2016

ONTARIO ELECTRICAL SAFETY REPORT

Contents

A Message From The Electrical Safety Authority's Chief Public Safety Officer

The Ontario Electrical Safety Report (OESR) is the only publication that provides a comprehensive, objective report on the state of electrical safety in Ontario. Over the 16 years of the OESR's annual publications, the report continues to provide robust and detailed information for those on the front lines of electrical safety.

The OESR plays an important role in advancing electrical safety – it provides the data to support evidence-based decision making by the Electrical Safety Authority (ESA) and our safety partners. The data collected in the report shapes ESA's organizational strategy and identifies areas where focus is needed due to concerning electrical safety trends.

For example, OESR emergency department information shows that over 900 electrical injuries are seen each year, in which 80 per cent have been classified as critical injuries. A significant proportion of these injuries occurred in the home. Armed with these data, ESA set to work on a non-occupational electrical safety strategy. Our work with other safety partners highlights that "no shock is a safe shock" and that anyone who suffers a shock should seek medical attention – all electrical injuries should be taken seriously. Further, ESA action plans will increasingly consider the non-occupational population, with a focus on electrical safety in the home.

Overall, the 2016 OESR shows decreases in electrical fatalities in general as well as occupational electrical-related fatalities more specifically. But there is still more work to do. In 2016, there were no fatalities due to powerline contact; however, there has been an increase in the number of powerline contacts. These near misses could, if not for chance or circumstance have resulted in a fatality. We will continue to collect, use and share the OESR data with our partners as ESA seeks to fulfill its vision of an Ontario free from electrical harm.

This report is a collaborative effort, possible only through the cooperation and participation from multiple sources of data, including the Office of the Coroner, the Ministry of Labour, the Office of the Fire Marshal and Emergency Management, the Canadian Institute of Health Information and the Workplace Safety and Insurance Board of Ontario. Thank you to all who helped contribute to the report's content.

I also want to thank all the individuals engaged in the electrical safety system from electricians to ESA's own staff, including the health care system who keep Ontarians safe from electrical harm every day. Thank you for all you do to advance electrical safety for our province.

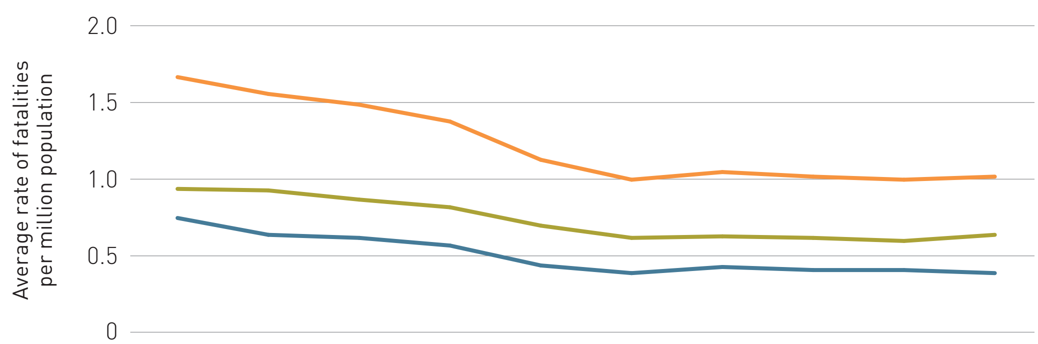
Scott Saint
Chief Public Safety Officer

Executive Summary

The Ontario Electrical Safety Report (OESR) is produced by the Electrical Safety Authority (ESA) to provide a comprehensive perspective of electrical fatalities and incidents in Ontario. Data presented in this report have been compiled from multiple sources, investigations and root-cause analyses. Information on potential electrical risks and high-risk sectors are provided. This report is used by ESA and others to better understand the dynamics of electrical safety, and to encourage the development of initiatives to improve the status of electrical safety in the province.

Over the past ten years (2007-2016), there has been a downward trend in the rates of electrical-related fatalities, electrical fire fatalities (where the ignition source was identified to be electrical), and electrical injuries in Ontario. While progress has been made to reduce the number of fatalities and injuries, the causes and contexts of serious incidents remain the same. Concerted efforts remain essential for rates to continue to decrease.

FIVE-YEAR ROLLING AVERAGE OF ALL ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2003-2016



	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Electrical fire	0.93	0.92	0.86	0.81	0.69	0.61	0.62	0.61	0.59	0.63*
Electrocution and burn	0.74	0.63	0.61	0.56	0.43	0.38	0.42	0.40	0.40	0.38*
Total electrical	1.66	1.55	1.48	1.37	1.12	0.99	1.04	1.01	0.99	1.01*

Source: ESA, Coroner and OFMEM records.

* Preliminary data subject to change.

Electrical Fatalities

In the past ten years, there were 142 electrical fatalities in Ontario. From 2007 to 2016, 54 people have died from electrocution (non-intentional death caused by contact with electricity) or by the effects of electrical burns, and 88 have died as a result of electrical fires (where the ignition fuel was identified as electricity and/or ignition source was electrical distribution equipment). In comparison, the previous ten-year period, from 2006 to 2015, reported 63 deaths from electrocutions and burns, and 97 fire deaths where the ignition source was identified as electrical.

Electrical-Related Fatalities (Electrocutions and Electrical Burn Fatalities)

The rate of electrical-related fatalities, defined as non-intentional deaths caused by contact with electricity, continue to decrease:

10-year period		
2007-2011	• 28 electrical-related fatalities • Five-year rolling average of 0.43 per million population	**Rate decrease of 12%**
2012-2016	• 26 electrical-related fatalities • Five-year rolling average of 0.38 per million population	

The number of utility-related electrocutions have accounted for 50% of all electrical-related fatalities in the past ten years:

10-year period	
2007-2011	• 36% of all electrical-related fatalities (10/28) were from powerline contact
2012-2016	• 31% of all electrical-related fatalities (8/26) were from powerline contact

Occupational electrical-related fatalities continue to outnumber non-occupational fatalities by a ratio of 2 to 1 in the past ten years:

10-year period	
2007-2011	• 64% of electrical-related fatalities (18/28) were occupational
2012-2016	• 69% of electrical-related fatalities (18/26) were occupational

Electricians and apprentice electricians account for 28% of occupational electrical-related fatalities between 2007 and 2016 as they are critically injured on the job when working on energized electrical panels or Ballasts/347V lighting.

The non-occupational electrical-related fatality rate has decreased compared to the previous year, as no deaths of this type were reported in 2016. The five-year rolling average rate also reflects this observation:

10-year period		
2007-2011	• Five-year rolling average of 0.15 per million population	**Rate decrease of 20%**
2012-2016	• Five-year rolling average of 0.12 per million population	

Fire Fatalities and Events

The rate of electrical fire fatalities (where the ignition fuel was identified as electricity and/or ignition source was electrical distribution equipment) has decreased when comparing the five-year rolling average in 2007-2011 and 2012-2016. In the most recent ten year period, this rate has decreased 29% when comparing between 2007-2011 and 2012-2016.

The number of fires where electricity was identified as the fuel of the ignition source has decreased by 42% between 2006 and 2015.

Cooking-related fires continue to be the most common type of fire where electricity was "the fuel of the ignition source:"

- In 2011, there were 834 cooking equipment fires;
- In 2015, there were 795 cooking equipment fires, a decrease of 5%.

Electrical distribution equipment fires are fires from electrical wiring, devices or equipment in which its primary function is to carry current from one location to another (e.g. wiring, extension cords, termination electrical panels appliance cords) with electricity as the fuel of the ignition source. This type of fire has slightly decreased over the most recent five years:

- In 2011, there were 532 electrical distribution equipment fires;
- In 2015, there were 459 electrical distribution equipment fires, a decrease of 14%.

Priority Issues

ESA uses incident data from the OESR to identify areas that present the greatest risk to Ontarians, to monitor changes in incidence, and to identify emerging trends and risks.

Based on the data collected in the past ten years, ESA has identified that the majority of electrical injuries and fatalities occur in the following specific areas. These areas have been identified as priorities for reducing electrical fatalities, serious injuries, damage and loss in Ontario:

- Powerline contact while working accounted for 31% of all occupational electrical fatalities between 2007 and 2016.
- Electrical trade workers accounted for 28% of all occupational-related fatalities between 2007 and 2016. There is at least one critical injury to an electrical trade worker each year. Safety incidents tend to be associated with unsafe work practices.

- Non-occupational electrical injuries, identified from emergency department visits in Ontario, have decreased 4% from 2011 to 2015; however, the severity of these visits has remained relatively constant between the five years.
- Misuse of electrical products and unapproved or counterfeit products account for a significant number of safety reports.
- ESA defines electrical products as appliances, cooking equipment, lighting equipment, other electrical and mechanical equipment and processing equipment. Data from OFMEM shows that the five-year average for electrical product fires (where electricity was identified as the fuel source) between 2006-2010 and 2011-2015 has decreased by 34%.
- An average of 1540 electrical loss fires (electrical distribution equipment and those where ignition sources were fuelled by electricity) occurred in residential structures in the past five years, and result in a minimum of six fatalities annually.

ESA Initiatives

Based on the information collected from the OESR, ESA introduced a strategic plan (Harm Reduction Strategy 2.0) in 2015 to focus on addressing those harms that represent the majority of incidents and fatalities. ESA is working towards a goal of a 20% reduction in electrical fatality and critical injury rate between 2015 and 2020. Additional details on ESA efforts can be found at www.esasafe.com.

ESA cannot reach its goal without significant work and support of its partners and stakeholders within the electrical safety system. We would like to acknowledge:

- those who generate and distribute electricity;
- electrical equipment manufacturers;
- standards organizations;
- safety organizations;
- installers of electrical equipment;
- educators;
- facility owners;
- injury response and treatment providers;
- government;
- researchers;
- injury prevention specialists;
- safety regulators, and worker safety advocates; and
- those who are end users of electricity.

Working together, we seek to reduce the number of electrical fatalities, injuries and fires with the ultimate vision of "An Ontario where people can live, work and play safe from electrical harm."

1.0 Purpose of this Report

This is the sixteenth report on the state of electrical safety in Ontario. It summarizes electrical incidents, electrical-related fatalities, injuries of an electrical nature and death, injuries and damage caused by fire incidents identified by the Office of the Fire Marshal and Emergency Management (OFMEM) and the local fire departments identifying fires and fire fatalities from electricity that were the ignition fuel and/or electrical distribution equipment identified as the ignition source.

The purpose of this report is to provide stakeholders within the broad electrical safety system with an update and a longitudinal perspective of electrical safety in Ontario. Those stakeholders include:

- Electrical utilities and those organizations that generate, transmit, and distribute electricity.
- Organizations that design, manufacture, distribute and supply electrical products.
- Electrical contractors who install, repair, and maintain electrical wiring installations and products in our homes, workplaces, and public spaces.
- Regulators and various levels of government that write policies and regulations to protect public safety.
- Canadian and international organizations which develop standards for electrical installation and products.
- Academic and commercial organizations that focus on safety research and development.
- Organizations such as insurance companies that create policies that drive organization and consumer behaviour to reduce risk.
- Health care providers, workplace and community-based safety organizations, education and training organizations each provide public communication, increase hazard-mitigation skills and awareness.
- Consumers who purchase electrical products, and use and rely on electricity every day in their home, workplaces, and public spaces.
- And more.

All of these organizations have an important role in contributing and improving electrical safety in Ontario.

1.0 Purpose of this Report

This report intends to educate and inform members of the electrical safety system by identifying key electrical safety risks. This information can be used to develop and improve standards, identify areas for continued safety research, influence the development of workplace and community-based safety programs, and lead to improved training, education and communication programs.

ESA is proud to be using an evidence-based approach by using the data gathered from the OESR to set corporate strategic goals, make recommendations for regulatory change, and implement safety campaigns to minimize and mitigate electrical harms for all Ontarians. In this report, we have included three success stories where we have leveraged the data collected from the OESR:

1. To establish our Harm Reduction 1.0 Strategic Plan *Getting to Zero – A Commitment to Safety*;
2. To implement safety campaigns on powerline safety for dump truck drivers; and
3. To amend the Ontario Electrical Safety Code to include expanded requirements for Arc Fault Circuit Interrupters (AFCIs).

1.1 Role of The Electrical Safety Authority

The Electrical Safety Authority (ESA) is an administrative authority acting on behalf of the Government of Ontario with specific responsibilities under Part VIII of the Electricity Act, 1998, and the Safety and Consumer Statuses Administration Act, 1996. As part of its mandate, ESA is responsible for administering regulation in four key areas:

- Ontario Electrical Safety Code (Regulation 164/99)
- Licensing of Electrical Contractors and Master Electricians (Regulation 570/05)
- Distribution Safety (Regulation 22/04)
- Product Safety (Regulation 438/07)

ESA operates as a private, not-for-profit corporation. Funding derives from fees for electrical oversight, safety services, and licensing of electrical contractors and master electricians. Activities include:

- ensuring compliance with regulations
- investigating fatalities, injuries and fire losses associated with electricity
- identifying and targeting leading causes of electrical risk
- promoting awareness, education and training on electrical safety
- engaging with stakeholders to improve safety

1.2 Case Studies

This report features several case studies of ESA root-cause investigations.

ESA conducts these investigations on select and serious incidents (especially those that include fatalities, critical injuries and/or serious fires), in order to determine the underlying root causes. The lessons learned from these investigations help to prevent future incidents and fatalities.

ESA's investigations go beyond compliance with any code, regulations or standard, and are not only limited to electrical safety dimensions, but also examine occupational health and safety, and the role of the integrated safety infrastructure.

Root-cause investigations assess both the events leading up to the incident and the surrounding conditions, and the events or conditions that went wrong and contributed to the incidents.

The case studies presented have been modified to protect the privacy of the individuals involved. Details from case studies for fire-related incidents have been generously provided by the OFMEM.

2.0 Electrical-Related Fatalities and Injuries

2.1 Electrocutions and Electrical Burn Fatalities

Electrocution occurs when a person is exposed to a lethal amount of electrical energy.

To determine how contact with an electrical source occurs, characteristics of that source before electrocution (pre-event) must be evaluated.

For death to occur, the human body must become part of an active circuit with an electric current that is capable of over stimulating the nervous system and/or causing damage to internal organs. The extent of injuries depends on the current's magnitude (measured in amperes (Amps)), the path in which the current travels through the body, and the duration it flows through the body (event). The resulting damage to the human body and the emergency medical treatment ultimately determines the outcome of the energy exchange (post-event) (National Institute for Occupational Safety and Health, 1991).

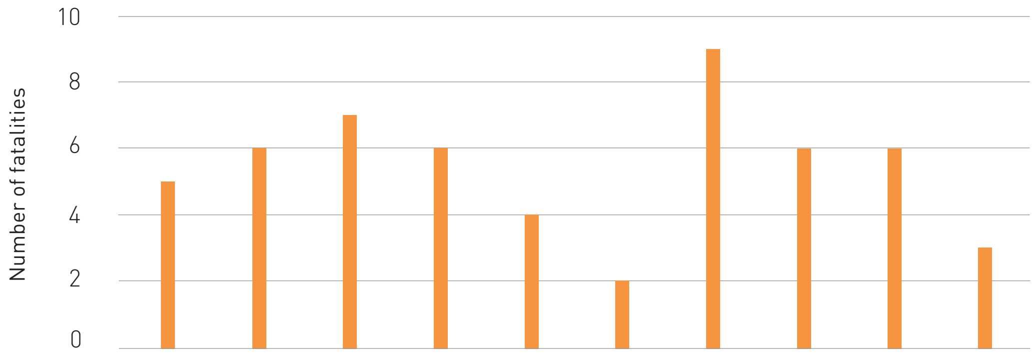
There were 54 electrical-related fatalities reported in Ontario in the ten-year span between 2007 and 2016, a decrease from 63 in the period between 2006 and 2015. The five-year rolling average rate of electrical fatalities has decreased by 12% when comparing 2007-2011 (0.43 per million population) and 2012-2016 (0.38 per million population).

Powerline fatalities have also decreased: when 2007-2011 and 2012-2016 were compared, there was a 20% decrease in the five-year rolling average rate of powerline electrocutions.

Residential (38%), industrial (28%) and public place settings (10%) were the most common places for electrical-related fatalities between 2012 and 2016.

The five-year rolling average rate of occupational electrical-related fatalities per labour force has decreased slightly at 4% when comparing 2007-2011 to 2012-2016. The five-year rolling average rate of non-occupational electrical-related fatalities per million population has decreased by 20% between the same time periods.

1 NUMBER OF ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2007-2016

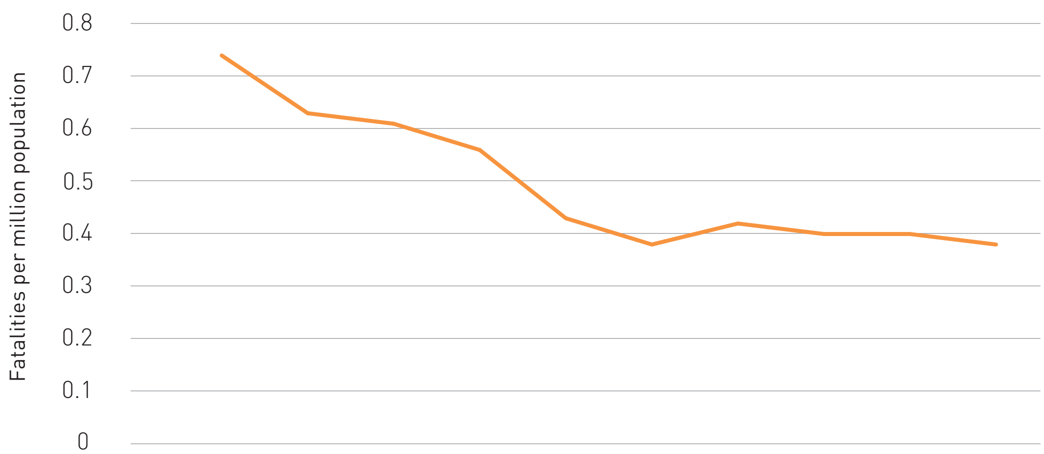


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number	5	6	7	6	4	2	9	6	6	3

Source: ESA and Coroners' records.

Conclusion
The number of electrical-related fatalities in 2016 has decreased when compared to 2015; there has been a **67%** reduction since 2009 (the year with the highest number of fatalities reported in the most recent 10-year period).

2 FIVE-YEAR ROLLING AVERAGE RATE OF ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2003-2016



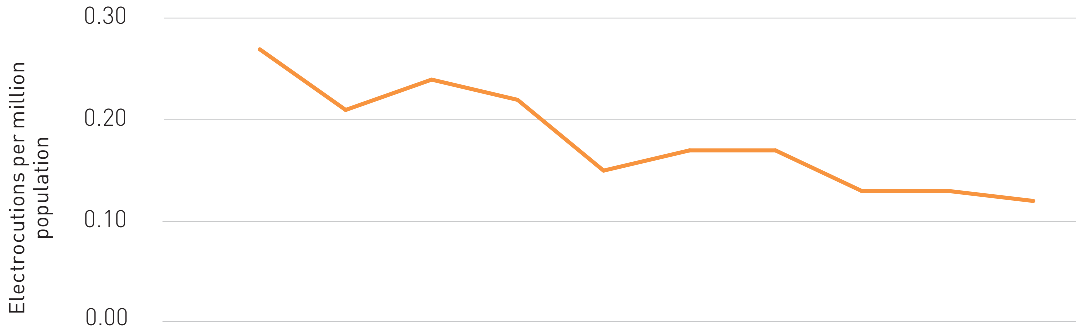
	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Rate	0.74	0.63	0.61	0.56	0.43	0.38	0.42	0.40	0.40	0.38

Source: ESA and Coroners' records.

Conclusion
The rate of electrical-related fatalities has slightly decreased when compared to the previous year of 2015; there has been a **12%** reduction when comparing the average rate at 2007-2011 and 2012-2016.

2.1 Electrocutions and Electrical Burn Fatalities

3 FIVE-YEAR ROLLING AVERAGE RATE OF POWERLINE FATALITIES IN ONTARIO, 2003-2016

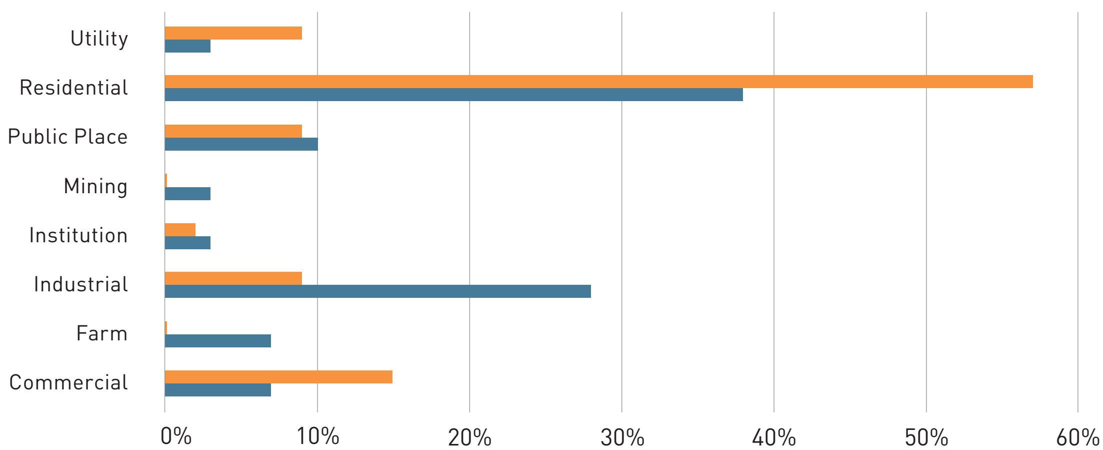


	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Rate	0.27	0.21	0.24	0.22	0.15	0.17	0.17	0.13	0.13	0.12

Source: ESA and Coroners' records.

Conclusion
In 2016, there were no powerline fatalities; there has been a **20%** reduction when comparing the rate at 2007-2011 and 2012-2016.

4 PERCENTAGE OF ELECTRICAL FATALITIES BY FACILITY TYPE IN ONTARIO, 2007-2011 AND 2012-2016

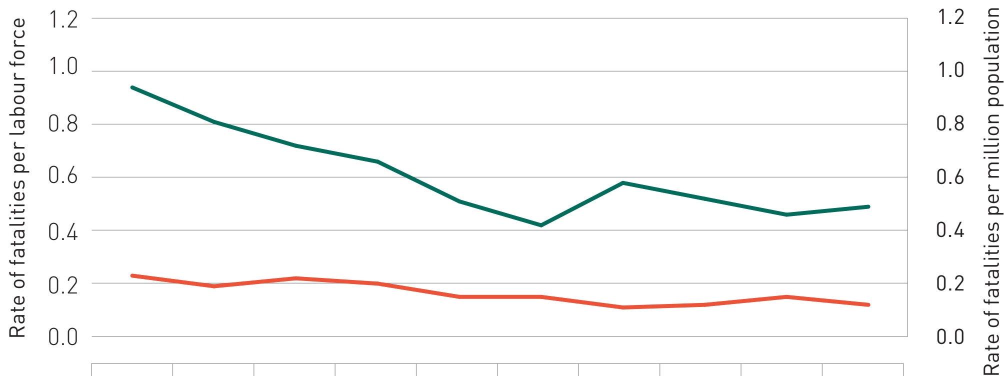


	Commercial	Farm	Industrial	Institution	Mining	Public Place	Residential	Utility
2007–2011	15%	0%	9%	2%	0%	9%	57%	9%
2012–2016	7%	7%	28%	3%	3%	10%	38%	3%

Source: ESA and Coroners' records.

Conclusion
Residential settings were the most common settings where electrical-related fatalities occur. In 2007-2011, residential, commercial, industrial and utility settings were the most common places for electrical-related fatalities; in 2012-2016, residential, industrial and public settings were the most common places for electrical-related fatalities.

5 FIVE-YEAR ROLLING AVERAGE RATE OF OCCUPATIONAL AND NON-OCCUPATIONAL ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2003-2016



	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Occupational	0.94	0.81	0.72	0.66	0.51	0.42	0.58	0.52	0.46	0.49
Non-occupational	0.23	0.19	0.22	0.20	0.15	0.15	0.11	0.12	0.15	0.12

Source: ESA and Coroners' records.

Conclusion

The five-year rolling average rate of occupational electrical-related fatalities has decreased by **4%** when comparing 2007-2011 to 2012-2016 per million labour force. The five-year rolling average rate of non-occupational electrical-related fatalities has decreased by **20%** per million population.

2.2 Occupational Electrical-Related Fatalities and Electrical Injuries

Occupational electrical-related fatalities are a significant and ongoing problem, and a particular hazard to those who routinely work near electrical sources. In Ontario, a study of occupational fatalities among construction workers between 1997 and 2007 found that electrical contact was responsible for 15% of fatalities; risk factors associated with occupational fatalities included direct contact with electrical sources, lower voltage sources, and working outdoors (Kim et al., 2016). Studies have shown that the greatest proportion of electrocution deaths occur among electricians and electrical helpers, utility workers and those working in construction and manufacturing industries. As well, electrical-related fatalities are more common among workers who are younger than the average age of occupational deaths overall. Contact with overhead powerlines is reportedly by far the most frequent cause of fatal occupational electrocution injury (Taylor et al., 2002).

For those who survive electrical injury, the immediate consequences are usually obvious and often require extensive medical intervention. However, the long-term after effects may be more subtle, pervasive and less well-defined. Long term effects are particularly difficult to diagnose, as the link between the injury and the symptoms can often go unrecognized by patients and their physicians (Wesner and Hickie, 2013; Theman et al., 2008).

Research has also examined the challenges of returning to work after electrical injury. Three distinct categories of challenges have been identified:

1. Physical, cognitive, and psychosocial impairments and their effects on their work performance.
2. Feelings of guilt, blame, and responsibility for the injury.
3. Having to return to the workplace or worksite where the injury took place.

The most beneficial supports identified by the injured workers include receiving support from family, friends, and coworkers, and undertaking rehabilitation services that specialize in electrical injury. The most common advice to others after electrical injuries includes:

1. Avoiding electrical injury
2. Feeling ready to return to work
3. Completing a Workplace Safety and Insurance Board injury/claims report
4. Proactively being a self-advocate
5. Garnering the assistance of individuals who understand electrical injuries to advocate on their behalf (Stergiou-Kita et al., 2014)

Between 2007 and 2016, there were 36 occupational electrical-related fatalities (an average of 3.6 electrical-related fatalities per year) compared to 40 electrical-related fatalities between 2006 and 2015 (an average of 4 electrical-related fatalities per year). In 2016, all electrical-fatalities were occupational. However, since 2013 there has been a 63% reduction in the number of occupational-related fatalities.

The five-year rolling average number of fatalities and critical injuries among workers (overall occupational safety) has decreased between 2007-2011 and 2012-2016; however, the five-year rolling average number of fatalities and critical injuries among electrical trade workers shows a smaller decrease comparing these two time periods.

When comparing the five-year rolling average rate, the occupational electrical-related fatalities has slightly decreased from 0.51 per million labour force population in 2007-2011, to 0.49 per million labour force population in 2011-2015. This is a decrease of 4%.

In the 2012-2016 time period, industrial (44%), public places (17%), commercial (11%), and farm settings (11%) were the most common places for occupational electrical-related fatalities. The most commonly cited causes of death were due to improper installation/ procedure (31%) and lack of hazard assessment (20%), when excluding unknown causes.

Between 2007 and 2016, electrical tradespeople accounted for 28% of all occupational electrical-related fatalities. This percentage is an increase from what was reported in 2006-2015, where electrical tradespeople accounted for 25% of all occupational electrical-related fatalities.

A review of data provided by the WSIB from 2007 to 2016 shows that males continue to outnumber females by approximately 3:1 in the number of WSIB lost time injury claims related to electrical injuries. Workers in the construction and services sector contribute to the highest number of WSIB lost time injury claims. Machine tool and electric parts, and heating, cooling and cleaning machinery were the most common sources of injury. Injury claims indicate that electrocutions and electric shock are more than double that of electrical burn injuries in this time period.

Section 2.5 provides a case study that is an example of the risk factors associated with an electrical-related fatality for an electrical worker.

Statistics Directly Related to ESA's Harm Reduction Priorities – WORKER SAFETY

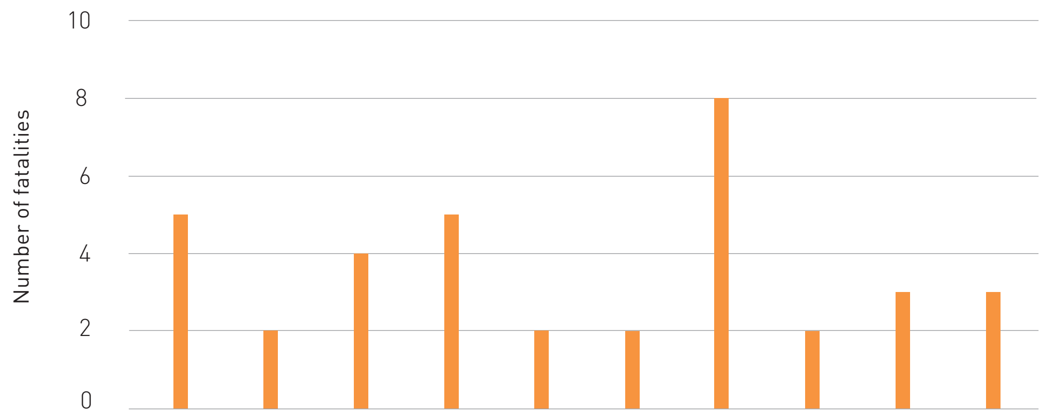
Five-year Rolling Average Comparison

Number of worker-related electrical fatalities and critical injuries based on data reported by the Ministry of Labour, incidents investigated by ESA, confirmed with the Office of the Coroner.

The worker safety five-year rolling average has decreased by 13% between 2007-2011 and 2012-2016

2.2 Occupational Electrical-Related Fatalities and Electrical Injuries

1 NUMBER OF OCCUPATIONAL ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2007-2016

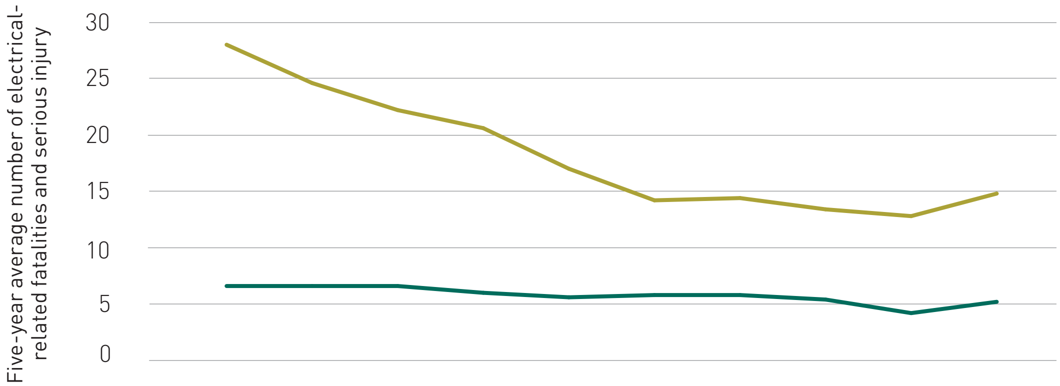


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Occupational	5	2	4	5	2	2	8	2	3	3

Source: ESA and Coroners' records.

Conclusion
The number of occupational electrical-related fatalities has decreased since 2007.

2 FIVE-YEAR ROLLING AVERAGE OF OCCUPATIONAL FATALITIES AND CRITICAL INJURIES IN ONTARIO, 2003-2016



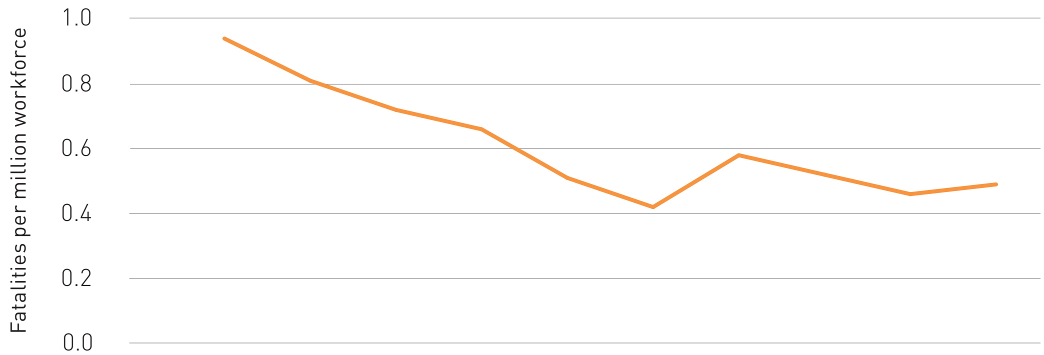
	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Occupational safety overall	28	24.6	22.2	20.6	17	14.2	14.4	13.4	12.8	14.8
Electrical trade	6.6	6.6	6.6	6	5.6	5.8	5.8	5.4	4.2	5.2

Source: ESA and Coroners' records.

Conclusion
The five-year rolling average number of occupational fatalities and critical injuries (overall occupational safety) has decreased by **13%** between 2007-2011 and 2012-2016; however, there has been a smaller decrease (**8%**) of occupational fatalities and critical injuries among electrical trade workers.

2.2 Occupational Electrical-Related Fatalities and Electrical Injuries

3 FIVE-YEAR ROLLING AVERAGE RATE OF OCCUPATIONAL ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2003-2016

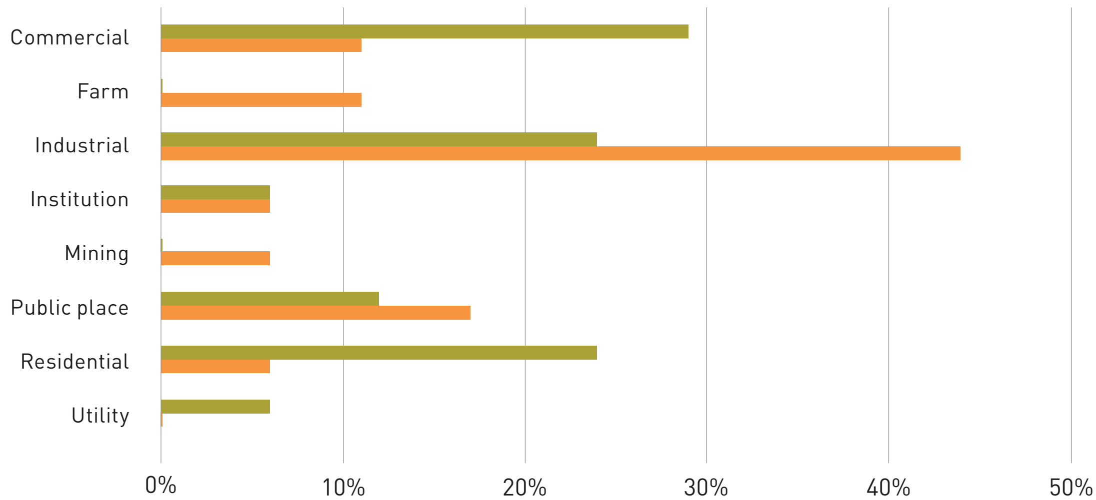


	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Occupational electrocutions	0.94	0.81	0.72	0.66	0.51	0.42	0.58	0.52	0.46	0.49

Source: ESA and Coroners' records.

Conclusion
The rate of occupational electrical-related fatalities has decreased by **4%** when comparing 2007-2011 and 2012-2016.

4 PERCENTAGE OF OCCUPATIONAL ELECTRICAL-RELATED FATALITIES BY FACILITY TYPE IN ONTARIO, 2007-2011 AND 2012-2016

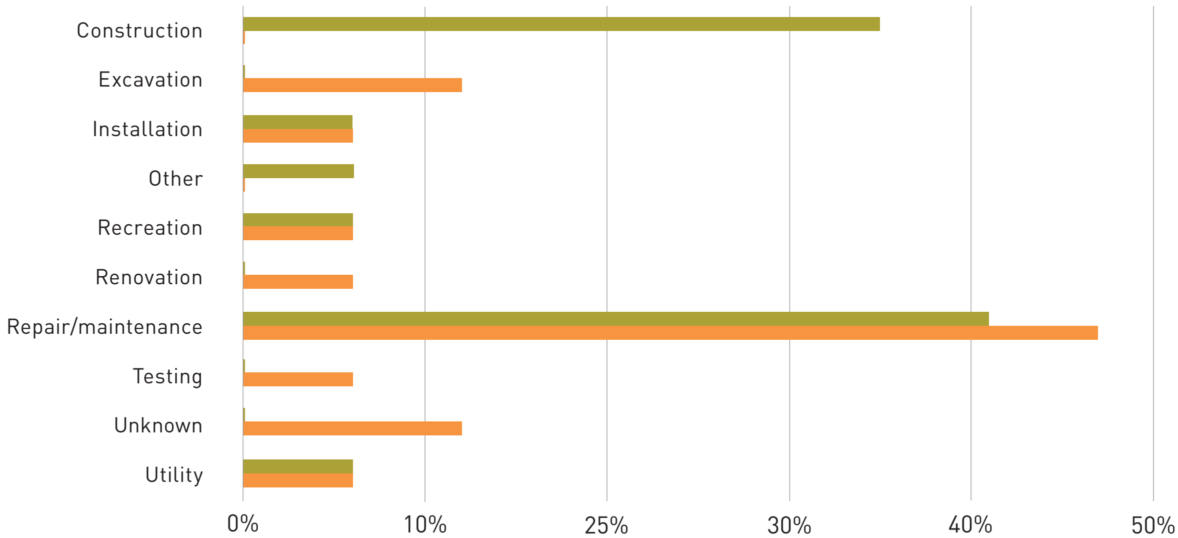


	Commercial	Farm	Industrial	Institution	Mining	Public place	Residential	Utility
2007-2011	29%	0%	24%	6%	0%	12%	24%	6%
2012-2016	11%	11%	44%	6%	6%	17%	6%	0%

Source: ESA and Coroners' records.

Conclusion
In 2007-2011, commercial, residential, and industrial settings were the most common settings for occupational electrical-related fatalities. In 2012-2016, industrial, public places, and commercial settings were the most common settings for occupational electrical-related fatalities.

5 PERCENTAGE OF OCCUPATIONAL ELECTRICAL-RELATED FATATLITES BY TYPE OF WORK IN ONTARIO, 2007-2011 AND 2012-2016

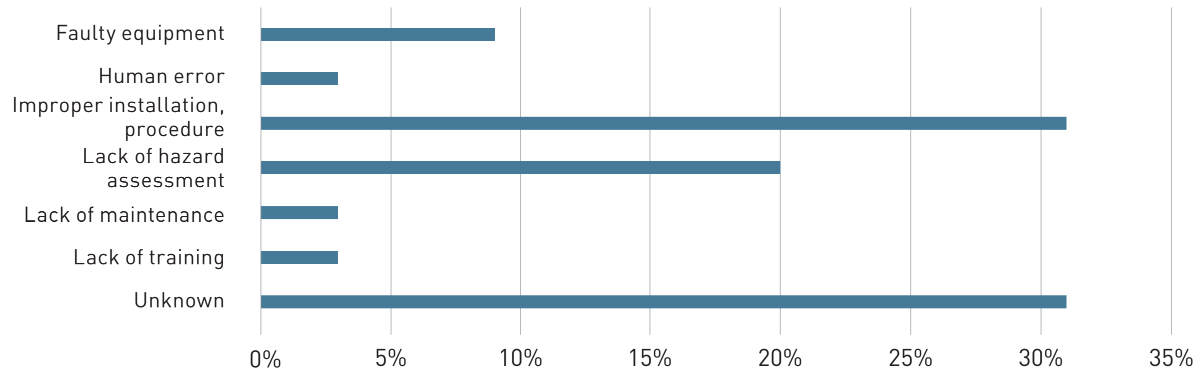


	Construction	Excavation	Installation	Other	Recreation	Renovation	Repair/ maintenance	Testing	Unknown	Utility
2007-2011	35%	0%	6%	6%	6%	0%	41%	0%	0%	6%
2012-2016	0%	12%	6%	0%	6%	6%	47%	6%	12%	6%

Source: ESA and Coroners' records.

Conclusion
In 2007-2011, repair/maintenance and construction activities were the most common types of work for occupational electrical-related fatalities. In 2012-2016, repair/maintenance and excavation were the most common types of work for occupational electrical-related fatalities.

6 PERCENTAGE OF OCCUPATIONAL ELECTRICAL-RELATED FATALITIES BY PROBABLE CAUSE IN ONTARIO, 2007-2016



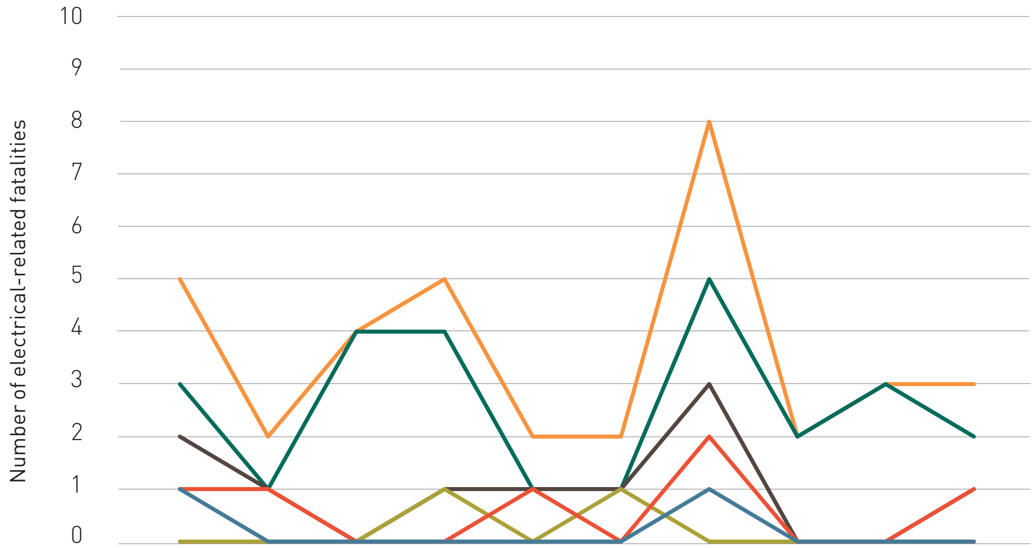
	Faulty equipment	Human error	Improper installation, procedure	Lack of hazard assessment	Lack of maintenance	Lack of training	Unknown
Probable cause of fatalities	9%	3%	31%	20%	3%	3%	31%

Source: ESA and Coroners' records.

Conclusion
Aside from unknown cause, the most commonly cited causes of occupational electrical-related fatalities were due to improper installation/procedure and lack of hazard assessment in the most recent ten-year period.

2.2 Occupational Electrical-Related Fatalities and Electrical Injuries

7 NUMBER OF OCCUPATIONAL ELECTRICAL-RELATED FATALITIES BY OCCUPATION IN ONTARIO, 2007-2016

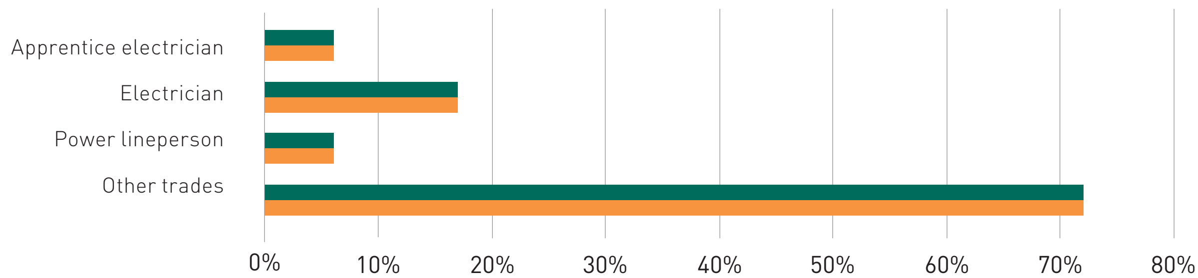


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Apprentice electrician	1	0	0	0	0	0	1	0	0	0
Electrician	1	1	0	0	1	0	2	0	0	1
Power lineperson	0	0	0	1	0	1	0	0	0	0
Total electrical trade	2	1	0	1	1	1	3	0	0	1
Other trades	3	1	4	4	1	1	5	2	3	2
Occupational electrocution	5	2	4	5	2	2	8	2	3	3

Source: ESA and Coroners' records.

Conclusion
The overall number of occupational fatalities have decreased since 2007; most notably amongst the electrical trade where there were no fatalities in 2014 and 2015. However, the number of fatalities in Other Trades has remained constant in the past ten years.

8 PERCENTAGE OF OCCUPATIONAL ELECTRICAL-RELATED FATALITIES BY TRADE, 2007-2011 AND 2012-2016



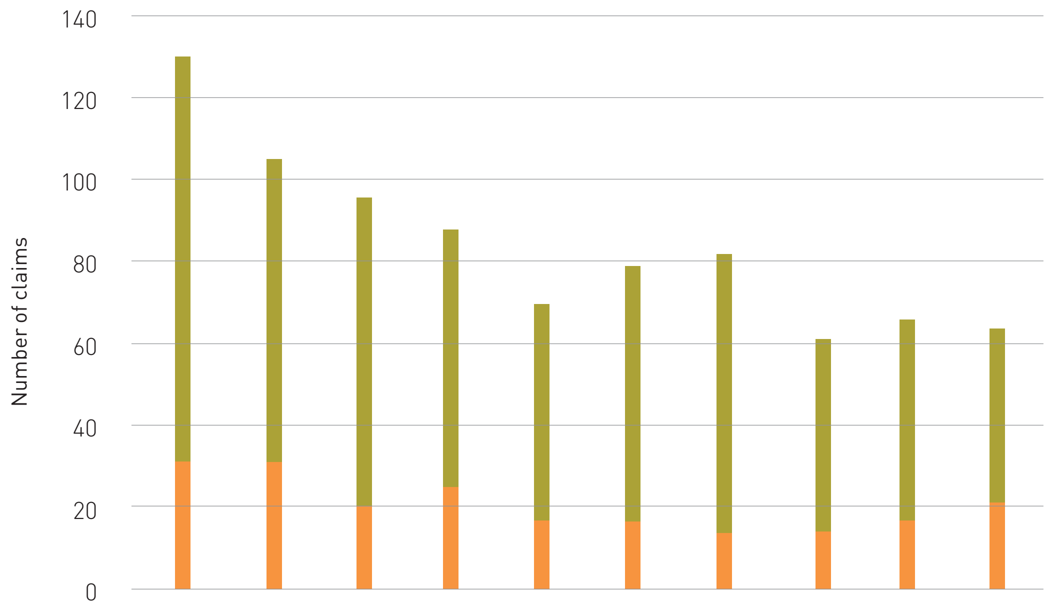
	Apprentice electrician	Electrician	Power lineperson	Other trades
2007-2011	6%	17%	6%	72%
2012-2016	6%	17%	6%	72%

Source: ESA and Coroners' records.

Conclusion

The percentage of electrical-related fatalities among electricians, apprentices and linespersons have remained the same in the two time periods. Workers from Other Trades contribute to the largest proportion of electrical-related fatalities.

9 NUMBER OF ALLOWED WSIB LOST TIME ELECTRICAL INJURY CLAIMS BY SEX IN ONTARIO, 2007-2016

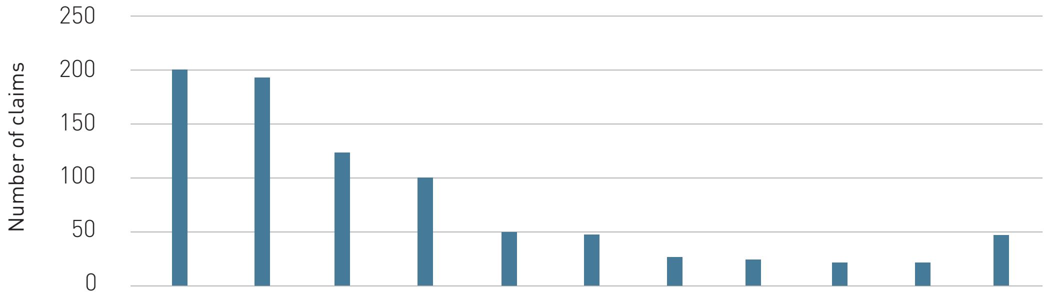


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Female	31	31	20	25	17	17	14	14	17	21
Male	99	74	76	63	53	62	68	47	49	43

Source: Workplace Safety and Insurance Board.

Conclusion
Since 2007, males continue to outnumber females by approximately 3:1 in the number of WSIB injury claims related to electrical injuries.

10 NUMBER OF ALLOWED WSIB LOST TIME ELECTRICAL INJURY CLAIMS BY SECTOR IN ONTARIO, 2007-2016



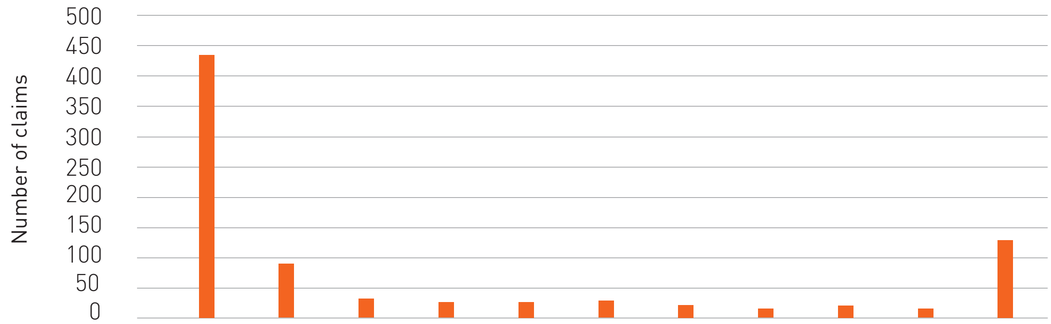
	Construction	Services	Manufacturing	Schedule 2*	Health care	Electrical	Transportation	Chemical/ process	Automotive	Food	Other
Number of allowed lost time claims	200	191	123	101	49	47	26	24	21	21	38

Source: Workplace Safety and Insurance Board.

Conclusion
Workers in the construction and service sector contribute to the highest number of WSIB lost time electrical claims between 2007 and 2016.

* Schedule 2 workers are those that work in firms funded by public funds (federal, provincial and/or municipal governments), firms legislated by the province but self-funded, or firms that are privately owned but involved in federally regulated industries such as telephone, airline, shipping and railway.

11 NUMBER OF ALLOWED WSIB LOST TIME ELECTRICAL INJURY CLAIMS BY THE TOP 10 SOURCES IN ONTARIO, 2007-2016

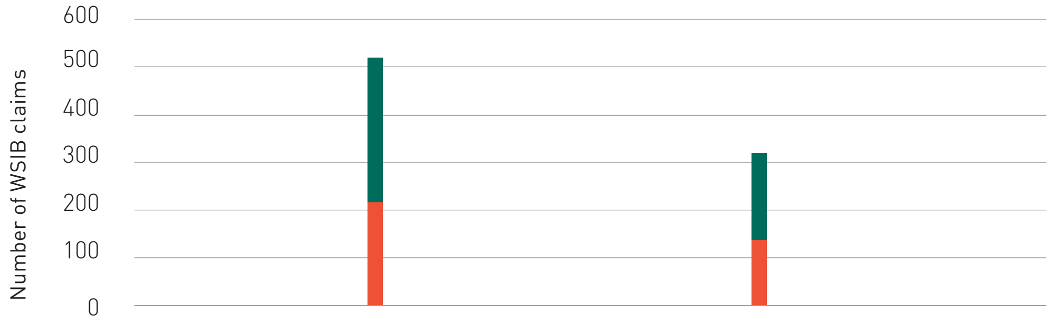


	Machine tool and electric parts	Heating, cooling and cleaning machinery	Metal woodworking and plastic, rubber concrete and other processing	Misc. machinery (e.g. audio, video, televisions, telephones, snowblowers)	Hand tools, powered	Fire, flame, smoke	Special process machinery (e.g. food slicers, paper, printing, wrapping, sewing, pumps)	Machinery unspecified	Furniture and fixtures	Office and business machines	Other sources
Number of allowed lost time claims	433	90	32	26	28	29	21	16	21	16	129

Source: Workplace Safety and Insurance Board.

Conclusion
Machine tool and electric parts, and heating, cooling and cleaning machinery were the most common sources of WSIB electrical injury claims between 2007 and 2016.

12 NUMBER OF ALLOWED WSIB LOST TIME ELECTRICAL INJURY CLAIMS BY NATURE OF INJURY IN ONTARIO, 2007-2011 AND 2012-2016



	Electrocutions, electric shocks	Burns (electrical)
2007-2011	308	181
2012-2016	214	138

Source: Workplace Safety and Insurance Board.

Conclusion
Injury claims indicate that electrocutions and electric shock are more than double that of electrical burn injuries in this time period.

2.3 Non-Occupational Electrical-Related Fatalities and Injuries

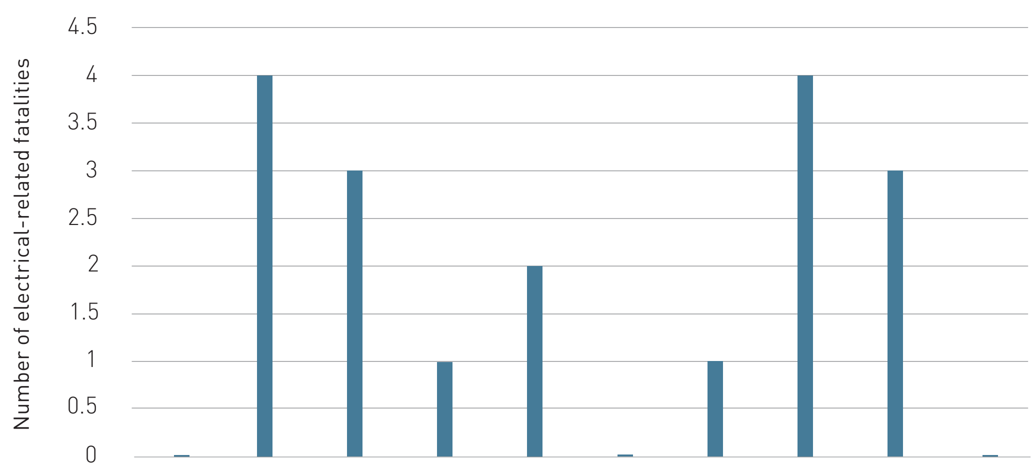
Injuries are a significant health problem. They are the leading cause of death for the young, and contribute substantially to the burden on the health care system. Many injuries are predictable and preventable.

In 2016, there were no non-occupational electrical-related fatalities. In 2015, there were 3 non-occupational electrical-related fatalities, and in 2014, there were 4 fatalities. With the exception of 2008 and 2014, occupational electrical-related fatalities outnumber non-occupational electrical fatalities.

Between 2007 and 2016, there were 18 non-occupational electrical-related fatalities (an average of 1.8 electrical-related fatalities per year). In the previous ten-year period (2006-2015) there were 23 non-occupational electrical-related fatalities (an average of 2.3 electrical-related fatalities per year). The five-year rolling average rate between 2007-2011 and 2012-2016 has decreased 20% from 0.15 per million population to 0.12 per million population.

In the past ten years, the residential setting (60%) was the most common place for non-occupational electrical-related fatalities. Theft (24%), and landscaping, lawn cutting and tree-trimming (12%) were the most common activities associated with fatalities when excluding unknown activities.

1 NUMBER OF NON-OCCUPATIONAL ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2001-2015

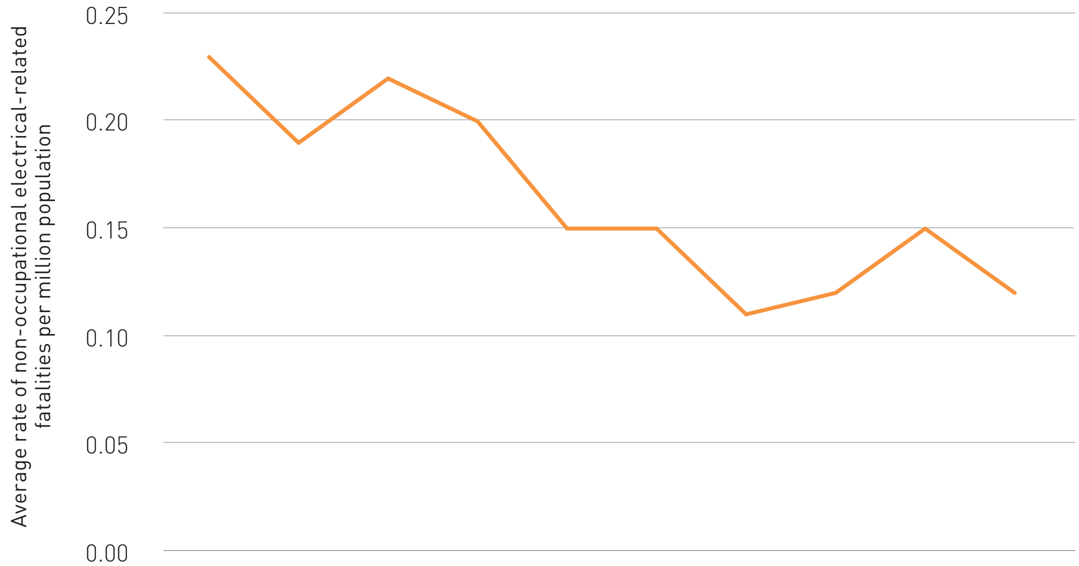


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Non-occupational	0	4	3	1	2	0	1	4	3	0

Source: ESA and Coroners' records.

Conclusion
The number of non-occupational electrical-related fatalities has remained variable in the past ten years.

2 FIVE-YEAR ROLLING AVERAGE RATE OF NON-OCCUPATIONAL ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2003-2016



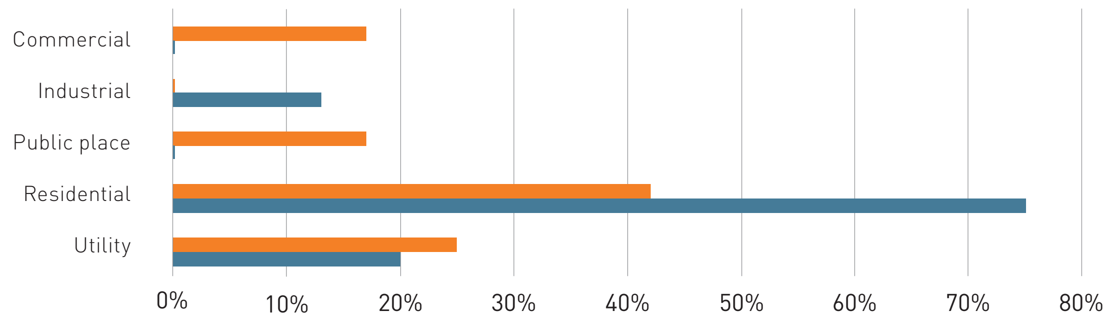
	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Non-occupational	0.23	0.19	0.22	0.20	0.15	0.15	0.11	0.12	0.15	0.12

Source: ESA and Coroners' records.

Conclusion
The five-year rolling average rate of non-occupational electrical-related fatalities has decreased by **20%** when comparing 2007-2011 and 2012-2016.

2.3 Non-Occupational Electrical-Related Fatalities and Injuries

3 PERCENTAGE OF NON-OCCUPATIONAL ELECTRICAL-RELATED FATALITIES BY FACILITY TYPE IN ONTARIO, 2007-2016



	Commercial	Industrial	Public place	Residential	Utility
2007-2011	17%	0%	17%	42%	25%
2012-2016	0%	13%	0%	75%	20%

Source: ESA and Coroners' records.

Conclusion
In the past ten years, the residential setting is the most common place for non-occupational electrical-related fatalities.

4 PERCENTAGE OF NON-OCCUPATIONAL ELECTRICAL-RELATED FATALITIES BY ACTIVITY TYPE IN ONTARIO, 2007-2016

	Landscaping, lawn cutting, tree trimming	Other	Recreation	Repair/ maintenance	Theft	Unknown	Vehicle
Type of activity	10%	10%	5%	5%	30%	35%	5%

Source: ESA and Coroners' records.

Conclusion
Theft and landscaping, lawn-cutting and tree-trimming, and other activities are the most common activities (excluding unknown) for non-occupational electrical-related fatalities.

2.4 Electrical Injury and Emergency Department Visits in Ontario 2006-2015

Factors that affect the presence of electrical injury and its severity depend on the magnitude of the electric current, its transmission (direct or indirect), body entry and exit sites, the path the current takes through the body, and the surrounding environmental conditions (e.g. wet or dry environments) (Duff, 2001).

Exposure to electricity can result in a range of injuries. It can lead to cardiovascular system injuries (e.g. rhythm disturbances), cutaneous injuries and burns, nervous system disruption and respiratory arrest, as well as head injuries, and fractures and dislocations (caused by being "thrown" or "knocked down") from the severe muscle contractions caused by the current. (Duff and McCaffrey, 2011; Koumbourlis, 2002).

From 2006 to 2015, approximately 14,224 visits to Ontario hospitals' emergency departments (ED) were due to electrical injury. The trend of males outnumbering females in electrical injuries is also observed in ED visits with 69% of ED visits from males. Adults (age 20-64 at 80%) and children (age 0-19 at 18%) comprised of 98% of all ED visits related to electrical injuries.

Using the Canadian Triage and Acuity Scale (CTAS), the severity of electrical injury was assessed upon visit. In the past ten years, 80% of ED visits were classified as the most severe – that is, requiring resuscitation, conditions that are a potential threat to life limb or function requiring medical intervention or delegated acts, or conditions that could potentially progress to a serious problem requiring emergency intervention (Canadian Triage and Acuity Scale between 1 and 3). In 70% of all ED visits, the principal diagnosis was identified as electrical current, and 4% of visits were from effects of lightning. Burns were the principal diagnosis in an additional 14% of cases.

When excluding unspecified place of occurrence, the most common locations for electrical injury were the home (37%), followed by industrial and construction locations (22%), and trade and service areas (21%).

Statistics Related to ESA's Harm Reduction Priorities – NON-OCCUPATIONAL ELECTRICAL SAFETY

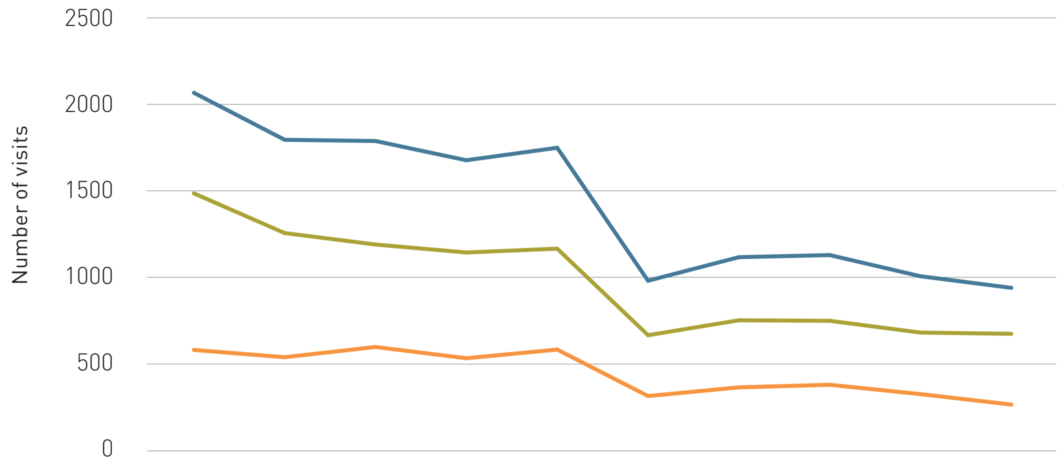
Five-year Rolling Average Comparison

Number of emergency department visits due to critical electrical injuries (Canadian Triage and Acuity Scale levels 1-3) reported to the Canadian Institute of Health Information.

The number of emergency department visits that were classified as critical visits has decreased by 41% in the five-year rolling average between 2006-2010 and 2011-2015

2.4 Electrical Injury and Emergency Department Visits in Ontario, 2006-2015

1 NUMBER OF EMERGENCY DEPARTMENT (ED) VISITS FOR ELECTRICAL INJURY BY SEX IN ONTARIO, 2006-2015

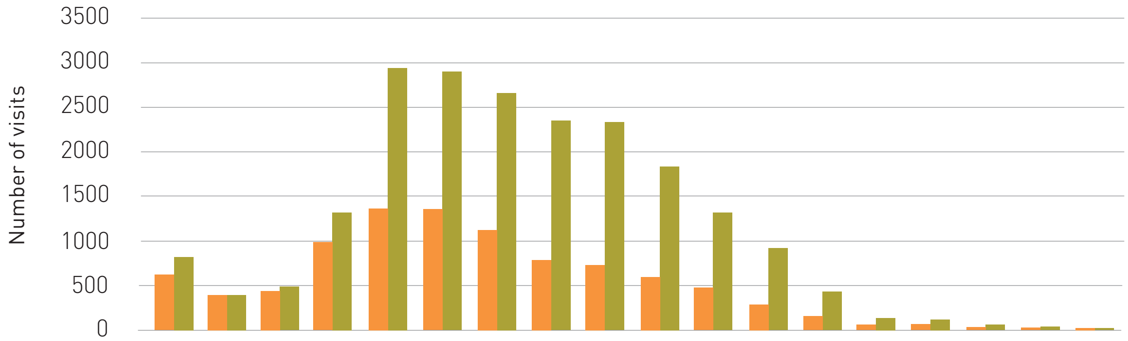


	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Female	580	538	597	532	582	314	364	379	325	265
Male	1483	1254	1188	1142	1164	665	751	748	680	673
Total	2063	1792	1785	1674	1746	979	1115	1127	1005	938

Source: ED All Visit Main Table, NACRS, CIHI.

Conclusion
The total number of ED visits for electrical injury has decreased by **54%** in the past ten years.

2 NUMBER OF EMERGENCY DEPARTMENT (ED) VISITS FOR ELECTRICAL INJURY BY AGE AND SEX IN ONTARIO, 2006-2015



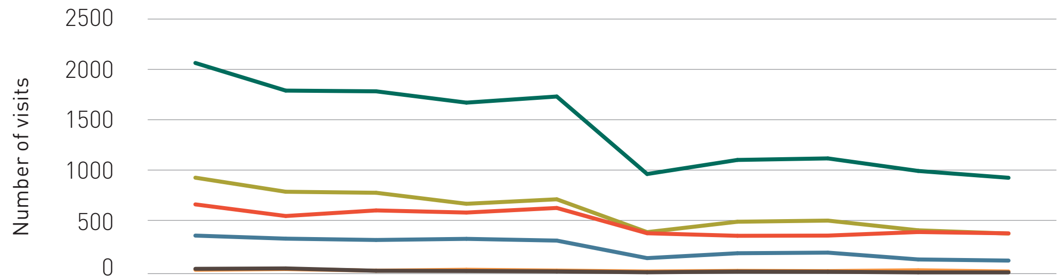
	0 – 4	5 – 9	10 – 14	15 – 19	20 – 24	25 – 29	30 – 34	35 – 39	40 – 44	45 – 49	50 – 54	55 – 59	60 – 64	65 – 69	70 – 74	75 – 79	80 – 84	85+
Female	621	393	438	987	1366	1357	1123	788	731	596	476	289	155	61	66	33	28	24
Male	820	396	486	1320	2942	2899	2660	2349	2332	1836	1316	918	430	136	120	61	38	21

Source: ED All Visit Main Table, NACRS, CIHI.

Conclusion
The number of males seen at the ED for electrical injury is greater than the number of females in all age groups in the past ten years. Adults (age 20-64 at **80%)** and children (age 0-19 at **18%**) comprised of **98%** of all ED visits related to electrical injuries.

2.4 Electrical Injury and Emergency Department Visits in Ontario, 2006-2015

3 NUMBER OF ED VISITS FOR ELECTRICAL INJURY BY CANADIAN TRIAGE AND ACUITY SCALE (CTAS) IN ONTARIO, 2006-2015



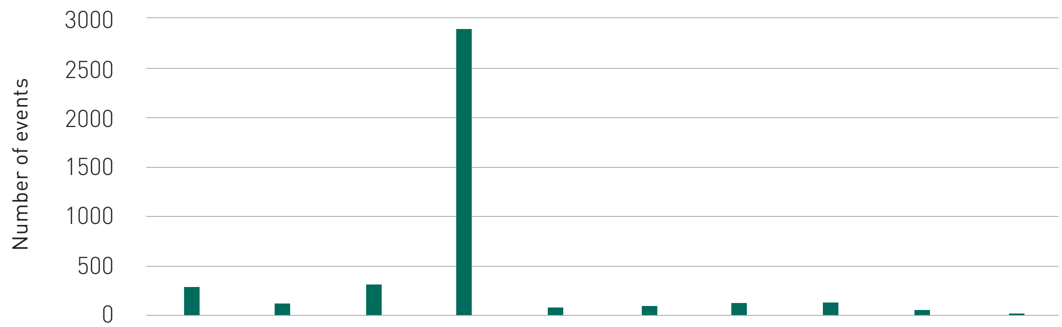
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Resuscitation/ life threatening (level 1)	35	42	26	35	27	18	24	22	30	18
Emergent/potentially life-threatening (level 2)	676	562	617	596	641	393	368	370	405	392
Urgent/potentially serious (level 3)	938	800	790	682	726	404	506	517	422	390
Less-urgent/ semi-urgent (level 4)	370	340	327	338	321	149	197	203	136	125
Non-urgent (level 5)	44	48	25	23	19	10	17	15	9	9
Total	2063	1792	1785	1674	1734	974	1112	1127	1004	937

Source: ED All Visit Main Table, NACRS, CIHI.

Conclusion

80% of ED visits for electrical injury were classified on the Canadian Triage and Acuity Scale (CTAS) at levels 1-3 (Resuscitation, Emergent, Urgent).

4 LOCATION OF BURNS ASSOCIATED WITH ELECTRICAL INJURY IN ONTARIO, 2006-2015

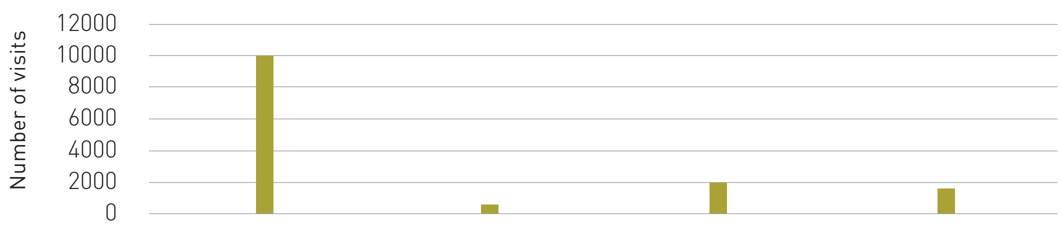


	Burn of head and neck	Burn of trunk	Burn of shoulder and upper limb, except wrist and hand	Burn of wrist and hand	Burn of hip and lower limb, except ankle and foot	Burn of ankle and foot	Burn of eye and adnexa	Burn of other internal organs	Burn of multiple body regions	Burn of unspecified body areas
Total	290	120	318	2900	80	97	126	133	54	20

Source: ED All Visit Main Table, NACRS, CIHI.

Conclusion
Of the ED visits from an electrical injury that resulted in a burn, the majority of injuries were found on the wrist and hand.

5 PRIMARY DIAGNOSIS OF EMERGENCY DEPARTMENT VISITS FOR ELECTRICAL INJURY IN ONTARIO, 2006-2015

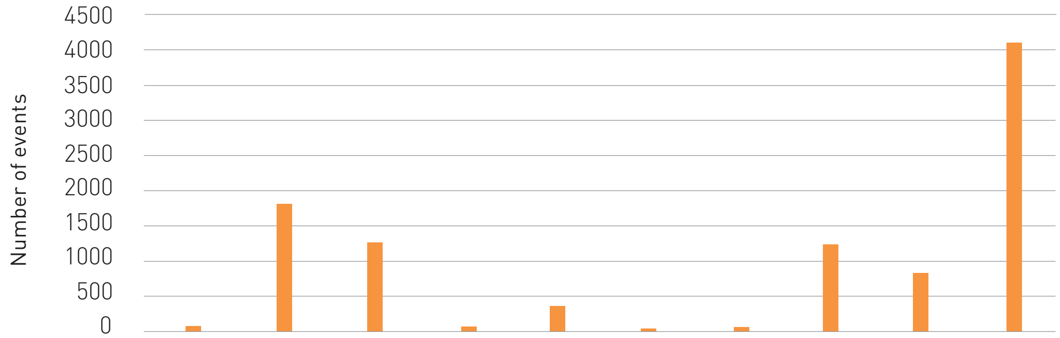


	Effects of electric current (T75.4)	Effects of lightning (T75.0)	Burns (T20-T31)	Other diagnoses
Total	10009	610	1996	1609

Source: ED All Visit Main Table, NACRS, CIHI.

Conclusion
The majority of ED visits for electrical injury had a principal diagnosis of electric current (**70%**), followed by burns (**14%**).

6 PLACE WHERE ELECTRICAL INJURY OCCURRED IN ONTARIO, 2006-2015



	Farm	Home	Industrial and construction area	Residential institution	School, other institution and public area	Sports and athletics area	Street and highway	Trade and service area	Other specified place of occurrence	Unspecified place of occurrence
Total	72	1806	1266	70	363	42	61	1231	826	4101

Source: ED All Visit Main Table, NACRS, CIHI.

Conclusion
While many ED visits from electrical injury were from unspecified place of occurrence, the most commonly reported place of injury were the home, industrial and construction areas, and trade and service areas.

2.5 Electrical Worker

Incident Summary

An electrical contractor was working in the enclosure of an energized disconnect switch when a screwdriver came into contact with energized parts within the switch. The resulting arc flash event caused severe burns to the contractor. The contractor succumbed a few days later due to these injuries.

The Incident

This job required replacing a disconnect switch, located in the electrical room (Figure 1) which fed a slitter line[1] and an indoor crane in a tube manufacturing plant. In the previous weeks, on different occasions, the electric circuit feeding the slitter and crane tripped due to undetermined reasons, stopping production. The on-site electrical contractor approached the plant manager about replacing the 200A disconnect switch with a 400A switch capable of handling a larger load and avoiding nuisance tripping. The plant manager agreed.

Figure 1: Location of switch in the electrical room

[1] A slitter uncoils rolls of steel, then it cuts (slits) the steel lengthwise as required by customer order. The steel is then manually relocated to a mill to form pipes.

2.5 Electrical Worker (continued)

The electrical contractor planned a complete plant shutdown on a Saturday (two days prior to the incident) to replace the old switch with the new one. However, he was unable to complete the job on this day. On Monday morning, all lines ran normally. Later in the morning, the electrical contractor approached the plant supervisor and asked when there would be a changeover (where the line is shut down to run different products on the line). During changeover, the electrical contractor proceeded to the electrical room to complete the job without notifying anyone of neither his actions nor the need to de-energize the equipment to the plant supervisor. The changeover was completed and once the line was powered, it ran normally. A few minutes later a loud bang was heard and the lights went off in the plant. Workers rushed to the electrical room to find the contractor's clothes ignited by an arc flash. Workers rushed to the contractor's aid to douse the fire and tended to him until ambulance arrived and transported him to the hospital. Before he was taken to the hospital, the contractor mentioned he used a screwdriver in the energized switch (Figure 2).

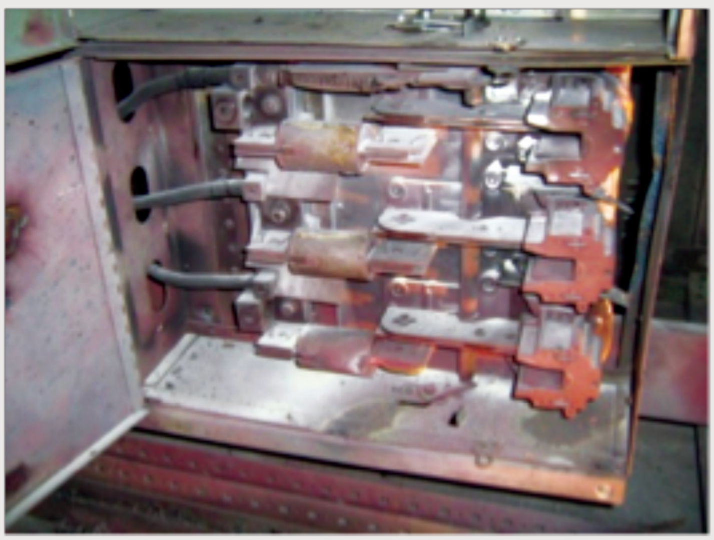


Figure 2: Disconnect switch where arc flash incident occurred

2.5 Electrical Worker (continued)

The contractor succumbed to his injuries a few days later at the hospital.

Further investigation revealed the following:

1. *Electrical safe work procedure was never discussed before or throughout electrical work* – Step-by-step work of the contractor was never discussed with plant management. Plant management had a general idea of the work being performed but the task specifics, potential electrical hazards, and work procedures were left to the on-site contractor. Discussion on electrical work with the plant manager or supervisors was limited to timelines of electrical work, cost of material, and when it affected plant production.
2. *Plant management was only involved on a macro level* – A detailed hazard assessment was not performed for this job. The job was handled similarly to other jobs where the company only discussed job cost and impact on production. Discussing electrical hazards may have highlighted the need to de-energize the system for the specific task that were being performed at the time of incident.
3. *Safety policies were not followed* – The on-site electrical contractor used the defeat mechanism on the disconnect switch to open the door and access energized equipment without interrupting power to the line. This violated the company's "Lockout Procedure" policy as "…the power to electrical equipment or power lines will be disconnected and locked out of service prior to being worked on."
4. *Requirement for additional time to complete the work was not communicated* – There was a lack of communication between the on-site electrical contractor and management staff throughout this job. The requirement to de-energize some circuits was not communicated to plant management. Moreover there was no communication to indicate a need to de-energize the disconnect switch when access to the equipment became necessary.

3.0 Utility-Related Equipment

Utility-related equipment includes electrical equipment and devices used by Local Distribution Companies (LDCs), privately owned companies, or property owners that distribute electricity to customers' facilities or buildings. Examples of such equipment include overhead and underground powerlines (including most equipment on utility poles), substations, electrical chambers (vaults), high-voltage switchgear and transformers. Utility-related equipment carries dangerous amount of energy or power, and if barriers are breached, can be fatal. Overhead and underground equipment barriers are typically clearances above and below the ground, while substation barriers typically include fences and walls. Each barrier is designed to prevent public access and prevent exposure to electric shock hazards.

From 2007 to 2016, there were 27 electrical-related fatalities associated with utility-related equipment, which made up 50% of the total electrical fatalities in Ontario in that period. This number has decreased by five deaths when compared to the previous ten year period of 2006-2015.

Contact specifically with powerlines accounted for 18 of the electrical-related fatalities in the most recent ten-year period, which contributed to 67% of utility-related equipment fatalities. The five-year rolling average rate for powerline electrocutions has decreased by 20% when comparing 2007-2011 and 2012-2016.

The number of overhead and underground powerline contacts have decreased by 40% since 2007. Overhead powerline contact remains the leading cause of utility-related electrical incidents, where a slight increase of all contact incidents was reported to ESA when compared to 2015. Most injuries as a result of powerline and utility-related equipment have also decreased over the past ten years. However, under-counting is especially prevalent with utility contact incidents, and this information should be interpreted with caution.

Section 3.1 provides a case study that is an example of the risk factors associated with overhead powerline contact among workers.

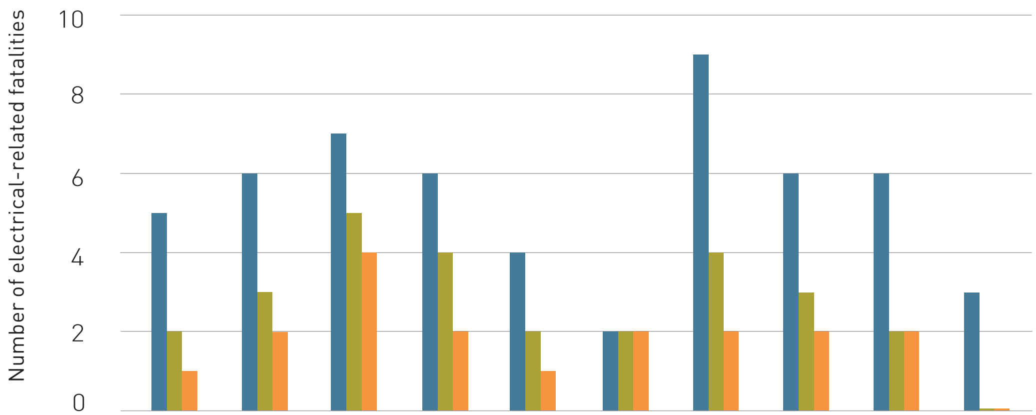
Statistics Directly Related to ESA's Harm Reduction Priorities – **POWERLINE CONTACT**

Five-year Rolling Average Comparison

The statistics below represent the number of worker and non-worker powerline-related contact incidents: data reported to ESA.

The powerline safety five-year rolling average has decreased by 18% between 2007-2011 and 2012-2016

1 NUMBER OF UTILITY-RELATED EQUIPMENT ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2007-2016



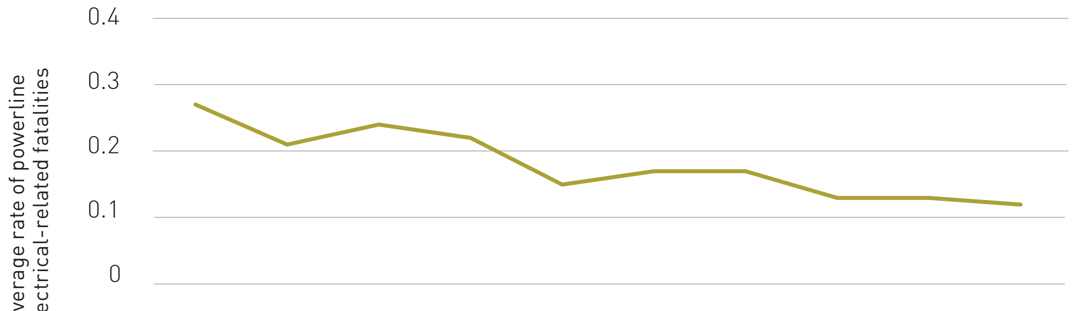
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Electrical-related fatalities	5	6	7	6	4	2	9	6	6	3
Utility equipment electrical fatalities	2	3	5	4	2	2	4	3	2	0
Powerline electrical-related fatalities	1	2	4	2	1	2	2	2	2	0

Source: ESA and Coroners' records.

Conclusion
The number of utility-related equipment fatalities has been decreasing since 2007; in 2016, there were no powerline fatalities reported.

3.0 Utility-Related Equipment

2 FIVE-YEAR ROLLING AVERAGE OF POWERLINE ELECTRICAL-RELATED FATALITIES IN ONTARIO, 2003-2016

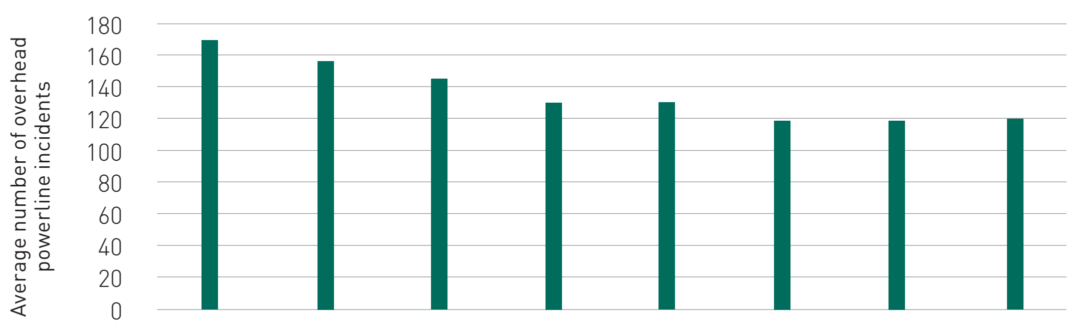


	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Rate	0.27	0.21	0.24	0.22	0.15	0.17	0.17	0.13	0.13	0.12

Source: ESA records.

Conclusion
The rate of powerline electrical-related fatalities has decreased by **20%** when comparing 2007-2011 and 2012-2016; the 2012-2016 rate has remained similar to the previous five-year period of 2011-2015.

3 FIVE-YEAR ROLLING AVERAGE NUMBER OF OVERHEAD POWERLINE INCIDENTS IN ONTARIO, 2005-2016

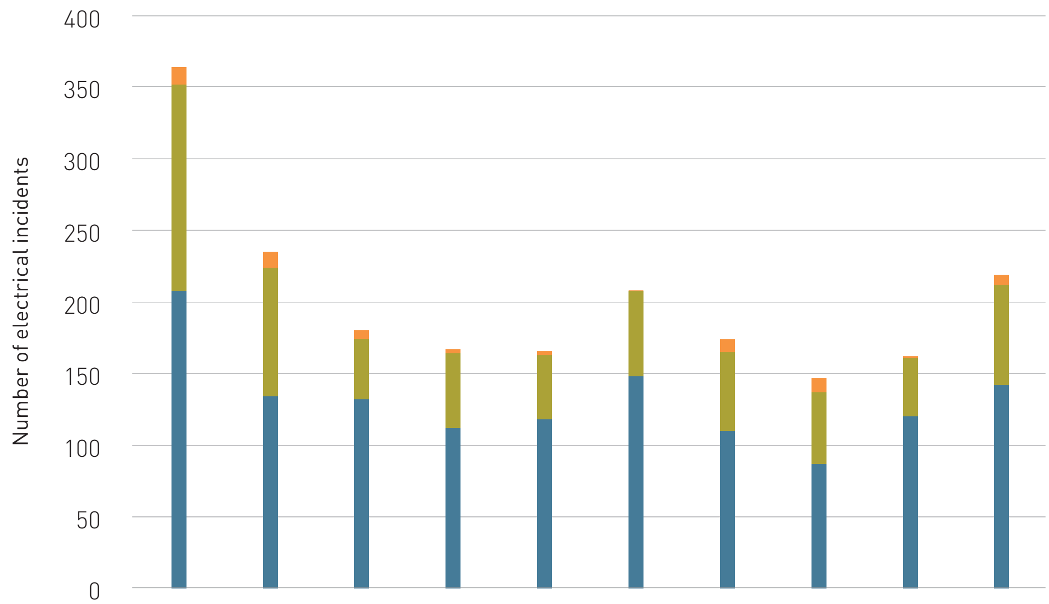


	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015	2012-2016
Number of overhead powerline incidents	169	156	145	130	130.2	118.6	118.4	119.6

Source: ESA records.

Conclusion
The five-year rolling average number of overhead powerline incidents has decreased by **18%** when comparing 2007-2011 and 2012-2016. The most recent five-year period of 2012-2016 shows a slight increase in overhead powerline contacts when compared to the previous time period of 2011-2015.

4 NUMBER OF UTILITY-RELATED ELECTRICAL INCIDENTS BY CONTACT TYPE IN ONTARIO, 2007-2016

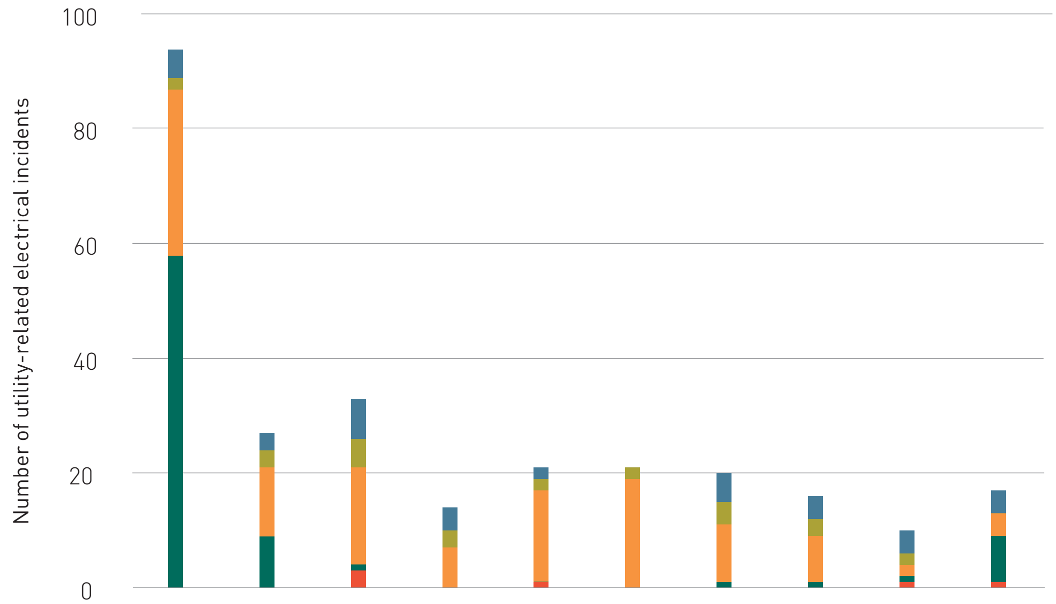


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vaults, substations & padmounts	12	11	6	3	3	0	9	10	1	7
Underground powerline contact	144	90	42	52	45	60	55	50	41	70
Overhead powerline contact	208	134	132	112	118	148	110	87	120	142

Source: ESA records.

Conclusion
Overhead powerline contact remains the leading cause in utility-related electrical incidents between 2007 and 2016; however, the total number of electrical incidents has decreased by **40%** when comparing 2007 and 2016. In 2016, the number of reported utility contact incidents by overhead, underground and vaults, substations and padmounts have increased when compared to the previous five years.

5 NUMBER OF UTILITY-RELATED ELECTRICAL INCIDENTS BY OUTCOME IN ONTARIO, 2007-2016



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Critical injury	5	3	7	4	2	0	5	4	4	4
Fatality	2	3	5	3	2	2	4	3	2	0
Non-critical injury	29	12	17	7	16	19	10	8	2	4
Property damage	58	9	1	0	0	0	1	1	1	8
Unknown	0	0	3	0	1	0	0	0	1	1

Source: Workplace Safety and Insurance Board.

Conclusion
The number of utility-related incidents that resulted in injury or property damage has decreased by **82%** since 2007. However, the number of critical injuries remains similar to what was reported in 2007.

3.1 Powerline Safety

The Incident

A grade blade operator was electrocuted when the dumptruck attached to his grader came into contact with an overhead powerline. Rather than remain in the grader, the operator stepped off the machine and received a shock from the difference in voltage between the energized equipment and grade, killing him instantly.

Incident Details

In a township of Ontario, a country road was recently paved, and the road shoulder required re-grading. In this area, overhead powerlines run perpendicular to the road at various sections, and signage "Caution – Overhead Wires" was placed to remind workers of the overhead hazard.

The grading operation consisted of a large dumptruck, a grader, and a grading blade attached to the two vehicles (Figure 1). The dumptruck would slowly rise, tilting the gravel and sand mixture onto a two-elevation trough as part of the grader. The trough would regulate the flow of the mix onto the road shoulder, and the angle would be controlled by the blade. The two vehicles, with the blade attachment, would move together as a unit at a walking pace (less than 5 km/h) to grade the shoulder.

The county had contracted an independent dumptruck driver and his vehicle for the job. The remaining crew of the grader driver and the grade blade operator were employees of the township.

On the day of the incident, work was started early in the morning and it was a clear day with high visibility; there were no visual obstructions to the overhead powerlines. As work progressed, the angle of the dumptruck box was raised gradually to unload the mixture into the grader hopper. Within 30-40 minutes of the start of the day, the box of the dumptruck was raised at a height that exceeded the clearance of the powerline (Figure 2). Unaware of the powerline, the box of the dumptruck contacted the powerline, thus energizing the dumptruck, the grader, and the grading blade. Realizing he had made contact with the powerline, the dumptruck driver stopped. The drivers of the dumptruck and the grader remained in their vehicles. However, the grade blade operator stepped off to the ground. The voltage difference between the grading device and the ground caused current to flow from the equipment through the victim's body and exiting his foot, resulting in electrocution.

3.1 Powerline Safety (continued)

Figure 1: Dumptruck and grader combination device working on the shoulder of the road.

Further investigation revealed the following:

1. *Job hazards need to be reviewed prior to starting work.* Posting "danger overhead" signs is insufficient to ensure workers' awareness of electrical hazards, and their safety.
2. *Danger cannot be easily detected even when environmental conditions seem favourable.* Vehicles moving slowly and high visibility to overhead powerlines do not exclude electrical hazards around powerlines.
3. *Education on the danger of powerlines, electrocution by step potential, and the safety procedure in the event of inadvertent contact with powerlines is essential to all workers.* In this incident, if the victim had stayed in his vehicle until the dumptruck was maneuvered away from the powerline, this incident would have been prevented.

Figure 2: The dumptruck box nearing overhead powerlines.

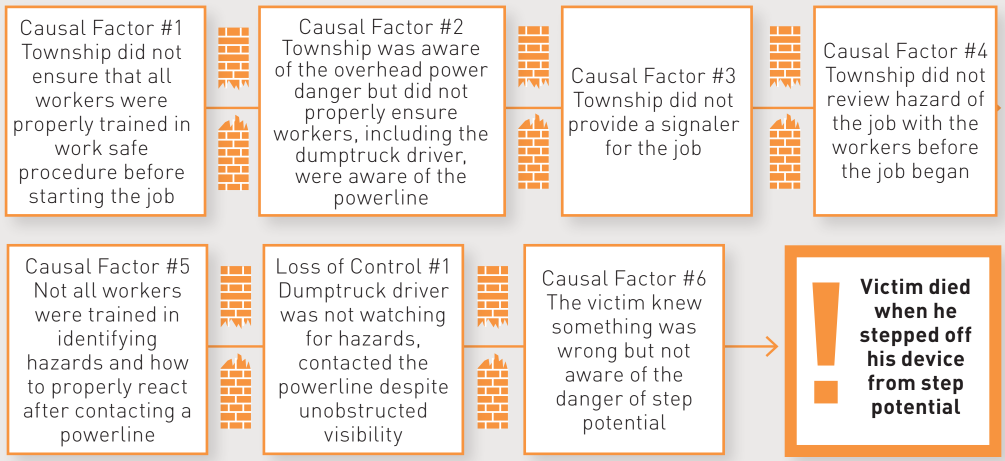
Touch and Step Potential

Injuries and fatalities from contacting powerlines arise from touch and step potentials created by these systems.

A touch potential (voltage) is created when an object touches an energized powerline. This object (e.g. boom of a truck) is now energized at the same voltage as the powerline. Anyone standing on the ground contacting the energized object is at risk of serious injury or electrocution. This creates a path from the energized object through the body and exiting the feet.

A step potential (voltage) is created when an energized object is dissipating voltage into the ground (e.g. a powerline touching the ground, or the boom of a crane touching a powerline and the voltage dissipating into the ground). As the voltage dissipates into the ground, this creates a risk of electrocution to the persons in the area, due to the differences in voltage levels between their feet.

3.1 Powerline Safety (continued)



4.0 Overview of Fires in Ontario

Fire remains a significant threat to life and property in urban and rural areas. In 2002 (the most recent national data in Canada) a total of 53,589 fires were reported in Canada. This number included 304 fire deaths, 2,547 fire injuries, and billions of dollars in property losses. Structural fires, especially residential fires, remain a critical concern. The high number of electrical incidents and the associated dollar loss, as well as the number of "deliberate" fires and their associated dollar loss, are the two other areas of major concern (Asgary et al., 2010).

Ontario reported 36,511 structural-loss fires (fires resulting in an injury, fatality or dollars lost) between 2011 and 2015. This number is a 2% decrease from 37,308 structural-loss fires between 2010 and 2014. Residential-loss fires account for 73% of structural loss fires from 2011 to 2015. Stove-top fires account for 8% of structural-loss fires and 11% of residential-loss fires. Since 2011, there has been a 5% decrease in total fires, a 4% decrease in structural-loss fires, and an <1% decrease in residential-loss fires.

For the period between 2011 and 2015, OFMEM identified the following as the most common ignition sources for structural-loss fires:

- Cooking (18%)
- Electrical distribution equipment - wiring (9%)
- Heating and cooling equipment (8%)
- Miscellaneous (includes fires – natural causes and chemical reactions)
- Cigarettes (7%)
- Appliances (5%)
- Other electrical, mechanical (4%)

When comparing 2006-2010 and 2011-2015, the average number of structure-loss fires per year by ignition source decreased 11% for cooking, 14% for electrical wiring, 19% for heating/cooling equipment, and 10% for appliances.

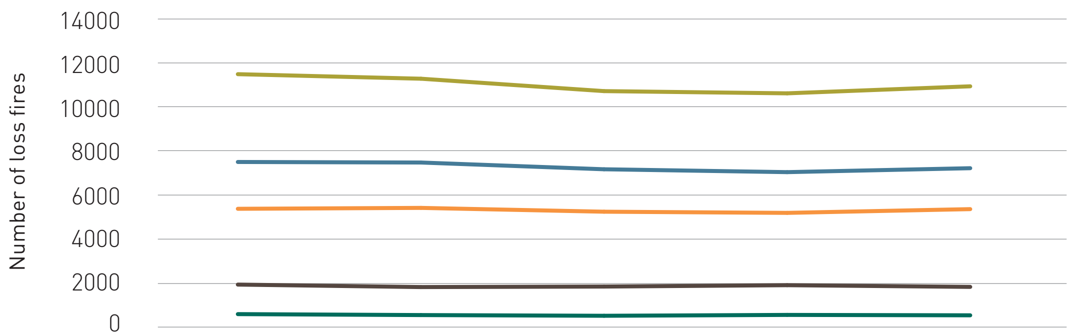
When structural-loss fires were limited to those where electricity was identified as the fuel source (but not necessarily the primary fuel energy source), the most common electrical-related products involved were:

- Cooking equipment (39%)
- Electrical distribution equipment (32%)
- Appliances (10%)

Electrical Products

ESA defines electrical products as appliances, cooking equipment, lighting equipment, other electrical and mechanical equipment and processing equipment. Data from OFMEM shows that the five-year average for electrical product fires (where electricity was identified as the fuel of the ignition source) between 2006-2010 and 2011-2015 has decreased by 34%.

1 NUMBER OF LOSS FIRES IN ONTARIO, 2011-2015

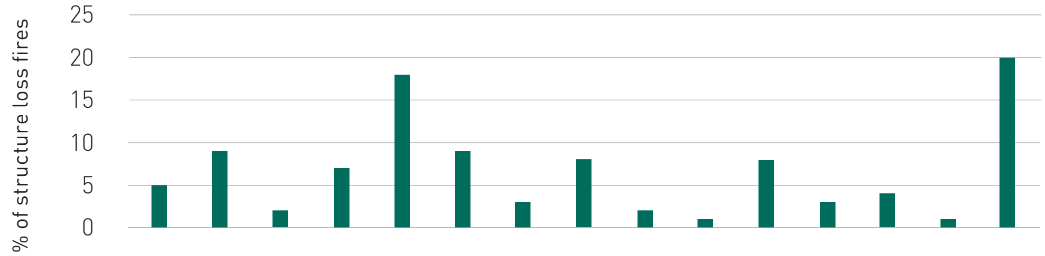


	2011	2012	2013	2014	2015
Total number of loss fires in Ontario	11501	11295	10733	10632	10951
Structure loss fires	7522	7497	7191	7061	7240
Residential loss fires	5400	5441	5268	5215	5385
Structure loss fires where electricity fueled the ignition source	1965	1853	1876	1938	1861
Structure loss stove-top fires	627	584	552	591	573

Source: OFMEM records.

Conclusion
The numbers of total fires, structure fires and residential fires have decreased between 2011 and 2015; however, the number of fires where the ignition sources were fuelled by electricity or from electrical distribution equipment has been more variable in the five-year period.

2 PERCENTAGE OF STRUCTURE LOSS FIRES BY IGNITION SOURCE IN ONTARIO, 2011-2015

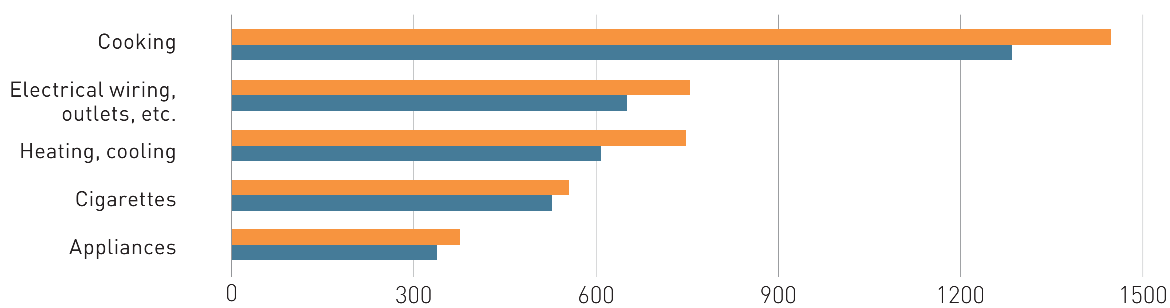


	Appliances	Arson	Candles	Cigarettes	Cooking	Electrical wiring	Exposure	Heating, cooling	Lighting	Matches, lighters	Miscellaneous	Other open flame tools	Other electrical, mechanical	Processing equipment	Undetermined
2011-2015	5%	9%	2%	7%	18%	9%	3%	8%	2%	1%	8%	3%	4%	1%	20%

Source: OFMEM records.

Conclusion
Aside from undetermined and miscellaneous sources, cooking and electrical wiring are the most common ignition sources for structure loss fires between 2011 and 2015.

3 FIVE-YEAR AVERAGE NUMBER OF STRUCTURE LOSS FIRES BY IGNITION SOURCE IN ONTARIO, 2006-2010 AND 2011-2015

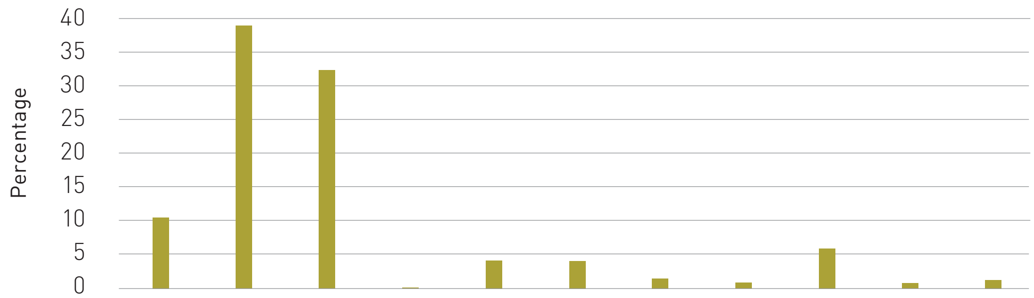


	Cooking	Electrical wiring, outlets, etc.	Heating, cooling	Cigarettes	Appliances
2006-2010	1447	755	747	555	376
2011-2015	1284	651	607	526	337

Source: OFMEM records.

Conclusion
Cooking equipment remains the most common ignition source in 2006-2010 and 2011-2015, although the average number of structure loss fires among cooking equipment, heating/cooling, electrical wiring, and appliances has decreased in the most recent time period.

4 PERCENTAGE OF STRUCTURAL LOSS FIRES FUELLED IN PART BY AN ELECTRICAL IGNITION SOURCE IN ONTARIO, 2011-2015

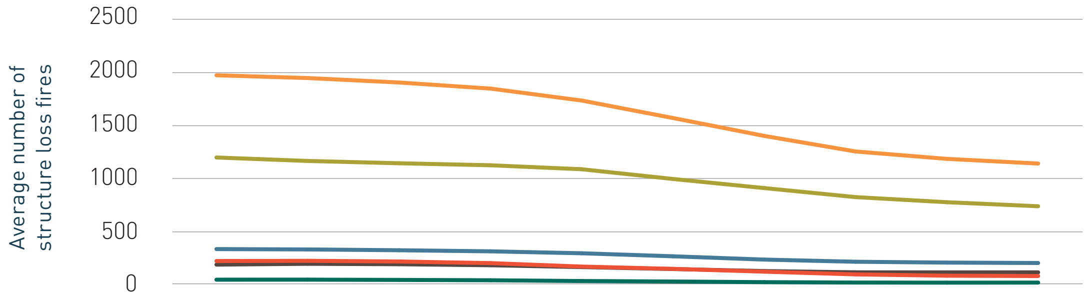


Appliances	Cooking	Electrical distribution equipment	Exposure	Heating, chimney	Lighting	Miscellaneous	Open flame	Other electrical, mechanical	Processing equipment	Undetermined
10.5%	38.9%	32.3%	0.1%	4.1%	4.1%	1.4%	0.8%	5.9%	0.8%	1.2%

Source: OFMEM records.

Conclusion
When the fire is from ignition sources that uses electricity, cooking equipment, electrical distribution equipment, and appliances were the most common ignition sources between 2011 and 2015.

5 FIVE-YEAR ROLLING AVERAGE NUMBER OF ELECTRICAL STRUCTURE LOSS FIRES BY PRODUCTS IN ONTARIO, 2002-2015



	2002-2006	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015
Appliances	332.2	328.8	321.2	311	292.6	264	232.8	212.2	204.4	200.4
Cooking equipment	1199.8	1167	1145.2	1126.2	1088.6	996.4	910.2	824.6	776.2	738
Lighting	219	221	214.8	199.4	166.6	145	118.4	92.6	80.2	77.2
Other electrical, mechanical	185.2	193	188.8	179.2	162	143.4	123.8	112	111.6	111.8
Processing equipment	42.4	42.6	40.2	36.8	29.6	25	19	15.4	14.4	15
Product safety overall	1978.6	1952.4	1910.2	1852.6	1739.4	1573.8	1404.2	1256.8	1186.8	1142.4

Source: OFMEM records.

Conclusion
Between 2006-2010 and 2011-2015, the five-year rolling average number of fires by total electrical products has decreased by **34%**.

Statistics Directly Related to ESA's Harm Reduction Priorities – PRODUCT SAFETY

Number of electrical product related fires: a product fire is defined as one involving appliances, cooking equipment, lighting equipment, other electrical, mechanical or processing equipment as classified by the Office of the Fire Marshal and Emergency Management data.

The product safety five-year rolling average has decreased by **34%** between 2006-2010 and 2011-2015

4.1 Fires Resulting in Fatalities

In 2007, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia and Northwest Territories reported 226 fire deaths (Wijayasinghe, 2011). In many of these incidents, many of them involved residential properties. The frequency of residential fires is concerning because they are the most common source of fire-related death (Miller, 2005). In 2002, 82% of the 304 fire deaths were residential fires (Council of Canadian Fire Marshals, 2002). Similarly in 2006, 80% of Americans who died in a fire died in a residence (Karter, 2007). In the early 1990s, residential fires caused deaths of between 4,000 and 5,000 Americans, and injured an additional 20,000 each year (Baker and Adams, 1993).

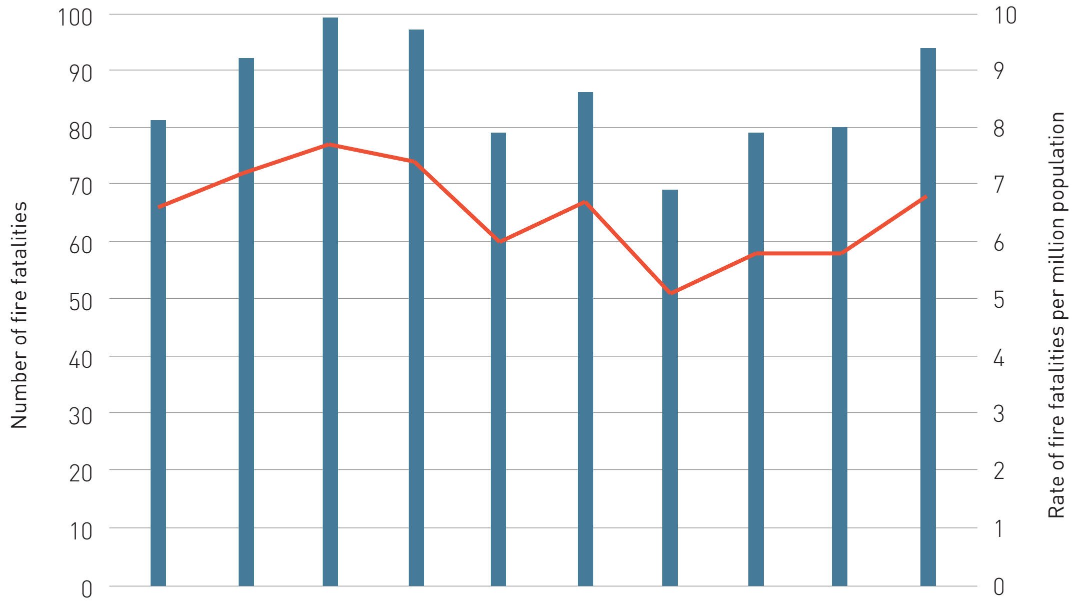
Ontario reported 856 deaths due to fires between 2006 and 2015. This number excludes fire deaths in vehicle collisions, fire fatalities among emergency response, or any fire deaths on federal or First Nations property. This number is more than what was reported between 2005 and 2014, where 845 deaths were reported. OFMEM reported that in 2015, the fire death rate was 6.8 deaths per million population, which is a 3% increase when compared to the fire death rate in 2006, which was 6.6 deaths per million population.

Structural-loss fires are fires that result in an injury, fatality and/or financial loss that occur in structures (as opposed to vehicles or the outdoors). In Ontario, there were 761 fire fatalities from structural-loss fires from 2006 to 2015. This is a slight increase when compared to the previous ten-year period of 760 fire fatalities from 2005 to 2014. OFMEM reported that in 2015, the structural-loss fire death rate was 6.2 per million population, which is a 2% increase when compared to the structural-loss fire death rate in 2006, which was 6.1 deaths per million population.

The OFMEM data identified 81 deaths in fires for which electricity was the fuel of ignition source or were from electrical distribution equipment between 2006 and 2015. Since 2006, the death rate from this type of fire has increased 23% from 0.47 deaths per million population to 0.58 deaths per million population.

In these types of fires in which the investigations were considered closed, 96% were considered accidental between 2006 and 2015. Stove or range-top burners accounted for 25% of fire fatalities fuelled at least by electricity.

1 NUMBER AND RATE OF ALL FIRE FATALITIES IN ONTARIO, 2006-2015



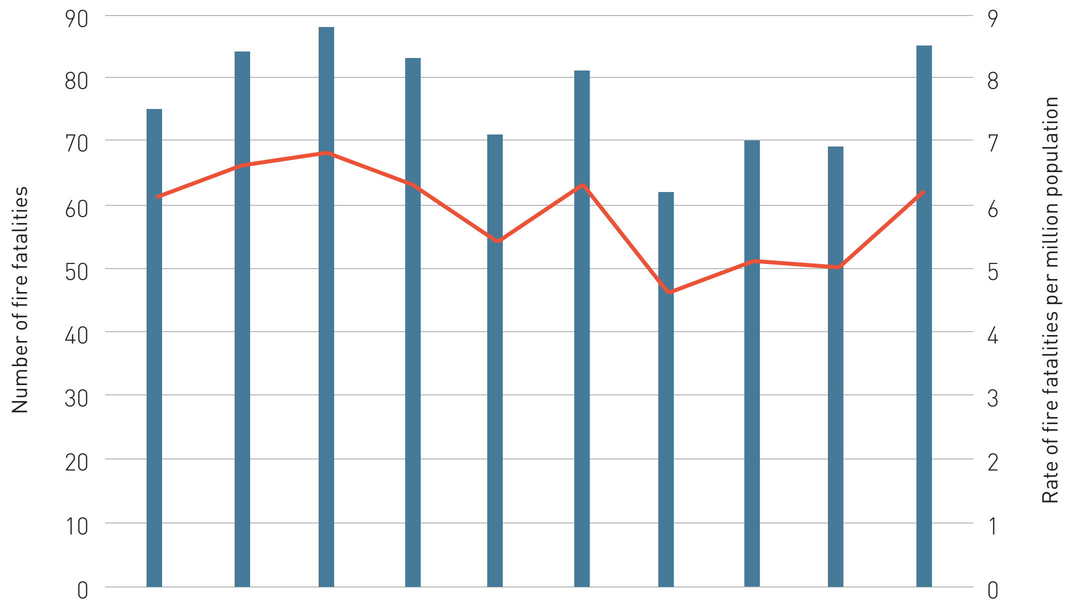
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
All fire fatalities in Ontario	81	92	99	97	79	86	69	79	80	94
Ontario population in millions	12.2	12.8	12.9	13.1	13.2	12.9	13.4	13.6	13.7	13.8
Fire death rate in Ontario	6.6	7.2	7.7	7.4	6.0	6.7	5.1	5.8	5.8	6.8

Source: OFMEM records.

Conclusion
The number and rate of fire fatalities have remained variable since 2006; however, the number and rate of fire fatalities have been slightly increasing since 2012.

4.1 Fires Resulting in Fatalities

2 NUMBER AND RATE OF FIRE FATALITIES IN STRUCTURE FIRES IN ONTARIO, 2006-2015

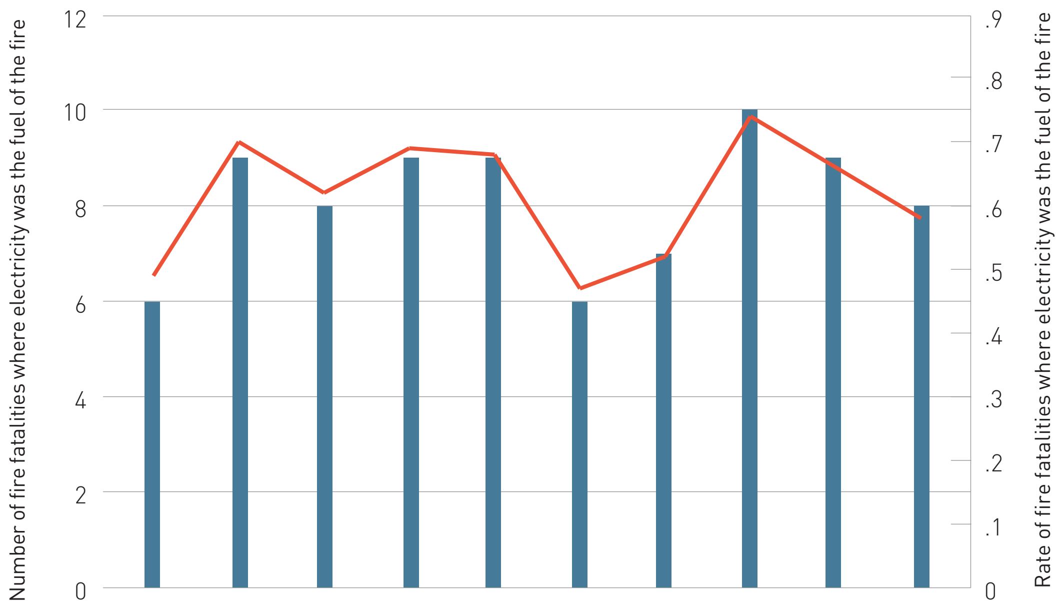


	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fire fatalities in structure fires	75	84	88	83	71	81	62	70	69	85
Ontario population in millions	12.2	12.8	12.9	13.1	13.2	12.9	13.4	13.6	13.7	13.8
Structure fire death rate in Ontario	6.1	6.6	6.8	6.3	5.4	6.3	4.6	5.1	5	6.2

Source: OFMEM records.

Conclusion
The number and rate of fire fatalities in structure fires have been showing a downward trend since 2006; however, the number and rate of fire fatalities have been variable in the last five years.

3 NUMBER AND RATE OF FIRE FATALITIES WHERE ELECTRICITY WAS THE FUEL OF THE FIRE IN ONTARIO, 2006-2015



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fatalities where electricity was ignition source	6	9	8	9	9	6	7	10	9	8
Ontario population in millions	12.2	12.8	12.9	13.1	13.2	12.9	13.4	13.6	13.7	13.8
Rate of fatalities where electricity was the ignition source	0.49	0.7	0.62	0.69	0.68	0.47	0.52	0.74	0.66	0.58

Source: OFMEM records.

Conclusion
The rate of fire fatalities where electricity fuelled the ignition source or were from electrical distribution equipment has been decreasing since 2013.

4.1 Fires Resulting in Fatalities

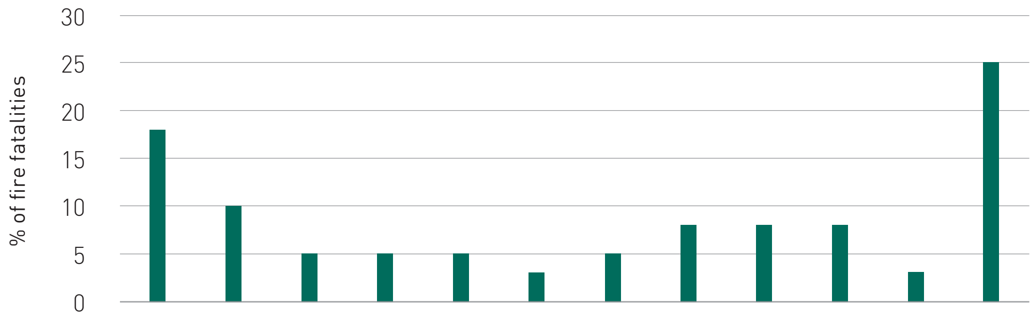
4 PERCENTAGE OF FIRE FATALITIES WHERE ELECTRICITY IS FUEL OF FIRE BY CAUSE CLASSIFICATION IN ONTARIO, 2011-2015 (CLOSED FIRE INVESTIGATIONS ONLY)

	Unintentional	Undetermined	Under investigation
Cause classification of fire fatalities	96%	2%	2%

Source: OFMEM records.

Conclusion
Almost all fire fatalities (**96%**) where electricity fuelled the ignition source or were from electrical distribution equipment are accidental.

5 PERCENTAGE OF FIRE FATALITIES WHERE ELECTRICITY IS FUEL OF FIRE BY IGNITION SOURCE IN ONTARIO, 2005-2014



	Circuit wiring – copper	Clothes dryer	Cord, cable for appliance, electrical articles	Electric blanket, heating pad	Extension cord, temporary wiring	Incandescent lamp	Other cooking items (e.g. toaster, kettle, electric frying pan)	Other electrical	Other electrical distribution items	Oven	Space heater – portable	Stove, range-top burners
Ignition source	18%	10%	5%	5%	5%	3%	5%	8%	8%	8%	3%	25%

Source: OFMEM records.

Conclusion

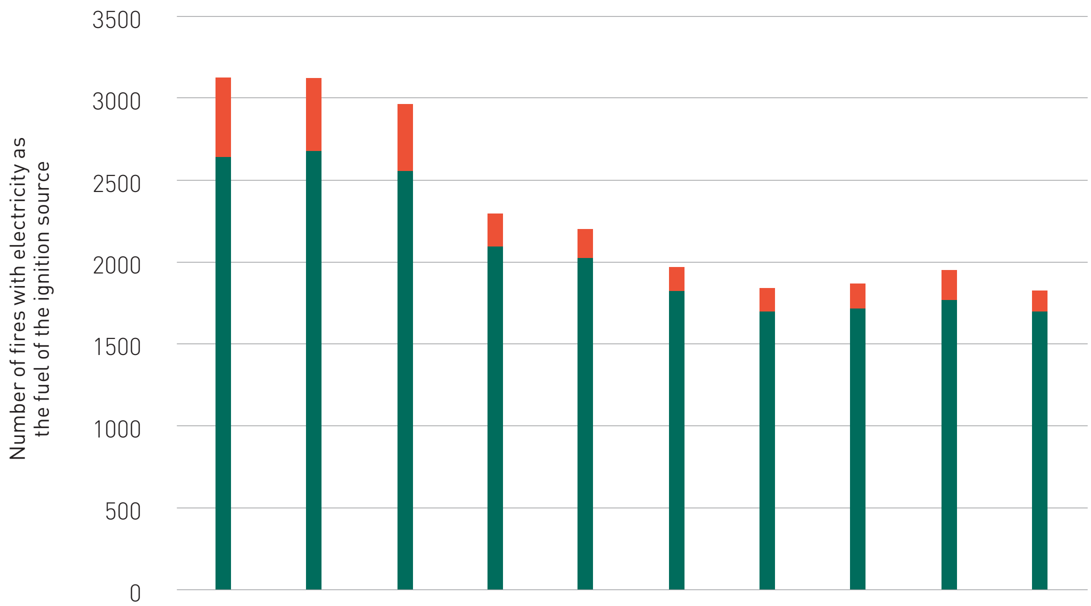
The stove remains the most common ignition source when examining fire fatalities where electricity fuelled the ignition source or from electrical distribution equipment in the most recent five-year period.

4.2 Fire Incidents with Electricity as the Fuel of the Ignition Source of the Fire

When electricity was the fuel of the ignition source of the fires, there were 20,698 loss fires and 2,464 no-loss fires for a total of 23,162 fires from 2006 to 2015. Over the same time period, there was a 36% decrease in loss fires and a 42% decrease in total fires.

Between 2011 and 2015, 81% of fires occurred in the residential setting. Cooking equipment (51%), electrical distribution equipment (22%), and appliances (11%) remained the most common ignition source in these fires.

1 NUMBER OF FIRES WITH ELECTRICITY AS THE FUEL OF THE IGNITION SOURCE IN ONTARIO, 2006-2015

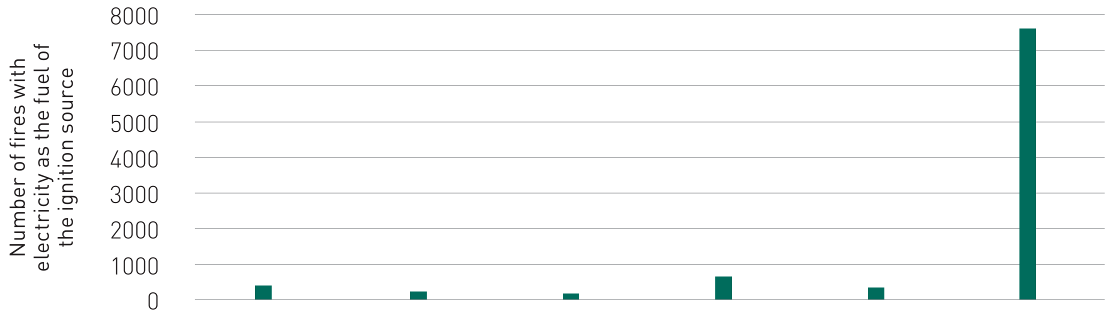


	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of fires with no loss	484	441	403	203	177	145	146	154	182	129
Number of fires with loss	2640	2681	2557	2094	2025	1823	1697	1716	1768	1697
Total fires with electricity as the fuel	3124	3122	2960	2297	2202	1968	1843	1870	1950	1826

Source: OFMEM records.

Conclusion
In 2015, the total number of fires where electricity was the fuel of the fire decreased slightly by **6%** when compared to 2014.

2 NUMBER OF FIRES WITH ELECTRICITY AS THE FUEL OF THE IGNITION SOURCE BY STRUCTURE CLASSIFICATION IN ONTARIO, 2011-2015



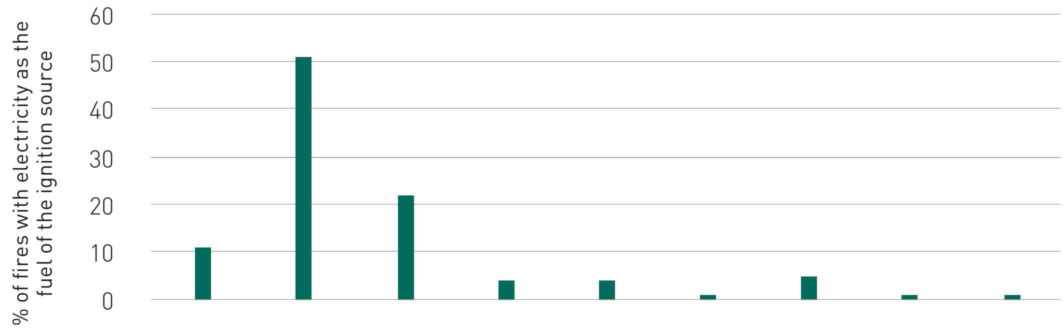
	Assembly	Business and personal services	Care and detention	Industrial	Mercantile	Residential
Structure classification	410	242	173	668	346	7618

Source: OFMEM records.

Conclusion
Residential structures were the most common structures (**81%**) in which fires where electricity was the fuel of the ignition source occurred between 2011 and 2015.

4.2 Fire Incidents with Electricity as the Fuel of the Ignition Source of the Fire

3 PERCENTAGE OF RESIDENTIAL FIRES WITH ELECTRICITY AS THE FUEL OF THE IGNITION SOURCE BY IGNITION SOURCE IN ONTARIO, 2010-2014



	Appliances	Cooking equipment	Electrical distribution equipment	Heating equipment, chimney, etc.	Lighting	Miscellani-ous	Other electrical, mechanical	Other electrical, mechanical	Undeter-mined
Ignition source	11%	51%	22%	4%	4%	1%	5%	1%	1%

Source: OFMEM records.

Conclusion
Cooking equipment and electrical distribution equipment are the leading sources in residential fires when electricity fuelled the ignition source.

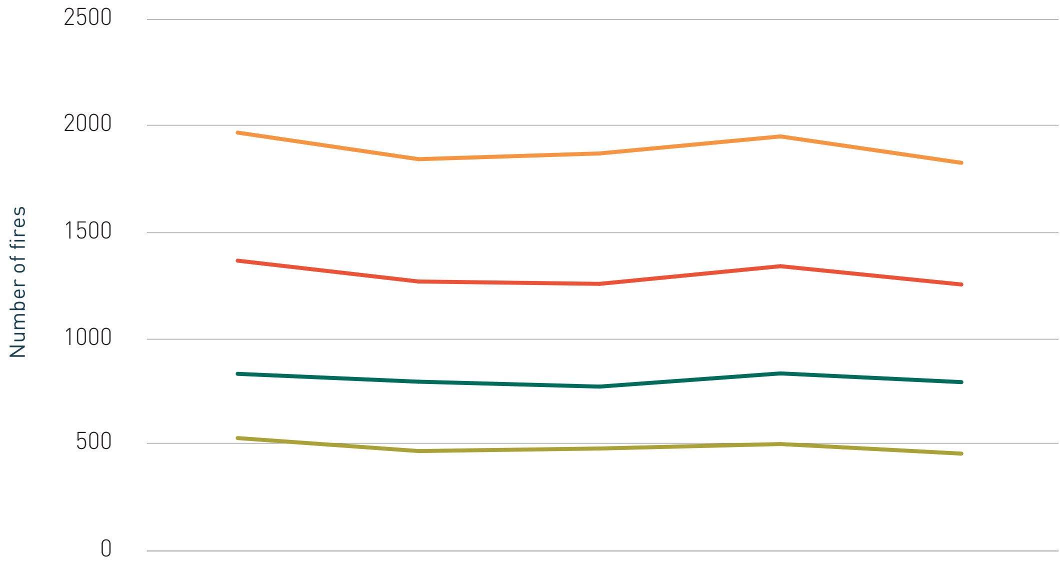
4.3 Cooking Fires with Electricity as the Fuel of the Ignition Source of the Fire

In 2007, the major cause of home fires in Canada from BC, AB, SK, MB, ON, NB, NS and NT were cooking fires (20%) (Wijayasinghe, 2011). In Ontario, from 2011 to 2015, there were 4,035 fires where the ignition source was cooking equipment fuelled by electricity. Since 2011, there has been a 5% decrease in this type of fire. Stove and range-top burners were the leading ignition source, followed by the oven and other cooking items. The overwhelmingly cited possible cause to these cooking fires was leaving the stove or range-top burner unattended.

The OFMEM fire-loss reporting system identified cooking equipment as one of the leading ignition sources associated with preventable home injuries. For residential fires that were ignited from cooking equipment that used electricity, it accounted for an annual average of 137 injuries among civilians and an average of three fatalities between 2011 and 2015. In this time period, cooking equipment is the leading ignition source in fires from electrical products or where electricity fuelled the ignition source. These fires resulted in an average loss of $18.3 million annually.

4.3 Cooking Fires with Electricity as the Fuel of the Ignition Source of the Fire

1 NUMBER OF COOKING EQUIPMENT AND ELECTRICAL DISTRIBUTION EQUIPMENT FIRES IN ONTARIO, 2011-2015

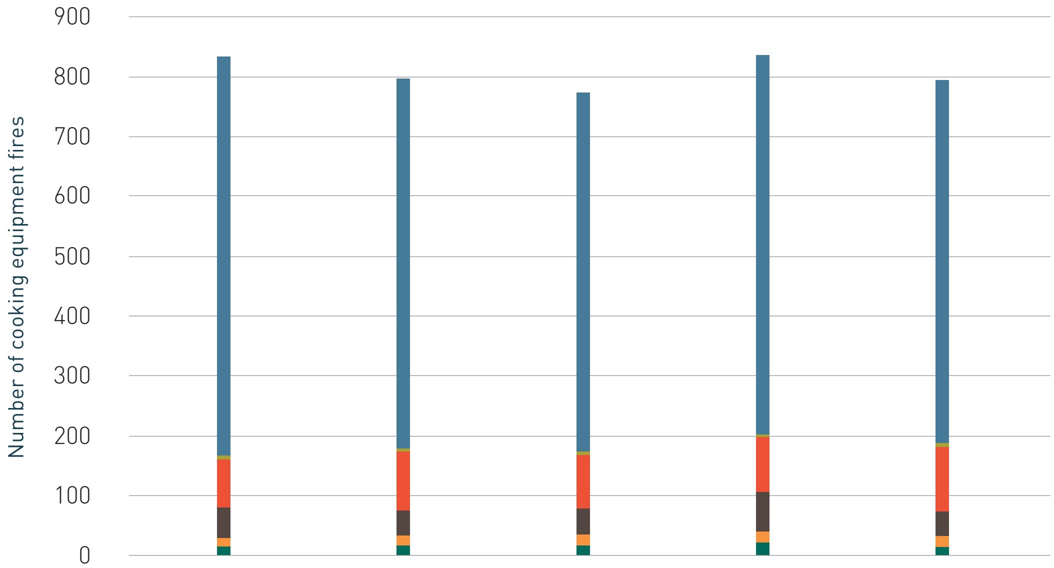


	2011	2012	2013	2014	2015
Cooking equipment	834	797	774	836	795
Electrical distribution equipment	532	471	483	504	459
Total cooking equipment and electrical distribution equipment fires	1366	1268	1257	1340	1254
Total fires with electricity as the fuel	1968	1843	1870	1950	1826

Source: OFMEM records.

Conclusion
The number of fires from cooking equipment (where electricity fuelled the ignition source) and electrical distribution equipment has decreased by **5%** when compared to 2011.

2 NUMBER OF COOKING EQUIPMENT FIRES WITH ELECTRICITY AS THE FUEL OF THE IGNITION SOURCE BY SOURCE IN ONTARIO, 2011-2015



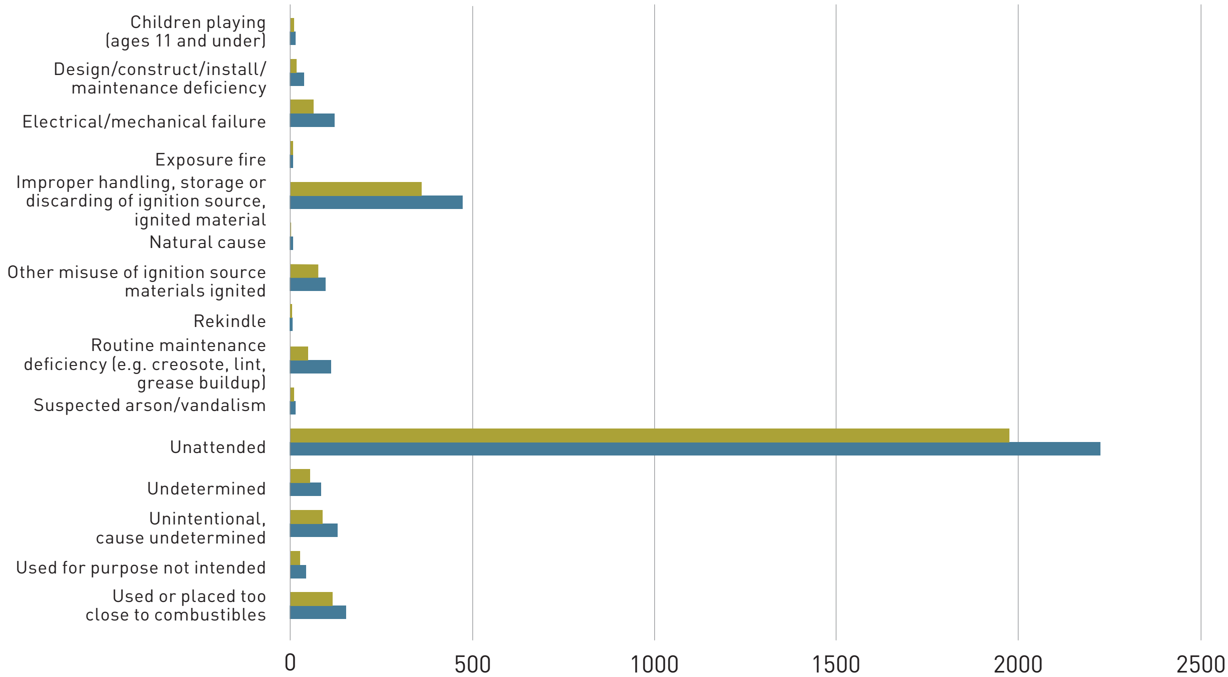
	2011	2012	2013	2014	2015
Stove, range-top burner	667	618	600	634	607
Range hood	7	5	6	4	7
Oven	80	99	90	92	108
Other cooking items	51	42	43	66	40
Microwave	14	16	19	18	19
Deep fat fryer	15	17	16	22	14

Source: OFMEM records.

Conclusion
Stoves/range-top burners are the leading sources (**77%**) of cooking equipment fires between 2011 and 2015.

4.3 Cooking Fires with Electricity as the Fuel of the Ignition Source of the Fire

3 NUMBER OF STOVE-TOP FIRES VS. COOKING EQUIPMENT FIRES BY POSSIBLE CAUSE IN ONTARIO, 2011-2015



	Children playing (ages 11 and under)	Design/construction/installation/ maintenance deficiency	Electrical failure/ mechanical failure	Exposure fire	Improper handling, storage or discarding of ignition source or ignited material	Natural cause	Other misuse of ignition source/ materials ignited	Rekindle	Routine maintenance deficiency (e.g. creosote, lint, grease buildup)	Suspected arson/vandalism	Unattended	Undetermined	Unintentional, cause undetermined	Used for purpose not intended	Used or placed too close to combustibles
Stove-top fires	5	13	60	3	356	0	72	1	45	6	1973	50	84	22	113
Cooking equipment fires	10	33	118	3	470	3	93	2	108	10	2224	81	126	39	149

Source: OFMEM records.

Conclusion
Leaving fires unattended is the most common cause of stove top and cooking equipment fires between 2011 and 2015.

4.4 Electrical Distribution Equipment with Electricity as the Fuel of the Ignition Source of the Fire

OFMEM defines distribution equipment as electrical wiring, devices or equipment where the primary function is to carry current from one location to another. Thus wiring, extension cords, termination, electrical panels, cords on appliances, etc. are considered distribution equipment. This is not to be confused with utility equipment from Local Distribution Companies.

In the five-year period between 2011 and 2015, the OFMEM identified 2,449 fires as electrical distribution equipment fires with electricity as the fuel of the ignition source. The five-year rolling average of electrical distribution equipment loss fires have decreased by 38% between 2006-2010 and 2011-2015.

The most common ignition source of electrical distribution equipment fires was circuit wiring-aluminum and copper, and the number of fires from this source has decreased by 23% when comparing 2007-2011 and 2011-2015. Electrical failure is the most common possible cause in these types of fires.

In 2007, an estimated 25,200 reported non-confined home structure fires in the United States involved electrical distribution or lighting equipment that resulted in 270 deaths, 1,050 injuries, and $663 million in direct property damage. Electrical distribution or lighting equipment accounted for 6% of home structure fires between 2003 and 2007, ranking fourth among major causes behind cooking equipment, heating equipment and intentional homes. Electrical distribution or lighting equipment also accounted for 12% of associated deaths (ranking behind smoking materials, heating equipment and cooking equipment). (Hall, 2008).

Section 4.5 provides a case study that is representative of the risk factors associated with electrical distribution equipment fires.

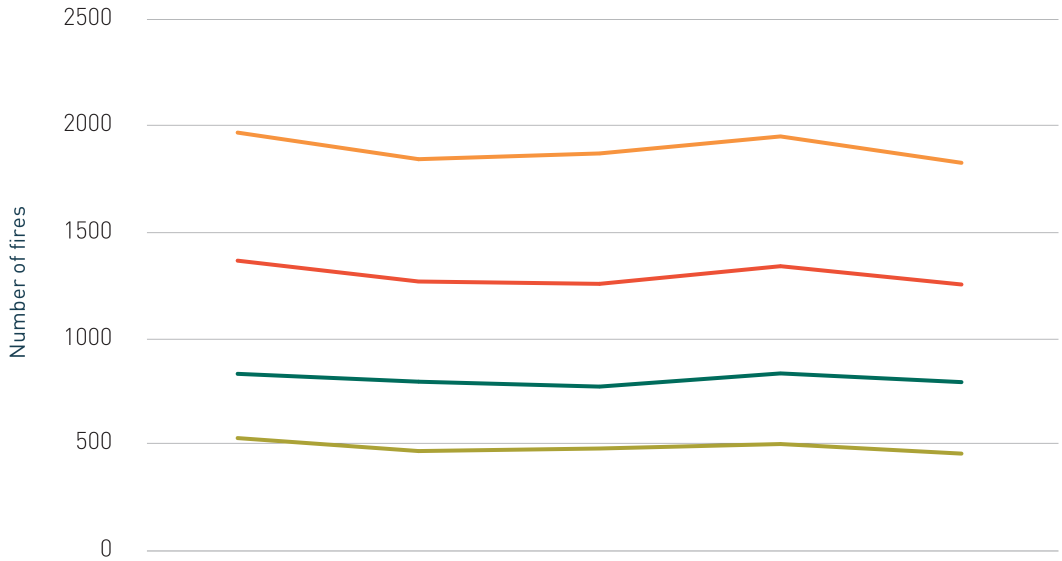
Statistics Directly Related to ESA's Harm Reduction Priorities – AGING INFRASTRUCTURE AND DISTRIBUTION EQUIPMENT FIRES

Number of electrical wiring-related fires: this includes fires from copper and aluminum wiring, extension cord, appliance cord, termination and electrical panel – electrical devices categorized by OFMEM as Distribution Equipment data.

The distribution fires related to aging infrastructure's five-year rolling average has decreased by **38%** between 2006-2010 and 2011-2015

4.4 Electrical Distribution Equipment with Electricity as the Fuel of the Ignition Source of the Fire

1 NUMBER OF COOKING EQUIPMENT AND ELECTRICAL DISTRIBUTION EQUIPMENT FIRES IN ONTARIO, 2011-2015



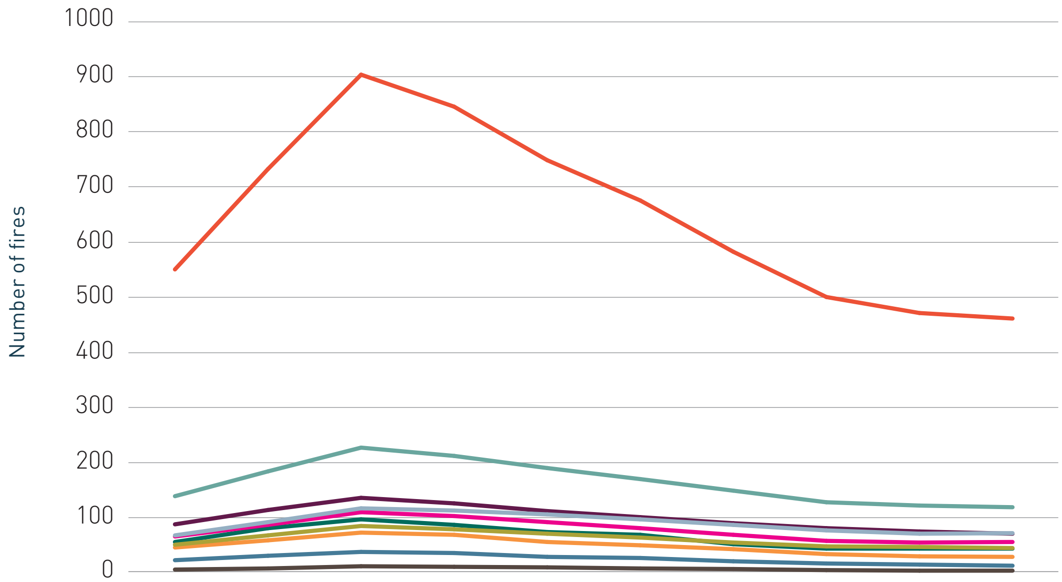
	2011	2012	2013	2014	2015
Cooking equipment	834	797	774	836	795
Electrical distribution equipment	532	471	483	504	459
Total cooking equipment and electrical distribution equipment fires	1366	1268	1257	1340	1254
Total fires with electricity as the fuel	1968	1843	1870	1950	1826

Source: OFMEM records.

Conclusion
The total number of electrical distribution equipment fires has decreased **14%** since 2011.

4.4 Electrical Distribution Equipment with Electricity as the Fuel of the Ignition Source of the Fire

2 FIVE-YEAR AVERAGE NUMBER OF ELECTRICAL DISTRIBUTION EQUIPMENT STRUCTURAL LOSS FIRES BY IGNITION SOURCE IN ONTARIO, 2002-2015



	2002-2006	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012	2009-2013	2010-2014	2011-2015
Circuit wiring - Al, Cu (includes conductors)	140	185	228	213	191	171	150	129	123	120
Cord, cable for appliance, electrical articles	69	93	118	114	107	98	88	78	72	73
Distribution equipment (includes panel boards, fuses, circuits)	89	115	137	127	113	102	91	82	76	72
Extension cord, temporary wiring	52	69	86	80	72	65	56	49	48	46
Meter	7	9	13	12	11	9	8	6	5	5
Other electrical distribution item	67	88	111	104	93	82	70	59	56	57
Service/utility lines (includes power/hydro transmission lines)	47	60	74	70	57	51	44	35	31	30
Terminations - Al, Cu (includes receptacles, switches, lights)	57	82	98	88	75	70	53	45	45	45
Transformer	24	32	39	37	30	28	22	18	16	14
Total	551	733	904	846	749	676	583	501	472	462

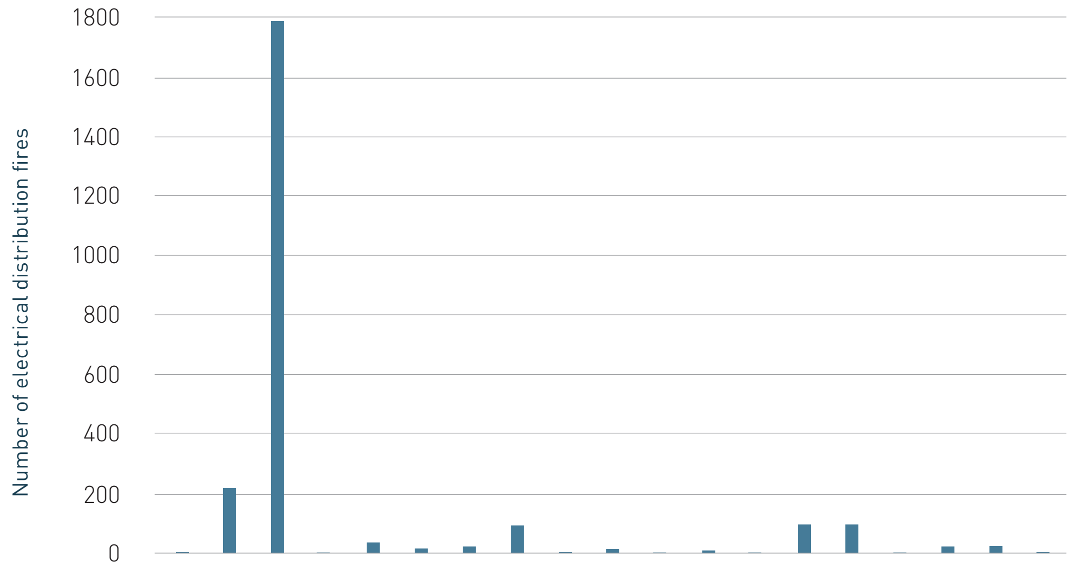
Source: OFMEM records.

Conclusion

Circuit wiring – aluminum and copper, remains the leading ignition source in electrical distribution equipment between 2002 and 2015. The five-year rolling average show a **38%** decrease between 2006-2010 and 2011-2015.

4.4 Electrical Distribution Equipment with Electricity as the Fuel of the Ignition Source of the Fire

3 NUMBER OF ELECTRICAL DISTRIBUTION EQUIPMENT FIRES BY POSSIBLE CAUSE IN ONTARIO, 2011-2015



Possible cause	Number of electrical distribution fires
Children playing (ages 11 and under)	1
Design/Construction/installation/ Maintenance Deficiency	220
Electrical / mechanical failure	1788
Exposure fire	2
Improper handling/storage/discard of ignition source or ignited material	36
Natural cause	17
Other misuse of ignition source/ material ignited	23
Other unintentional cause, not classified	93
Rekindle	1
Routine maintenance deficiency, e.g. creosote, lint, grease buildup)	13
Suspected vandalism	2
Unattended	8
Under investigation	1
Undetermined	97
Unintentional, cause undetermined	96
Unknown, not reported	1
Used for purpose not intended	24
Used or placed too close to combustibles	24
Vehicle collision	2

Source: OFMEM records.

Conclusion

Electrical/mechanical failure is the leading cause of electrical distribution fires between 2011 and 2015.

4.5 An Electrical Panel Fire

A fire began in an electrical panel located near the stairway of a two-storey mixed business/residential building that resulted in $250,000 damage. The fire was investigated by the local fire department, police, the Office of the Fire Marshal and Emergency Management (OFMEM), and ESA. The only viable ignition source was electrical; the neutral bus bar in the electrical panel.

The building was estimated to be between 50-100 years old by the OFMEM. It comprised of a three bedroom apartment on the upper level and a mini-mart on the main level.

Some of the resulting damages in the building include:

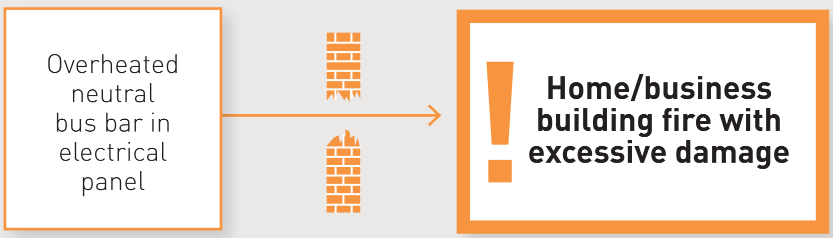
- Exterior fire patterns were limited to two second-floor windows and the rear door at the back of the building. Smoke and soot deposits were found directly above the upper edge of the windows and the door. An outdoor metal staircase provided exit from this doorway to ground level.
- The main floor ceiling collapsed onto the floor of the retail space. The collapse was due to fire travel inside the ceiling cavity and fire suppression.
- At the rear area of the retail space, the office and storage area sustained light smoke damage and water damage.
- The staircase to the upper floor showed soot deposits which were significantly heavier at the top of the staircase than at the bottom.
- The walls in the upper region of the staircase were blistered and showed fragmentation and consumption of the gypsum boards at the top.
- The electrical subpanel, which was located at the top of the staircase and fastened to a wooden plywood sheet showed fire patterns at the rear of the panel.
- Plywood was consumed top down from the area of the neutral bus bar inside the panel in an upside down 'V'-pattern.
- Fire damage was observed in wooden components around the electrical panel, which became progressively less as one moved away from the area.

Investigation findings:

- The fire travelled from the electrical panel to the stairs, through the cavity between the ceiling of the first floor and the floor of the second level.
- The tenant of the apartment on the second floor was out at the time of the fire.
- The call to 911 was made four hours after the mini-mart closed.
- The point of origin of the fire was determined to be in the electrical subpanel at the top of the stairs.

4.5. An Electrical Panel Fire (continued)

- No other viable or credible ignition sources were found.
- Fire breached the walls in the upper portion of the staircase exposing wooden studs and consuming some of the wooden structure.
- Fire spread into the hallway and the kitchen of the second floor. When the fire breached the walls behind the kitchen cabinets, it added to the fuel.
- The cause was determined to be a failure in the neutral bus bar within the panel, causing overheating of the bus bar and heating the panel surface. The excessively hot surface of the panel resulted in the primary ignition sequence of the wooden sheet of plywood followed by the surrounding wooden structure.



Due to the severity of damage, it could not be determined whether the panel was wired properly. However, a typical cause of overheating of the neutral bus bar is loose terminations. Regular maintenance of the electrical panel by an electrical contractor, especially in older infrastructures, can prevent this incident. A licensed electrical contractor would also ensure all terminations are torqued properly.

5.0 Product Safety

On August 1, 2007, the Ministry of Government and Consumer Services (MGCS) filed Ontario Regulation 438/07 *Product Safety,* enabling the ESA to address the safety of electrical products and equipment offered for sale, sold and used in Ontario. Requirements outlined under O. Reg 438/07 as of July 1, 2008 specify that manufacturers, importers, distributors, wholesalers, retailers, certification bodies and field evaluation agencies are required to report serious electrical incidents and defects to ESA.

O. Reg 438/07 authorizes the ESA to protect the public against potentially unsafe electrical products in the marketplace through:

1. Responding to product safety reports;
2. Removing potentially unsafe electrical products, counterfeit and unapproved products from the marketplace;
3. Requiring manufacturers to notify the public of potentially unsafe products; and
4. Implementing prevention-based and proactive detect activities.

ESA has developed target response strategies for various potentially unsafe products.

The *Canada Consumer Product Act* in 2011 created concurrent product safety systems from consumer electrical products in Ontario, including mandatory reporting obligations to ESA and Health Canada. On June 26, 2013, the MGCS amended the O. Reg 438/07 *Product Safety* to revoke the mandatory reporting requirements. As a result, manufacturers, importers, distributors, wholesalers, retailers, certification bodies and field evaluation agencies are no longer required to report serious electrical incidents and defects with consumer electrical products to ESA. All incidents involving consumer electrical products are now handled by Health Canada.

Since 2007, there has been a 158% increase to the number of product incidents reported to the ESA. During this ten-year period, 2011 reported the highest number of incident reports (1,601 reports). In 2016, there were 432 reports, a notable decrease when compared to the number of incidents reported in 2011 mainly due to the decrease in reports of incidents and defects with consumer electrical products to ESA.

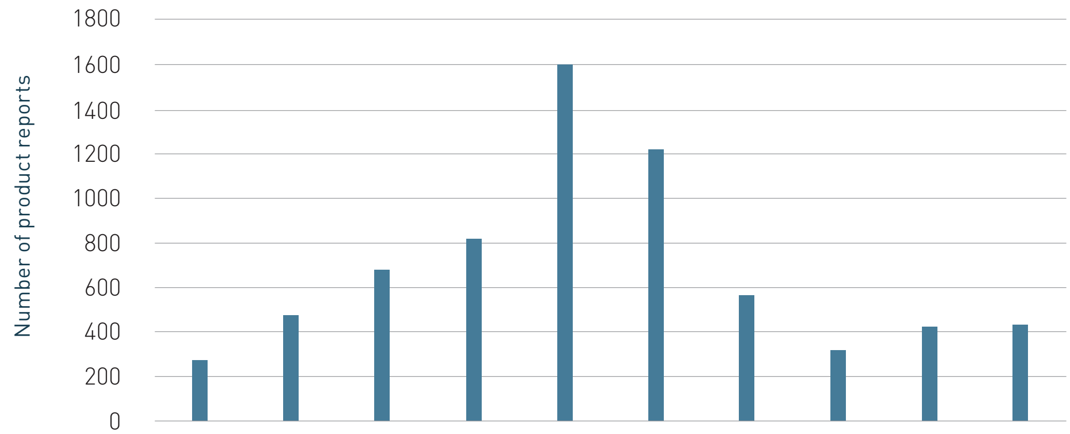
In the most recent fiscal year (2016-2017), Health Canada reported a 23% increase of reports received on consumer electrical and electronic products when compared to the previous year (2015-2016). Kitchen appliances continued to be the most commonly reported product group to Health Canada, followed by telephone and accessories, and lighting goods. A large increase in the number of incidents involving products with lithium ion batteries have been reported this year (LaRiccia, 2017).

In 2016, all product safety investigations initiated by the ESA were a result of the voluntary reporting. Eighty-one percent of reports were identified to be Priority 2 (no reports were classified as Priority 1), which meant that the ESA could direct a range of corrective action plans to assure that no further serious incidents or accidents could occur.

Product safety investigations are classified as Unapproved (a product that has not been tested and evaluated to the applicable Canadian Safety Standards and may not be safe to use), Certified (a product that was properly certified but reported to have a safety problem, or perceived safety problem), and With Suspected Counterfeit Label. In 2016, 78% of safety reports were classified as Unapproved products.

5.0 Product Safety

1 NUMBER OF PRODUCT INCIDENT REPORTS SUBMITTED TO ESA ONTARIO, 2007-2016

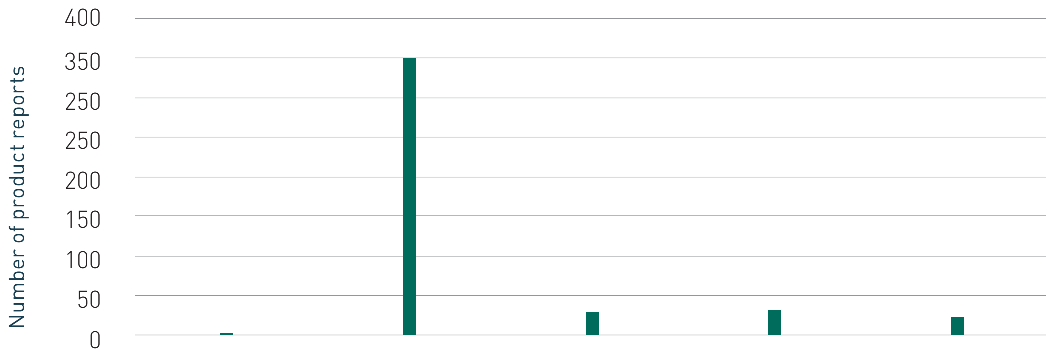


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number of reports submitted	274	475	679	817	1601	1220	564	316	423	432

Source: ESA records.

Conclusion
Since 2007, the number of product incident reports has increased by **158%**. Compared to the previous year of 2015, the number of reports for 2016 has increased by **102%**.

2 NUMBER OF PRODUCT INCIDENT REPORTS BY PRIORITY LEVEL IN ONTARIO, 2016

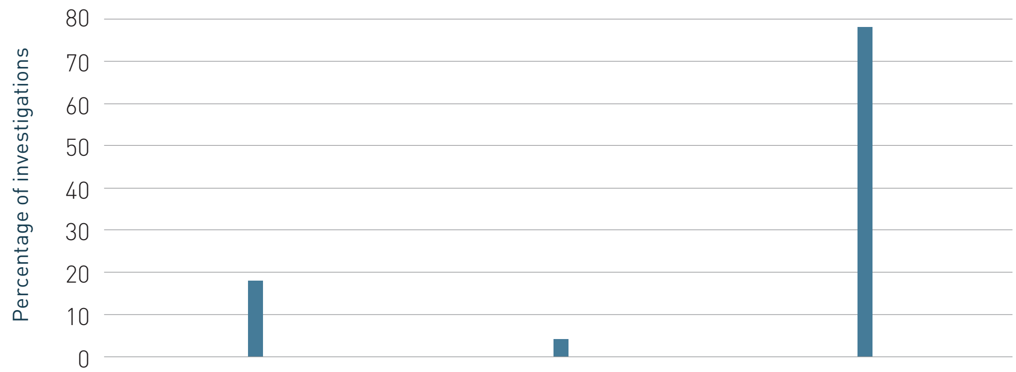


	Priority 1 (most important)	Priority 2	Priority 3	Priority 4 (least important)	Triaged By Health Canada
Priority level	0	350	28	32	22

Source: ESA records.

Conclusion
In 2016, **81%** of electrical incident reports to the ESA were classified as priority level 1 or level 2.

3 PERCENTAGE OF PRODUCT INCIDENT REPORTS BY TYPE IN ONTARIO, 2016



	Certified	With suspected counterfeit label	Unapproved
Investigation type	18%	4%	78%

Source: ESA records.

Conclusion

In 2016, **78%** of electrical incident reports were from unapproved electrical products.

Acknowledgements

ESA acknowledges and thanks the **Ontario Ministry of Labour** (MOL) for providing information, notifying ESA of occupational electrical injuries, and co-operating with ESA in the investigation of these incidents.

ESA thanks the **Office of the Fire Marshal and Emergency Management** (OFMEM) for its continuing support in providing information on fire-related electrical incidents, partnering with ESA on stove-top fire initiatives, and notifying ESA of electrical fire incidents.

ESA also thanks the following organizations for their support:

- The Office of the Chief Coroner for Ontario for sharing coroners' information on electrical-related fatalities and other deaths in Ontario;
- The Workplace Safety and Insurance Board of Ontario (WSIB) for providing occupational injury information; and
- The Canadian Institute of Health Information (CIHI) for providing information on emergency department visits for electrical injury.

Development of this report was led by a team from the ESA including Freda Lam, Said Ismail, Francis Hardy, Mark Chmielewski and Joel Moody, with assistance from staff of ESA's Utility Regulations, Product Safety and Communications departments.

Methodology

ESA receives data from various resources to compile this report. These include the Office of the Chief Coroner, MOL, AWCBC, OFMEM and WSIB. ESA then cross-references these data with the Coroners' reports, OFMEM's reports, and ESA's root-cause investigation data to ensure accuracy and understanding of the incidents. Data on non-serious incidents are taken as provided.

Electrical Safety Authority's Data

ESA uses Ontario population estimates from Ontario Ministry of Finance (Historical and projected population for Ontario under three scenarios, 2006-2041, Part A: Estimates) to determine electrocution and death by fire as rate per population, and Statistics Canada labour force population estimates (CANSIM, table 282-0002) to determine occupational injury rates.

The 2007 to 2016 electrocution statistics are based on Ontario Coroners' reports, ESA records and MOL reports. At time of writing, OFMEM fire fatality information is only partially completed due to pending investigations and confirmations.

Data provided by the Office of the Chief Coroner takes precedence over other data in the event of discrepancies.

The electrocution and electrical burn fatality cases in the report are unintentional in nature. Suicide and deliberate attempts to injure are excluded, as well as deaths by lightning strikes. Electrocution from criminal activities such as theft of power, vandalism, pranks or vehicles hitting a utility pole are counted as part of the statistics but are not included as part of preventable deaths. Death resulting from a fall but initiated by an electrical contact to a worker would not be recorded as an electrical-related fatality and therefore would not be accounted for in electrical injury data.

This report separates occupational and non-occupational (the general public) incidents for reason of stakeholder interest and to aid in identifying strategies to reduce the harm.

Workplace Safety and Insurance Board Data

The WSIB defines lost time injuries (LTIs) as all allowed claims by workers who have lost wages as a result of a temporary or permanent impairment. LTIs counts include fatalities. This data is provided by WSIB Enterprise Information Warehouse, data as of March 31, 2017 for all injury years.

Allowed lost time injuries for electrical burns and electrical-related fatalities are based on the following CSA Z795-96 Nature of Injury Codes:

- 05200 Electrical burns
- 05201 First-degree electrical burns
- 05202 Second-degree electrical burns
- 05203 Third-degree electrical burns
- 05290 Electrical burns, N.E.C.
- 09300 Electrocutions, electric shocks

Emergency Department Visits

Separations data from the National Ambulatory Care Reporting System were provided by the Canadian Institute for Health Information (CIHI). Emergency Department separation data used in this report are classified according to the Canadian Modification of the 10th revision of the *International Classification of Diseases* (ICD-10-CA).The inclusion criterion for the report was the presence of T75.4, T75.0, W85, W86, W87, or X33 codes indicating an electrical injury including being a victim of lightning, among any of the diagnosis or external cause codes assigned to a record.

Reliability of Data

The numbers and figures in this report are based on current information provided to ESA as of July 31, 2016. Parts of this material are based on data and information provided by the Canadian Institute for Health Information. However, the analyses, conclusions, opinions and statements expressed herein are those of the author, and not necessarily those of the Canadian Institute for Health Information. These numbers may change in subsequent reports due to additional information received after the publication of the report. These changes and explanations will be noted in future reports.

Fire Source Data

The OFMEM reports its data by calendar year. Data collection and verification for the year has a one-year lag in reporting in the OESR. The OFMEM does not publish Ontario statistics until all fire departments have reported. The larger departments – Toronto and Hamilton generally do not finish their filing until September of the following year. At the time of writing, some OFMEM data for 2016 is unavailable and data for 2015 is presented instead. The number of fire incidents and fire fatalities are current as of July 18, 2017, and are considered to be the most accurate at this point in time.

The OFMEM provides information on all fire incidents except for those on Federal or First Nations properties. Likewise, information on fire fatalities do not include those on Federal or First Nations properties, nor fire deaths in vehicle accidents.

ESA reports fire incidents based on data provided by the OFMEM to ESA on:

- All fires where the ignition source was reported as "electrical distribution equipment" or the fuel of the ignition source was reported as "electricity."
- Fire incidents and fire fatalities investigated by OFMEM where the ignition source was reported as "electrical distribution equipment" or the fuel of the ignition source was reported as "electricity."

In addition, ESA conducts its own investigation of fires when called by the local fire department to assist or when jointly investigating fire incidents with the OFMEM. ESA presents data that are consistent with the reporting convention of the OFMEM. Fires are reported by ignition source where the fuel of the ignition source was reported as electricity. It is worth noting that with the exception of fires with distribution equipment and fires identified as electricity as the ignition source by the fire departments or OFMEM, electricity was not the primary fuel associated with the fire. These situations are illustrated below.

In the OESR, these fires will be categorized into two types of fires. These are:

1. Fires caused by the ignition of combustibles (liquid and solids) around an electrical device, equipment, appliance or installation, but were not the direct result of a failure of electrical equipment or devices or electrical current or arc flash coming into contact with the object. When the primary fuel associated with the fire is not electricity (such as leaving a stove unattended with the oil catching fire), the OFMEM label these fires as cooking fires rather than electrical fires. In addition, the OFMEM does not recommend using numbers of fire deaths to identify trend and key issues.

   Typically, these types of fire were the direct result of misuse of the equipment, device or appliance. Some examples of these types of fires are:

   - Grease fires on an electrical stove top as a result of cooking left unattended.
   - Clothing catching fire while cooking.
   - Clothes dryer catching fire caused by the appliance overheating due to improper cleaning of the lint cache.
   - Combustible catching fire around heaters or electronics when they are placed too close to the heat source.

2. Fires caused by the ignition of combustibles around an electrical device, equipment, appliance or installation and were the direct result of the failure of the device, equipment or installation. In these cases, typical fires are caused by insulation surrounding electrical wiring failing and igniting a combustible in close proximity, or equipment or devices failing, causing them to overheat and later, start a fire. Insulation failure could be caused by natural aging, premature aging resulting from overloading, or by mechanical breakdown of the insulation. Fires related to wiring and wiring devices are classified by the OFMEM as distribution equipment. Please note that the definition of distribution equipment in the fire section is quite different than the distribution equipment in the powerline section of the report.

   Examples of these fires are:

   - Carpet igniting caused by heat build-up of an extension cord placed under a carpet. Over time the insulation of the extension cord fails due to foot traffic on the cord which leads to mechanical breakdown of the insulation.
   - Electrical wires poorly terminated and an installation performed without using any protective enclosure. Arcing occurs over time resulting in a fire of combustibles around the wires.
   - Fire caused by a failure of a seized motor powered by electricity.

In the fire section of the OESR, ESA uses OFMEM's method of categorizing types of ignition source class. By OFMEM's definition, distribution equipment are electrical wiring, devices or equipment whose primary function is to carry electrical current from one location to another. Thus, wiring, extension cord, termination, electrical panel, cord on appliances are considered distribution equipment. Please note that distribution equipment defined by the OFMEM is not the same as Distribution Equipment defined by the Local Distribution Companies.

When fire fatality rates are calculated, ESA displays data as it is calculated by OFMEM, which uses Statistics Canada population estimates as the denominator. When fire fatality data is added to electrical-related death data, Ministry of Finance population estimates are used as the denominator.

References

Asgary A, Ghaffari A and Levy J. (2010) Spatial and temporal analyses of structural fire incidents and their causes: A case of Toronto, Canada. *Fire Safety Journa*l, 45(1), 44-57.

Baker DE and Adams P. (1993). Residential Fire Detection. University Extension, University of Missouri-Columbia: Columbia.

Council of Canadian Fire Marshals (2002). Annual Report: Fire losses in Canada. Council of Canadian Fire Marshals and Fire Commissioners: Ottawa.

Duff K and McCaffrey RJ. (2001). Electrical injury and lightning injury: A review of their mechanisms and neuropsychological, psychiatric, and neurological sequelae. *Neuropsychology Review*, 11, 2, 101-16.

Hall, JR (2008). Homes Fires Involving Cooking Equipment. National Fire Protection Association, Fire Analysis and Research Division: Quincy, MA.

Karter MJ (2007). Fire Loss in the United States during 2006. National Fire Protection Association, Fire Analysis and Research Division: Quincy, MA.

Kim H, Lewko J, Garritano E, Moody J and Colontonio A (2016). Construction fatality due to electrical contact in Ontario, Canada, 1997-2007. *Work*, 54(3), 639-46.

Koumbourlis, AC. (2002). Electrical injuries. Critical Care Medicine, 30, 11 (Suppl):S424-30.

LaRiccia, F. (2017, June). Electrical consumer product update open session. Presentation presented at the Canadian Advisory Council on Electrical Safety, Halifax, NS.

Miller, I. (2005). Human Behaviour Contributing to Unintentional Residential Fire Deaths 1997-2003. New Zealand Fire Service Commission Research Report Number 47.

National Institute for Occupational Safety and Health (1991). Fatality Assessment and Control Evaluation (FACE) Project Protocol. Division of Safety Research: Morgantown, WV.

Ontario Fire Marshal (2009). Reducing Residential Stovetop Fires in Ontario: Toronto.

Ontario Ministry of Finance. (2017). *Ontario Population Projections Update*, 2016-2041. Queen's Printer for Ontario.

Statistics Canada. Table 282-0087 – *Labour force survey estimates (LFS) by sex and age group, seasonally adjusted and unadjusted, monthly (persons unless otherwise noted).* CANSIM 282-0002 (database). (Accessed August 1, 2017).

Stergiou-Kita M, Mansfield E, Bayley M, Cassidy JD, Colantonio A, Gomez M, et al. (2014). Returning to work following electrical injuries: workers' perspectives and advice to others. J Burn Care Res, 35(6), 498-507.

Taylor AJ, McGwin G, Valent F, Rue LW. (2002). Fatal occupational electrocutions in the United States. *Injury Prevention*, 8(4), 306-12.

Theman K, Singerman J, Gomez M, Fish JS. (2008). Return to work after low voltage electrical injury. *J Burn Care Res*, 29(6): 959-64.

Wesner ML and Hickie J. (2013). Long-term sequelae of electrical injury. *Canadian Family Physician*, 59(9), 935-99.

Wijayasinghe, M (2011). Fire Losses in Canada Year 2007 and Selected Years. Canadian Council of Fire Marshals and Fire Commissioners, Alberta.

This document was prepared by the Regulatory and Safety Programs Division of the Electrical Safety Authority.

For queries and additional information, please contact Freda Lam at freda.lam@electricalsafety.on.ca

ISSN 2369-4572 (Print)
ISSN 2369-4580 (Online)