent on regulatory adoption of the Code by jurisdictions
- Facilitate labour mobility and skill transferability between provinces and territories
- Create additional costs to organizations (as a result of transitioning away from the current system)

All impacts listed above may have associated economic impacts in terms of GDP, jobs, and tax revenue.

For the purpose of this study, a "jurisdiction" is defined as a geographical area in Canada to which there is an authority to enact the electrical Code adopted by that authority. A jurisdiction may be a province, territory or municipality. When used in this study, "across" or "between" jurisdictions indicates that a difference exists in the electrical Codes used in these respective geographical areas. Therefore, the scope of this study was limited to impacts experienced by organizations or individuals that work across borders or in multiple jurisdictions in Canada. For the purpose of this study, any stakeholder who works exclusively in one jurisdiction is assumed to not experience any impacts as a result of misalignment. The term "CE Code" used throughout this report refers to Part I of the CE Code, except where otherwise indicated. Finally, for the purpose of this study, the term "project" refers to any activity with an electrical installation component and therefore requires the use of the CE Code by the installer.

1.2 Report outline

The remainder of this report is structured as follows:

- **Section 2: Background** provides background on the CE Code.
- **Section 3: CE Code misalignment** summarizes our findings from literature, research (interviews), data collection, and analysis (including any estimates of costs).
- **Section 4: Potential impacts of CE Code harmonization** presents our findings on the cost of adopting a unified standard, and the economic impacts of adopting a unified standard.
- **Section 5: Future scenarios and areas for future research** describes next steps for moving towards harmonization or alternative approaches to regulation, and identifies areas for future research.
- **Section 6: Summary of findings** summarizes and concludes.

A series of Appendices provide further details on the study.

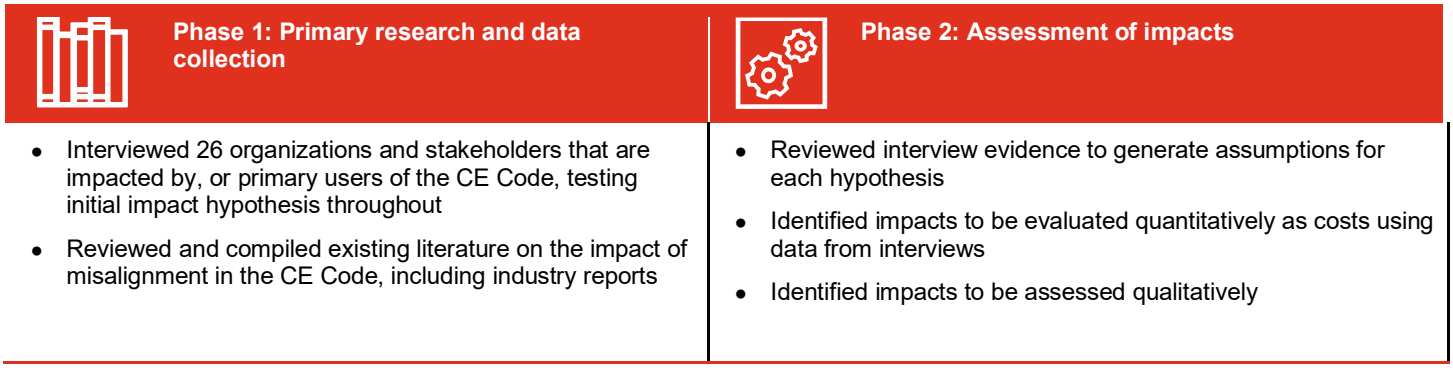
1.3 Study approach

The study approach includes the assessment of the following key elements:

- Economic impacts of current CE Code misalignment between jurisdictions; and
- Potential economic impacts of moving to CE Code harmonization across Canada

The approach used to assess the potential impacts of CE Code misalignment and potential harmonization is outlined in the figure below.

Figure 1.1: CE Code harmonization study approach



A full list of sources is available in Appendix E: References.

1.4 Acknowledgements

The following groups provided valuable support and participation in this study:

- The staff from the Standards Council of Canada
- Members of SCC's Provincial-Territorial Advisory Committee
- CSA Group
- Electro-Federation of Canada
- The organizations and stakeholders that participated in interviews. Refer to Appendix A for a list of organizations interviewed.

Section 2: Background

This section provides a background of the CE Code and users of the Code, with a focus on potential sources of misalignment.

2.1 Overview of the Canadian Electrical Code

In Canada, most standards for electrical safety are published by the Canadian Standards Association ("CSA Group").

These standards form the Canadian Electrical Code and are structured into the following five parts:[1]

- Part I (CSA C22.1)*: General rules for installation and maintenance of electrical installations*
- Part II (CSA 22.2)*: Evaluating electrical equipment*[2]
- Part III (CSA 22.3)*: Power distribution safety*
- Part IV (CSA 22.4)*: Objective-based industrial electrical Code*
- Part VI (CSA 22.6)*: Electrical inspection Code for existing residential occupancies*

The primary purpose of the Code is to minimize fire and shock hazards. Part I is the focus of this study.

For the purpose of this report, C22.1 or Part I of the Canadian Electrical Code is referred to solely as the "CE Code" or "the Code." The CE Code governs the installation and maintenance of electrical equipment, and is a critical part of the Canadian electrical safety system and infrastructure. The CE Code is a voluntary standard, developed as a model code that can be adopted and enforced at the discretion of provincial or territorial regulatory authorities.

Parts II and III are referenced in Part I of the Canadian Electrical Code. Part I also references the National Building Code of Canada, National Fire Code of Canada, and many other Canadian and International Codes and standards. Part II of the CE Code is a series of product standards that provide electrical safety requirements intended to reduce the risk of fire and shock hazards, and are suitable for use in conformity assessment (testing, inspection and certification). To meet the requirements outlined in Part II, products are to be certified by an accredited certification organization. Provincial and territorial regulations outline the specific certification marks that are recognized in that province or territory, which are shared across most jurisdictions. These regulations also often state that electrical products cannot be used, sold or distributed unless certified by an accredited certification organization.[3] Because certification organizations are able to certify products for Canadian or North American markets according to multiple sets of standards, the use of Part II in Canada typically does not vary between jurisdictions or drive misalignment in the same way as Part I.

The Code, along with third party certifications and requirements, protects the well-being of electrical workers and users. It is not designed or intended to be used as a guide or manual for untrained individuals or groups.[4] The CE Code is not the only consideration for electrical equipment in Canada. Depending on the location and the nature of a project, provincial requirements, bylaws, and industry standards (such as for the petroleum industry) may also apply. The engineers on a project determine if that project plans are compliant with the relevant requirements. If builders are sourcing electrical equipment internationally, global standards such as the International Electrotechnical Commission (IEC), and other national or regional standards may also apply. The compatibility of the equipment with applicable standards in Canada needs to be confirmed by engineers, certification organizations, and AHJ inspectors.

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[1] *Parts of the Canadian Electrical Code*. American National Standards Institute.

[2] It should be noted that Part II and Part III of the Canadian Electrical Code contain a series of standards, and therefore differ in structure from other parts of the Canadian Electrical Code.

[3] Understanding the Canadian Electrical Regulatory System. Part II: Canadian Provinces and Territories. Canadian Perspectives Codes and Standards Electrical Inspections Features January/February 2002. IAEI Magazine.

[4] CSA C22.1:21 Section 0 - Object, scope and definitions.

Regulation based on the CE Code uses a prescriptive approach; that is, it specifies requirements that can be assessed visually or by measurement. This is in contrast to a performance or objective-based approach to legislation, which focuses on outcomes rather than providing specific installation requirements.[5] As a result of industry demand, Part IV of the Canadian Electrical Code (CSA C22.4) was developed in 2009 and uses an objective-based approach for the purpose of installations at industrial facilities. Part IV is intended for use by industrial users authorized and recognized by the regulatory authority in a jurisdiction. This also allows for large industrial users to essentially regulate their own projects.

2.2 Detailed overview of Part I

As noted previously, the CE Code consists of five parts, with Part I being the safety standard for electrical installations at buildings, structures or premises. This subsection provides an overview of Part I of the Code.

2.2.1 Structure and main areas

The rules contained in the 2021 (25th edition) of the CE Code are divided into 43 evenly numbered sections. Sections 0 through 16 and 26 are considered general rules for electrical installations. Some general rule sections include grounding and bonding, wiring methods, and protection and control. The remaining sections, 18 to 24 and 28 to 86, are supplementary rules or rules that supplement or amend the general rules and apply to electrical installations for particular locations or circumstances. Some supplementary rule sections include those for hazardous locations, signs and outline lighting, electrical communication systems, renewable energy systems and mobile homes. Part I of the CE Code also contains information on metric units, reference publications, and committees and subcommittees involved in the development and implementation of the Code with respect to electrical installations. A key feature of Part I with respect to this study appears on the title page of the Code, stating “The Canadian Electrical Code, Part I, is a voluntary Code for adoption and enforcement by regulatory authorities,” allowing provinces and territories to adopt and enforce the Code using their respective regulatory authorities.

For the remainder of the report, C22.1 or Part I of the Canadian Electrical Code is referred to solely as the “CE Code,” or “the Code” unless otherwise indicated.

2.2.2 Code cycle and regulatory process

The CE Code is developed by Canadian Standards Association (CSA Group) through a process approved by SCC. It is revised every three years with the participation of volunteers across various industries and organizations, including those belonging to the Technical Committee on the CE Code, Part I (“the Committee”), as described in Appendix C of the Code. The Committee is responsible for the development of the Code according to its three year cycle. Members of the Committee include regulatory representatives from every province and territory, including representatives from three municipal inspection authorities, industry associations, certification and inspection organizations, manufacturers, educators and government agencies. Each section of the Code also has a smaller subcommittee composed of stakeholders most impacted by that section.

[5] Regulatory Approach, Expert Advisory Panel on occupational health and safety. Government of Ontario.

As contained in Appendix C —The Technical Committee on the Canadian Electrical Code, Part I — Organization and Rules of Procedure, the Committee is to include the following:

- a Chair and Vice-Chair as appointed by the members
- an Executive Committee
- subcommittees
- a Project Manager (nonvoting) appointed by CSA Group
- no more than 43 voting members, meeting the requirements in the table below

Figure 2.1: Requirements for Technical Committee voting members

Group	Minimum number of voting members	Maximum number of voting members
Regulatory authorities (e.g. Provincial, territorial, municipal)	11	16
Owners/operators/producers (e.g. Electrical manufacturers, designers and installers, installation users)	9	14
General interest representatives (e.g. Electric utilities, fire chiefs, issuers of building Codes, educators, certification organizations)	9	16
Associate, liaison and ex officio members (nonvoting)	As required	

Source: *CSA C22.1:21 - C.2.3.1.1, C.2.2.1*

Regulatory authorities represented on the Committee are selected from provincial, territorial and municipal inspection authorities. Inspection authorities may also have the responsibility of adoption of the CE Code in their jurisdiction as AHJs. In addition to the Committee, there is also the Regulatory Authority Committee (RAC), which advises the Committee on the legality and enforceability of any language used in potential changes to the Code. The voting members of the RAC include a Chair and Vice-Chair and the regulatory authority members of the Committee. The voting members of the RAC are the AHJ representatives from jurisdictions that are members of the Committee.[6]

Any person, organization or committee can submit a request to the project manager to amend the CE Code, which can then be voted on by the members of the Committee. Changes to the Code can be made to improve safety, adopt a new technology, correlate with other standards or clarify wording. CSA Group conducts impact assessments for certain approved Code changes to evaluate the potential impact of the change. These include a consultation process regarding the change, assessment of impacts to key stakeholders and assessment of anticipated economic impact. These impact assessments are often cited by jurisdictions when communicating the change to the public. Jurisdictions are also permitted to conduct their own consultation and impact assessments to explore potential impacts of a Code change.[7]

In addition to participating on the Committee, representatives of regulatory authorities are also members of the Canadian Advisory Council on Electrical Safety (CACES). CACES is recognized as the central regulatory authority for electrical safety by SCC's Accreditation Program for Product, Process and Service Certification Bodies. CACES helps ensure electrical safety in various ways, including monitoring problems in the field, providing advice to AHJs and providing a forum for exchange of information. Other members of CACES include representatives of SCC, Health Canada and organizations for standards development, certifications and field evaluation.[8]

[6] CSA C22.1:21 - C3.1 to C3.3

[7] CSA Group. Canadian Electrical Code Full Impact Assessment - Subject 4064 Update Section 4: Installation of identified conductors at control locations https://www.technicalsafetybc.ca/sites/default/files/2018-07/Impact%20Assessment%20-%20Subject%204064.pdf

[8] Electrical industry: Electrical Safety Regulation in Canada: The Canadian Advisory Council on Electrical Safety. https://www.electricalindustry.ca/latest-news/633-electrical-safety-regulation-in-canada-the-canadian-advisory-council-on-electrical-safety

2.3 Affected organizations and their roles with respect to the Code

This subsection outlines the groups that are affected by the CE Code and describes their interactions with the Code and their baseline economic footprint[9].

2.3.1 Authorities Having Jurisdiction

As previously noted, the CE Code is a voluntary code that can be adopted and enforced at the discretion of provincial or territorial regulatory authorities. A regulatory authority can refer to an AHJ that is responsible for adopting the Code for its jurisdiction, or a regulatory inspection body that is responsible for the enforcement of the CE Code. An AHJ is delegated by their provincial or territorial government. According to the CE Code Handbook released by CSA Group, an AHJ is a broad term describing "an organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure." In many cases, an AHJ may be responsible for both adoption and enforcement of the Code in a jurisdiction. The AHJ can also adjust or amend the CE Code in their jurisdiction as necessary using technical deviations. CSA Group develops model codes that can be re-written, amended or even replaced by provinces, territories and selected municipalities under the Constitution Act of Canada.[10] This includes the CE Code published by CSA Group, which can be used as a "model" for a jurisdiction's electrical Code.

For the purpose of this study, we use the term AHJs to refer to the bodies that govern Code adoption and enforcement. We understand that some jurisdictions such as Alberta use private organizations for electrical inspections and that some municipal AHJs do not adopt their own Code, but regulate and enforce electrical safety using the Code adopted by the province. However, unless otherwise indicated separately, the term AHJs will refer to the process of adoption and the actions of enforcement, licensing, permits, among others.

With respect to electrical safety, AHJs across Canada have the option to adopt the CSA Group CE Code "as-is," to adopt it with technical deviations, or to publish a different Code based on the CE Code. These options lead to differences in requirements between jurisdictions. Figure 2.2 lists Canada's provincial and territorial AHJs and the electrical Code or regulation used in the jurisdiction. Whether or not a jurisdiction chooses to adopt the CE Code "as-is," or with technical deviations, the Code is often renamed according to the province or territory (e.g. Manitoba Electrical Code, Nunavut's Electrical Protection Act). For the purpose of this report, the term "regulatory adoption" refers to the adoption of the CE Code by a jurisdiction, whether or not technical changes are made before or after adoption.[11]

[9] *Electricity providers and utilities also have the ability to be impacted by CE Code misalignment due to the relationship between Part I for consumer electrical installations and standards contained in Part III for power distribution safety. For example, meters are a Part III item, but plug into a Part I meter base. From this perspective, utilities would be impacted by Part I changes, even though they use Part III for their power distribution installations. However, due to electricity providers often only operating within one province and territory, we have not explored potential impacts to these stakeholders resulting from CE Code misalignment between jurisdictions.*

[10] Tiered Energy Codes: Best Practices for Code Compliance. Andrew Pride. Efficiency Canada September 2020.

[11] The regulatory adoption process by a jurisdiction can also be framed as code development at the provincial, territorial or municipal level. This is because AHJs have the authority to make technical deviations to the CE Code, essentially "developing" their own Code, using the original CE Code developed by CSA as a starting point. However, for the purpose of this report, the phrase "Code development" will strictly refer to the CE Code development process, conducted by CSA every three years through a process approved by SCC. This Code development process is described in Section 2.2.2 above. The phrase "regulatory adoption" used throughout this report will refer to the adoption of the CSA Code by jurisdictions, with or without technical deviations.

Figure 2.2: Provincial and territorial AHJs in Canada

Province or territory	Provincial/territorial AHJ	Regulation(s) and Act(s) in effect	Current CE Code in effect (as of November 2021)
British Columbia (BC)	Technical Safety BC	Electrical Regulations	2018
Alberta (AB)	Alberta Municipal Affairs	Alberta Electrical Code Regulation	2018
Saskatchewan (SK)	Technical Safety Authority of Saskatchewan	Electrical Inspection Act Electrical Inspection Regulations Electrical Code Regulations	2021
Manitoba (MB)	Manitoba Hydro	The Manitoba Electrical Code	2018
Ontario (ON)	Electrical Safety Authority	Ontario Electrical Safety Code	2018
Québec (QC)	Régie du bâtiment du Québec	Chapter V of the Québec Construction Code - Electricity Chapter 2 of the Québec Security Code	2015
New Brunswick (NB)	Province of New Brunswick Department of Public Safety	The Electrical Code Regulations - Regulation 84-165	2018
Nova Scotia (NS)	Nova Scotia Labour and Advanced Education	The Electrical Code Regulations	2021
Prince Edward Island (PEI)	Prince Edward Island Inspection Services	Electrical Inspection Act - Electrical Inspection and Code Regulations	2021
Newfoundland and Labrador (NFL)	Province of Newfoundland and Labrador	Electrical Regulations	2021
Yukon (YK)	Yukon Department of Community Services	Electrical Protection Act	2018
Northwest Territories (NWT)	Northwest Territories Public Works and Services	Electrical Protection Act Electrical Protection Regulations	2018
Nunavut (NT)	Nunavut Community and Government Services	Electrical Protection Act Electrical Protection Regulations	2018

Source: CSA Group

In the process of regulating electrical safety and adopting Codes, larger AHJs often conduct their own impact assessments to understand how a change in the CE Code will affect industry and users at the provincial and territorial level. As previously discussed, in addition to developing electrical Codes for jurisdictions, AHJs are often also involved in inspection services.

2.3.2 Manufacturing

In Canada, there are various manufacturing sectors, subsectors and industries that are subject to electrical standards. These sub sectors include, but are not limited to, electrical equipment manufacturing, wire and cable manufacturing, and

wiring device manufacturing. The total revenue for electrical equipment manufacturing in Canada is $12.4 billion.[12] Organizations that are impacted by electrical installations outlined in the Code are likely to operate in the manufacturing industries listed below. In total, these industries account for 2.6% of Canadian jobs and 2.5% of Canadian GDP. We note that not all products manufactured are affected by the Code. For example, transportation manufacturing includes products affected by the Code, such as mobile homes, mobile commercial buildings, and electric cars, and other products that are not affected by the Code, such as other automobile manufacturing.

Figure 2.3: Key statistics on select Canadian manufacturing industries, 2020

Manufacturing subsector	Employment (% of Canadian total)	GDP in millions, $2012 chained (% of Canadian GDP)	Select 5-digit NAICS industries	Major players
Machinery manufacturing (333)	127,918 (0.8%)	$14,757 (0.79%)	• Engine and turbines • Construction machinery • Heating and air-conditioning equipment • Pump and compressors	• General Electric • Nortek • INNIO Group • ATS Automation Tooling Systems
Computer and electronic product manufacturing (334)	54,963 (0.36%)	$5,801 (0.31%)	• Communications equipment • Audio & video equipment • Semiconductors & other electronic components • Medical devices	• Circa Enterprises • Medtronic • Raytheon Technologies
Electrical equipment, appliance and component manufacturing (335)	35,100 (0.2%)	$3,457 (0.18%)	• Electrical equipment • Wire & cable • Wiring devices • Lighting fixtures • Major household appliances	• ABB • Schneider Electric • Hubbell • Eaton • Siemens • Leviton
Transportation equipment manufacturing (336)	184,623 (1.2%)	$22,138 (1.18%)	• Truck, trailer & motor homes • Automobile electronics • Aircraft, engine & parts	• Magna International • Veoneer • Bombardier
Total	**402,604 (2.6%)**	**$46,153 (2.5%)**		

Source: Statistics Canada Table 36-10-0434-06, IBISWorld Industry Research

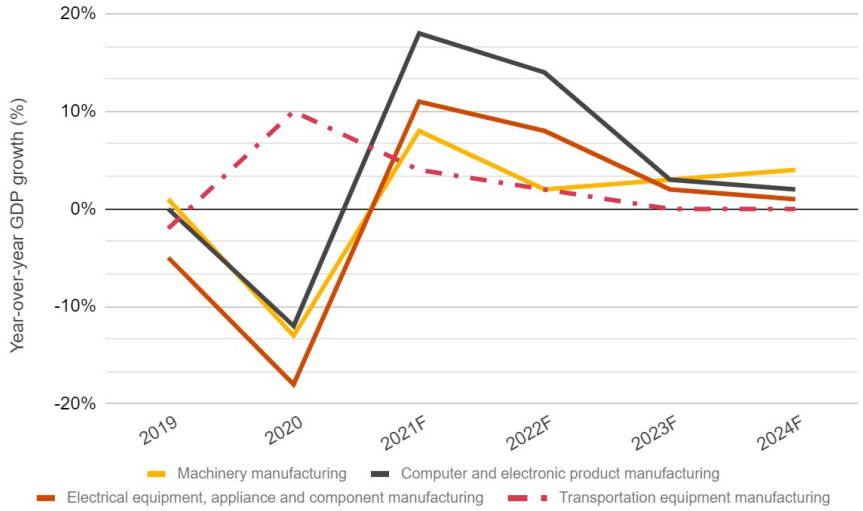
Products designed within these industries must be able to be installed according to relevant electrical Code that is in place in the jurisdiction of installation. Therefore, manufacturers are required to design, manufacture, certify, and hold inventory (as applicable) of the products based on the requirements of the jurisdiction in which they plan to sell their products. Manufacturers of products are also subject to Part II of the Code, which outlines equipment standards that are intended to reduce the risks associated with fire and shock hazards for products that would be installed according to Part I. Certain Manufacturers also perform equipment installations and therefore must comply with both Part I and Part II of the Code.

[12] *2022 Pathfinder: Benchmark Study & Industry Profile.*

Of the sectors listed in the table above, Part I of the CE Code is most directly related to electrical equipment, appliance and component manufacturing, which has annual revenues of approximately $9 billion.[13] Equipment and components manufactured in this subsector are likely to be installed and used in other manufacturing industries, such as those for machinery, power systems, instrumentation and control systems or mobile homes.

Many manufacturing subsectors experienced contractions in 2020 due to the COVID-19 pandemic, and as a result, are expecting significant growth to 2024 as the economy recovers.[14] Transportation equipment manufacturing did not experience a drop in GDP during 2020, and is therefore expecting lower cumulative growth over the next four years, as displayed in the figure below.

Figure 2.4: Canadian manufacturing industries, GDP growth 2019 - 2024



Stakeholder engagement found that electrical manufacturing firms operating across multiple jurisdictions have potential to be significantly impacted by CE Code misalignment. These impacts are explored in detail in Section 3.

2.3.3 Construction

Construction services can be provided by contractors, or by firms operating within the “design-build” or “engineering, procurement, and construction” industries.[15] As shown in the figure below, there are multiple subsectors of construction in Canada, including building construction, energy, utilities and mining, industrial, heavy and civil engineering, and specialty trades. Construction is a major industry for Canada, making up approximately 7.3% of annual GDP and 6.3% of employment.

Although there are major players in the specialty trade contracting subsector, the electrician segment within this subsector is mostly composed of small and specialized operators. Because electricians are suppliers to construction projects, the demand for them and other specialty trade contractors is largely dependent on the growth of other construction industries, in addition to external factors such as construction values and renovation expenditures.[16]

[13] Sum of revenues for 2020 NAICS 33521, 3352, 3353 and 3359. Source: IBISWorld.

[14] Conference Board of Canada E-Data.

[15] For the purpose of this report, construction services and design engineering services have been considered separately, even for firms that are classified as “design-build” or “engineering, procurement and construction”.

[16] IBISWorld NAICS Report 23821.

Figure 2.5: Key statistics on the construction sector in Canada

Construction subsector	Employment (% of Canadian total)	GDP in millions, $2012 chained (% of Canadian GDP)[17,18]	Select 5-digit NAICS industries	Major players
Construction of buildings (236)	235,194 (1.54%)	$77,456 (4.00%)	• Residential • Industrial building and structures • Institutional and commercial buildings	PCL Constructors EllisDon Aecon Ledcor
Heavy and civil engineering (237)	150,454 (0.98%)	$65,346 (3.38%)	• Oil and gas pipelines • Land subdivision • Highway, streets and bridges	Aecon Graham AECOM Quanta Services
Speciality trade contractors (238)	577,439 (3.77%)		• Foundation and structure contractors • Electricians and electrical contractors and other wiring installation contractors • Plumbing, heating and air-conditioning	Chemco Electrical Contractors Ainsworth Black & McDonald
Total	**963,087 (6.29%)**	**$140,987 (7.28%)**		

Source: Statistics Canada Table 36-10-0434-06, IBISWorld Industry Research

Construction firms are responsible for ensuring that through the execution of engineering designs, they adhere to the CE Code. The Code governs their installations of electrical equipment and components, power systems, instrumentation and controls, wiring, cabling and other activities. To perform installations, construction firms sometimes hire local electrical union labour in the jurisdiction of work who would be familiar with the latest Codes and standards. However, our stakeholder engagement found that potential still exists for construction firms to be negatively impacted by CE Code misalignment when working across jurisdictions. These impacts are explored in more detail in Section 3.

[17] Statistics Canada: Industries in sector 23 are special hybrids that correspond to sections of the North American Industry Classification System (NAICS) Code 23. Therefore, GDP for construction of buildings (236) is a combination of 23A (residential building construction) and 23B (non-residential building construction) GDP as per Statistics Canada Table: 36-10-0434-01 (formerly CANSIM 379-0031), while 237 and 238 is the remaining GDP share.

[18] Please note that aggregates are not always equal to the sum of their components.

2.3.4 Design engineering

For the purposes of this report, we define design engineering as the service of designing a building or system that would include electricity and electrical components, therefore requiring the use of the CE Code for meeting installation and mechanical requirements. This may include the application of electricity in health care spaces, electrical systems for fire protection or emergency electrical supply for buildings. Design engineering firms may hire external construction contractors to execute their designs or provide in-house construction services.

Figure 2.6: Key statistics on the design engineering sector in Canada

Industry group	Employment (% of Canadian total)	GDP in millions, $2012 chained (% of Canadian GDP)	Select 5-digit NAICS industries	Major players
Architectural, engineering and related services (5413)	195,946 (1.28%)	$24,918 (1.29%)	• Architectural services • Engineering services • Building inspection services • Testing laboratories — Electrical testing	IBI Group WSP Canada SNC-Lavalin Stantec AECOM

Source: Statistics Canada Table 36-10-0434-06, IBISWorld Industry Research

These firms must design buildings and electrical systems in compliance with Code, and building Codes in the local jurisdiction where the asset will be constructed. The designs must also ensure that all necessary electrical systems and equipment (e.g. electrical equipment and components, power systems, cabling, etc.) meet installation requirements, achieve necessary regulatory permits and align with other discipline-based Codes and standards (e.g. mechanical, civil, structural, etc.). Our interviews confirmed that design engineering firms that are involved in projects in multiple provinces can therefore be affected by CE Code misalignment.

2.3.5 Certification organizations

Part I of the CE Code requires that electrical products installed under Part I are approved to the Part II standards. Thus, Part II (products standards) and Part I (installations) are closely related. Inspection authorities ensure that electrical installations are installed according to Part I of the Code using a product that is certified by an accredited certification organization. Therefore, to be installed properly under Part I of the Code, a product must be first certified by a certification organization recognized by the Standards Council of Canada or approved through a field inspection. Certification organizations test and assess electrical products for safety, recognizing their approval with certification markings. Under Part I of the Code, individuals or organizations are legally required to only install products that have been approved and certified by an accredited evaluation or certification organization. These organizations, such as Underwriters' Laboratories (UL), Canadian Standards Association (CSA Group) or Electrical Safety Authority (ESAFE) operate in the area of testing, inspection and certification in Canada, which falls under the architectural, engineering and related services industry group, identified in the table above. Many of these organizations also operate internationally, and therefore provide testing, inspection and certification services for consumer products across the world, and have certification marks that are used globally. Our stakeholder engagement found that certification organizations rely on Part II of the CE Code to conduct their business, and even though product standards in Part II are referenced within Part I of the CE Code, they are not significantly impacted by any misalignment in Part I. Products governed by Part II of the CE Code include refrigeration equipment, electrical burner control systems, and electrical laboratory equipment.

2.4 Sources of misalignment in the Canadian Electrical Code

There are multiple reasons for CE Code misalignment between jurisdictions. Below, we outline these key drivers of misalignment.

2.4.1 Technical deviations

Provinces and territories have various tools they can use to tailor the CE Code for use in their jurisdiction, deviating from the national Code released by CSA Group. Technical deviations can be made by provinces and territories by adding, removing or adjusting individual rules within the Code prior to release of the jurisdictions' electrical Code. Ontario releases the Ontario Electrical Safety Code (OESC) as the provincial regulation for installation and maintenance of electrical equipment, which is adapted from the newest version of the CE Code. Jurisdictions can put clauses, additional standards or amendments in their Codes as necessary for their use. This may include clauses, standards or amendments that were not approved by other jurisdictions for use in the national Code. Technical deviations therefore create differences between the national CE Code, the Code that is released and adopted in the jurisdiction, and other jurisdiction's Codes, which may not have the same technical deviations.

In contrast, some jurisdictions choose to automatically adopt the CE Code as provincial or territorial regulation, and deviate from the national Code only through the use of bulletins or published interpretations of the Code.[19] The ability of the AHJ or Chief Electrical Inspector to publish technical deviations from the national Code is often written in the jurisdictions' electrical regulations. These technical deviations occur following adoption, and are available to the public on the respective AHJ's website. For example, Alberta utilizes "STANDATA" electrical Code bulletins, which are posted online and help users to interpret certain sections of Part I. STANDATA bulletins are also used to communicate technical deviations and recommended practices for use of the Code.[20] Technical deviations sometimes occur to accommodate adoption of new technologies that were not included in the most recent version of the Code, or to allow for one-time exceptions to the Code for the purpose of a specific project. Different interpretations of the Code released by AHJs through bulletins can also create differences in how the same Code section may be interpreted in different provinces.

2.4.2 Timing of Code adoption

As shown in Figure 2.7, the timing of adoption of the latest CE Code differs by AHJ, regardless of whether technical deviations are made. This is driven by the fact that AHJs do not coordinate with each other on adoption timing, and each has a different process for adoption. Some jurisdictions adopt the CE Code "as is," meaning that there are no technical deviations to the Code prior to its release and application in the jurisdiction. These jurisdictions are able to implement and enforce the new Code much sooner than other jurisdictions that undertake technical deviations or further analysis prior to adopting. Each AHJ may have a different reason for the length of time between the release of the latest Code and the date in which it is adopted in their respective province or territory. For some jurisdictions, the newest version of the Code automatically comes into force after a fixed amount of time has passed from the Code release date by CSA Group.[21]

In addition, the following factors can impact the timing of adoption and enforcement of the Code:

- Adoption
  - Impact assessments
  - Drafting of regulation and translation revisions
  - Public and industry consultation
  - Allowing time for users and educators to become familiar with the Code

[19] For the purpose of this study, we are referring to any bulletins or interpretations of the jurisdiction's Code that cause it to deviate from the interpretation or use of the national Code, recognized as a "technical change". Bulletins or interpretations that do not create a difference between the jurisdiction's Code and the national Code are not being considered.

[20] Alberta Government Publications https://open.alberta.ca/publications/standata-electrical-safety-information-bulletin-2018-canadian-electrical-Code

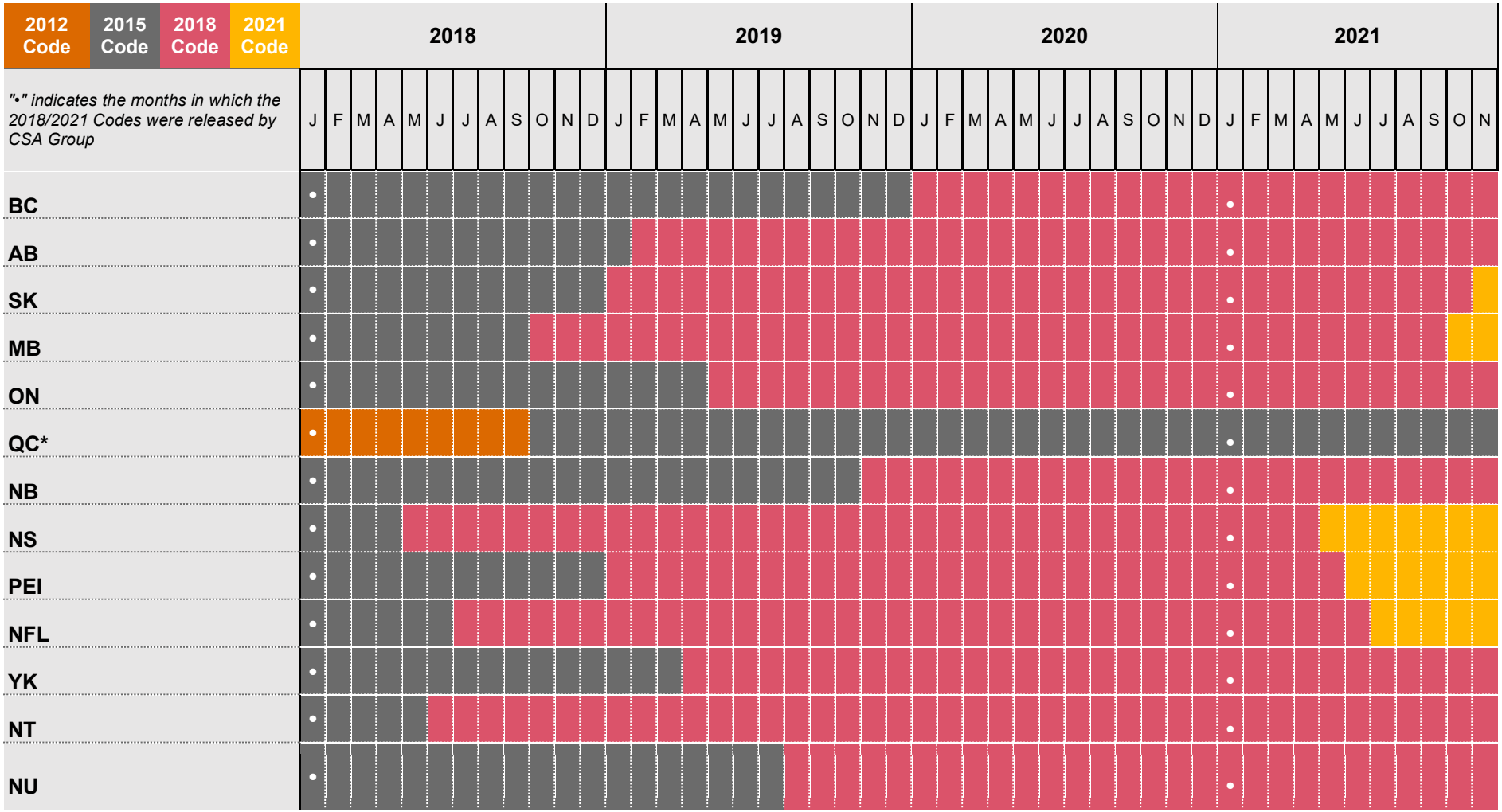
[21] Pierre McDonald - Electrical Industry News Week. *Codes and Standards - Provincial Legislation and the Administrative Requirements of the CE Code*

- Enforcement of Code after adoption
  - Publishing technical deviations
  - Answering stakeholder questions

The French version of the CE Code is released three months after the English version. Therefore, the AHJ for Québec must wait these three months to access the French version of the CE Code released by CSA. In addition, Québec dedicates additional time to revise the French version of the electrical Code at the provincial level and have a French public review, creating additional time spent in adoption. This additional time sometimes causes Québec to skip Code cycles so that they do not fall too far behind other provinces. Currently, Québec is using the provincial Code based on the 2015 CE Code, having skipped the adoption of the 2018 release.

Due to differences in timing of adoption between jurisdictions, there is potential for time periods in which two or even three different Code versions are being used across the country. Therefore, misalignments may exist due to differences between these Code editions, creating impacts for different types of organizations. As shown in the figure below, it can take from between four to 24 months for a jurisdiction to adopt the newest version of the Code after its release. Our interviews indicate that timing in adoption, rather than technical deviations, is responsible for the majority of significant misalignments.

Figure 2.7: Timing of Code adoption by Canadian jurisdictions (as of November 2021)



*Québec notes a six month transitional period following Code adoption to train professionals and workers.

Source: CSA Group

2.4.3 Regional and sub-provincial variations

Some provinces have multiple regulatory authorities responsible for administering the CE Code. Each regulatory authority has responsibility for administering the CE Code under the applicable Code in the jurisdiction, whether it is the CE Code adopted by the provincial or territorial AHJ, or a municipal by-law adopted by a municipal AHJ.[22]

Prior to spring of 2021, Manitoba had multiple electrical Codes being used in the province. The *Manitoba Electrical Code, 13th version*, which governs "the construction, installation, maintenance, repair, extension, alteration and use of electric wiring and related facilities using or intended to use power supplied by Manitoba Hydro, except within the City of Winnipeg."[23] Although Manitoba Hydro governed electrical installations under this Code as a provincial AHJ, the City of Winnipeg had similar responsibilities under the *Winnipeg Electrical By-Law No. 86/2018* and *The 2018 City of Winnipeg Electrical Technical Interpretations.* Thus, the Manitoba Electrical Code adopted by Manitoba Hydro did not apply to the City of Winnipeg. However, in May 2021, *The Building and Electrical Permitting Improvement Act (Bill 38)* was enacted by the Legislative Assembly of Manitoba. Schedule C of Bill 38, *The Manitoba Hydro Amendment Act*, outlines that the City of Winnipeg will adopt the Manitoba electrical Code, establishing and enforcing the use of one uniform Code across the province.[24]

For engineers or construction companies that are unfamiliar with conducting activity in a particular region, having multiple Codes and/or multiple regulatory authorities can cause confusion, especially if the Codes have differences. Our interviews with companies that conduct work in jurisdictions with multiple Codes indicate that there can be confusion as to whether the municipal or provincial Code applies and which is the appropriate Code to use. The impact of this misalignment driver will be explored further in Section 3.2.4.

2.4.4 Enforcement

Differences in interpretations by inspectors can create inconsistency in the application of the code, which is not related to misalignment between jurisdictions. Electrical inspection authorities in provinces, territories and certain municipalities have the responsibility of enforcing the Code in their respective jurisdiction. These authorities may take the form of government, electrical utility providers or even private inspection agencies. Some jurisdictions have multiple inspection authorities, whereas others only have one. Individual electrical inspectors under these authorities are responsible for ensuring adherence to the CE Code by reviewing designs and inspecting installations. The Chief Electrical Inspector for each jurisdiction participates as a member of the Regulatory Authority Committee ("RAC") of the CE Code, which helps ensure the language used in any changes to the Code are enforceable and legal in all jurisdictions.[25] Alberta specifically has a privatized Safety Code system, in which electrical inspectors aren't a part of the government, but report to municipalities, corporations, or agencies accredited by the Alberta Safety Codes Council. The Alberta Safety Codes Council certifies electrical inspectors.[26] In addition, many large industrial firms in Alberta are self-accredited, but must register their plans with the Safety Council and are subject to audits.

In addition to differences between jurisdictions, differences in the enforcement of the Code has the ability to create misalignment within a jurisdiction. This misalignment comes from differing interpretations of language used in the Code regarding inspections and enforcement, therefore enabling an inspector to use his or her judgment during inspection. For example, a note on the use of Rule 28-400 of the Code states:

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[22] Understanding the Canadian Electrical Regulatory System. Part II: Canadian Provinces and Territories. Canadian Perspectives Codes and Standards Electrical Inspections Features January/February 2002. IAEI Magazine. https://iaeimagazine.org/features/understanding-the-canadian-electrical-safety-regulatory-system-part-ii-canadian-provinces-and-territories/

[23] Manitoba Hydro. https://www.hydro.mb.ca/accounts_and_services/permits_and_inspections/pdfs/manitoba_electrical_Code.pdf

[24] The Legislative Assembly of Manitoba. 3rd Session, 42nd Legislature. Bill 38 The Building and Electrical Permitting Improvement Act (Various Acts Amended and Permit Dispute Resolution Act Enacted). https://web2.gov.mb.ca/bills/42-3/b038e.php#C

[25] Understanding the Canadian Electrical Regulatory System. Part II: Canadian Provinces and Territories. Canadian Perspectives Codes and Standards Electrical Inspections Features January/February 2002. IAEI Magazine. https://iaeimagazine.org/features/understanding-the-canadian-electrical-safety-regulatory-system-part-ii-canadian-provinces-and-territories/

[26] Alberta in Canadian Electrical Code Adoption - CSA Group.

Upon the inspection of an installation, if it is the opinion of an inspector that automatic restarting of such motor-operated machinery as saws, routers, millers, wood and metal turning lathes, conveyors, or other moving machinery would create a hazard on return of voltage after stopping due to failure of voltage, the motor control device will be required to provide low-voltage protection.[27]

Our stakeholder engagement revealed that inspectors have some ability to interpret Codes for the purpose of determining whether an installation is safe or not safe. Therefore, although some judgment will likely always be required by inspectors, the scope for applying judgment is still a potential source of misalignment between jurisdictions. This is taken into consideration by the Committee when reviewing potential Code changes, according to the following criteria included in Appendix C of the Code:

Is this Rule enforceable (i.e. it is written in unambiguous language, using indisputable criteria)?

***Note:** The Code user must also be able to determine compliance from a visual inspection of the installation on site and without the use of supplementary information or judgment. Rules that, in their wording, require a great deal of judgment on the part of the reader may not be consistently enforced and are a source of conflict and frustration to users of the Code.*[28]

Beyond language in the Code, if a particular jurisdiction is behind in adoption of the most current Codes, the status of newer technologies that have since been introduced may be unclear to Code users. According to jurisdiction's regulations, regulatory authorities have the ability to permit the use of products that are not included in the most recent Code as long as the product has been certified or approved through inspection. This can create misalignment where certain products can be used in some jurisdictions, but not others. Inspectors sometimes will allow these technologies even if a jurisdiction is behind in adoption, and will look to engineering opinions or bulletins for potential approval for the use of the product and its installation. In addition, we understand from interviews that individual inspectors are not always up-to-date on the most recent Code adopted in their jurisdiction, or the Code that is in use for the installation they are reviewing. Ultimately, when it comes to new technologies or overall enforcement of the Code, decisions by individual inspectors can create inconsistencies for electrical inspections and the enforcement of the CE Code both across and within jurisdictions.

2.5 Discussion of technical barriers to trade and their implications

Lack of alignment of regulation and Codes across Canadian provinces and territories can act as a technical barrier to trade, specifically exports of services. Regulatory inconsistencies, such as in the misalignment of electrical Codes across provinces and territories, are a type of interprovincial trade barrier that can add costs for operations operating in more than one province. A recent working paper from the International Monetary Fund (IMF) estimates that complete liberalization of internal trade in goods could increase Canada's GDP per capita by approximately 4%, a significant boost.[29] This lack of alignment affects all industry sectors involved in construction and maintenance including residential construction, mining, oil and gas, and infrastructure.

In response to technical barriers to trade between provinces, the Canadian Free Trade Agreement (CFTA) was enacted in July 2017. This agreement among all provinces and territories of Canada was created to "reduce and eliminate to the extent possible, barriers to the free movement of persons, goods, services, and investments within Canada and to establish an open, efficient, and stable domestic market" through the enhancement of trade, labour mobility and investment across provincial and territorial borders.[30] Among other mutually agreed principles, the agreement also recognizes that to achieve the above goals, existing regulatory measures that create or reinforce technical barriers need

[27] This note on Rule 28-400 is included in Appendix B of CSA C22.1-21. Appendix B ("Notes on Rules") is non-mandatory and is used for information and clarification of the CE Code.

[28] CSA C22.1:21 Appendix C: Guide to Guide to Subcommittee chairs for evaluation of proposals submitted in accordance with Clause C5.4.1 and for evaluation of Subcommittee reports required in accordance with Clause C5.4.5

[29] Alvarez, J., I. Krznar and T. Tombe (2019), "Internal Trade in Canada: Case for Liberalization", IMF Working Paper, WP/19/158.

[30] CFTA. https://www.cfta-alec.ca/

to be reconciled. More specifically, the CFTA is working to identify and reconcile the negative impacts to trade barriers resulting from differing regulatory measures and restrictions to labour mobility between provinces.

Other organizations are currently investigating the impacts on technical barriers to trade. For example, the Building Development Branch in Ontario's Ministry of Municipal Affairs and Housing has completed an overview of cross-country misalignment in construction codes in an effort to outline key milestones for harmonizing Ontario's Building Code with the National Construction Codes. This overview identified sources of misalignment, which are very similar to those of the CE Code, but did not analyze associated costs. To our knowledge no studies have addressed misalignment in the CE Code.

These impacts of misalignment will be explored and analyzed further in Section 3 of this report.

2.6 International context of misalignment

Below, we provide brief descriptions of national alignment in electrical codes in the US, Australia and Europe. The US system is similar to Canada whereby individual states, regions and cities can determine adoption timing and technical deviations. Australia has a national electrical code adopted by all states on a unified schedule without technical deviations. Europe's system is in between, where each country has its own organization for electrical standards that determines how to adopt a set of international standards, while working to maximize harmonization and trade capabilities across European countries.

United States

The United States has a national electrical code that is adopted by all 50 states. The National Electrical Code (NEC), similar to the CE Code Part I, is the benchmark for electrical installation, design and inspection and has a three-year code cycle. In between editions of the NEC, the National Fire Protection Agency, which is in charge of the development of the code, releases tentative interim amendments.

Each state has the right to adopt and make technical deviations to the NEC in the development of their own state electrical code. Technical deviations to the Code are often made by states to accommodate "local geographic, climatic and geologic conditions." Each state has its own timeline as to when it adopts the newest version of the Code. The date of adoption for state departments can range anywhere from immediately after the Code is released to over four years after. In many states, counties, cities and other local jurisdictions can also adopt the Code locally. This can result in some jurisdictions adopting the newest Code version faster than the remainder of the State, resulting in the use of two (or even three to four) different Code versions within a single state. The dates of adoption for counties and cities are often later than for the state in which they reside, with some local jurisdictions still using the 2011 NEC.[31]

Similar to Canada, misalignment in the United States electrical system is largely driven by states and local jurisdictions adopting different versions of the national Code at different times, in addition to making technical amendments. Due to the large size of markets and larger number of states and jurisdictions compared to Canada, misalignment has the potential to be a significant issue in the United States. This finding was supported by interviews where stakeholders had experience in US markets.

Australia

In Australia and New Zealand, AS/NZS 3000, Electrical installations, known as the Wiring Rules, are technical rules for electricians to properly design, construct and verify electrical installations.[32] There are two separate parts to the Wiring Rules: the first outlining regulatory requirements and the second containing solutions to achieve electrical safety principles. All states in Australia comply with the Wiring Rules without technical deviations. This ensures very little misalignment in electrical installations across provinces. The most recent version of the Wiring Rules was released in 2018, superseding the 2007 version. Since its release in 2018, Standards Australia has published two amendment

[31] IAEI - NEC Code Adoption. https://www.iaei.org/page/nec-code-adoption
[32] Wiring Rules - Standards Australia. https://www.standards.org.au/engagement-events/flagship-projects/wiring-rules

documents for the Code. Industry and users of the Code are given a transitional period in which they can understand and comply with the changes in the amendment documents.[33]

Europe

For the development of wiring and electrical standards, many countries across the world use the International Electrotechnical Commission (IEC) 60364, Electrical Installations for Buildings (IEC 60364), standards. The purpose of the IEC is "to promote international co-operation on all questions concerning standardization in the electrical and electronic fields."[34] Within Europe, these standards are published by the European Committee for Electrotechnical Standardization (CENELEC) as HD 60364. CENELEC is composed of 34 member countries, including France, Germany, Finland, Sweden, Spain, Turkey, Denmark, Greece and the United Kingdom. Each CENELEC country has its own organization for electrical standards, and uses IEC 60364 to guide the development of its own national wiring standards. The use of IEC 60364 helps to maximize harmonization and trade capabilities across European countries.[35] IEC 60364 can be described as a "collection of documents that define fundamental principles, practices, and performance requirements which reflect the European concept of wiring and distribution systems."[36] For many years, representatives from North America have been involved in IEC standards and the harmonization of IEC 60364 and electrical standards in North America has been an ongoing discussion. However, for international harmonization to occur between European and North American standards, further research will need to be conducted to account for differences in infrastructure and to determine which standards may be favoured for worldwide adoption.[37]

[33] Queensland Government. eSAFE Electrical Bulletins 2021. https://www.worksafe.qld.gov.au/news-and-events/newsletters/esafe-newsletters/esafe-editions/esafe-electrical/2021-bulletins/may-2021/wiring-rules-amendment-two-released

[34] International Standard IEC 60364-1 Fifth edition 2005-11.

[35] Lori Tennant, IAEI Magazine. How the IEC Relates to North America – Particularly IEC 60364. https://iaeimagazine.org/standards/how-the-iec-relates-to-north-america-particularly-iec-60364/

[36] GT Engineering. IEC 60364 VS NEC. https://www.gt-engineering.it/en/Insights/iec-60364-vs-nec

[37] Jim Pauley, IAEI Magazine. *The Challenge to Having Global Codes and Standards.*

Section 3: Impacts of CE Code misalignment

3.1 Overview

This section presents our findings on the economic impacts of misalignment in the CE Code. Our overall observation is that on an economy-wide basis, cost impacts resulting from misalignment in the CE Code are not causing material economic costs in most situations. However, in rare circumstances, misalignment has the potential to create material one-time costs for firms operating in certain industries, such as manufacturing and construction. The majority of costs resulting from CE Code misalignment are driven by timing in adoption of new versions of the Code, rather than technical deviations. The impacts of misalignment are assessed in the subsequent subsections below on a qualitative and quantitative basis, depending on materiality and data availability. Refer to Appendix C for details on our hypotheses that were rejected as a result of our stakeholder engagement and analysis.

Figure 3.1 summarizes the impacts of misalignment we identified, which are described in further detail below. The affected industries and groups indicate those that bear the largest share of these impacts, including costs.

Figure 3.1: Material and immaterial impacts from CE Code misalignment

Materiality of impact	Impact from misalignment	Affected industries and groups				
		Manufacturers	Regulatory authorities	Construction	Design engineering	Consumers
Material	Manufacturing and management of additional stock-keeping units (SKU)	✓				
	Jurisdictional regulatory adoption process		✓			
	Additional Code review for those working across jurisdictions	✓		✓	✓	
	Lack of clarity surrounding which Code applies			✓	✓	
Immaterial or less material	Transferability of skills and labour mobility			✓		
	Transferability of electrical design between jurisdictions				✓	
	Limited innovation and product selection					✓

3.2 Material impacts from misalignment

3.2.1 Manufacturing and management of additional stock-keeping units (SKUs)

In rare cases, misalignment in regulatory adoption of the CE Code Part I across provinces can mean that different products are required in different parts of the country. This situation can impact manufacturing firms that fabricate and distribute machinery, cable, buildings, and other electrical equipment nationwide. The examples of this issue that we identified are all related to misalignment in adoption timing, rather than any other sources of misalignment such as jurisdictional technical deviations.

Under most circumstances, misalignment in Part I of the Code does not impact which products will be used, because it focuses on installation requirements. However, there are situations where the CE Code Part I can impact which products are required. This situation is most likely to impact manufacturers of prefabricated systems or products that require on-site installation, for example, modular housing or prefabricated buildings require different specification adjustments based on where the item is going to be used. These items may be designed, produced and deployed between different jurisdictions across Canada.

In a situation where changes in installation requirements between Code cycles affect product requirements, manufacturing firms need to supply two products where they otherwise would have supplied one. This means that they may need to keep old inventory, manufacture multiple versions of products, or design and produce special retrofitting material to be able to service clients in each province or territory. Carrying multiple units to ensure there is product for multiple locations increases the cost of inventory. This can be magnified if suppliers are moving away from carrying a particular older product (often called a stock-keeping unit ("SKU")) due to decreased demand for the product. Manufacturers interviewed that had faced this situation identified the following impacts on their operations:

- Increased manufacturing and assembly costs
- Increased costs for materials, components, labour and training
- The need to run parallel assemblies for both the new product, and the lower-volume older product
- The potential for products to be "overbuilt," meaning that more expensive material will be used on more inexpensive products just to limit the number of materials that are not duplicated for each SKU
- Reduced economies of scale, which manufacturers rely on to keep production costs low
- Opportunity costs, such as the need to draw resources away from innovation, and research and development

Manufacturers typically try to reduce the number of SKUs they manage to reduce the cost of carrying multiple products and efficiently and effectively carry inventory. Naturally, changing technology and high demand for availability from customers drives up the number of SKUs a manufacturer may carry. Therefore, the management of SKUs needs to delicately balance any costs associated with carrying soon-to-be obsolete inventory, potential revenues, customer satisfaction, and market share associated with continuing to produce and carry those products.[38] Beyond the additional costs to produce additional SKUs, carrying too many SKUs can create the following problems.[39]

- Lack of space and pick-face availability
- Capital tied up in obsolete or excess product
- Additional inventory carrying costs (e.g. insurance, taxes, administration)

[38] SKU rationalization: Finding the right balance between too many and too few. William J. Williams and Farzad Mahmoodi, CSCMP's Supply Chain [Quarterly].

[39] A Case for SKU Management: The Implications of SKU Proliferation. Fortna. https://www.fortna.com/insights-resources/a-case-for-sku-management-the-implications-of-sku-proliferation/

Therefore, manufacturers may be forced to manage the above impacts as a result of CE Code misalignment if more than one SKU is needed to supply different provinces.

As more provinces and territories transition to new Code versions, the demand for products needed to meet previous Code versions decreases, reducing economies of scale and driving up unit costs. Sometimes the cost of retrofitting products or product changes can be passed on to consumers if there is an obvious adjustment to the product, such as improved safety. However, we understand from interviews that manufacturers tend to absorb the costs associated with trying to fix a problem in the field due to a change in the Code because changes are often insignificant or not obvious.

Material impacts resulting from the manufacturing and management of additional SKUs may occur in the instance where provinces are delayed or misaligned in their adoption of a Code version, where a change in installation requirements affects product requirements. In a harmonized system, when product requirements have changed, all SKU management for those products would be eliminated and the inventory management would be transferred to the SKU that complies with the updated Code. This would mean that older SKUs would no longer be needed in any jurisdictions. Therefore, harmonization has the potential to positively impact the supply, quality, and costs of products that exist or are coming on the market.

Assessing the costs

Through our interviews, we learned of an occasion in which a rewrite of Rule 10-210 in grounding requirements for meter sockets in the 2018 Code created misalignment in product requirements between provinces, resulting in additional costs for manufacturers. Because provinces and territories adopted the 2018 version of the Code at different times, some manufacturers had to issue installation kits to retrofit the current installation of the product to meet the new single point grounding requirements. These installation kits were sold in the provinces that decided to implement the 2018 Code change before other provinces, during the time before new products could be developed to align to the new Code requirements. Some provinces, such as Nova Scotia, permitted a technical deviation to Rule 10-210, which allowed compliance with the previous Code (2015) until manufacturers were able to supply a meter base to comply with the adjusted rule.[40] Some manufacturers chose to produce multiple SKUs to meet the different requirements in various provinces, and eventually switched to only one product once every jurisdiction was on the 2018 version of the Code. This instance of misalignment had associated costs of material, in addition to costs for engineering, retraining, revised literature, recertification, and other overhead components. The estimated cost of materials alone for one manufacturer that chose to issue retrofitting kits was approximately $200,000 per year.[41] Stakeholders indicated that the scenario described above is a rare occurrence with each new version of the code. Some participants who have worked in the electrical manufacturing industry for multiple decades described having only encountered an impact once in their careers.

Potential cost(s): Occur in rare circumstances where Code changes impact product requirements that cannot be immediately met by manufacturers. Costs will depend on how jurisdictions and manufacturers react to the change.

2018 CE Code Rule 10-210 example - retrofitting kits

- **Assumptions:**
  - $200,000 per year of additional cost for manufacturing firm with market share between 22% and 25%
  - Same approach across all manufacturing firms
- **Potential impact to Canadian economy:**
  - Between ~$800,000 and $900,000 per year until manufacturers can develop new product to meet new grounding requirements

[40] Nova Scotia Labour and Advanced Education Electrical Bulletin 2018 - 03.

[41] This estimate was provided by a manufacturer.

Based on interviews, we understand that in some cases, CE Code differences in product requirements can be mitigated by adjusting installation practices as opposed to manufacturing different products. This example is discussed in more detail in section 5.3.1.

3.2.2 Jurisdictional regulatory adoption

Currently, each jurisdiction devotes resources to determining whether and how to adopt the CE Code. This process is different for each jurisdiction in Canada. As previously discussed, some jurisdictions adopt the Code "as is" a certain number of months after a new Code is released by CSA Group, and sometimes use bulletins, technical interpretations or STANDATA to communicate any technical deviations to the Code after it has been adopted.[42] Other jurisdictions, including Ontario, Québec and Manitoba make technical deviations to the Code prior to its adoption in the province and re-release it to the public as the jurisdiction's electrical Code.

The process of adopting these Codes differs between jurisdictions, and often depends on the availability of resources and level of stakeholder engagement necessary in the province or territory. For example, Ontario's Electrical Safety Authority (ESA) has a provincial Code committee of approximately five advisors and three engineers that complete their own impact assessments of the latest changes in the CE Code, which are then presented to the provincial government for potential recommendation and approval. Larger jurisdictions like Ontario typically have staff available to thoroughly examine each change in the Code to weigh its potential impacts on public safety and burden on industry. The province of Québec also has a technical committee with various stakeholders, including the electricity provider for the province, Hydro Québec. The AHJ for the province of Québec hires a contractor to conduct an impact assessment for select changes in the Code from the previous cycle, and potential technical deviations. Providing an adequate impact assessment is a legal obligation for the province of Québec, and can cost anywhere from $50,000 to $80,000, occurring once every three years and taking up to six months to complete. Large jurisdictions with many stakeholders understand that consultation and a review process for the CE Code may cause delay in adoption or create misalignment; however, they see it as a necessary process for the AHJ to do their due diligence in order to ensure the safety of their citizens and their industries. Many smaller provinces and territories do not have the resources to dedicate to this process, and thus typically adopt the national Code "as is" without any provincial or territory-specific technical deviations. They may also use impact assessments that have been completed by CSA Group to communicate any Code changes to their stakeholders, as opposed to conducting their own consultation and impact assessments.[43]

Assessing the costs

The cost of the regulatory adoption process in each jurisdiction depends on the level of detail in which the national Code is reviewed and amended. Some larger provinces have higher costs for this process as a result of having provincial Code committees, and the costs they incur for conducting stakeholder engagement that is conducted with the public and industry leaders. Because technical deviations to the national Code will create misalignment and have industry and public safety impacts, AHJs take these deviations seriously. It is a rigorous process undertaken by a provincial or territorial Code committee to justify the need for a technical deviation to the national Code. This is because electrical standards have the potential to impact not only safety and industry in a jurisdiction, but also social factors such as housing affordability. Along with technical deviations, administrative changes (e.g. those that regulate permits, licensing, scope of the Code, etc.) also often need to be adjusted at the provincial or territory level. Even smaller provinces and territories that adopt the Code "as is" will dedicate resources to release technical deviations following adoption.

It is important to note that the potential costs estimated below will not necessarily be reduced or eliminated as a result of CE Code harmonization. These costs are presented as impact per province or territory, and are likely to only be experienced by the larger jurisdictions in Canada who conduct their own impact assessments or make extensive technical deviations (approximately 3 provinces). In a harmonized system, costs may even be increased for some jurisdictions if

[42] Alberta Municipal Affairs defines STANDATA as "a provincewide variance, interpretation or information bulletin related to safety codes and standards, issued by the Public Safety Division of Municipal Affairs."

[43] For the purposes of this study's cost assessment, it has been assumed that any impact assessment of the changes in the national CE Code conducted by a regulatory authority is a step and cost attributable to the jurisdictional regulatory adoption process in a jurisdiction.

they are forced to adhere to the most stringent standards among all jurisdictions. This is discussed in further detail in Section 4.

Potential cost(s): Can range from negligible to significant depending on the jurisdiction, AHJ, and whether a contractor is hired in addition to the in-house assessment. These costs occur mainly for Ontario, Quebec, and British Columbia, who undertake the most substantial Code review processes.

Impact assessment conducted by AHJ

- Assumptions for internal development and review
  - Occurs every three years
  - 50% utilization of five technical advisors and three engineers for one year[44] (1,040 work hours/individual)
  - Hourly rate between $36.99 (technical services)[45] and $39.19 (public administration)[46] per hour

Impact: between approximately $300,000 and $325,000 every three years, per province or territory, or between $900,000 and $975,000 across the three provinces that are most likely to be affected. Costs in Quebec are likely to be higher due to additional review and translation revisions in French.

Incremental costs of external impact assessment

Impact: between $50,000 and $80,000 every three years

3.2.3 Additional Code review for those working across jurisdictions

Employees who engage in work across multiple provinces or territories may require additional training for each jurisdiction in which they work, depending on both the version of the Code being used, and/or any technical deviations. These impacts would occur only when a firm begins a project in a new jurisdiction with different Code requirements. All firms working with the Code must also update themselves when a new Code is adopted. Potential impacts for firms are often based on the number of employees affected and the level of additional training required. Firms operating in different industries or sectors may experience this impact from misalignment, including design engineering firms, construction firms, and design-build firms. As discussed in the subsequent section, Code research is often necessary before a project commences to ensure the correct standards are being used.

An individual or firm operating in multiple jurisdictions would need to become familiar with the Code requirements in each jurisdiction where they operate. However, this knowledge would be applied each time a project occurs in the province or territory in question. This research and learning would therefore only occur if a project is occurring in a jurisdiction new to the firm, or each time a Code is released (which occurs regardless of misalignment).

If firms fail to do this proactively, they may need to go back and re-learn or adjust their approach to the project. If the research isn't done beforehand, especially if wrong equipment or material was used, there can be significant time and material expenses, which are discussed in subsection 3.2.4. Therefore, Code review may be necessary for those working across provinces to avoid or minimize the potential risk associated with uncertainty of which Code applies.

Assessing the costs

For firms to get up-to-date on differing Code requirements, there may be between 20 to 40 hours worth of work per person for as many as 10 people, depending on the size of the project. Reviewing multiple Codes can be time-consuming, as it is not clear at first glance whether or not a jurisdiction's electrical Code has been largely based on the CE Code with practically no deviations, or rather contains many technical deviations. An individual within a firm may spend up to a day to become familiar with the electrical requirements for a specific project or jurisdiction, which is sometimes built into a

[44] Assumption made as it takes approximately 50% utilization for one year or 25% utilization for two years.

[45] Hourly rate (2020) for professional, scientific and technical services in Canada. Statistics Canada Table: 14-10-0064-01 (formerly CANSIM 282-0072)

[46] Hourly rate (2020) for public administration in Canada. Statistics Canada Table: 14-10-0064-01 (formerly CANSIM 282-0072)

project's cost. This preparatory work that is necessary for projects occurring in different jurisdictions, and the associated costs, wouldn't exist in a harmonized system where there is one Code and minimal to no differences across all Canadian jurisdictions. Although this impact is material, it was described by interviewees as minimal because, outside of rare occurrences, training on Code differences is a one-time cost that occurs every three years and isn't always attributable to a specific project. Thus, it is difficult to estimate the potential cost of this impact, as the number of people, hours and hourly pay rates vary across firms, jurisdictions and projects. Total impact to the economy would also depend on the number of firms operating across jurisdictions. However, some high-level estimates we received from stakeholders are included below.

Potential cost(s): Occurs for a project in a new jurisdiction or following the adoption of a new Code. One-time costs can range from one to 10 people per project, 20 to 40 hours per person, at varying salaries; or 1-5% of project time.[47]

Example: a design-build firm accepts a project in a jurisdiction where they have not conducted prior work

- Assumptions for one-time cost:
  - Range of FTEs: 1 to 10
  - Range of hours per FTE: 20 to 40 hours
  - Salary ranges: $31.15 (construction)[48] to $36.99 (technical services)[49] per hour
- **Maximum impact (per firm): ~$15,000**
- **Minimum impact (per firm): ~$600**

3.2.4 Lack of clarity surrounding which Code applies in jurisdictions

Businesses may incur costs if they are unaware of which Code applies and incorrectly apply the wrong Code. As described in Section 2, certain provinces have both provincial/territorial and municipal regulatory authorities. Cities such as St. John's, Vancouver and Winnipeg have municipal electrical bylaws, in addition to provincial electrical standards as identified in Section 2.3.1. The following is an extraction from Section 7.0 of the City of Vancouver Electrical By-Law, demonstrating the relationship between the city's by-law and the use of the provincial Code in the rest of British Columbia:

Council adopts and makes part of this By-law the Canadian Electrical Code, Part I, 24th Edition, Safety Standard for Electrical Installations, Canadian Standards Association Standard C22.1-2018, subject to any variations adopted pursuant to the Safety Standards Act. Where there is a conflict between a provision of this By-law and the Canadian Electrical Code adopted pursuant to section 7.1, the provision of this By-law shall prevail.

Therefore, if a project is being conducted in the City of Vancouver by an individual or firm unfamiliar with the jurisdiction and the Code that applies, it may be unclear that in the case of any differences between the city by-law and the BC Electrical Code (contained in the *Safety Standards Act*), which one prevails. If this isn't known, a project may proceed with the wrong standard and be forced to correct errors associated with using the incorrect Code.

This lack of clarity around which AHJ has authority, and therefore which Code applies, has the ability to impact design engineering and construction firms, and we understand from interviews that this does happen even to experienced firms. For example, we understand that there are situations where construction firms completed an installation as per requirements in the province, and then found out that municipal requirements apply, which forced them to incur significant costs in rectifying the situation. The size of the impact depends on the severity of the issue, and how quickly it is caught. Sometimes Code officers help resolve the issue and explore alternatives to ensure a project is adhering to the appropriate

[47] These estimates of potential cost(s) have been extracted solely from our stakeholder engagement. Real potential costs may be less than or exceed these estimates.

[48] Hourly rate (2020) for construction in Canada. Statistics Canada Table: 14-10-0064-01 (formerly CANSIM 282-0072)

[49] Hourly rate (2020) for professional, scientific and technical services in Canada. Statistics Canada Table: 14-10-0064-01 (formerly CANSIM 282-0072)

Code. However, if there is no choice or alternative and a change needs to occur, there can be significant costs in terms of material and time to install.

We note that the final design of a building or system must be approved by an engineer that is licensed in the jurisdiction; therefore, any issues would likely be caught at that stage. In addition, construction groups often seek labour and subcontractors that are local, to understand the local context and to have knowledge on the local Codes. These workers may be able to identify inconsistencies, but are not ultimately the ones responsible for adherence to the Code.

Most stakeholders declined to quantitatively estimate the impact of this issue. This is because the extent of an impact from lack of clarity in which Code applies depends on how far a project may proceed using the incorrect Code. If it is clear from the outset which Code is to be used, then an organization may only experience a cost impact associated with the time they spent doing research to determine which Code is most appropriate and adhere to this Code (similar to the costs discussed in subsection 3.2.3). In a worst-case scenario, there is potential for an organization to complete an entire project using the incorrect Code, in which case adjustments and redesigns at significant costs may have to be made to ensure adherence to the appropriate electrical requirements. One cost estimate we received that is associated with the need to adjust a project from an incorrect to a correct code was approximately 1,500 man hours between five to six workers, amounting to $50,000 of labour and additional materials, and two weeks of additional time to the project timeline. Though there are associated costs for additional Code review and education, as described above, these costs are expected to be less than those experienced if a mistake was made. Moreover, there is still a chance for error even if individuals review and educate themselves on the local Code. Whether these impacts materialize depends on a firm's individual situation and awareness of local Code requirements; therefore, it is not possible to extrapolate the impacts across the economy. However, we understand from interviews that even experienced firms do encounter this issue and may incur material costs from it.

Potential cost(s): Occurs if a project proceeds using the incorrect Code for the jurisdiction where the work is taking place. Impact depends on how far a project proceeds using the incorrect Code (and at what stage it is discovered), and the time and costs associated with making adjustments according to the appropriate Code.

Example:

- Assumptions for maximum impact:
  - Project is fully completed before it is realized that the incorrect Code was used for electrical installations
  - Each installation component is affected by differences between the Code that was used and the correct Code
- **Maximum impact:** Loss of project budget allocated for electrical work
- Assumptions for minimum impact:
  - Mistake is discovered at the outset of the project, or at a stage in which no prior installation work would be affected
  - No adjustments or modifications need to be made to existing installations
  - Affected project labourers must review appropriate Code
- **Minimum impact:** Labour hours spent on Code review

3.3 Less material impacts and potential impacted sector/organization

3.3.1 Transferability of skills and labour mobility

We found little to no evidence identifying that CE Code misalignment is a barrier to labour mobility or skill transferability in Canada. Despite the requirement for additional training in some cases (as described above), no interviewees identified that this was a significant barrier to workers moving between jurisdictions. This is partially due to the fact that certain trades and occupations such as electricians and engineers are required to be licensed in each province or territory they

operate. For example, the design of an infrastructure project being built in Alberta needs to be approved by a professional engineer that has a license under the Association of Professional Engineers and Geoscientists of Alberta (APEGA). Obtaining a professional engineering license for any province or territory normally requires an engineering degree, a certain number of years working under a Professional Engineer, and passing an exam. These provincial licensing requirements, rather than misalignment, may limit interprovincial mobility for these types of occupations. Workers in certain trades have the opportunity to obtain a Red Seal under the Interprovincial Standards Red Seal Program, which allows them to work across provinces and territories in Canada without having to obtain a different license for each jurisdiction. This designation encourages interprovincial mobility for skilled trades which are often in high demand across all Canadian provinces and territories. According to interviews, trades workers are following instructions set out by the engineers and construction managers, and would not require additional training to adjust to changes between jurisdictions.

3.3.2 Transferability of electrical design between jurisdictions

CE Code misalignment has the potential to obstruct the transferability of electrical designs between jurisdictions, as a result of having to adhere to a different Code when designing an electrical element or system. If misalignment obstructed a firm's ability to reuse electrical designs for projects in different provinces or territories over time, there may be cost impacts as a result of lost efficiency, and additional labour and time spent completing designs. This has the potential to impact firms working in multiple jurisdictions at the same time. However, changes between jurisdictions are normally minimal and would not require substantial reworking of large design specifications. The fact that engineers are required to be certified in the province or territory in which the project is built would support making the required adjustments. Finally, our interviews with design engineering firms for large residential, industrial and commercial projects revealed that due to multiple factors relating to a project, such as climate, building Codes, location of the project , most are already designed to specification and thus very rarely transferred or duplicated exactly in another jurisdiction. This also means that any adjustments to an already existing design can be built into a project's cost and passed on to the purchase price for the customer or client.

3.3.3 Limited innovation and product selection

Some stakeholders raised concerns that the need for duplicate products, described under Section 3.2.1, would limit international wholesale products from entering Canada, and limit overall product selection. Given the rarity of this issue, as described in section 3.2.1, it is unlikely that misalignment would create these effects to any significant degree.

There is mixed belief as to whether misalignment in the CE Code across jurisdictions in Canada significantly limits innovation. Some manufacturers feel that misalignment in the Code results in smaller markets across provinces and territories, narrowing choices in those jurisdictions. Some stakeholders also feel that harmonization of the CE Code could reduce costs for consumers by allowing installation of the most innovative technology country-wide. Others stated that although the Code may not necessarily limit innovation, the Code can be slow in keeping up with the latest technologies and doesn't often consider technologies until they become mainstream. As such, stakeholders sometimes must go through additional steps for AHJs or inspectors to permit the use of newer technologies that have been certified, but are not yet addressed in the latest version of the CE Code adopted in that jurisdiction. These approvals often take the form of technical deviations at the local level, and require additional signatures and paperwork, which can create time and cost constraints for those installing new technologies. For some organizations, the use of newer technologies can positively impact a company's business plan or profitability, and are therefore pursued through technical deviations or special approvals.[50] However, overall, our research did not find that misalignment has significant impacts on innovation or product selection.

[50] Examples from our stakeholder engagement include wireless fire alarm systems and wireless switches.

3.4 Discussion of findings

Current misalignments in the Code do not necessarily create clear or tangible costs for all organizations that use the Code in their day-to-day business. As a result, many participants in stakeholder consultation were not comfortable providing estimates of potential costs they incur as a result of misalignment, as many of these impacts are not easily tracked or fully quantifiable and/or happen unpredictably and rarely. Therefore, using information gathered from stakeholder interviews, it was difficult to quantify the monetary value of the impacts from CE Code misalignment, and our assessments of costs of misalignment reflect this. It was evident that the magnitude of impacts can vary significantly across firms, instances, sectors and jurisdictions. Some also described any costs they experience as a result of misalignment as “manageable.” However, we did gather insights as to how misalignment affects businesses, as well as how it influences consumers and other stakeholders outside of their industry, which are presented above.

Through stakeholder engagement, we did not find evidence that CE Code misalignment discourages or prevents businesses from entering new jurisdictions. Where there are costs caused by misalignment, these are absorbed by firms or sometimes passed on to customers, but they do not significantly impact business decisions. Even though stakeholders were unable to quantify any impacts they have experienced from misalignment, or described any costs they face as “manageable,” virtually all participants were supportive of CE Code harmonization and felt as though reducing misalignment would be beneficial for the efficiency of the Canadian electrical system.

Section 4: Potential impacts of CE Code harmonization

In addition to impacts of CE Code misalignment, our interviews also covered potential impacts of CE Code harmonization. This section summarizes stakeholders' views on harmonization, what harmonization may look like in the future, and potential impacts to stakeholders and organizations as a result of CE Code harmonization.

4.1 Overview of stakeholders' views on harmonized standards

Interviews completed for this study revealed that stakeholders are supportive of harmonizing the CE Code across the Canadian provinces and territories. In fact, virtually all interviewees from industry were supportive of harmonization, while recognizing that there are practical barriers to it. The reasons for this support often depend on the industry in which a stakeholder operates, and the impacts they may experience as a result of misalignment. These views have been described in detail in Section 3, as well as summarized below.

Misalignment in the CE Code creates the following costs:

- **Manufacturing and management of multiple SKUs** in scenarios where changes between Code versions have implications for product standards
- **Labour costs to governments** associated with AHJ employees who work on amending the Code in each jurisdiction
- Labour costs associated with **Code review** for employees who work across multiple jurisdictions
- Cost impacts resulting from the **use of an incorrect Code** in a jurisdiction

In addition to the impacts listed above, CE Code harmonization also has the potential to **reduce administrative costs** associated with purchasing Codes and standards. Only one Code will need to be purchased by firms who use it, rather than multiple Codes for jurisdiction across Canada. Though some Codes are available for free to view online, the Ontario Electrical Safety Code, for example, retails for minimum $195.00 per copy

The majority of industry stakeholders did not anticipate incremental costs of moving to a harmonized system. However, some stakeholders raised the possibility of the following negative impacts resulting from harmonization:

- Cost impacts if all provinces and territories are to be brought up to the **most stringent standards** among all jurisdictions. However, we note that we did not identify particular provinces or territories that have significantly more stringent requirements than others.
- Lower ability of jurisdictions to **consult with their stakeholders** on changes to the CE Code

The size and extent of the potential impacts above depend on how harmonization is implemented. Therefore, in a future state with harmonization, these potential impacts are not guaranteed to be realized. In the following subsections, we explore what harmonization of the CE Code may look like, and potential impacts to any organizations or stakeholders beyond the potential benefits and costs described earlier in this report.

4.2 What harmonization may look like

4.2.1 Legal implications

Provinces' and territories' right to govern electrical safety in their jurisdictions is protected by the Canadian Constitution. Section 92A (1) of the *Canadian Constitution Acts, 1867 to 1982* reads as follows:

"In each province, the legislature may exclusively make laws in relation to (c) development, conservation and management of sites and facilities in the province for the generation and production of electrical energy."

This legislation is supported by the power of provincial legislatures to regulate general matters of a local or private nature, including construction of buildings and houses.[51] Therefore, in order to fully harmonize the CE Code across jurisdictions and ensure that the CSA Group CE Code is adopted outright by all, this section of the Canadian Constitution would need to be amended.

For the purpose of this analysis, we assume that the Canadian Constitution will not be amended for the purpose of harmonizing the CE Code. That means that provinces and territories will maintain the ability to make their own laws in relation to electrical energy (according to Section 92A (1)) in any harmonization structures explored below. Therefore, to ensure harmonization it would be necessary for provinces and territories to agree on any recommended approach to harmonize, and to implement such changes or structures in their jurisdictions. Each province and territory would have the right to not participate in such an agreement, and also to withdraw from any agreement at any time.

In the subsections below, we describe options to reduce the economic costs of misalignment through harmonization. These options were proposed by stakeholders through our interviews. Our findings indicate that the output of these strategies would benefit all users of the Code who work across jurisdictions. The execution of these strategies are most likely to impact AHJs and inspection authorities. How each approach may affect these groups is described in more detail in Section 4.3.

Align timing of Code adoption

As noted earlier, our interviews indicate that timing in adoption, rather than technical deviations made by individual provinces, is responsible for the majority of significant misalignments. There is currently a lag in adoption across all jurisdictions, meaning that the newest version of the CE Code is not adopted by any provinces immediately after being published by CSA Group. A lag in adoption occurs for all jurisdictions to an extent, as users need to review and become familiar with the new Code and any changes since the previous Code cycle. For some jurisdictions this lag can be longer due to the need to consult stakeholders and industry representatives, propose technical deviations, or make changes to the translation of the Code, among other steps. Without taking away jurisdictions' rights to adopt the Code how they wish, having jurisdictions align on the timing of Code adoption would reduce discrepancies in Code requirements between jurisdictions. This approach would ensure that at least the same version of the Code is being used across the country.

Remove municipal-provincial variations

At this time, several municipalities are recognized as regulatory authorities and conduct inspection services for their jurisdiction. The City of Calgary is an example of a regulatory authority with respect to Code enforcement. The City conducts inspections according to the provincial electrical standards in the Alberta Safety Codes Act. In addition to conducting inspections, some municipalities adopt the CE Code and develop their own electrical installation by-laws. A municipal by-law has the potential to differ from the Code adopted by the province or territory in which the municipality resides. Some cities such as Vancouver, St. John's and Winnipeg have written and implemented their own municipal by-laws for electrical standards based on the CE Code.

[51] National Research Council Canada. *Model Code adoption across Canada* https://nrc.canada.ca/en/certifications-evaluations-standards/Codes-canada/model-Code-adoption-across-canada

As described in Section 3, having more than one electrical Code in effect within a jurisdiction can create confusion for organizations working across borders. We understand from interviews that those working with the Code sometimes are unclear about which electrical Code applies or is enforced when there is both a municipal, and a provincial or territorial Code in effect. Merging municipal Code variations with the appropriate provincial or territorial Code in effect could eliminate the confusion that arises for organizations beginning work in a jurisdiction with two or more Codes. Major municipalities in Canada such as Winnipeg, Calgary, Vancouver and Victoria represent municipal authorities on the Committee. These municipalities and cities would still be able to participate in development of the CE Code from both a national Committee level, as well as a provincial and territorial level. Such an approach may mean that municipalities may request more representation at the national and provincial or territorial level, or that revisions/technical deviations normally considered for urban areas may need to be accommodated within the provincial or territorial adoption of the CE Code.

4.2.2 Role of regulatory authorities

As described above, without making changes to the Canadian Constitution, provinces and territories will maintain their ability to develop and manage their own electrical standards. In a scenario where the CE Code has to be adopted by jurisdictions at the same time, the role of regulatory authorities is likely to remain the same. Provincial and territorial regulatory authorities could continue to be active in the development process of the national Code, as well as responsible for technical Code deviations, interpretations, and inspections in their respective jurisdictions. However, timing of adoption is aligned among jurisdictions, there may be resulting impacts to when and how technical deviations are made or consultation is conducted. Therefore, there may be implications for resources committed to regulatory adoption and enforcement by regulatory authorities. In a scenario where municipal and provincial variations are removed, the role of municipal AHJs would likely change. This impact is described in further detail in Section 4.3.1.

4.3 Impact to organizations and stakeholders

In our interviews, stakeholders from industry were consistent in not anticipating any incremental costs from moving to a harmonized Code.[52] This is because under the status quo, industry users of the CE Code also have to become familiar with a new CE Code every Code cycle. They did not anticipate that transitioning to a new Code that is harmonized would carry additional incremental costs. Potential impacts of the above harmonization strategies on stakeholders and organizations outside of industry are discussed below.

4.3.1 Code development and regulatory adoption

CE Code harmonization has the potential to impact the Code development and regulatory adoption process at a national, provincial, territorial, and municipal level. Any changes to this process are likely to impact AHJs most significantly. AHJs are not only heavily involved in the CE Code development process at the national level, but are also responsible for the regulatory adoption of the provincial, territorial and sometimes municipal, electrical Code. Under the status quo, it takes jurisdictions different amounts of time to develop and adopt their CE Code, depending on the resources available and if the AHJ wishes to make technical deviations. Stakeholders informed us that the development and adoption process of the CE Code at the provincial or territorial level can take up to a year after the CE Code has been released by CSA Group. Depending on the jurisdiction, this time delay may be used for the AHJ to review the Code, make technical deviations, and communicate changes to the public. The time delay is also for educational instructors and other users to get up-to-speed on the new Code. For some AHJs that conduct extensive stakeholder engagement and conduct their own impact assessments, this process can take even longer than one year.

In an environment where jurisdictions are required to adopt a new CE Code at the same time, some may be forced to develop their Code at a quicker pace than they currently do in order to meet the required adoption date. This will most likely apply to jurisdictions that include many deviations to the CE Code before re-releasing it to the public for use or conduct extensive consultation prior to the release. Other jurisdictions that normally adopt the Code “as-is,” or with few technical deviations, may not be able to adopt the Code as quickly as usual and then would need to wait until the agreed-upon national adoption date. For jurisdictions in the former case, having a time constraint may not allow enough time for

[52] To the extent that an industry player is not involved as a regulatory authority or directly in the Code development or regulatory adoption process.

the impact assessments or stakeholder engagement that they currently conduct, or may increase the cost of those processes. Therefore, these jurisdictions may need to make changes by adopting the Code "as-is," or with fewer technical deviations than they would normally implement prior to release of the Code. One option to address time constraints would be for these jurisdictions to instead release technical deviations after the newest Code version has been adopted. This is similar to the approach of the province of Alberta, which implements its technical deviations through STANDATA releases after the CE Code has been adopted "as-is."

4.3.2 Transition costs from additional consultation

Adjusting how provinces and territories adopt their electrical standards will likely require stakeholder consultation. This would include discussion and stakeholder consultation at the national level between SCC, CSA Group and Committee members of the CE Code. In addition to consultation surrounding a CE Code adoption day and/or the removal of municipal electrical by-laws, a transition period while moving to a more harmonized system may be required. The process of additional consultation between national stakeholders would likely generate transition costs (e.g. additional staff time) for SCC and CSA Group, which have not been assessed as part of this study.

In addition, with any change to how or when the CE Code is adopted in a province or a territory, AHJs would likely need to conduct additional consultation with stakeholders in their jurisdiction. Stakeholders may include construction firms, design engineering firms, inspectors, electricians, manufacturers, among others. Consultation would communicate the new approach to provincial or territorial adoption, on top of consultation that is already conducted for CE Code changes. Additional consultation with these stakeholders would generate transition costs for the AHJs across Canada.

It is expected that apart from participating in consultation, there would be no additional transition costs for industry.

Section 5: Future scenarios

5.1 Next steps for implementation

There are other factors that should be considered in enhancing the effectiveness of a harmonized system in the future. These suggestions will occur outside any necessary legal adjustments that are required to implement a harmonized national system. The future scenarios discussed below were raised by stakeholders during the interview process.

5.1.1 Increased consideration of provincial and territorial input at national level

Representatives from each province and territory are present and active in the Code development process. However, some stakeholders suggested that the voices of provinces and territories are not always heard at the national level. These stakeholders noted that if inputs from provinces and territories were taken more into consideration during the Code development process, there may be less need for them to amend the Code. This includes provinces and territories participating closely in the language and writing of the Code, as well as CSA Group's impact assessment process. Stakeholders, most notably manufacturers, feel that regulators and inspection agencies need more say in the CE Code because they are the most affected when many changes are put forward. Increased provincial and territorial involvement in CSA Group's impact assessment process specifically has the potential to decrease the duplication of impact assessments for Code changes. If national impact analysis was more aligned with provincial requirements for this analysis, any work being redone by AHJs may not have to be so extensive. This has the potential to save costs for impact assessments conducted either internally or by a contractor. However, as previously discussed, many jurisdictions assess CE Code changes to weigh safety benefits against the potential burden on the industry within their jurisdiction. Therefore, AHJs may still be legally obligated or choose to continue to conduct their own impact assessments even when heavily involved at the national level. Because some jurisdictions have resources available and wish to do their due diligence for the public, these processes may not be affected by CE Code harmonization.

In an effort to listen more to the voices and opinions of provinces and territories, CSA Group has developed the CE Code Policy Advisory Committee (CE Code PAC). The following describes the basis of the CE Code PAC:

"The CE Code PAC provides a forum for the Provinces and Territories to work together to develop a common set of government policy priorities that are intended to be used to inform the development of the Canadian Electrical Code Part I, with the larger goal of harmonization of regulatory references of the CE Code, Part I across Canada, in terms of both content and timing."[53]

CSA Group listening more to the thoughts of provinces and territories at the national level, including by way of the CE Code PAC, will be significant in the effort to harmonize the CE Code across jurisdictions in the future.

5.1.2 Streamlining French translation process

Interviews identified that French translation is one of the factors that impact the timing of CE Code adoption at the provincial or territorial level. For provinces where translation is an issue, there can be additional time delays in adoption as a result of language used in the national Code not matching up with language used within a province or territory. At the national level, the French version of the CE Code is released after the English version. In addition, the French version released by CSA Group sometimes doesn't meet the same language standard of French documents that are released provincially. As a result, some provinces start the adoption process only when the French version is published, and sometimes must revise the translation completed by CSA. Streamlining the French translation process at the national level could reduce the need for language revisions by provinces and territories after the Code release, and potentially also facilitate the release of the French and English Codes at the same time. In addition, this has potential to increase the speed at which provinces and territories adopt the CE Code, reducing time differences between when jurisdictions adopt

[53] CSA Communities. CE CODE Policy Advisory Committee - Policy Priorities Oct 2021.pdf

the Code and making harmonization more feasible. It was suggested that this could be achieved through continued involvement of provincial and territorial AHJs, as well as additional collaboration with organizations that are familiar with French technical vocabulary.

5.1.3 Public review in French at national level

At this time, there is no public review of the CE Code in French at the national level. As a result, some provinces and territories conduct their own French consultation which can be time consuming and costly. As a bilingual country, French consultation of the CE Code and any related changes could be a step that is taken at the national level to ensure consistent understanding and decrease duplication of French consultation efforts across jurisdictions. This therefore has the potential to increase the speed at which provinces and territories adopt the CE Code, enabling more harmonized adoption. It will also likely increase the cost of the overall translation process.

5.1.4 Summary

In conclusion, without suggesting a particular strategy for harmonization, stakeholder engagement revealed that for harmonization to occur the following would be needed:

- Increased consideration of provincial and territorial input at national level
- A public review in French at national level
- Streamlining French translation process

These factors have potential to speed up the regulatory adoption process and reduce the need for jurisdictions to make technical deviations.

5.2 Options to mitigate the impacts of misalignment

To proceed with the current state of the CE Code as it is described in this report, there are several factors that could be considered to ensure a more efficient system, even in an environment with misalignment. A system without harmonization would be further enhanced if the following recommendations were paired with the above steps for implementation, to the extent that they are possible without a national or harmonized CE Code.

5.2.1 Database with all technical deviations

Most AHJs publish their Codes and any associated technical deviations on their websites, sometimes in the form of individual PDFs that are released as more deviations are made. Information on federal, provincial, territorial and municipal Codes in effect across jurisdictions, including links to AHJ websites, are available on CSA Group's Community portal.[54] However, users must navigate from the CSA Group portal to each jurisdiction's website to locate Codes and technical deviations. Stakeholders who use the CE Code in their work were vocal about how it can be difficult to locate these Codes and technical deviations for the multiple jurisdictions across Canada even with existing resources. Searching through Codes for deviations and differences, or obtaining Code books have time implications that can create costs for organizations. In addition, lack of clarity and ease of access creates potential for error for those who are designing or constructing according to a particular Code, as described in Section 3. Ultimately, some manufacturers, design engineering firms, and construction firms feel that technical deviations or interpretations for the CE Code for provinces, territories and municipalities can be difficult and very time consuming to find.

A central resource or database that details each jurisdiction's regulatory authorities, Codes, and applicable technical deviations without navigating to multiple other websites could be more user friendly by organizations that operate across borders. One central location would reduce confusion and time spent searching for Code differences, and increase the clarity of what Codes apply for those who may be working on multiple projects in multiple jurisdictions at one time. In

[54] https://community.csagroup.org/community/electrical/electrical-installation-and-maintenance-canadian-electrical-Code-pt-i/canadian-electrical-Code-adoption

addition, a central location where jurisdictional differences can be easily compared may help to illustrate Code best practices, and encourage harmonization and sharing among jurisdictions.

5.2.2 More accessible learning opportunities for changes to the Code

It was made clear through stakeholder engagement that many CE Code users don't understand the most recent changes in the Code as well as they should. CSA Group generally issues a document identifying changes, however, it is up to regulatory authorities, consultants and other stakeholders to search for that document, pay for the document or enroll in a course on any changes for a fee. It was suggested that there should be a free course that is mandatory for select groups to maintain their license under the licensing body (example: Professional Engineers of Ontario). Stakeholders also suggested that it should be CSA Group's duty to make knowledge on any changes more accessible to users in order to minimize any negative impacts or costs associated with lack of knowledge or clarity.

5.2.3 Adjusting Code cycle length

Some stakeholders expressed that the three-year Code cycle is very short and does not provide sufficient time for a thorough Code development and adoption process. They feel that many changes in updated codes are due to mistakes, misformulations or other issues needing to be corrected from previous versions and that these mistakes and corrections could be avoided with a longer Code cycle. Potential benefits raised of a longer Code cycle include more time for:

- A more extensive impact assessment analysis to be conducted by CSA aligned with requirements of provincial and territorial AHJs, thereby reducing the duplication of impact assessments for Code changes;
- A public review in French to occur and a more detailed translation process; and
- Training workers and users of the Code.

However, other stakeholders expressed that a longer Code cycle may mean that the Code could be more lagged in keeping up with current technologies, creating the need for ongoing technical deviations and approval of technologies that are not outlined in the Code. Where these technical deviations vary by province, they can drive further misalignment. Additional research and engagement would be required to explore adjusting the three-year cycle currently used for the CE Code.

5.3 Areas for future research

This section considers areas for research that were out of scope for this study, but are important to the ongoing discussion surrounding CE Code misalignment and potential harmonization.

5.3.1 Alignment with international standards

Lack of alignment between product Codes and international standards can act as a barrier to trade, mainly in manufactured electrical products. In addition, standards can make business difficult for international firms trying to navigate a combination of national, provincial and potentially municipal Codes when trying to enter Canadian markets. This process is often referred to as the "standards arena." Code differences are sometimes a result of infrastructure or voltage differences across countries. Through stakeholder engagement, we were made aware of a situation where a change in the 2018 CE Code in the section on grounding and bonding created a misalignment between the product requirements of the CE Code and the United States' NEC. This misalignment meant that manufacturers would need a different SKU for the Canadian market and the United States market. Due to the small size of the Canadian market, manufacturers chose not to create an additional SKU for the Canadian market. As a result, contractors installing the product adjusted their installation practices to adhere to the CE Code. This situation affected 85% of the switches in the market, and was estimated to create an impact of over $19 million across Canada annually, incurred by contractors.[55] Because these issues often relate most significantly to product standards rather than installation standards, it is beyond

[55] This is an approximate estimate provided by a manufacturer. It was approximated using an average hourly rate of $80 per hour for contract work, and an additional two minutes added to the process of installation for this product.

the scope of this study to assess. However, our interviews indicate that this issue may have significant impacts for Canadian manufacturers and consumers, and affect Canada's ability to maintain its international competitiveness. It would be valuable to understand to what extent Canada's exports and imports are significantly impacted by differences in standards compared to other factors (such as differences in voltage). Any potential benefits should also be weighed against costs including a potentially lower degree of control over standards.

5.3.2 Impacts on product innovation

This study tested the hypothesis that misalignment may impact development and implementation of new products. We did not find evidence that this is the case; however, stakeholders noted that the Code development process as a whole can be an impediment to adopting new technologies. As discussed in the report, there can be a significant lag between when a new version of the Code is published and when it is adopted. There can be uncertainty around the status of newly-introduced products during this lag. Some stakeholders also feel that the Code can be slow in keeping up with the latest technologies and doesn't often consider technologies until they become mainstream. Although there are ways for inspectors to accommodate new products, installers cannot know how inspectors will choose to handle them. Further research is warranted on whether changes to the overall Code adoption system could promote development and use of new technologies.

Section 6: Summary of findings

6.1 CE Code misalignment and impacts

On the basis of the discussion in this report, we found the following:

- Misalignment in the CE Code between and across jurisdictions is a result of:
  - **Technical deviations** to the national CE Code made by AHJs prior to adoption
  - Differences between jurisdictions' **timing of adoption**, resulting in many jurisdictions using different versions of the CE Code
  - **Regional and sub-provincial variations**, where some cities or municipalities have their own electrical Codes within the province or territory they are located
  - Differences in **enforcement of the CE Code**, resulting from jurisdictions having multiple inspection authorities, and/or individual inspectors having the ability to interpret or enforce the Code as they see fit so long as safety requirements are met

We found that although misalignment in the CE code does not create ongoing material costs, there are certain circumstances where it does create material costs. In these instances, CE Code misalignment has the potential to create significant impacts to manufacturers, construction firms, design engineering groups and regulatory authorities. These impacts are driven by one, many or all of the reasons behind misalignment, as listed above. A summary of these findings from stakeholder consultation and analysis are in Figure 6.1 below.

Figure 6.1: Summary of material impacts from CE Code misalignment

Material impact	Description	Frequency
Manufacturing and management of additional stock-keeping units (SKUs)	**Significant costs for manufacturers most often occur when changes are made in the latest version of the Code and jurisdictions adopt it at different times.** In rare cases, a new version of the code can have implications for electrical products required. This means that there may be different product requirements across jurisdictions. Manufacturers are then forced to carry and manufacture two different SKUs or potentially modify existing equipment installations to be able to service multiple jurisdictions. Impacts from manufacturing and management of additional SKUs are normally absorbed by manufacturers, but can sometimes be passed on to consumers. Manufacturers interviewed described one example of this issue, which we estimate would have created costs of $800,000 to $900,000 across the entire Canadian economy. These impacts occur rarely: those in the manufacturing business for decades were able to point to one or two examples at most.	**Rare**

Jurisdictional regulatory adoption process	**CE Code misalignment can generate costs for the economy when jurisdictions dedicate time and labour resources to make technical deviations to the Code.** Depending on the jurisdiction, the time spent by regulatory authorities reviewing the Code, making technical deviations, and re-releasing the Code exclusively for one jurisdiction can be significant. In addition to the regulatory adoption process, some provinces expend resources to conduct their own impact assessments of CE Code changes, conduct additional stakeholder engagement, and revise the French translation, all beyond what is already completed by CSA. However, these impacts arise from the right for provinces and territories to develop and implement their own electrical Code which is embedded in the Canadian Constitution. As a result, these impacts will not necessarily be reduced or eliminated through harmonization. Jurisdictions absorb the cost impacts from the regulatory adoption process. However, these cost impacts may exist even in a harmonized system. These costs are only incurred by larger provinces that undertake large scale reviews, specifically Ontario, Quebec, and British Columbia. For each province and each code cycle, costs may range from $308,000 and $326,000 for in-house evaluation and an additional $50,000-$80,000 if external evaluators are involved. We note that addressing misalignment would not necessarily reduce these costs because provinces have a constitutional right to govern electrical safety in their jurisdictions.	**Recurring every code cycle**
Additional Code review for those working across jurisdictions	**Cost impacts occur when staff must spend time reviewing changes in the CE Code across jurisdictions.** This is a one-time cost that occurs when a firm undertakes a project in a jurisdiction with a Code they have not worked with before, and is paid for by the employer of those working across jurisdictions. The cost depends on the number of FTE hours and FTE hourly wage rates that are spent reviewing the Code used in the new jurisdiction. These impacts exist directly as a result of misalignment, and recur depending on changes in Code versions and project locations. However, the cost of these impacts are likely to be included in the initial project's budget, and are also one-time costs until the Code is updated in that jurisdiction. Cost impacts will depend on the number of times a firm requires additional Code review and the number of staff that need to undertake this review. Based on input from interviews, we estimate one-time costs between $600 and $15,000 each time a firm enters a jurisdiction with new Code requirements.	**Common**
Lack of clarity surrounding which Code applies in jurisdictions	**Cost impacts may occur if firms conduct work in a jurisdiction using the wrong Code.** This would apply in jurisdictions where there are two Codes in use and there is confusion or error surrounding which Code prevails, or lack of knowledge of both Codes**.** Jurisdictions with two Codes normally include a set of provincial standards and a municipal or city by-law relating to electrical installations. Cost impacts can vary depending on when a potential error is discovered. Costs can be negligible if the project doesn't progress significantly using the wrong Code, but can be large if the project progresses significantly before the error is discovered. These cost impacts are often generated by labour and materials needed to correct any errors and ensure adherence to the appropriate Code. Interviews indicate that this can happen even with experienced design engineers and construction contractors, and that costs can be material. These costs are absorbed by the firm that experiences the error. We were not able to quantify these potential costs; however, interviews indicated that costs can be material when a serious error occurs, which would be infrequently. One example cited cost approximately $50,000.	**Infrequent**

We initially hypothesized other potential negative impacts of CE Code misalignment that may be experienced by organizations, such as limited innovation, transferability of electrical designs or labour mobility. However, through stakeholder engagement we learned that these impacts are less material and do not affect the majority of the stakeholders.

6.2 CE Code harmonization and impacts

Although we did not identify significant recurring costs from misalignment, virtually all industry stakeholders felt that they would be better off under a harmonized system. Almost all industry participants involved in this study expressed support for harmonizing the CE Code, understanding that there may be barriers to implementing it. Beyond minimizing or eliminating the negative impacts of misalignment discussed above, CE Code harmonization has potential to benefit most stakeholders in the Canadian Electrical System by reducing potential costs and increasing efficiency.

Because the Canadian Constitution protects provinces' and territories' right to govern electrical safety in their jurisdictions, the Constitution would need to be amended for full adoption of the CE Code to occur nationally without deviations by jurisdictions. Therefore, for CE Code harmonization to be improved across Canadian jurisdictions, other strategies need to be explored.

The majority of costs resulting from CE Code misalignment are driven by timing in adoption of new versions of the Code, rather than technical deviations. As a result, aligning the timing of code adoption across jurisdictions was a strategy recommended by multiple stakeholders during engagement for this study. Alignment in the timing of Code adoption could be achieved by selecting a time at which all jurisdictions must adopt the newest version of the CE Code.

In addition, industry stakeholders suggested the removal of municipal Codes (often in the form of by-laws) from certain jurisdictions. This strategy was recommended as it would minimize or eliminate any potential costs associated with conducting work using the incorrect Code. This impact is only a concern in jurisdictions with more than one Code in effect (for example, a municipal by-law and provincial electrical regulations). Errors may arise when it is not clear which Code prevails in the jurisdiction, or an organization is not aware that there is a municipal Code in effect.

The harmonization strategies above have potential to impact regulatory authorities, particularly AHJs that are most affected by time constraints related to the CE Code. Many AHJs use the time between Code release and adoption to review the new version of the Code, make technical deviations, conduct stakeholder engagement, and complete economic impact assessment of any changes. Industry stakeholders can also be affected, as many educational instructors and users of the Code use the time to get up to speed on the new Code. Ultimately, any potential changes to the timing in which jurisdictions adopt the Code has potential to affect the regulatory adoption process. These effects could differ based on each jurisdiction's adoption process. In addition, we understand from interviews that any approach to CE harmonization would likely require additional consultation, both for SCC and CSA Group to consult stakeholders, and for jurisdictions to consult their stakeholders and the public. Stakeholder engagement could therefore create one-time costs for the harmonization process.

In conclusion, without suggesting a particular strategy for harmonization, stakeholder engagement revealed that for harmonization to exist, the following would be needed:

- Increased consideration of provincial and territorial input at national level
- A public review in French
- Streamlined French translation process

These factors have potential to speed up the regulatory adoption process and reduce the need for jurisdictions to make technical deviations.

Appendix A: Interview list

The table below lists the organizations that were interviewed for the purpose of this study. Many individuals who were interviewed are also involved in industry commissions, committees and councils. Note that more than one interview was conducted for select organizations. We again would like to thank all participants for their insightful comments.

Figure A-1: Stakeholder interview list

Organization	Title(s) of participants
Ainsworth	Director of Electrical, GTA Vice President, Ontario Electrical and Energy Services
ATCO	Electrical Designer, ATCO Structures and Logistics Manager, Engineering and Design
Canem	President and COO
CSA Group	Technical Advisor, Wiring Devices
Eaton	Marketing Manager, Electrical Assemblies Manager, Codes and Standards
Electrical Safety Authority (ESA)	Senior Director, Engineering and Regulations
ESAFE	Technical Manager
Government of Alberta	Provincial Electrical Administrator
Government of Northwest Territories	Acting Director, Compliance and Licencing
Régie du bâtiment du Québec (Government of QC)	Engineer, Regulatory and Consulting
Graham Construction	Senior Project Manager
Hubbell	Manager, Standards and Industry Specifications, Harsh and Hazardous Industries, Global Codes
IBI Group	Director, Office Lead
IPEX	Manager, Codes and Standards
Marex	Principal
Northern Cables	Director of Engineering
PCL Construction	Lead Quality Coordinator Power Systems Technical Specialist
Signify	Technical Policy Manager, Standards and Regulations
Standard Products	Regulatory Affairs Director Executive Vice President of Marketing
Stantec	Electrical Engineering Lead
Technical Safety BC	Senior Safety Officer, Electrical Director, Policy and Regulatory Affairs
Underwriters Laboratory (UL) Canada Inc.	Lead Regulatory Services Representative
WSP	Engineering Manager
Siemens Canada (former)	Other involvement and experience: SCC
IEEE	Other involvement and experience: CSA Group, API and IEC Standards, Alberta Electrical Sub-council
CSA Group (former)	Other involvement and experience: CACES, BC Electrical and Elevator Safety, IAEI Magazine

Appendix B: Interview questionnaire

Questions for industry stakeholders

Part 1: Background

1. What is your current role and your background in the industry?
2. What are your main lines of business and activities?
3. What is the approximate size of your operations in terms of revenue (if able to share) and number of employees?
4. In which regions do you operate? (provinces/ territories within Canada and internationally)

Part 2: Impact of misalignment

5. What areas of misalignment in the CE code and its application are you aware of? Between which jurisdictions is there misalignment?
6. How does this misalignment impact your business?
7. Could misalignment affect the ability of new players to enter the market or develop new products?
8. How much of your workforce typically works across provinces? Are there occupations for which this is more common? Are there occupations that you have more difficulty hiring for?
9. What are the approximate annual costs to your operation in terms of additional:
    a. Labour required (and for which occupations), for training and implementation
    b. Equipment costs
    c. Other costs (please specify)
10. Are there any other ways in which your operations are affected in terms of costs, revenue, or operations?

Part 3: Transition to alignment

11. Do you support alignment? Please explain your choice.
12. What do you anticipate would be the incremental costs to you to transition to an aligned system, compared to the status quo?

Questions for government stakeholders

Part 1: Background

1. What is your current role and your background in government?
2. What is the scope of your work related to the CE Code Part I?
3. Do you have experience in any other jurisdictions?

Part 2: Impact of misalignment

4. What is the process for adoption of a new version of the code in your jurisdiction? What is the cost in terms of time and resources?
5. What do you see as the main costs and benefits of having different codes and standards in different jurisdictions?

Part 3: Transition to alignment

6. Does the government you represent support alignment? Please explain your choice.
7. What do you anticipate would be the incremental costs to your government (and other stakeholders) to transition to an aligned system, compared to the status quo? (ex. impacts of changes to existing codes, time spent consulting on consulting with industry, organizational implications)

Appendix C: Rejected hypotheses

Below are details on potential impacts we hypothesized would result from CE Code misalignment across jurisdictions at the outset of this project. These impacts were not supported by interview evidence and were deemed non-existent and/or irrelevant to misalignment, and therefore were not addressed in detail for our study.

1. **Lower compliance to current version of CE Code**
   - Sector(s) affected: construction

   Our interviews did not identify evidence that misalignment has led to lower compliance of the CE Code. Those most likely to be non-compliant are those completing DIY projects or individual handypersons, who are unlikely to be working across provinces.

2. **Inability to apply optimum minimum standards**
   - Sector(s) affected: all

   Although an outcomes-based standard may be more optimal, misalignment is not a reason why it is not being applied.

3. **Ease of entering into new markets**
   - Sector(s) affected: manufacturing, construction, design engineering

   Our interviews did not identify any evidence that misalignment would affect costs sufficiently to discourage entry into other provinces.

Appendix D: Limitations

Data limitations: PwC has relied on the information provided by organizations interviewed regarding the potential impacts of harmonization. PwC has relied upon the completeness, accuracy, and fair presentation of all information and data obtained from those organizations and the various sources set out in our report, which were not audited or otherwise verified. The findings in this report are conditional upon such completeness, accuracy, and fair presentation, which have not been verified independently by PwC. Accordingly, we provide no opinion, attestation or other form of assurance with respect to the results of this study.

Where the information or data provided is not sufficient to conduct the analysis that has been requested, we have made assumptions, as noted throughout the report.

Receipt of new information: PwC reserves the right, at its discretion, to withdraw or revise this report should we receive additional information or be made aware of facts existing at the date of the report that were not known to us when we prepared this report. The findings are as of November 2021 and PwC is under no obligation to advise any person of any change or matter brought to its attention after such date, which would affect our findings.

Reliance on third party data/information: We relied upon the completeness, accuracy and fair presentation of all the information, data, advice, opinion or representations obtained from third parties, public sources and the Standards Council of Canada ("SCC"), which is detailed under the Scope of our Work section (collectively, the "Information"). We have not conducted any audit or review of the Information of, nor have we sought external verification of the Information. We accept no responsibility or liability for any losses occasioned by any party as a result of our reliance on the financial and non-financial information that was provided to us or found in the public domain.

Technology assessment: We are not technical experts and are not in a position to assess the technical aspects of electrical equipment and systems. Thus, any statement in this report regarding the technical aspects of electrical equipment and systems reflects our understanding based on discussions with SCC and stakeholders.

Use limitations: This report has been prepared solely for the use and benefit of, and pursuant to, a client relationship exclusively with the Standards Council of Canada ("SCC"). We understand that the SCC may share our report with third parties. SCC can release this report to third parties only in its entirety, and any commentary or interpretation in relation to this report that SCC intends to release to the public either requires PwC's written consent; has to be clearly identified as SCC's own interpretation of the report; or SCC is required to add a link to the full report. PwC accepts no duty of care, obligation or liability, if any, suffered by SCC or any third party as a result of an interpretation made by SCC of this report.

Further, no other person or entity shall place any reliance upon the accuracy or completeness of the statements made herein. In no event shall PwC have any liability for damages, costs or losses suffered by reason of any reliance upon the contents of this report by any person other than SCC.

This report and related analysis must be considered as a whole: Selecting only portions of the analysis or the factors considered by us, without considering all factors and analysis together, could create a misleading view of our findings. The preparation of our analysis is a complex process and is not necessarily susceptible to partial analysis or summary description. Any attempt to do so could lead to undue emphasis on any particular factor or analysis.

We note that significant deviations from the above listed major assumptions may result in a significant change to our analysis.

Appendix E: References

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