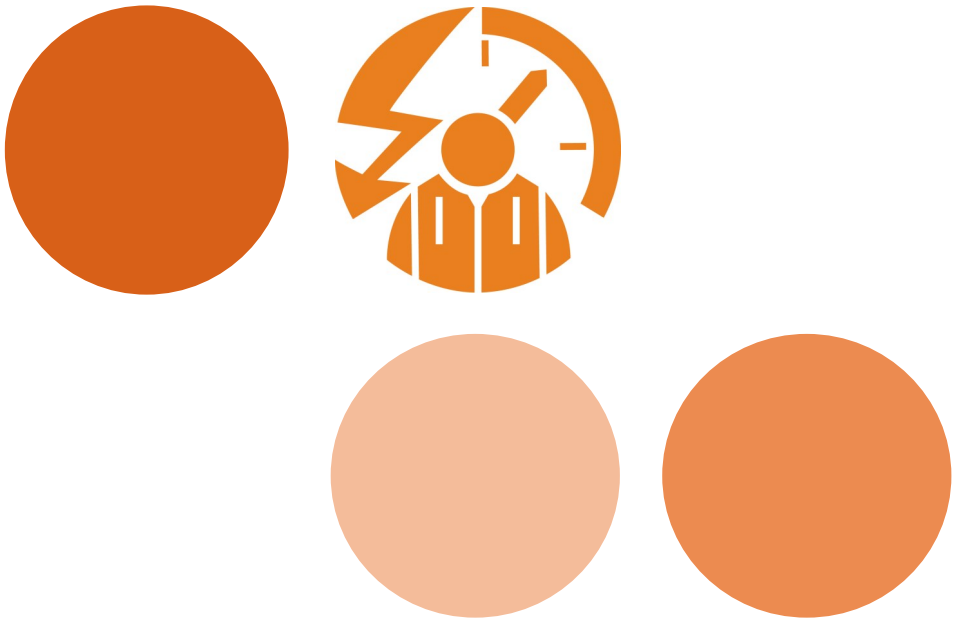

Public Safety - Electrical Accidents Report 1998-2015

September 2016

eea | Electricity Engineers' Association

Document Information

Acknowledgement and disclaimer

This report has been prepared by the Electricity Engineers' Association of New Zealand (EEA) to provide high-level public safety analysis to CEOs and senior managers in the electricity supply industry. The report is based on publicly available data and acknowledges the assistance of Energy Safety.

The EEA thanks the joint EEA / ENA Public Safety Working Group for their support and valuable feedback throughout the development of this report.

All data compiled and analysed in this report rely on the *Summaries of reported electrical and gas accidents* published by Energy Safety from 1998 to 2015. The EEA gives no warranty of accuracy or reliability as to the information contained in this report, and accepts no responsibility for loss arising in any way from, or in connection with, errors in or omissions of any information in this report. This report should not be relied upon without first obtaining specific advice.

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Executive Summary

INTRODUCTION

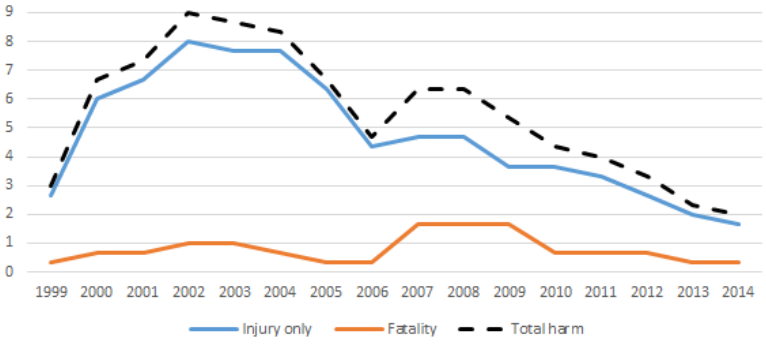
The EEA *Public Safety - Electrical Accidents Report 1998-2015* aims to assist electricity supply companies in understanding industry performance in public safety. It provides a visualisation tool for public fatality and serious harm trends over the past two decades.

This report supports the work of the joint EEA/ENA Public Safety Working Group, which gathers representatives from Transpower, networks, generators and retailers. It can be used by industry CEOs and senior managers to look at further education programmes and safety campaigns, as part of their responsibilities under the Electricity Act.

GENERAL PUBLIC

An analysis of notifiable electrical accidents to the general public from 1998 to 2015 shows, despite a bump in 2007, a falling number of fatalities since then from an average of two to close to zero in 2014.

Figure 1. General public and youth harm trends, 1999-2014 (three-year moving averages)



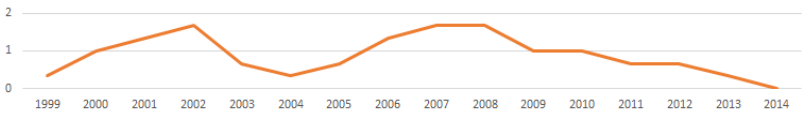
More evidently, the number of people harmed dramatically decreased since about 2002, from an average of nine persons harmed in 2002 to as low as two in 2014. Although the average number of young people aged 17 and under has similarly decreased since 2003, this group is of particular concern as it represents close to a third of the general public harmed.

Trend analysis of accidents by voltage and accident mechanisms indicates that the decrease in general public harm mainly concerns harm from high-voltage assets (11 kV), and suggests that efforts by the electricity supply industry (ESI) have been successful in tackling the main cause of accidents over the analysed period, i.e. the number of trespasses resulting in harm. However, despite falling trends, unauthorised access to ESI assets such as poles or substations remains a critical public safety issue, as the last two reported general public fatalities in 2011 and 2013 were both a direct result of individuals unlawfully climbing high-voltage structures.

Low voltage accidents were the most frequent to affect the general public over the years 1998 to 2015. About one in two accidents resulting in 230 V or 400 V electric shocks were due to a broken or disconnected neutral, or phase and neutral transposition. These have been a recurring safety problem and we recommend the industry continue to monitor these events.

NON-ELECTRICAL WORKERS

Figure 2. Non-electrical workers, Fatality trends, 1999-2014 (three-year moving averages)

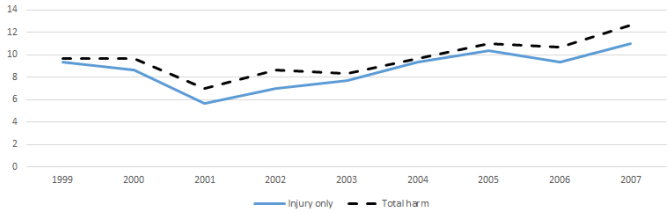


The fatality trend to non-electrical workers has been oscillating over the past two decades, but more recently has been following a downward trend from an average of two in 2008 to an

average of zero fatality in 2014. Although farm workers were not the most susceptible to being harmed, they were those most likely to receive a fatal electric shock and represented half of all fatalities.

The analysis of notifiable electrical accidents involving non-electrical workers covered the years 1998 to 2008 only, due to the reporting of worker electrical accidents being transferred to the Department of Labour in 2009. The EEA is currently working with WorkSafe to obtain further data post-2008.

Figure 3. Non-electrical workers, Injury trends, 1999-2007 (three-year moving averages)



The harm trend to non-electrical workers has increased over the years 1998 to 2008 from a three-year average of seven in 2001 to 13 in 2007. Accident mechanisms that tended to follow a similar upward trend included: excavation (also the main cause of accident), operating a mobile plant or truck, vegetation management and working on a roof or scaffold. 9% of non-electrical workers harmed were killed, a lower percentage than for the general public for which 14% of all injuries resulted in fatalities over the 1998-2015 period.

The type of occupations listed often involved working near ESI assets, mostly 11 kV equipment which concerned one in two annual accidents over the period.

RECOMMENDATIONS

While the EEA recognises that this analysis lacks indicators on non-electrical accidents involving both the general public and non-electrical workers (such as trespass in generation sites), as well as information on non-notifiable events and near misses, the results and trends highlighted in this report should provide some tangible evidence to support the work already done by ESI companies and the development of their safety strategies for the future.

The EEA therefore recommends that ESI executives and health and safety managers note the results of this report and in particular continue to monitor:

- Safety issues related to low voltage accidents affecting the general public (broken neutral, phase to neutral transposition).
- The protection of both low (pillar boxes) and high-voltage assets (substations, power poles) against trespass and vandalism.
- Campaigns targeted at educating non-electrical workers on safety around overhead lines and underground services. Targeted workers' groups would include heavy equipment operators, construction workers, arborists and farm workers.

We also invite ESI executives and safety managers to formally support further collection of public safety data at a national level by the EEA.

Preface and Scope

PREFACE

Energy Safety has provided summaries of electrical accidents and the results of their investigations since 1998. Whilst Energy Safety has published annual trend analyses on accidents involving the general public and, until 2008, on accidents involving electrical and non-electrical workers, these do not clearly separate installations related accidents from works accidents and therefore have been of limited use for the electricity supply industry (ESI).

It was brought to the EEA's attention that a more targeted analysis of publicly available public safety information would be beneficial to ESI CEOs and senior health and safety managers. This project also directly supports the **joint EEA/ENA Public Safety Working Group's work objectives**, namely:

- to analyse of available data on incident trends, and
- to share details and learning from incidents.

SCOPE

Because this report is based on data published by Energy Safety, the scope of our analysis has been limited to:

- **electrical accidents involving the general public from 1998 to 2015,**
- **electrical accidents involving non-electrical workers from 1998 to 2008** (investigations on workplace and worker related electrical accidents were transferred to the Department of Labour, now WorkSafe, in 2009),
- **electrical fatalities among non-electrical workers from 2009 to 2015** (data provided by WorkSafe on our request).

We then extracted accidents that involved ESI assets. The definition of "point of supply" being somewhat impracticable*, we based our selection on the fact that service lines will be protected by a fuse supplied by the network company at the point of connection. On that basis, accidents involving faults occurring on the service line, mains entry box, meter box or switchboard (if the fault was on the supply side) on the consumer's premises are also included in our analysis. Public harmed while touching appliances or other non-ESI equipment but due to faults on the network's side are also included in the report. Train roof accidents and street light accidents are excluded as safety and maintenance of those assets are not the ESI's responsibility.

The information presented in this report covers **electrical accidents that are notifiable under the Electricity Act 1992**, resulting in either serious harm (fatality, loss of consciousness or injury that necessitates an admission to the hospital or medical treatment) or significant property damage. A few notes have been included on reported electrical fire accidents, however such comments should be regarded as informational only as these accidents are largely underreported to Energy Safety.

* In the Electricity Act 1992, the "point of supply" is defined in relation to a property as *"the point or points on the boundary of the property at which exclusive fittings enter that property"*.

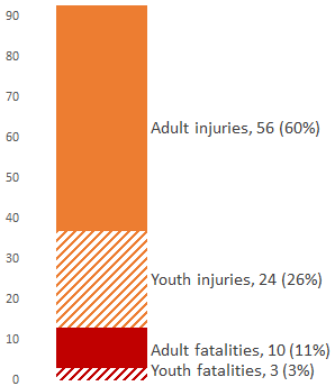
General Public Harm Trends

SUMMARY OF HARM CAUSED TO THE GENERAL PUBLIC, 1998-2014

Over the years 1998 to 2015 (18 years)*, **86 notifiable electrical accidents involving the general public** were reported to Energy Safety, an average of five accidents per year. These notifiable accidents resulted in **93 casualties, including 13 fatalities (14% of public harmed)**. More than one in four people harmed were under 18 years old.

Two accidents did not directly harm the public but caused significant property damage. Five other accidents caused multiple harm, including one boat mast accident injuring five recreational sailors. The four other multiple-harm accidents involved one person being injured while assisting a victim (broken neutral, motor vehicle accident, tree trimming, erection of gazebo).

Figure 4. General public - Total harm, 1998-2015

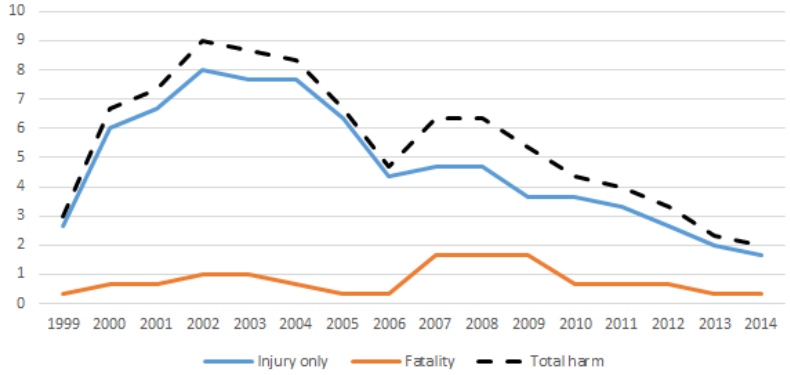


MAIN HARM TRENDS

Five persons were harmed every year on average over the reporting period, however the general public harm trend has been decreasing dramatically from a high average of about nine persons harmed in 2002 to as low as two in 2014.

There is a constant trend of one fatality per year on average involving the general public, with a small peak in 2008, which was due to four fatalities in one single year (actual figure). The 2008 peak cannot be attributed to a particular public safety issue: all four were due to very different causes.

Figure 5. General public - Fatality and injury trends, 1999-2014 (three-year moving averages)



27 young persons aged 17 or under were harmed over the reporting period 1998-2015, representing about 29% of the total population harmed and on average two youth per year. The number of young persons harmed in an electrical accident has gone down since 2003 from a high average of four to lower than one in 2014.

Figure 6. Youth harmed in an electrical accident, 1999-2014 (three-year moving averages)

PROFILE OF THE GENERAL PUBLIC HARMED

Household occupants were the most affected by electrical accidents, representing half of all general public harmed. Their profile category covers people of all ages harmed in their home, or in the direct vicinity of their house.

People harmed in a recreational environment come far second, representing 16% of all people harmed, followed by pedestrians and unauthorised public (both 8 to 9%). Members of the public included in the 'other' profile category are too diverse to be considered on its own (car drivers, school students, unspecified public).

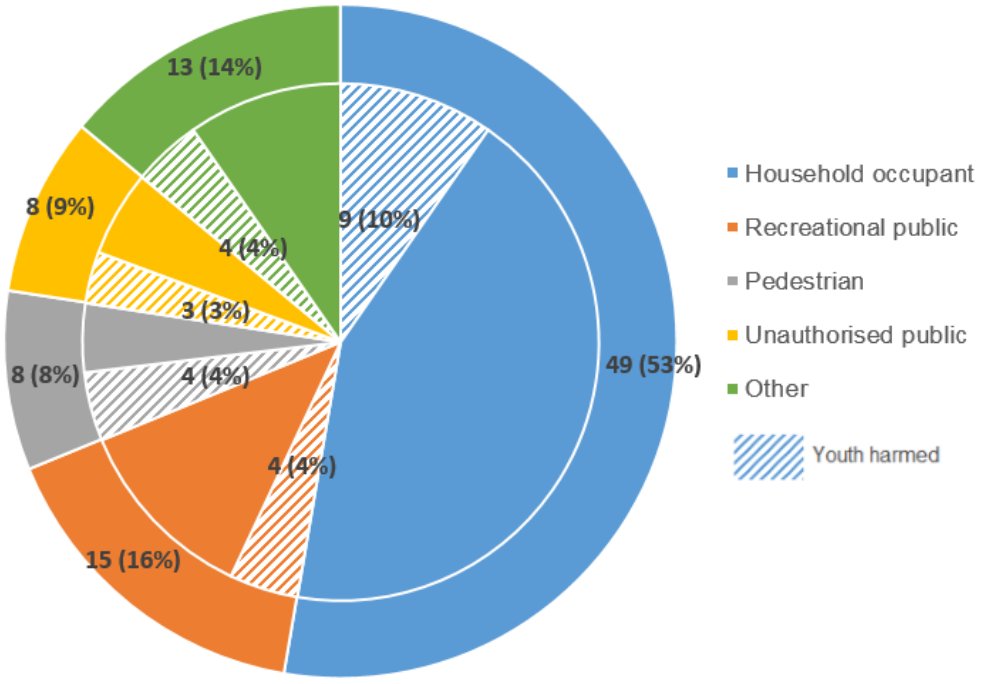
YOUTH PROFILE

Young people were mainly injured in a domestic environment (nine in total, or 35% of all harmed youth). They represent 18% of all household occupants harmed.

In comparison, it is worth noting that half of the reported harmed pedestrians were younger than 18 years old. It is difficult to draw any clear conclusion out of this observation, which is based on relatively low figures, but this proportion could perhaps be explained by the inability of young people to recognise an electrical hazard when they encounter one on their way (cf. exposed cable on the ground, etc.).

The four youth classified under recreational public were, in three cases, children climbing power poles located in commonly used playgrounds, and in one case a child touching a live wire from a pillar box (left damaged and unreported) while playing with a group of friends. Considering the environment in which the accidents took place the EEA considered it was more appropriate to regard them as recreational public rather then unauthorised public deliberately accessing ESI structures.

Figure 7. General public - Public harmed by profile, 1998-2015

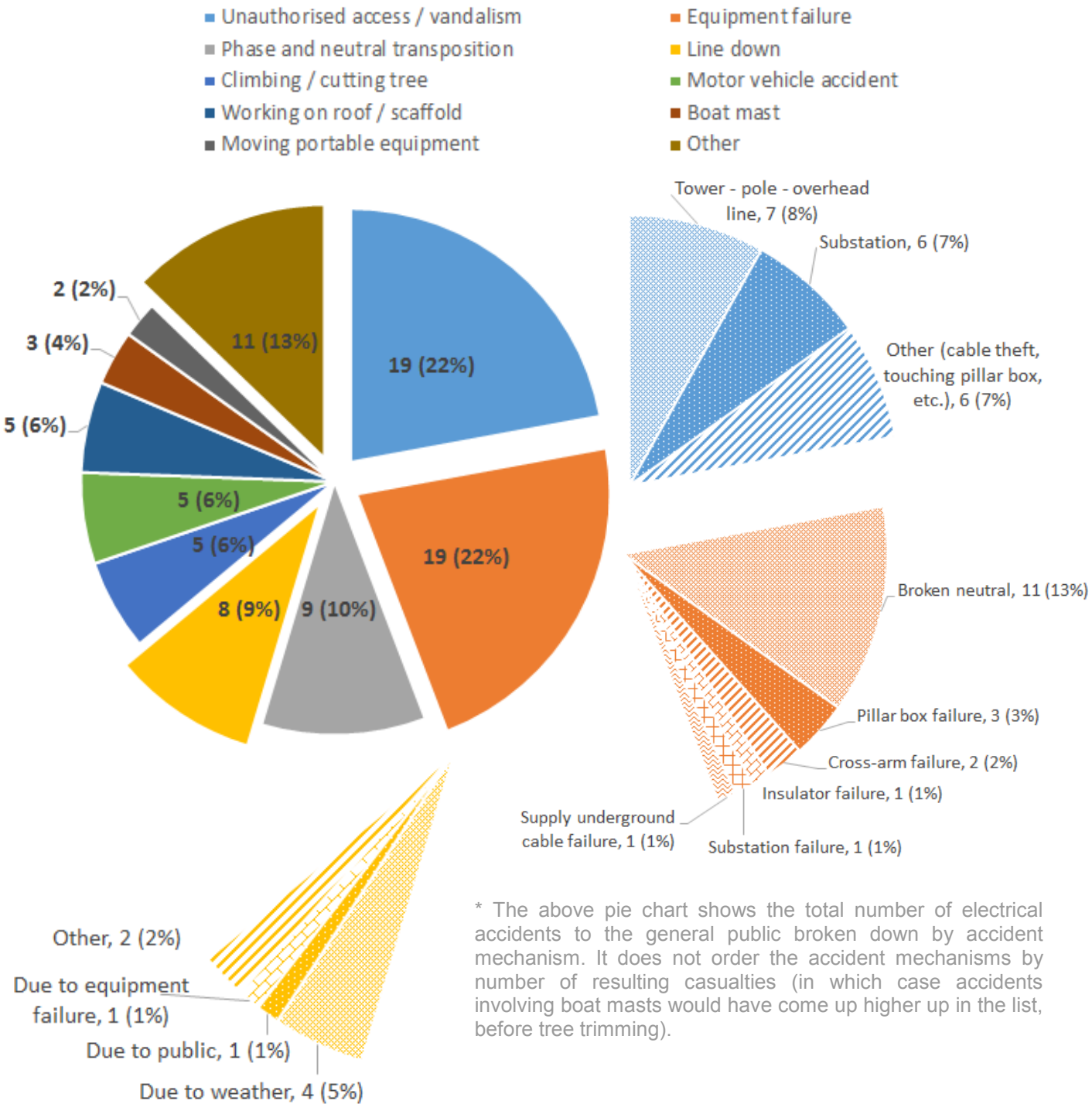


General Public
Accident Mechanisms

OVERVIEW OF THE MAIN ACCIDENT MECHANISMS INVOLVING THE GENERAL PUBLIC

The two main accident mechanisms involving the general public were unauthorised access to ESI equipment (substation, tower, pole) and equipment failure (i.e. broken neutral), each for 22% of all cases over the reporting period.

Figure 8. General public - Accident mechanisms, 1998-2015



* The above pie chart shows the total number of electrical accidents to the general public broken down by accident mechanism. It does not order the accident mechanisms by number of resulting casualties (in which case accidents involving boat masts would have come up higher up in the list, before tree trimming).

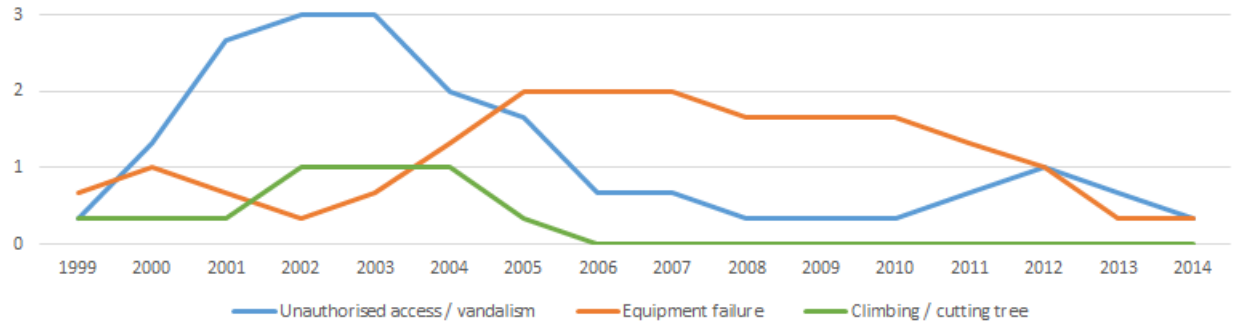
General Public
Accident Mechanisms

MAIN ACCIDENT MECHANISM TRENDS

Most accident mechanisms identified on figure 8, page 8, happened too irregularly to be interpreted, but three specific accident mechanisms seemed to follow more obvious trends:

- **Unauthorised access / vandalism**: Accidents from unauthorised access or vandalism of ESI equipment seem to have peaked in 2002 at an average of three per year and have decreased to less than one accident per year since 2006. This could be regarded as possible evidence of the success of recent measures implemented by ESI companies to deter unlawful access to ESI sites.
- **Equipment failure**: Accidents due to equipment failure increased to an average of two per year in 2005, before slowly decreasing again. Broken neutrals are a recurring type of equipment failure causing harm to the general public, while other equipment such as cross-arms only failed punctually over the reporting period.
- **Climbing / cutting tree**: No notifiable electrical accident involving members of the general public climbing or cutting trees have been reported since 2006.

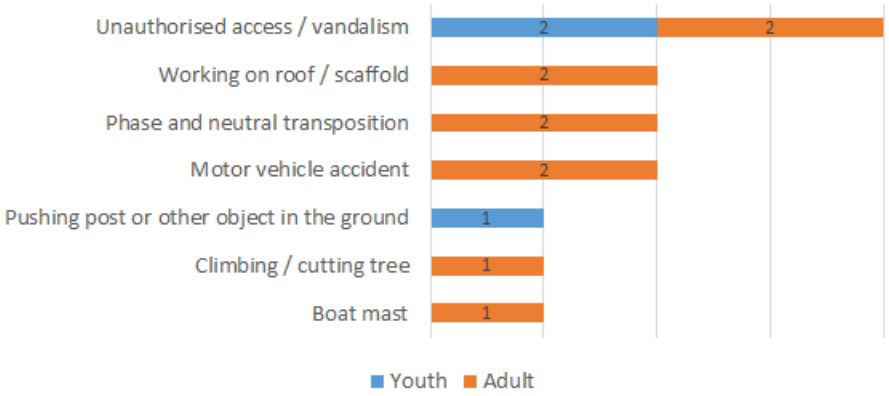
Figure 9. General public - Accident mechanism trends, 1999-2014 (three-year moving averages)



MAIN FATALITY MECHANISMS

Of the 13 fatalities reported between 1998 and 2015, most involved unauthorised access to ESI structures (climbing of poles, access into substations) or vandalism (cable theft, intentional damage of ESI equipment), followed by work on roof or scaffold (contact with overhead lines), phase and neutral transposition (livening of metal structures or pipes) and motor vehicle accidents (contact with fallen overhead lines).

Figure 10. General public - Fatalities by accident mechanism, 1998-2015



Descriptions of the three fatal youth accidents:

- A child received a fatal electric shock when he touched a steel fence post outside a property. The pole had been hammered and contacted a LV cable buried in the ground. (2008)
- A young person climbed a security fence surrounding a zone substation, climbed a concrete pole supporting the 33kV bus work and contacted live parts. (2008)
- A youth received a fatal electric shock and burns when he climbed a sub-transmission tower located in a park. The investigation found the safety of the tower was adequate. (2004)

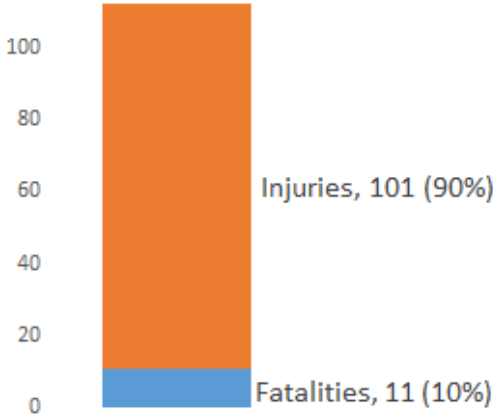
Non-Electrical Workers Harm Trends

SUMMARY OF HARM CAUSED TO NON-ELECTRICAL WORKERS, 1998-2008

Over the years 1998 to 2008 (11 years)*, **107 notifiable electrical accidents involving non-electrical workers** were reported to Energy Safety, an average of 10 accidents per year. These accidents resulted in **at least 112 casualties, including 11 fatalities (10% of non-electrical workers harmed)**.

Five accidents caused multiple harm, including three that resulted in a fatality and harm to another person, all due to contact with overhead lines while repairing a fence or equipment. The other two multiple-harm accidents involved contact with overhead lines while pouring concrete and a short-circuit caused by a length of steel during earthquake strengthening in a substation.

Figure 11. Non-electrical workers - Total harm, 1998-2008



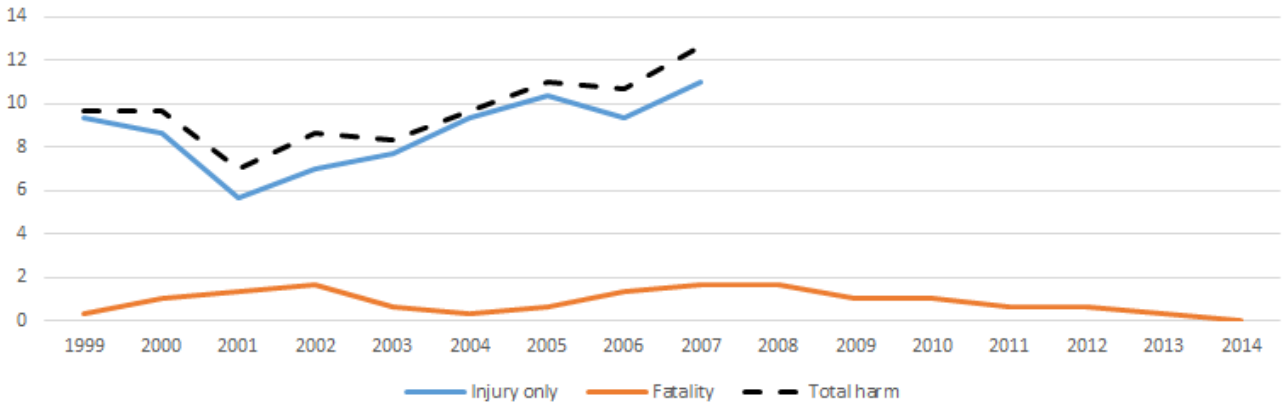
* Energy Safety stopped publishing data regarding notifiable electrical accidents involving non-electrical workers in 2009, when workplace and worker accident reporting was transferred to the Department of Labour / WorkSafe. On our request, WorkSafe provided a list of non-electrical worker fatalities from 2009 to 2015, and the EEA is working with them to obtain further data post-2008.

MAIN HARM TRENDS

10 non-electrical workers were harmed per year on average over the reporting period. The harm trend has increased over the years from an average of 7 in 2001 to 13 in 2007.

WorkSafe provided data on non-electrical worker fatalities after 2008. The fatality trend, presented as three-year averages in the graph below, oscillated around one fatality per year, moving up again from an average of zero to two fatalities in 2008, before decreasing again. There has been no non-electrical worker fatality since 2013.

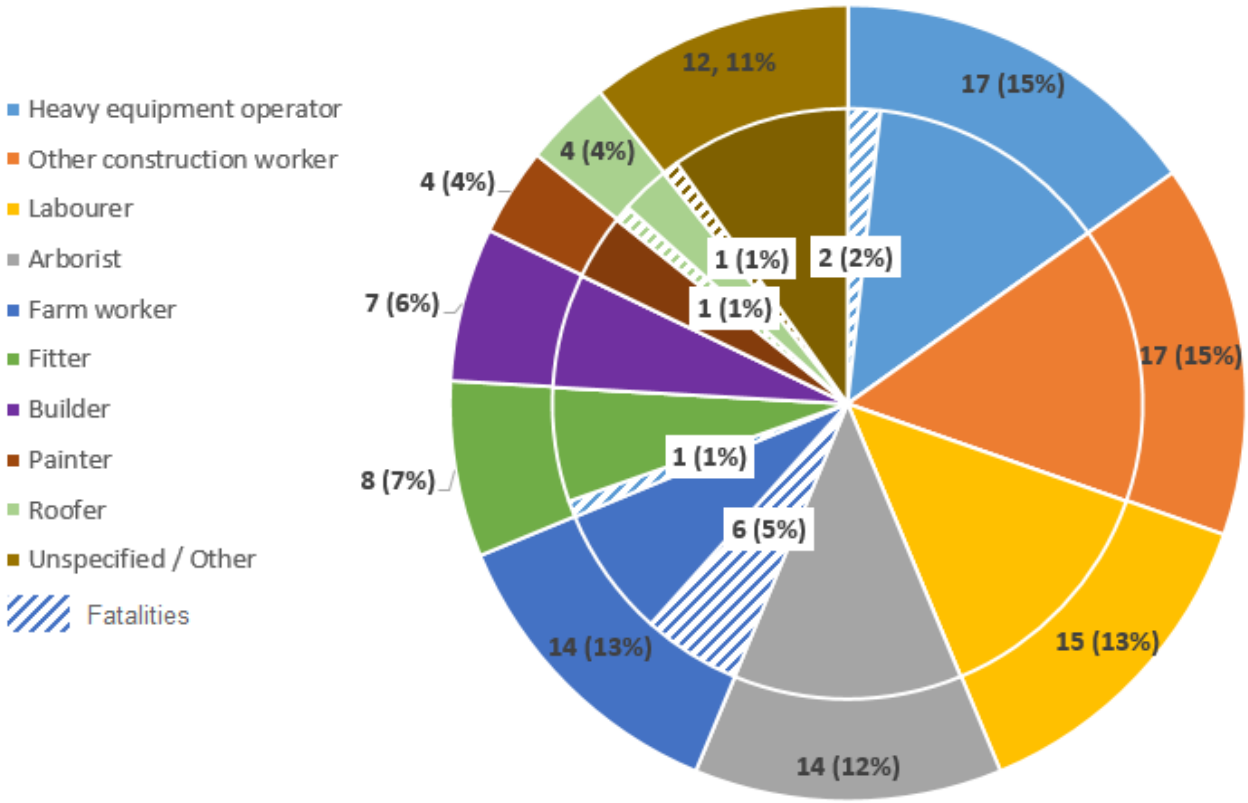
Figure 12. Non-electrical workers - Fatality and injury trends, 1999-2014 (three-year moving averages)



PROFILE OF NON-ELECTRICAL WORKERS HARMED

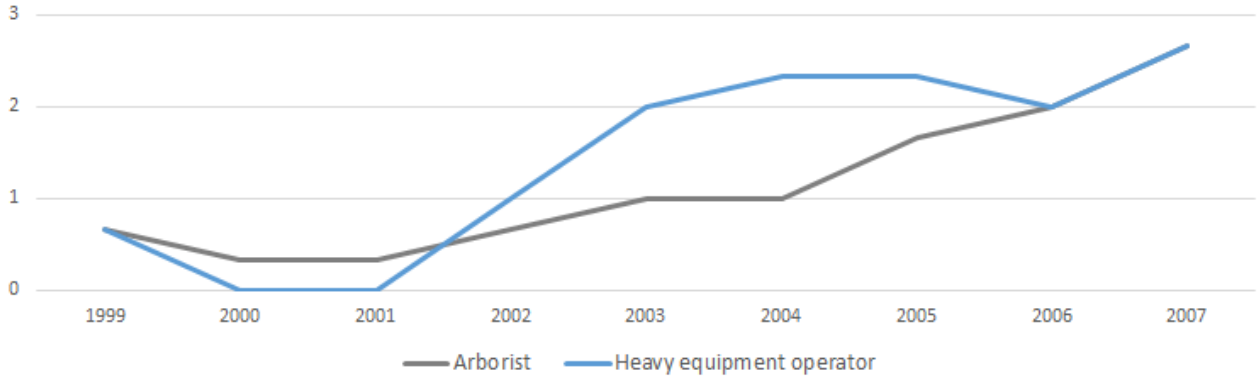
The main non-electrical workers susceptible to be harmed were heavy equipment operators (15% of all non -electrical workers harmed), labourers, arborists and farm workers (13% each). The latter were the most affected in terms of fatality rate. The 'other construction workers' category mainly covers workers involved on work sites but whose occupation was not specified, therefore no conclusion can be drawn from this particular category.

Figure 13. Non-electrical workers - Persons harmed by work category, 1998-2008



Of all the above non-electrical worker categories, harm trends regarding heavy equipment operators and arborists are worth further analysis. Both trends seem to have slightly increased over the reporting period from averages below one casualty per year to almost three per year. This observation is verified in the analysis of accident mechanism trends in figure 16, page 13.

Figure 14. Non-electrical workers - Selected harm trends, 1999 - 2007 (three-year moving averages)

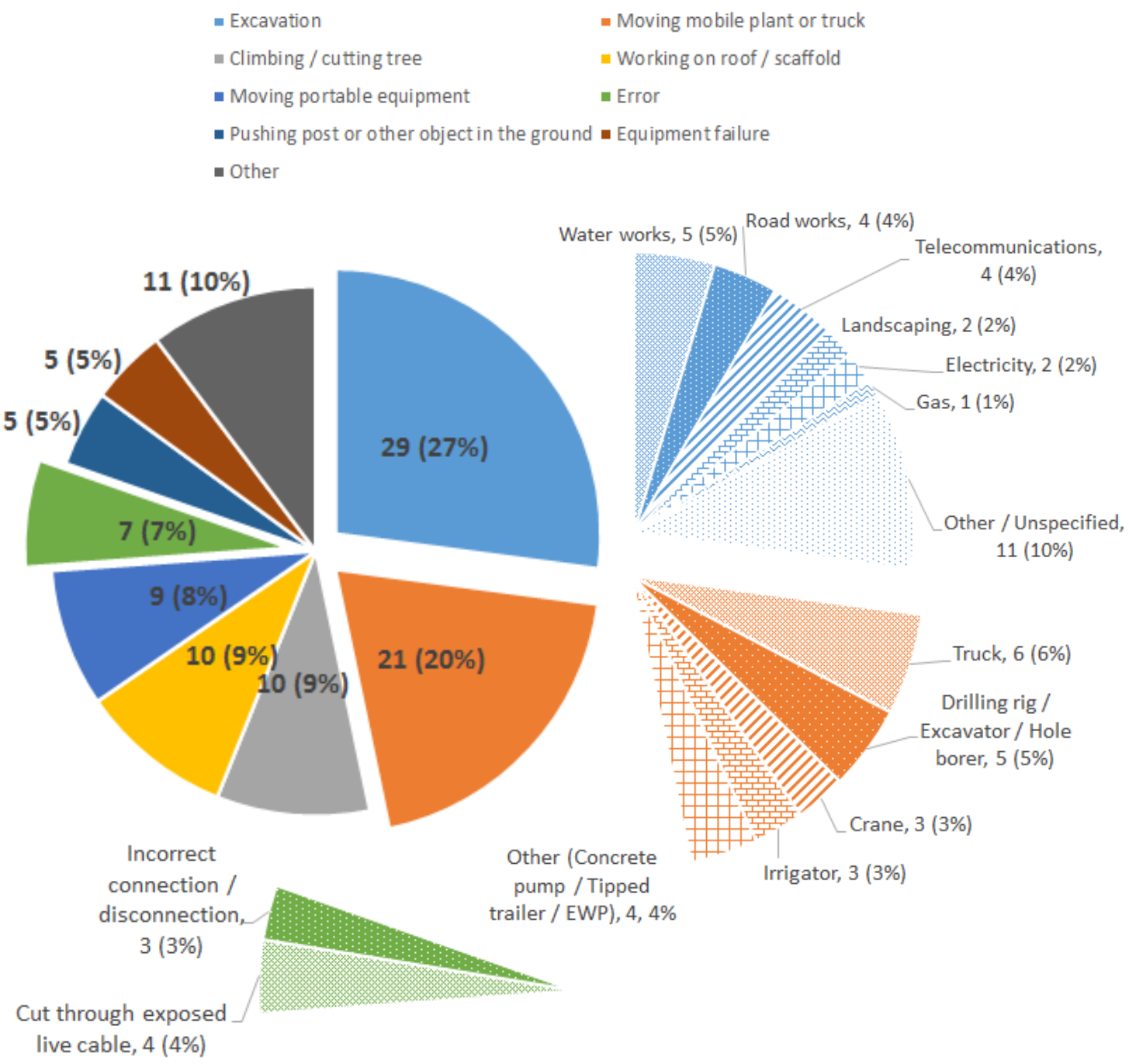


Non-Electrical Workers Accident Mechanisms

OVERVIEW OF THE MAIN ACCIDENT MECHANISMS INVOLVING NON-ELECTRICAL WORKERS

The two main accident mechanisms involving non-electrical workers were excavations in 27% of all cases over the reporting period, and operating a mobile plant or truck in 20% of all cases. Tree trimming, working on a roof or scaffold, and moving portable equipment (i.e. ladder, pipe) came next in 9% of all cases each.

Figure 15. Non-electrical workers - Accident mechanisms, 1998-2008



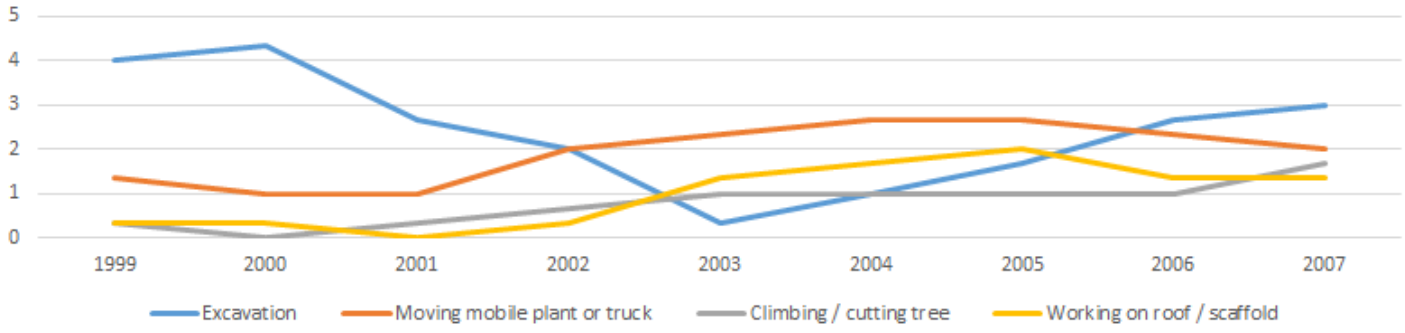
Non-Electrical Workers Accident Mechanisms

MAIN ACCIDENT MECHANISM TRENDS

Half of the accident mechanisms identified on figure 15, page 12, such as moving portable equipment or pushing probe in the ground, are too irregular to be properly interpreted. Four accident mechanisms seem to have followed a slightly upward trend over the reporting period: tree cutting and working on a roof or scaffold from an average of about 0.3 accident in 1999 to about 1.7 in 2007, moving mobile plant or truck from an average of 1.3 accident in 1999 to 2 in 2007, and excavation from an average of 0.3 in 2003 to 3 in 2007 (although down from a higher average of 4 accidents in 1999).

Unfortunately the absence of published worker data from 2009 onwards prevents us from analysing more recent results and verify whether the above trends have progressed in the same direction or not.

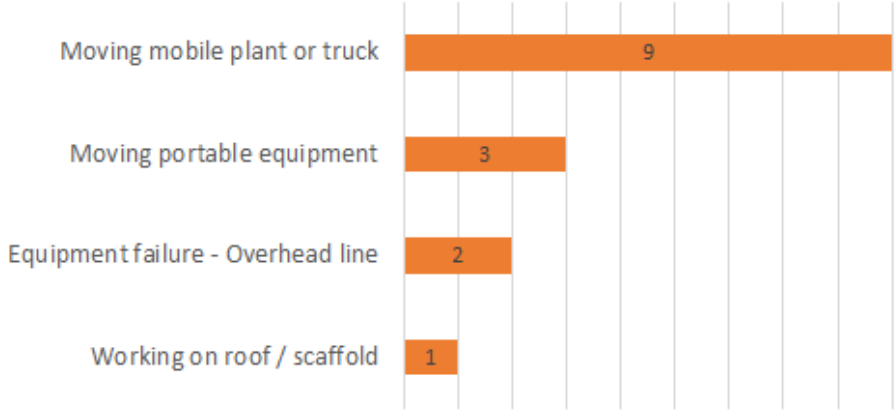
Figure 16. Accident mechanisms to non-electrical workers, 1998-2008 (three-year moving averages)



MAIN FATALITY MECHANISMS

WorkSafe having provided complimentary data post-2009, we were able to analyse all reported non-electrical worker fatalities from 1998 to 2015. There were 11 fatalities over the 1998-2008 reporting period, or 15 over the 1998-2015 reporting period. Of these 15 fatalities reported, a majority were due to contact with overhead lines while operating mobile plants or trucks. Three fatalities happened while moving portable equipment (fence or irrigation pipe), two due to fallen overhead lines (equipment failure) and one resulted from work being performed on the roof of a farm shed.

Figure 17. Non-electrical workers - Fatalities by accident mechanism, 1998-2015



OVERVIEW OF REPORTED ELECTRICAL FIRE ACCIDENTS

32 electrical fire accidents involving electricity supply assets were reported to Energy Safety between 2002 and 2015. Because this type of electrical accident is largely underreported, the charts below should only be used as illustrations of the kind of mechanisms that can lead to an electrical fire and as general information to be brought to the attention of ESI CEOs.

Of all 32 electrical fire accidents, more than half took place in a domestic environment. In general, these were due to equipment failure or to flooding of equipment (water tracking through the mains cable from a power pole or a mains entry box to the household's meter box or switchboard).

Note that numerous fires (about 20) that started in switchboards due to careless terminations of wires or any other uncertain reasons were not considered of direct concern to the ESI and therefore were not included in the analysis.

Figure 18. Electrical fire accidents - Affected sites, 2002-2015

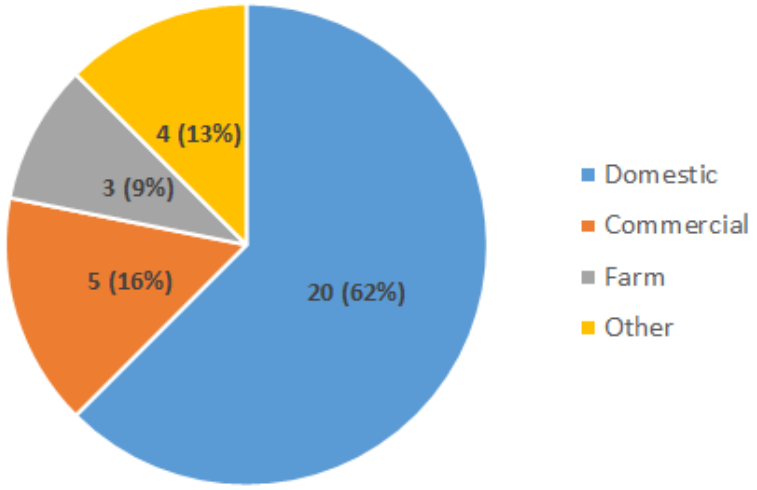
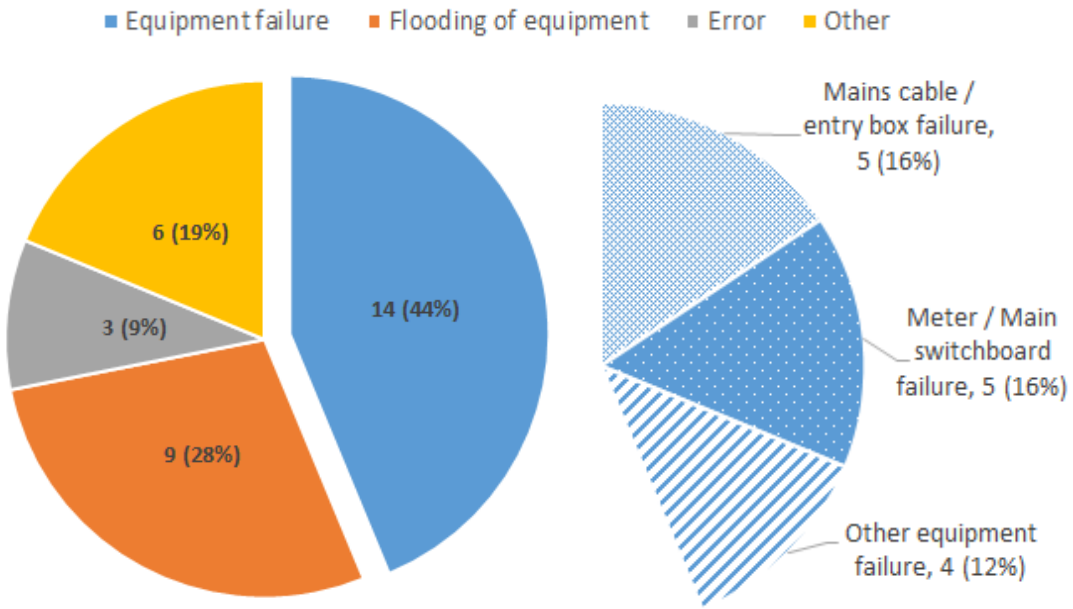


Figure 19. Electrical fire accidents - Accident mechanisms, 2002-2015



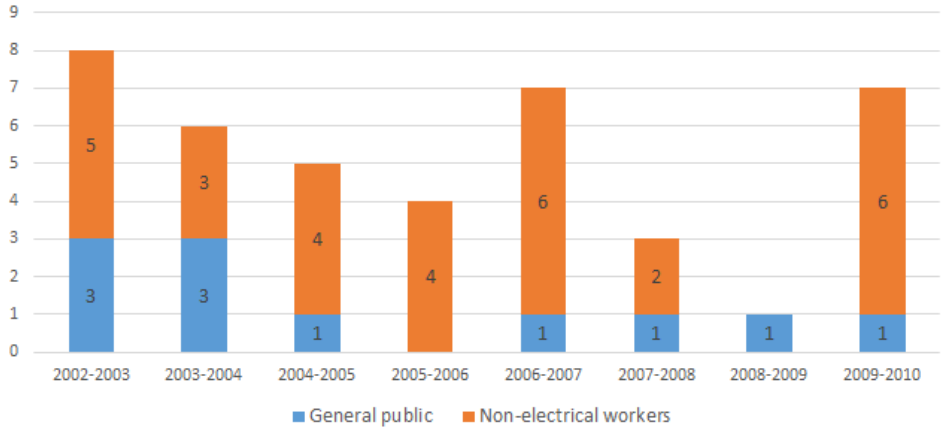
PRELIMINARY NOTES

The data presented on pages 15 and 16 are included in this report for information only. Benchmarking is not possible due to the variations in reporting definitions between Australia, the United Kingdom and New Zealand and due to missing or underreported data (different levels of serious harm reporting requirements in Australian states; UK statistics including ESI non-electrical accidents, etc.).

Data for Australia was extracted from reports published by ERAC (Electrical Regulatory Authorities Council) and from the HSE (Health and Safety Executive) Electricity Industry Database for the United Kingdom.

FATALITIES IN AUSTRALIA AND IN THE UNITED KINGDOM

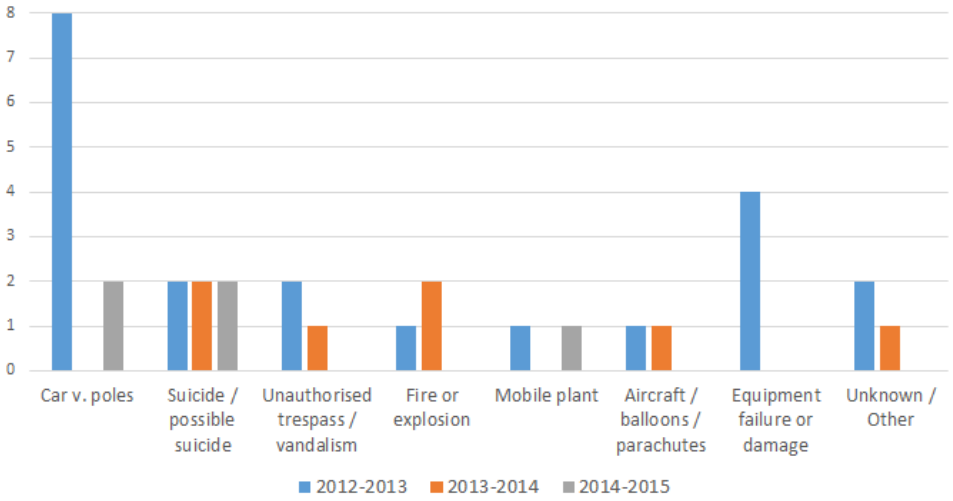
Figure 20. Australia - Fatalities by public type, 2002-2010 (years ending in June)



There was an annual average of 1.4 general public fatalities and 3.8 non-electrical workers fatalities in Australia over the financial years 2003 to 2010.

The exact accident causes are not provided, but ERAC reports highlight that all fatalities involved contact (direct or indirect) with overhead lines, with the exception of two general public fatalities that occurred in a substation or switchyard (in 2003-2004 and in 2009-2010).

Figure 21. UK - Fatalities by accident cause, 2013-2015 (years ending in March)



In the United Kingdom, the main fatality causes over the financial years 2013 to 2015 were road traffic accidents (10 fatalities, including deaths from cars crashing into power poles), suicide (6), vandalism (3) and fire or explosion (3).

The number of UK fatalities has sharply decreased over these three years, from a total of 21 in 2013 to five in 2015.

BREAKDOWN OF THE MAIN ACCIDENT CAUSES IN THE UK

Figure 22. UK - Breakdown of accident causes and percentage of harm, 2013-2015 (years ending March)

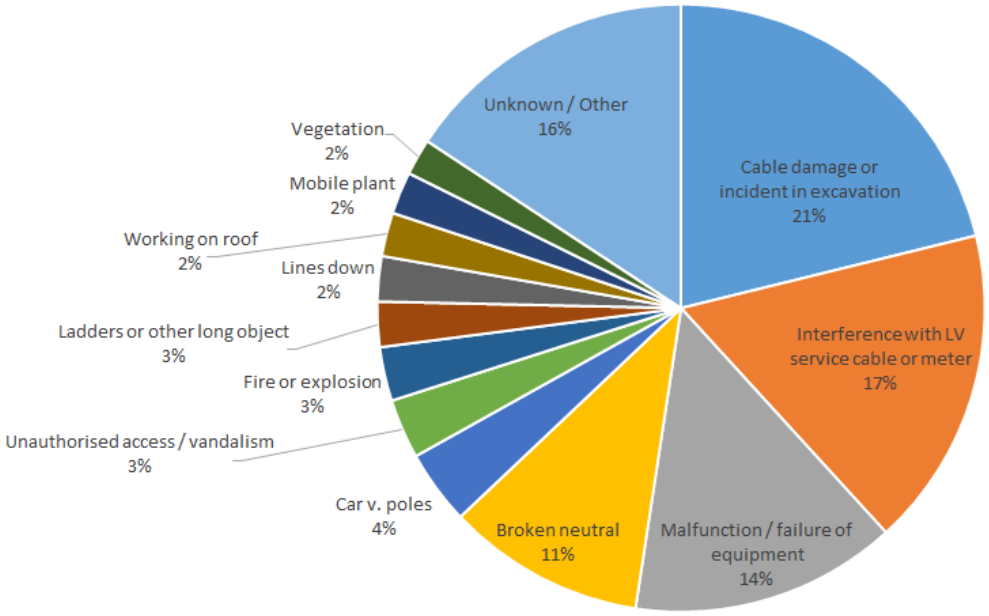


Figure 23. UK- Four main accident causes by total harm, 2013-2015 (years ending in March)

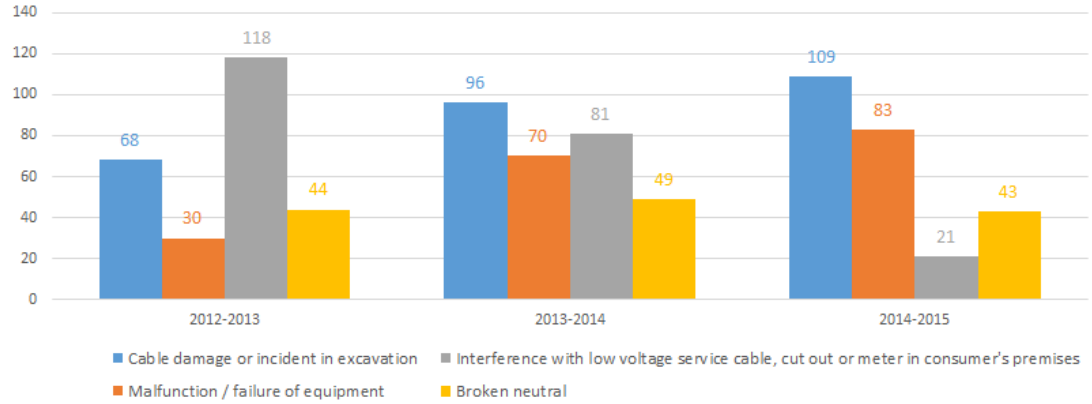


Figure 22 shows that cable damage (21% of harm cause over 2013-2015), interference with low voltage service cable or meter at the consumer's premises (17%), malfunction or failure of equipment (14%) and broken neutral (11%) are the four main public harm causes in the United Kingdom.

Whilst broken neutrals seem to be a recurring problem, harm from interference with low voltage service cables or meters has sharply decreased from 118 injuries in 2013 to 21 in 2015. Of particular concerns are accidents involving cable damage or incident in excavation, as well as equipment malfunction or failure, which have both caused increasing harm over the three-year period.

An analysis of UK 'other events' (which include near misses, property damage, etc.) indicates that vandalism, falling vegetation, fallen overhead lines, malfunction or failure of equipment and interference with low voltage cables or meters at the customer's premises are the five most numerous events experienced by the UK electricity supply industry. Of these, 'other events' involving interference with low voltage services, cable damage and malfunction of equipment have been rising over 2013 to 2015, with only vandalism and overhead lines events showing a declining trend.

Conclusions

Conclusions for the ESI and the EEA / ESI Public Safety Working Group

This report has been developed to support ESI companies, as well as the work of the joint EEA/ENA Public Safety Working Group, which gathers health and safety representatives from the electricity generation, transmission, distribution and retail sectors.

The report provides evidence that accidental contact with overhead lines and underground services is a critical safety issue, in particular for non-electrical workers involved in operating mobile plant or truck (20% of reported accidents), or in excavations (27%).

So is trespass and vandalism to the general public. An analysis of general public electrical accidents broken down by voltage shows that the frequency of accidents involving 11 kV assets has reduced from an average of 2.3 accidents per year over the 1998-2005 period to an annual average of 0.7 over the 2006-2015 period. Along with falling trends of unauthorised access to ESI equipment and equipment failure, this would suggest that ESI assets have become better protected and more reliable over the past decade. However, the last two reported general public fatalities in 2011 and 2013 were both a direct result of individuals unlawfully climbing high-voltage structures. This serves as a sad reminder that although notifiable accidents involving unauthorised access to ESI sites have declined over the years, this accident mechanism remains a highly sensible work area for the ESI.

Looking at the frequency of general public accidents involving 230 V (two per year) and 400 V (one per year) equipment, which has remained unchanged over both the 1998-2005 and the 2006-2015 periods, we would also recommend the ESI to take further action on protecting the general public from low voltage assets.

The report also identified key target audiences, including household occupants (DIYers but not only) and recreational public for the general public; heavy equipment operators, labourers, arborists and farm workers for non-electrical workers. These align with the Public Safety Working Group's priority work areas for 2016 and 2019, including: agriculture/horticulture, third-party contractors working in the vicinity of ESI assets and recreation.

The Public Safety Working Group has agreed in its five-year strategy to support WorkSafe's objectives, published in their *Statement of Intent 2014-2018*, to reach a public fatality rate target of **lower than 0.8 fatality per million people exposed to electricity**. With zero fatality among the general public in 2014 and 2015, and among non-electrical workers since 2013, the public safety statistics relevant to the ESI are definitely moving in the right direction. But it doesn't mean that the industry can take a rest: safety awareness campaigns require constant effort and monitoring if we want to keep up with the good results.

Glossary

Definitions of terms

The EEA has included the definition of some expressions used in the report for further clarification. Words that do not appear in the below definitions should be understood as per their common meaning.

General public

Persons affected by an electrical accidents

- *Household occupant*: either within their house or in the direct vicinity of their house (garden, driveway, pavement)
- *Pedestrian*: while walking past electrical equipment or structures
- *Recreational public*: in a recreational environment (sailing or fishing, playing in a park, staying in a motor camp)
- *Unauthorised public*: deliberately accessing or vandalising ESI equipment (i.e. climbing or unlawfully accessing ESI structures, cable thefts). This category does not cover people accessing ESI structures clearly located in recreational public areas (often children playing around, unaware of the risks of electricity).
- *Youth*: any general public aged 17 or under

Note that an accident mechanism and the public suffering from that particular accident may sometimes be covered by different categories (for example when a pedestrian picks up an exposed live cable from a pillar box after another member of the public vandalised the equipment).

Non-electrical workers

Worker categories

- *Arborist*: includes tree trimmers, forestry workers, landscape gardeners
- *Farm worker*: includes farmers as well as vine or orchard workers
- *Fitter*: includes plumbers, pipe fitters and gasfitters
- *Heavy equipment operator*: includes mobile plant operators (crane, concrete pump, excavator, etc.) as well as truck drivers
- *Other construction worker*: includes specific construction workers such as carpenters, fencers, civil workers, as well as any other construction worker occupations not clearly identified in the accident summaries
- *Unspecified / Other*: includes any other profession that did not fit in other work categories, such as shop clerks, technicians, house movers, as well as other unspecified profession that could not be determined through the accident description

Accident mechanisms

- *Moving portable equipment*: covers accidents that happened while moving ladders, irrigation pipes, fence wires, etc. Also covers accidents that happened while working on a roof but whose root cause was due to the handling of long objects such as steel length, etc.
- *Working on roof / scaffold*: covers accidents that happened while working on a roof (house, shed, etc.), a scaffold or on the roof of a parked truck while loading or unloading cattle or equipment.

Trend calculations

Rather than using actual data for each reporting year, which is difficult to analyse due to year-to-year fluctuations, trends in harm figures and accident mechanisms have been presented as three-year moving averages. The years indicated on trend graphs represent the middle year over a three-year period (i.e. 2009 for 2008-2009-2010 average results).

Appendices - General public

Table 1. General public - Number of injuries only, 1998-2015 (Actual results)

Number of people injured (excluding fatalities)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Household occupant	2	2	2	5	1	5	6	2	2	2	2	2	3	3	1	1	2	0	43
Recreational public	0	0	0	5	1	0	3	0	0	1	0	0	0	1	0	0	1	1	13
Pedestrian	0	0	0	0	0	0	1	1	0	3	1	1	0	1	0	0	0	0	8
Unauthorised public	0	0	0	2	1	0	0	0	1	0	0	0	0	0	1	0	0	0	5
Other	1	0	1	1	1	2	2	1	0	0	2	0	0	0	0	0	0	0	11
Total	*3*	*2*	*3*	*13*	*4*	*7*	*12*	*4*	*3*	*6*	*5*	*3*	*3*	*5*	*2*	*1*	*3*	*1*	*80*

Table 2. General public - Number of fatalities, 1998-2015 (Actual results)

Number of fatalities	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Household occupant	0	0	0	1	0	1	0	0	0	1	2	0	1	0	0	0	0	0	6
Recreational public	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Unauthorised public	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	3
Other	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Total	*0*	*1*	*0*	*1*	*1*	*1*	*1*	*0*	*0*	*1*	*4*	*0*	*1*	*1*	*0*	*1*	*0*	*0*	*13*

Table 3. General public - Accident mechanisms, 1998-2015 (Actual results)

Accident mechanism Number of accidents	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Unauthorised access / vandalism	0	0	1	3	4	2	3	1	1	0	1	0	0	1	1	1	0	0	19
Equipment failure	0	1	1	1	0	0	2	2	2	2	2	1	2	2	0	1	0	0	19
Phase and neutral transposition	0	1	0	0	0	1	2	0	0	1	1	1	1	1	0	0	0	0	9
Line down	0	0	0	0	0	0	1	0	0	2	0	2	0	1	1	0	1	0	8
Climbing / cutting tree	1	0	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	5
Motor vehicle accident	0	1	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	5
Working on roof / scaffold	1	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	5
Boat mast	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	3
Moving portable equipment	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Other	1	0	0	2	0	1	1	0	0	2	1	0	1	1	0	0	0	1	11
Total	*3*	*3*	*3*	*8*	*5*	*8*	*12*	*4*	*3*	*7*	*7*	*4*	*4*	*6*	*3*	*2*	*3*	*1*	*86*

Appendices - General public

Table 4. General public - List and description of fatalities, 1998-2015 (youth highlighted in orange)

Accident number	Year	Type of public	Accident mechanism	Site	Voltage (V)	Description
130922-01	2013	Unauthorised public	Unauthorised access / vandalism	ESI	11,000	A person climbed HV structure (substation for a single wire earth return system) following a dispute and died. Another person believed to be his girlfriend and who went to help the victim received severe burns. Safety distance between OH line and ground non-compliant due to road works over time.
110314-01	2011	Unauthorised public	Unauthorised access / vandalism	ESI	11,000	The victim and his brother-in-law were climbing a power pylon - a flashover occurred when victim approached too close to live HV conductor and he fell.
100405-01	2010	Household occupant	Phase and neutral transposition	Domestic	230	A homeowner went to check a hot water cylinder as water was too hot and received an electric shock when he touched a copper water pipe. Connection at mains entry box was transposed causing the neutral in the installation to be live.
090116-01	2008	Driver	Motor vehicle accident	Road	11,000	A car with two adults and 3 children hit a wood power pole in Blenheim and brought down the 11kV OH line. On exiting the car, 2 adults and 1 child touched the wires and received electric shocks, resulting in one adult fatality and burn injuries.
081230-01	2008	Household occupant	Working on roof / scaffold	Domestic	230	Homeowner was using a portable electrical sander, working on the barge board close to the overhead mains and it is likely he contacted the mains and received a fatal electric shock.
080508-01	2008	Household occupant	Pushing post or other object in the ground	Domestic	400	A child received a fatal electric shock when he contacted a steel fence post that had been hammered into the ground outside a property. Steel pole had contacted a LV cable buried in the ground.
081024-01	2008	Unauthorised public	Unauthorised access / vandalism	ESI	33,000	A young person climbed a security fence surrounding a zone substation, climbed a concrete pole supporting the 33kV bus work and contacted live parts.
2007/003	2007	Household occupant	Phase and neutral transposition	Domestic	230	A person received a fatal electric shock when contact was made with earthed metal that had become live as a result of a phase neutral transposition.
2004/065	2004	Recreational public	Unauthorised access / vandalism	Public	66,000	A youth received a fatal electric shock and burns when he climbed a sub-transmission tower located in a park. Investigation found safety of the tower adequate.
2003/009	2003	Household occupant	Working on roof / scaffold	Domestic	230	A property owner painting on a scaffold at a rental property received a fatal electric shock when he contacted the OH mains. Connection of the mains tails from the conduit bell mouth was at a joint covered by PVC tape which had degraded over time and unraveld to expose a live conductor. Metal scaffold was in direct contact with earth. Arrangements should have been made to disconnect the mains.
2002/006	2002	Recreational public	Boat mast	Water	11,000	A man was pushing his catamaran and trailer over the sand at an estuary when the mast contacted an 11kV OH line and the man received a fatal shock.
2001/075	2001	Household occupant	Climbing / cutting tree	Domestic	33,000	A homeowner received a fatal electric shock while trimming a bamboo hedge when one of the canes made contact with a 33kV OH line. Another person came to assist and received shock and burns.
1999/046	1999	Driver	Motor vehicle accident	Road	11,000	A woman received a fatal electric shock when the car she was in hit a pole and brought down an 11kV OH line. Victim was half out of the vehicle.

Appendices - Non-electrical workers

Table 5. Non-electrical workers - Number of injuries only, 1998-2008 (Actual results)

Number of workers injured (excluding fatalities)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Arborist	1	1	0	0	1	1	1	1	3	2	3	14
Builder	0	1	0	0	1	2	0	0	1	1	1	7
Farm worker	2	1	1	0	0	0	1	1	0	0	2	8
Fitter	1	0	0	2	1	0	2	0	0	1	0	7
Heavy equipment operator	2	0	0	0	0	3	3	1	2	1	3	15
Labourer	3	5	0	3	0	1	0	0	2	1	0	15
Other construction worker	1	3	2	2	0	0	0	3	2	2	2	17
Painter	1	0	1	1	0	0	0	1	0	0	0	4
Roofer	0	0	0	0	0	1	1	1	0	0	0	3
Other	0	1	1	1	0	1	3	0	2	0	2	11
Total	*11*	*12*	*5*	*9*	*3*	*9*	*11*	*8*	*12*	*8*	*13*	*101*

Table 6. Non-electrical workers - Number of fatalities, 1998-2015 (Actual results)

Number of fatalities	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total 1998-2008	2009	2010	2011	2012	2013	2014	2015	Total 1998-2015
Farm worker	1	0	0	2	0	1	0	0	0	1	1	6	2	0	0	1	0	0	0	9
Fitter	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Heavy equipment operator	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	2
Roofer	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1
Other	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2
Total	*1*	*0*	*0*	*3*	*1*	*1*	*0*	*0*	*2*	*2*	*1*	*11*	*2*	*0*	*1*	*1*	*0*	*0*	*0*	*15*

Table 7. Non-electrical workers - Accident mechanisms, 1998-2008 (Actual results)

Accident mechanism Number of accidents	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Excavation	4	5	3	5	0	1	0	2	3	3	3	29
Moving mobile plant or truck	3	1	0	2	1	3	3	2	3	2	1	21
Climbing / cutting tree	1	0	0	0	1	1	1	1	1	1	3	10
Working on roof / scaffold	0	1	0	0	0	1	3	1	2	1	1	10
Moving portable equipment	1	0	1	3	0	1	0	1	0	0	2	9
Error	0	2	0	0	0	0	1	1	1	1	1	7
Pushing post or other object in the ground	1	1	0	0	1	0	0	0	2	0	0	5
Equipment failure	0	0	1	0	0	1	1	0	1	1	0	5
Other	2	2	0	1	0	0	2	0	1	1	2	11
Total	*12*	*12*	*5*	*11*	*3*	*8*	*11*	*8*	*14*	*10*	*13*	*107*

Appendices - Non-electrical workers

Table 8. Non-electrical workers - List and description of fatalities, 1998-2015

Accident number	Year	Worker category	Accident mechanism	Site	Voltage (V)	Description
WorkSafe	2012	Farm worker	Equipment failure - Overhead line	Farm	11,000	An 11 kV power line was hanging low to ground, the farmer was electrocuted. Wife severely injured.
WorkSafe	2011	Unspecified / Other	Moving mobile plant or truck			A boat repairer was erecting flapoles. The gantry contacted overhead power lines during transit.
WorkSafe	2009	Farm worker	Moving mobile plant or truck	Farm	22,000	Double fatality - A couple of farmers were electrocuted when boom from tractor struck high voltage power lines.
090114-03	2008	Farm worker	Moving portable equipment	Farm	66,000	A farmer installing an agricultural electric fence received a fatal electric shock and another farmer who came to assist was injured. The fence was laid on the ground beneath a 66kV power line. When the fence wire was pulled up it contacted the overhead power line. Compliance with ECP34 checked positive.
2007/018	2007	Heavy equipment operator	Moving mobile plant or truck	Work site	22,000	A truck driver received a fatal electric shock when the truck-mounted crane he was operating contacted the 22kV OH line. The operator unloaded pipes somewhere other than instructed.
2007/064	2007	Farm worker	Moving mobile plant or truck	Farm	230	A farm worker drove a tipped trailer into a live LV line supplying power to a shed. He got down from the tractor and when he stood on the ground with his hands still touching the vehicle he received a fatal electric shock.
2006/010	2006	Roofer	Working on roof / scaffold	Farm	11,000	Roofing contractor received fatal electric shock from physical contact with OH line. Was working on farm shed roof, which was 1.5m away from OH lines. Shed had been built by farmer.
2006/021	2006	Heavy equipment operator	Moving mobile plant or truck	Work site	11,000	Concrete pump operator received fatal electric shock when pumping boom he was operating came in contact with 11kV OH line. Boom remote control may have been faulty.
2003/012	2003	Farm worker	Equipment failure - Overhead line	Farm	230	A farmer received a fatal electric shock as he was attending to a dead cow in a paddock during a storm. He was unaware that the cow was lying on fallen line. The protective fuses did not operate due to high resistance of current path. Condition of the old lines had been noted but not considered an immediate danger.
2002/047	2002	Fitter	Moving mobile plant or truck	Farm	11,000	Two fitters were trying to fit irrigation structure to chassis of unit when irrigator arm swung up and made contact with an 11kV OH line, resulting in one fatal shock and burns to the other worker.
2001/001	2001	Farm worker	Moving portable equipment	Farm	11,000	An orchard worker received a fatal electric shock when he raised an aluminium irrigation pipe into the air and made contact with an 11kV OH line. He had been instructed not to raise pipe.
2001/074	2001	Unspecified / Other	Moving mobile plant or truck	Industrial	11,000	A sawmill owner and a mechanic were repairing a hoist on a truck under 11kV OH lines. At some point the hoist was lifted and made contact with the line, causing the mechanic to receive a fatal shock and the sawmill owner to receive a shock.
2001/077	2001	Farm worker	Moving mobile plant or truck	Farm	11,000	Apiarist received a fatal electric shock when metal boom of truck-mounted crane contacted an 11kV OH line. Another person received a shock when he went to assist.
1998/072	1998	Farm worker	Moving portable equipment	Farm	11,000	The stock manager at a farm property raised an irrigation pipe (probably to shake a rabbit from the pipe) when it contacted an 11kV OH line, resulting in a fatal electric shock.

Appendices - Voltages

Table 9. General public - Accidents by voltage, 1998-2015

Accidents by voltage (in V)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	1998-2005 frequency	2006-2015 frequency
230	1	2	2	2	1	2	4	1	2	3	3	1	4	3	1	1	1	1	1.9	2.0
400				1		1	3	2		2	1	2		1	1		1		0.9	0.8
11000	2	1	1	2	2	5	4	1		1	2			1	1	1	1		2.3	0.7
33000				2	2				1		1								0.5	0.2
66000							1												0.1	0.0
110000				1															0.1	0.0
220000												1							0.0	0.1
Unknown										1				1					0.0	0.2
Total	*3*	*3*	*3*	*8*	*5*	*8*	*12*	*4*	*3*	*7*	*7*	*4*	*4*	*6*	*3*	*2*	*3*	*1*	*5.8*	*4.0*

Table 10. Non-electrical workers - Accidents by voltage, 1998-2008

Accidents by voltage (in V)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Frequency
230		1	1			2	3	1	5	3		1.5
400	1	3				2	1	1	1	3	2	1.3
6,600	2	1										0.3
11,000	8	6	2	11	2	4	4	3	6	2	9	5.2
22,000		1								1		0.2
33,000			2		1		2	2	1	1	1	0.9
66,000											1	0.1
110,000	1							1				0.2
220,000							1					0.1
Unknown									1			0.1
Total	*12*	*12*	*5*	*11*	*3*	*8*	*11*	*8*	*14*	*10*	*13*	*9.7*