A response to the Review of Queensland's *Electrical Safety Act 2002* – key definitions and emerging technologies

Discussion paper

Electrical Safety Office
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Queensland Government

Contents

1.0 Have your say

This is an opportunity for community members, industry and registered industrial organisations to provide feedback on both the recommendations of the Review of Queensland's *Electrical Safety Act 2002* Final Report and three key issues detailed in this discussion paper. These three issues explore electrical safety considerations of new and emerging technologies, the changing landscape of electricity and the workforce and understanding, and electrical safety and electric vehicles.

Feedback on this discussion paper will be used to inform Government consideration of options and provide an informed, objective and transparent basis for decision making. All interested parties are invited to provide a response to the specific issues raised in this discussion paper by **27 June 2023**.

Feedback on the other topic areas and recommendations of the final report will be used to inform Government consideration and will help in developing an approach to implementation. Responses to the matters raised in the final report (beyond the particular issues raised in this discussion paper) are due by **15 August 2023.**

It is important that everyone has a voice in this process, noting some parties may not have partaken in the review process.

Responses can be sent to espolicy@oir.qld.gov.au

Confidentiality

In the interests of transparency and to promote informed discussion, the Office of Industrial Relations (OIR) would prefer responses to be made publicly available where possible. However, if a person making a response does not want that response to be public, that person should clearly note a preference for confidentiality in the response.

While OIR will endeavour to identify and protect material claimed as confidential, as well as the personal information of a respondent, if an application is received under the *Right to Information Act 2009* (Qld) for this material, there is no guarantee that information will not be disclosed.

2.0 Introduction

The first electric light entered Queensland homes in the 1800s. Since that time, electricity and related technologies have transformed, alongside the regulation of electricity and electrical safety. The electrical equipment used in Queensland homes, workplaces and communities has also undergone rapid transformation with the invention and adoption of new and emerging technologies that make energy generation, storage and use accessible for the whole community. While greatly benefitting society, electricity is dangerous. It poses a risk that we cannot see, but it is all around us every day. It is important that Queenslanders are protected from electrical safety risks, without being unnecessarily hindered as they go about their daily lives.

Queensland's electrical safety framework

The Queensland Government's dedicated electrical safety framework (ES framework) seeks to manage the risks presented by electricity to prevent death, injury and the destruction of property. The enabler of the ES framework is dedicated electrical safety legislation; namely the *Electrical Safety Act 2002* (Qld) (the Act). The ES framework, including the Act, the *Electrical Safety Regulation 2013* (the Regulation), codes of practice, and Australian Standards, supports safe access to electricity and use of electrical equipment in our workplaces, homes, schools and hospitals.

The Electrical Safety Office (ESO), which is part of OIR, is established pursuant to the Act to regulate electrical safety risks. This includes compliance and enforcement regulation of prescribed electricity entities, compliance of electrical equipment, participation in the development of national and international minimum safety standards, occupational and contractor licensing, accreditation of auditors and certification of equipment certifiers, and education and awareness. The ESO also administers the Electrical Equipment Safety System (EESS); the national framework for a consistent approach to equipment safety in participating jurisdictions.

The Act contains three key concepts that define the scope of the ES framework's regulatory reach: 'electrical equipment', 'electrical installation' and 'electrical work'. When equipment is considered 'electrical equipment' for the purposes of section 14 of the Act, it becomes subject to requirements under the Act. This includes duties of care, the Minister's recall powers and incident and reporting requirements. As such, the precise meaning of the technical term 'electrical equipment' is fundamental to which equipment is, and is not, regulated by the ESO. At present, the term is defined by way of a threshold level of volts. Equipment that is of greater than 'extra low voltage' (ELV) is within the definition of 'electrical equipment' with few exceptions. The Act defines 'electrical installation' to mean a group of 'electrical equipment' that is permanently electrically connected.[1] Finally, work involving 'electrical equipment', or an 'electrical installation' is considered to be 'electrical work',[2] which in turn necessitates licensing by the ESO (being a full licence or restricted licence) and/or supervision requirements in order to undertake these forms of work. Each element of electrical equipment', 'electrical installations' and electrical work' have nuances where exclusions apply to 'electrical equipment', 'electrical installations' and electrical work' have nuances where exclusions apply to particular categories of equipment, situations or occupations.

[1] See section 15 of the *Electrical Safety Act 2002* (the Act).
[2] Section 16 of the Act.

Examples of 'electrical equipment' and 'electrical installations'

The purpose of the ES framework is to prevent death, injury and the destruction of property caused by electricity. Electrical risks align to this legislative purpose as follows:

- death – caused by electrocution, fatal electric shock and electrically initiated fire.
- injury – caused by electric shock, burns and arc flash.
- property damage and destruction – caused by electrically initiated fire.

Examples of common items of equipment that fall within the definition of 'electrical equipment' are stoves and electric hot water systems, which can both operate at 240V AC (therefore above the 50V AC definition of ELV). An example of portable 'electrical equipment' are pedestal fans that operate at 240V AC. An everyday piece of household electrical equipment, a pedestal fan can pose an electrical hazard when they are faulty or defective, resulting in risks including electric shock, burns and fire. The potential harm these risks can pose are severe, including death and injury. Defective electrical equipment impacts consumers who own the equipment, in addition to electrical workers who may work on the equipment.

The likelihood of harm occurring is reduced through the ES framework, which places duties throughout the supply chain to ensure the equipment is safe and compliant before it reaches the consumer. Recall powers and prohibition powers are also established by the ES framework in respect of electrical equipment. Additional protections further reducing the likelihood of harm occurring are provided through the EESS. Another electrical hazard posed by pedestal fans is unsafe electrical work, this poses risks including electric shock and burns which can result in severe injury or death. Unsafe work primarily impacts the person undertaking the work, however, can also extend to those using the equipment subsequent to the work. The likelihood of harm occurring is reduced through the ES framework where a licensing requirement exists to work on this equipment mitigating the likelihood of unsafe work by ensuring only those with specialist knowledge and skills to work on the equipment safely can undertake the work.

For items captured within the electrical equipment definition, a number of regulatory levers are available to respond to critical risks to life and property. These levers are a responsive mechanism for the ESO, Regulator and the Minister to protect the community from immediate risks. An example of the use of one of these levers involved particular models of misting fans in 2020.

Effective 9 June 2020, particular models of misting fans were recalled due to easily contactable parts of the fan being 'live' which could cause electric shock. This is a specific example of an immediate electrical risk (electric shock causing injury) via 'electrical equipment' (a misting fan, and particularly exposed live parts within it). The recourse to Ministerial recall was enabled by these fans being greater than ELV and therefore within the definition of 'electrical equipment'.

Changing electrical landscape

The rate of technological change has never been as swift as it is now. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Chief Executive Dr Larry Marshall has described this change as a tidal wave of disruption and stated that it is critical to get ahead of it.[3] The rate of technological change is impacted by many global trends including climate change, energy security, scarcity of resources, mass production and changes to our lifestyles.

[3] Seven megatrends that will shape the next 20 years - CSIRO.

New electrical technologies offer exciting advancements that will improve lifestyles and reduce carbon emissions, however, the risk profile associated with these new technologies – from different electricity generation and distribution methods through to portable battery packs – must be considered and assessed.

Renewables and emerging technologies

Since the establishment of Queensland's ES framework in 2002, the landscape in which Queenslanders interact with electricity has changed immensely. New risks are emerging with the rapid transformation of the electricity grid, renewable energy technologies and the increase in consumer interaction with electricity, energy storage and electrical equipment. However, in parallel, new and innovative uses of existing technology is presenting new electrical safety risks. Further, the way in which skilled workers work safely with electricity is also evolving to keep pace with technological advancement and adoption.

The pace of change is now unlike anything Queensland has experienced in the past. Noting the growing focus and reliance on new and emerging technologies, particularly renewables, the landscape will continue to change. This transformation involves the increasing commonality of equipment with novel electrical risk profiles and while, in general, this equipment includes improved safety features, the risk of injury, death and property destruction must be appropriately managed. As risks are better understood, community, industry and the Government's ES framework must be positioned to adapt.

Government energy transformation policy and trends

We are seeing an increasing and mutually reinforcing shift in both energy generation technology and focus on re-prioritised energy policy across the globe. It is no different in Queensland. The Queensland Government has committed to transition and transform Queensland's electricity grid to ensure clean, reliable and affordable energy for the future. Spurred on by renewable energy targets and an accessible economic landscape that encourages both public and private investment into renewable energy projects, the way that Queenslanders interact with electricity, and how workers and businesses operate is being transformed.

In September 2022, the Queensland Energy and Jobs Plan (QEJP) was released. The QEJP's vision is to ensure clean, reliable, and affordable energy providing power for generations. The QEJP has coverage from 2022 to 2035 and seeks to achieve a number of outcomes for Queensland's electricity system. Driving the QEJP are Renewable Energy targets of:

- 50 percent renewable energy by 2030
- 70 percent renewable energy by 2032
- 80 percent renewable energy by 2035.

The Queensland Government has released a number of other strategies, plans and initiatives to guide the energy transition across community, industry and government. These include, but are not limited to:

- The Queensland State Infrastructure Strategy (released in June 2022) includes objectives of realising our future as a renewable energy superpower, creating liveable communities, connecting our regions and building a Brisbane 2032 legacy. The 1,022 projects outlined in the strategy have a combined value of over $14 billion and all include significant electrical installations, electrical work and electrical equipment. These energy projects are spaced throughout Queensland with a particular focus on regional Queensland.
- The Brisbane 2032 Olympic and Paralympic Games (the Olympics) is being positioned as a carbon neutral event and will include renewable energy installations.

- The Queensland Zero Emission Vehicle Strategy 2022-2032 and the Zero Emission Vehicle Action Plan 2022-2024.

In addition, Construction Skills Queensland (CSQ) released Queensland's Renewable Future (August 2022), which considers the pipeline of renewable energy projects in Queensland and the impact on investment, jobs and skills.[4] The report and subsequent interactive data on the CSQ website identified 217 projects that may proceed to delivery with a combined estimated value of $73.4 billion.[5]

To respond to the growing focus on a net zero and renewable future, consumers, industry and government are shifting the use of existing technology and are welcoming new technologies.

Reviewing Queensland's ES framework

In 2019, safety concerns regarding large scale solar farms escalated, resulting in legislative change. However, it was determined that the regulations about safety on solar farms did not fall within the powers granted under the Act.

In response, on 25 June 2019, the Queensland Minister for Education, Minister for Industrial Relations and Minister for Racing, the Honourable Grace Grace MP (the Minister), announced that the Commissioner for Electrical Safety, Mr Greg Skyring (the Commissioner), would lead discussions on safety in large-scale solar farms.

In January 2020, the Commissioner delivered findings and recommendations to the Minister in the form of the Improving Electrical Safety in Queensland: A Report by the Commissioner for Electrical Safety (the Commissioner's Report). The first recommendation of the Commissioner's Report was that the Queensland Government should undertake a review of the Act, including the objects of the Act and regulation-making powers, to ensure it is fit for purpose and can keep pace with new and emerging technologies.

In August 2020, the Minister announced the *Review of Queensland's Electrical Safety Act 2002* (the Review), to be undertaken by an external independent reviewer with the support of a departmental secretariat within OIR. In December 2020, Mr Dick Williams was appointed as the Independent Reviewer (the Reviewer), with the Review's terms of reference requiring consideration of:

- all definitions under the Act to ensure relevance and effectiveness
- all duties and requirements under the Act and Regulations, including on suppliers and generating entities, to ensure relevance and effectiveness
- how the Act can be future proofed for other emerging energy technologies, including renewable energy generation and storage devices
- aligning the provisions of the Act with Queensland's work health and safety legislative scheme under the *Work Health and Safety Act 2011* (Qld) (WHS Act)
- how any recommendations resulting from the review will create public value by enhancing Queensland's ES framework (increasing the net benefit to the community through evidence based legislative and/or regulatory change).

In December 2021, a Final Report containing 83 recommendations was provided to the Government. The Review was broad and comprehensive, reflecting the significant technological advancements that have occurred in the last 20 years, particularly in energy generation and storage. Ensuring that Queensland's ES framework remains fit for purpose in the wake of significant technological advancements forms the basis of a number of key review recommendations. Many of these recommendations pertain to the scope of the legislation and definitions of key terms used throughout.

[4] Construction Skills Queensland 2022. Queensland's Renewable Future: investment, jobs and skills. CSQ, Brisbane, Australia.
[5] Renewables Projects | CSQ.

Beyond this, the recommendations are comprehensive in providing reform proposals across the breadth of the ES framework.

Discussion paper

Given the expansive nature of the Review, this paper focuses on issues relating to emerging electrical safety risks and how they intersect with key concepts in the ES framework, being the definitions of 'electrical equipment', 'electrical installation' and 'electrical work'. As these concepts define the scope of the ESO's regulatory powers and trigger various duties, reporting and licensing requirements, they have a wide-reaching impact across the framework and across industry. As such, community feedback is paramount in deciding on the dimensions of a contemporary ES framework.

Consultation

Community input is sought on central topics of emerging technologies and the Act's key definitions. While this paper is limited to these key issues, OIR welcomes feedback on all recommendations made by the Review. This will assist Government in developing an approach to implementation, by providing key insights and ensuring everyone has a voice in this process, noting some interested parties may not have engaged in the consultation processes conducted by the Review in 2021.

2.1 Overview of Discussion paper

This paper explores three core topics, providing information on the issue (problem definition), options for addressing the issue and questions for community and industry consideration.

Table 1: Overview of topics

	Topics	Part 3
1	Electrical safety considerations of new and emerging technologies	Section 3.1
2	Changing landscape of electricity and the workforce	Section 3.2
3	Electrical safety and electric vehicles	Section 3.3

Topic 1 considers the risks and options presented by emerging technologies related to energy generation, transmission, distribution (including energy storage) and utilisation (equipment changes relevant to the emerging technology or expanded uses of existing technology). This includes the relationship between the 'electrical equipment' definition and extra low voltage equipment, including solar photovoltaic[6] (PV) modules and related renewable energy technology equipment.

Topic 2 considers the changing nature of work in relation to electricity and emerging risks due to technological advancement and how work is conducted. This includes whether existing exemptions under the 'electrical work' definition contemplate risks identified in the Review.

Topic 3 looks specifically at the electrical safety risks presented by electric vehicles and considers the existing education and training landscape, current licensing requirements and the shape of an electrical safety framework into the future. While this topic area could be considered under the broader definition of 'electrical equipment' (Topic 1) and 'electrical work' (Topic 2), its emerging ubiquity, diversity and interest to consumers, industry and various regulators have led to standalone treatment in Topic 3.

[6] Photovoltaic refers to cells converting light into electricity at an atomic level.

3.0 Detailed options statements

3.1 Electrical safety considerations of new and emerging technologies

Current regulatory framework

Queensland's dedicated ES framework has been briefly summarised at Part 2.0 (Introduction). Among other matters, it was noted that the Act establishes:

- duties, including a primary duty of care and duties regarding designing, manufacturing, importing, suppling, installing and repairing electrical equipment
- licensing, accreditation and certification requirements relating to installing, auditing and certifying electrical equipment and its installation
- Ministerial recall orders if it is or will place persons or property at risk
- incident and other reporting requirements
- classification, registration and certification requirements, including in relation to a national register.

It was further noted at Part 2.0 that three key concepts define the scope of the ES framework's regulatory reach: 'electrical equipment', 'electrical installation' and 'electrical work'. The ES framework does not regulate all equipment that operates electrically. Rather, the technical term 'electrical equipment' defines what is regulated by the ES framework via the following definition (section 14 of the Act):

14 Meaning of electrical equipment

(1) Electrical equipment means any apparatus, appliance, cable, conductor, fitting, insulator, material, meter or wire that—
  a) is used for controlling, generating, supplying, transforming or transmitting electricity at a voltage greater than extra low voltage; or
  b) is operated by electricity at a voltage greater than extra low voltage; or
  c) is part of an electrical installation located in an area in which the atmosphere presents a risk to health and safety from fire or explosion; or
  d) is, or is part of, a cathodic protection system.

(2) Electrical equipment does not include any apparatus, appliance, cable, conductor, fitting, insulator, material, meter or wire that is part of a vehicle if—
  a) the equipment is part of a unit of the vehicle that provides propulsion for the vehicle; or
  b) the electricity source for the equipment is a unit of the vehicle that provides propulsion to the vehicle.

Broadly, the concept of 'electrical equipment' is defined by way of a threshold; namely those forms of equipment with voltage 'greater than extra low voltage'. Only equipment that falls within the definition of 'electrical equipment' becomes subject to requirements under the Act. This includes duties of care and incident reporting requirements. Therefore, the scope of the meaning of 'electrical equipment' dictates the kinds of equipment the ESO regulates.

Where items are excluded from the "electrical equipment" definition, this has secondary impacts, most notably excluding them from electrical work licensing requirements, supply chain duties and incident notification requirements.

Sub-sections (c) and (d) are exceptions to the rule, as they define specific forms of 'electrical equipment' without reference to a minimum voltage threshold. Further, the definition of 'electrical equipment' also contains exclusions for some elements of a vehicle at section 14(2) of the Act (electric vehicles are discussed further at Part 6.0 of this paper). That is, even if those parts are greater than extra low voltage, they are currently excluded from the definition of 'electrical equipment'.

Exceptions aside, voltage levels play the central role in the definition of 'electrical equipment'. Three levels are recognised throughout the Act, defined as follows:

> ***extra low voltage*** means voltage of 50V or less AC RMS, or 120V or less ripple-free DC.
> ***low voltage*** means voltage greater than extra low voltage, but not more than 1,000V AC RMS or 1,500V ripple-free DC.
> ***high voltage*** means voltage greater than low voltage.

Related to the concept of 'electrical equipment' is 'electrical installation', defined by section 15 of the Act. Essentially, an 'electrical installation' is a group of items of 'electrical equipment'. An example is the permanently connected switchboard, wiring, lighting and socket outlets in a house.

> ***15 Meaning of electrical installation***
> (1) An electrical installation is a group of items of electrical equipment that—
> a) are permanently electrically connected together; and
> b) can be supplied with electricity from the works of an electricity entity or from a generating source; and
> c) do not include items that are works of an electricity entity.

3.1.1 Problem identification

Relationship between current regulation and energy transformation

As noted in Part 2.0, the landscape in which Queenslanders interact with electricity has changed significantly since 2002. Technology with novel electrical risk profiles falling outside the Act's ambit is increasingly common. In particular, extra low voltage (ELV) equipment has proliferated in diverse forms but is not captured as part of the definition of 'electrical equipment'.[7]

At the time the Act was introduced, it was considered that ELV equipment had a low risk profile. This equipment usually operated at the lower end of ELV, such as 9V or 12V. Devices of greater power tended to be LV plug-in or fixed wired equipment, with the main types of battery equipment being devices such as torches, clock radios and other devices with replaceable, non-rechargeable batteries.

At that time, the potential harm of defective equipment or unsafe work on ELV equipment was viewed as mild and not requiring government intervention such as that applying to LV equipment.

The example of solar, explored in detail below, is important and instructive – a single solar panel is ELV and therefore not a form of 'electrical equipment'. When not connected to form an array that adds up to being LV, it is currently not captured by the 'electrical equipment' definition and therefore

[7] The Act provides for only two exceptions: where the equipment is part of a *cathodic protection system* or where the equipment is part of an electrical installation located in an area in which the *atmosphere* presents a risk to health and safety from fire or explosion: s 14(2).

the specific regulatory requirements under the ES framework do not apply, including, amongst others, supply chain duties, licensing requirements, recall duties and incident notification duties.

Where technology operates at LV or HV and fits within the confines of the 'electrical equipment' definition, it is already captured by the ES framework (see the example in Part 2.0). Certainly, the ambit of new and emerging technologies extends to LV and HV. However, given the structure of the ES framework, this paper's focus is on new and emerging electrical technologies operating at ELV.

It is important to note, however, that not all ELV equipment has evolved. For instance, replacing AA batteries, and charging and replacing batteries in items such as a battery-powered drill, are not considered to pose risks requiring consideration of a regulatory response.

Other safety regulations

Where electrical items of any voltage are present in a workplace, the Act's primary duty of care applies.[8] This requires the person conducting the business or undertaking to ensure the workplace is electrically safe. Further, under Australian Consumer Law, businesses must meet a set of basic consumer guarantees when they sell products or services, which applies to electrical items both in and out of the Act's scope.

Finally, the EESS is a regulatory framework aimed at increasing consumer safety in household electrical equipment throughout participating jurisdictions in Australia and New Zealand. The household equipment captured by the EESS is defined as 'in-scope equipment'. The EESS forms Part 2A of the Act. As the EESS covers only LV items,[9] the relevant technologies considered in this paper are not presently captured as in-scope equipment by the EESS. Therefore, requirements for supplier registration and for equipment imported to be registered do not apply. Consultation with participating jurisdictions would need to occur to consider any amendment to the EESS status quo.

Electrical Safety considerations of ELV equipment

There are various forms of new and emerging technologies that often operate at ELV, including solar PV panels, Battery Energy Storage Systems (BESS) and rechargeable battery packs. The context for solar PV panels can range from household rooftops to large scale solar farms.

<u>Solar PV</u>

The scale of solar uptake and consequent workforce changes are briefly noted in the context of the general growth in renewable energy generation, before considering the potential electrical safety risks.

Scale of solar usage and renewables generally

The use of solar PV cell technology is continuing to become increasingly common. Being installed anywhere from caravans to household rooftops to commercial (large scale) solar farms, PV solar is diverse and continues to be a significant contributor to meeting renewable energy targets.

As of 31 July 2022, there were a total of 885,000 rooftop solar systems in Queensland. Installation numbers have grown exponentially; with 475 occurring in 2007 to 89,971 in 2021.

[8] Section 30 of the Act.
[9] Section 48B of the Act.

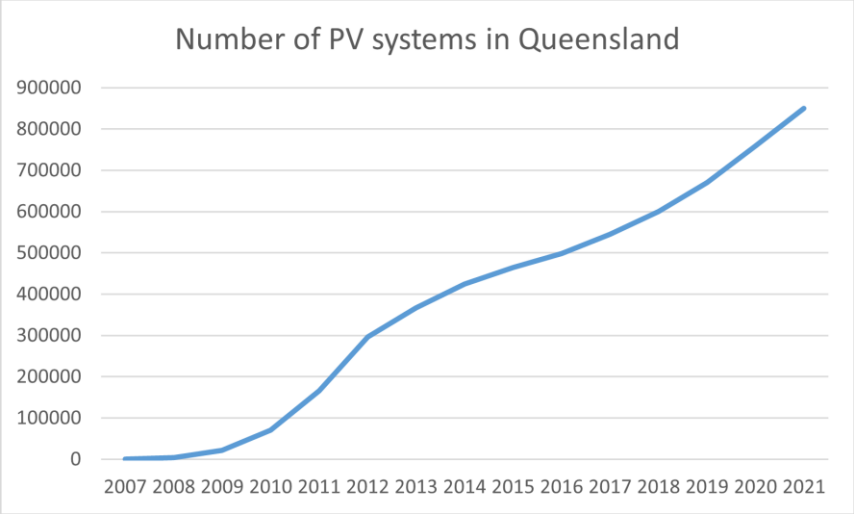


Figure 1: Number of PV systems in Queensland

As of June 2022, 21.4 percent of Queensland's energy was derived from renewable energy sources, with a combination of rooftop solar, commercial solar, wind, hydro and bioenergy. Independent modelling indicates significant projected growth in a variety of renewable sources of electricity; including solar PV (see Figure 2).[10]

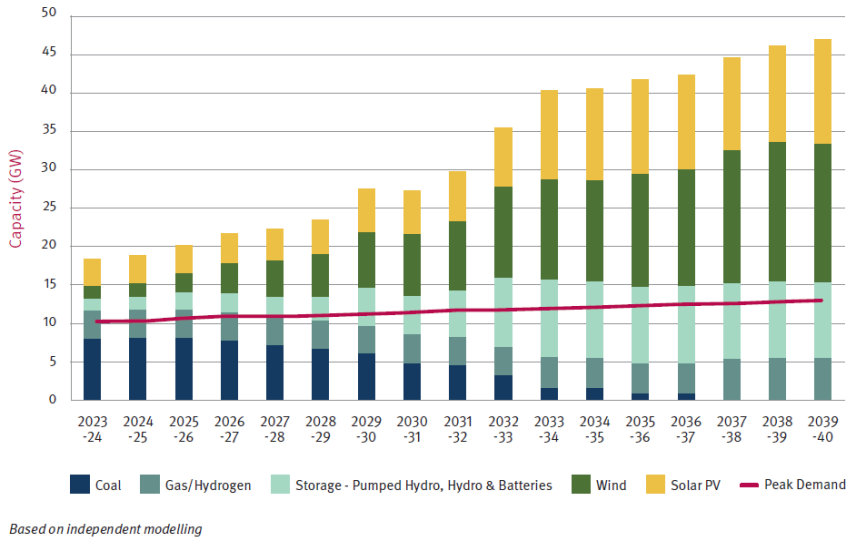


Figure 2: Projected growth of electricity sources

Contexts of solar usage

It is useful to distinguish two common contexts in the use of solar that differ significantly in size and scale: rooftop solar, such as that on domestic properties, and solar farms.

Rooftop solar

Interactions with energy generation in a domestic context, mainly through rooftop solar, has only emerged in the last two decades. Previously, electricity generating systems were the purvey of large electricity entities alone. Now, energy generation is available to renters and homeowners as well as to those operating businesses and community facilities such as schools, sporting facilities, retail centres and car parks. In these residences, commercial and community settings, there are often scenarios where several solar panels (also known as a PV array) are linked and then connected with a BESS and an inverter to form an energy generating and storage system. This example of equipment connected to form a system can occur in a form that is either at ELV but has high energy capacity

[10] *Queensland Energy and Jobs Plan 2022.*

(and outside the scope of the Act), or it could result in a system that operates at LV, with similar high energy density but also higher voltages, and is therefore covered by current regulatory scope of the Act.

Solar farms

Solar farms have components of electrical equipment that operate individually at ELV in the form of solar PV panels, but, when installed, operate or transmit electricity at above ELV. Solar farms may have systems with components of AC and DC systems and voltages at ELV, LV and HV. Solar farms may also have assemblies of large pre-installed equipment such as switchboards or switch rooms.

Solar farms include AC and DC electricity at differing voltage levels, different sources of electricity and different conductive material such as PV solar array and modules which are considered to be live (energised) as soon as they are removed from packaging.

Workforce and community interactions

Changes to the energy generation landscape have caused more workers to interact with renewable energy technologies or work in new ways with existing electrical equipment. For example:

- new supply chain opportunities due to the demand for solar and the opening of business opportunities to assist with the supply of this technology in Queensland. Often this technology is not designed and manufactured in Australia, but instead is imported from overseas. While this is not a concern in itself, it can translate to less direct regulatory oversight.

- work to install solar, and the emergence of a workforce dedicated to that task in both roof tops and in solar farm contexts. This work spans both labourers and electrical workers depending on the activity and the voltage of the solar panel. This is further explored below.

- work to maintain the solar, including the emergence of a maintenance industry for this technology.

- work to disconnect and dispose of equipment that has reached the end of its working life or is no longer required or wanted.

Workers involved in these forms of work include licensed electrical workers and contractors, labourers in labour hire arrangements and employees and contractors of Government Owned Corporations. Input on other workers involved is appreciated through written responses to this paper.

Electrical safety risks and incidents

Solar installations of all types, including domestic, commercial and solar farms, pose certain electrical safety risks. Work on this equipment, when connected, may result in the joined equipment operating at a higher voltage than the individual pieces of equipment and therefore, at an increased voltage which changes the risk profile of this work, and the harm posed.

Further contributing to the risk profile for ELV solar panels is that unlicensed individuals may lack specialist technical knowledge in how to comprehensively manage electrical safety risks. Technological developments, which allow a variety of ELV equipment to be combined, heighten this risk.

Work on solar farms includes establishing the solar farm initially, by locating, mounting, fixing and connecting solar panels, as well as ongoing maintenance, and finally, disconnection. The electrical aspects of a solar farm pose a number of specific risks; exemplified by several incidents that have affected workers at solar farms in Queensland.

Where defective or unsafe work, including the installation of defective equipment, is undertaken at the construction stage of the solar farm, an increased risk is posed to those completing maintenance. This risk of harm therefore extends beyond electrical workers to labourers undertaking maintenance. These risks can lead to electric shock, arc flash, and fire, which can ultimately result in injury, death and damage to property and equipment.

In the case of rooftop solar, unsafe work or defective equipment can expose the community to these risks.

The risks are comparable to those seen in a traditional electrical installation such as that of the switchboard, wiring, lighting, socket outlets and other electrical equipment permanently connected for a house or residential unit. These traditional installations are captured within the scope of the ES framework under the definition of 'electrical installation' and therefore receive additional regulatory oversight.

From 2015-16 to the present, there have been nine serious electrical incidents relating to solar installations.[11]

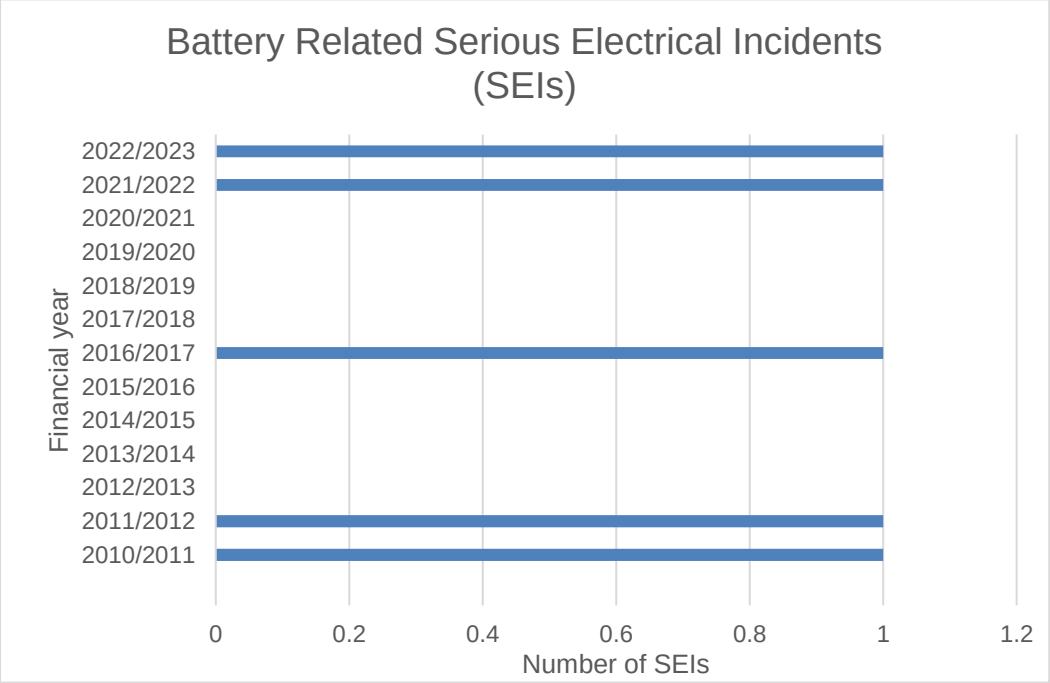


Figure 3: Solar related serious electrical incidents in Queensland

These figures do not include incidents outside of the legislative definitions (and therefore the reporting requirements) of a 'Dangerous Electrical Event' or 'Serious Electrical Incident'. The definition of these terms is linked to the definition of 'electrical equipment' and therefore to equipment at LV or HV (but not ELV).[12] As such, the ESO may only become aware of an incident involving ELV where the incident is very serious or causes a fatality. This means the data available to the ESO in relation to renewable energy and other ELV technology is incomplete. It is hoped that written responses to this paper will elicit further data on ELV incidents.

As an example, in 2021, a homeowner was changing and reconfiguring solar panels when fatally electrocuted. While this incident was reported, due to the solar panels operating at ELV it did not meet the definition of a 'Serious Electrical Incident'. This incident highlights the risk posed by the energy stored in ELV equipment and the seriousness of the consequences, including injury and death.

[11] Electrical Safety Office SEI Data 2015/16 to 2022/23.
[12] Sections 11 and 12 of the Act.

The ESO is only notified of incidents relating to renewable energy technologies, such solar installations, where the incident arises from 'electrical equipment'. Incidents arising from equipment that falls outside of the current definition of 'electrical equipment' are not currently notifiable. As an example, in the first quarter of 2023 in the Gold Coast and Ipswich regions of Queensland, ESO Electrical Safety Inspectors have responded to five separate incidents involving smart meters connected to solar PV installations. These incidents involve an equipment failure that resulted in a loss of energy supply, damage to property (through fire) and electric shock to occupants. These renewable energy installations range in age from being established between 2019 to 2022.

Knowing that these risks arise and that the current ES framework is limited in its ability to encapsulate these gives rise to the question of the most appropriate measure for reducing or eliminating the potential for harm. Options are considered at [3.1.3], below.

Electrical installations

Reflecting the previously centralised energy generation landscape, the current definition of 'electrical installation' includes a criterion that an electrical installation 'can be supplied with electricity from the works of an electricity entity or from a generating source.' In practice this creates an ambiguity where energy generation systems, such as solar farms, may be excluded from this definition as they are not 'supplied with electricity.' This may exclude solar farms from the regulatory requirements for electrical installations. As such, the definition of 'electrical installation' may need to be updated to accurately capture technologies now and into the future.

Where a solar farm has a generation capacity of 30MW or above, a generation authority would likely be gained through the Department of Energy, resulting in status as an 'electricity entity' under the Act. The 'works' of an electricity entity, being its electrical equipment and electric line-associated equipment (section 25 of the Act), are regulated by way of a duty to ensure the 'works' are electrically safe (section 29 of the Act). Solar farms are defined as having an operating capacity from 100 kw. Where energy generation systems (such as solar farms) reach a generation capacity of 30mW they reach the threshold to be a generating entity. While works of an electricity entity are excluded from the definition of 'electrical installation', there are a significant number of energy generation systems operating below 30mw that may not be captured by the 'works of an entity' or 'electrical installation' definitions.

The ES framework sets out a series of duties and regulatory requirements for both electrical installations and the works of an electricity entity to ensure the safety of this equipment and those working on it. However, as indicated above, some emerging energy generation systems may fall outside of both definitions and therefore, outside of regulatory reach.

Battery Energy Storage Systems (BESS)

Concurrent to the rise of solar and other renewable energy generation technologies is the growth in uptake of BESS. These systems consist of one or more batteries that store electrical energy for later use. These systems are a cost-effective way to store energy generated by solar and other renewable sources. Varying in size from small domestic systems designed to store energy produced from solar rooftop installations to commercial systems linked to large energy generation operations, such as solar farms, these systems are becoming increasingly common in Queensland. They can operate at ELV or LV.

As ELV systems do not meet the definition of 'electrical equipment', the ESO is unable to apply the current regulatory framework which covers electrical equipment, electrical work, electrical workers, and installations and the Minister is unable to mandate a recall on defective equipment.

As the installation is not subject to development or building approvals, the quantity and location of BESS in Queensland is unknown. However, it is understood that BESS are widely used, with the

potential to therefore impact many members of the community. Figure 4 depicts an example of a BESS arrangement, in this case connected to solar as the generating source.

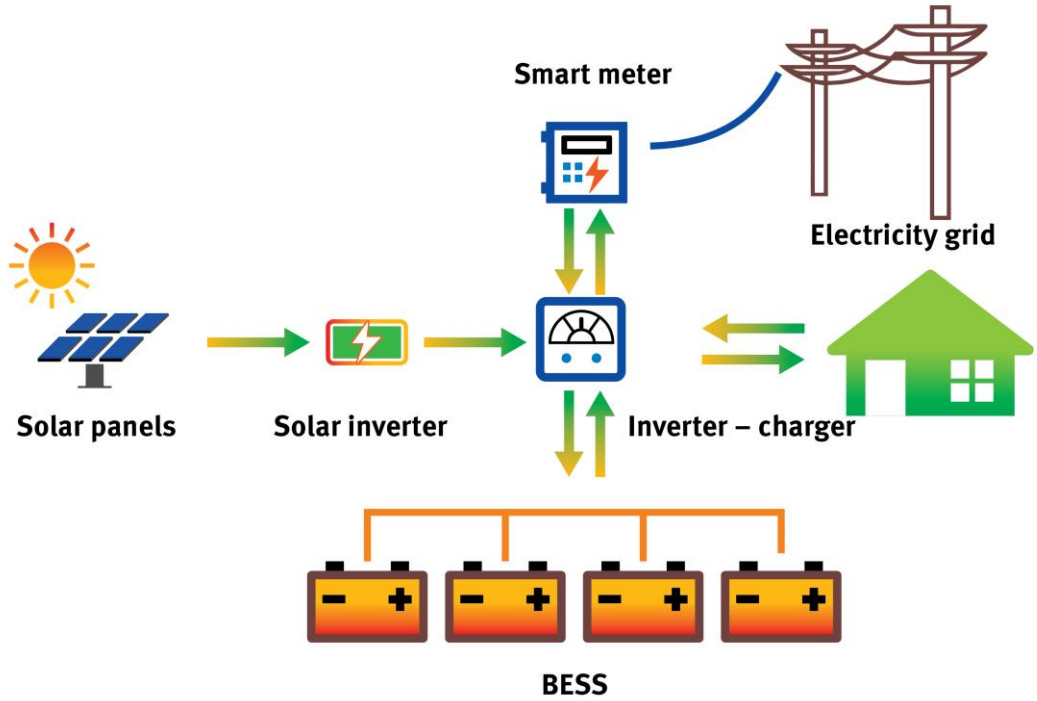


Figure 4: Battery Energy Storage System (BESS) arrangement

Much like the emergence of solar PV technology, the rise of BESS has been a significant change for the workforce and the community. Renewable energy targets and financial benefits for installing BESS are likely to drive further transformation.

Workforce and community interactions

Potential impacts for community and workforce begin at the supply chain, where the demand for this technology has opened opportunities for design, manufacture, supply and importation.

Beyond the supply chain, a workforce has also emerged that installs BESS. Installation includes the locating, mounting and fixing of the technology, in addition to the connection of an inverter and connection to form an electrical installation as well as generation technology such as a solar PV array. Figure 4 depicts this. Feedback is sought on the composition of the workforce completing this work. The workforce is currently understood to include licensed electrical workers and contractors, labourers, unlicensed members of the community and workers for electricity entities.

Naturally, BESS requires maintenance and, at the end of its life, disconnection, removal and disposal. These emerging areas of work will continue to expand as technology ages and reaches the end of its life.

The community also has a growing interaction with BESS through its increased presence in residential settings, in community precincts and in workplaces. This increased interaction can amplify the risks posed by this equipment.

Electrical safety risks and incidents

BESS can have significant energy storage capacities, and pose potential risks that lead to fire, explosion flash (sudden uncontrolled release of the stored energy creating arc flash risk (even at ELV)), exposure to hazardous chemicals and/or electric shock.

Without adequate maintenance of a BESS and replacement of aged parts, the risk of harm occurring through fire increases.[13] This risk of harm is increased where there is defective equipment, or interference with the equipment results in damaged parts. Work on this equipment can pose a risk of electric shock, arc flash or exposure to hazardous chemicals. The growing presence of BESS in the community means there is the potential of increased exposure of people to the risks. From 2010-2011, there were five SEIs (under the current ES framework) relating to batteries (see Figure 5 below).[14]

These SEIs include BESS, battery charging devices and batteries connected to electricity for an uninterrupted power supply. This data is limited by the current ES framework, where incidents involving ELV are not captured.

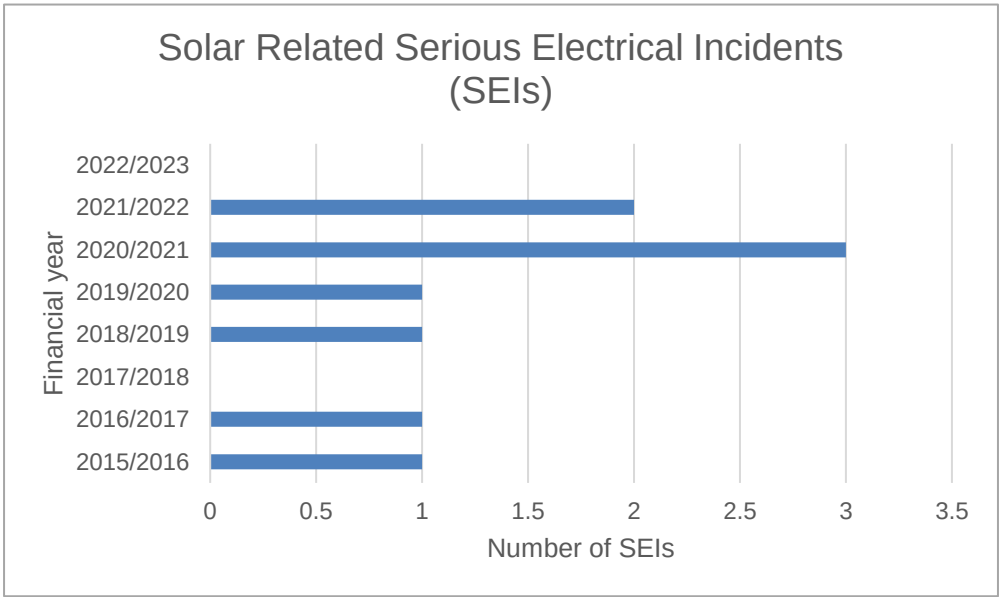


Figure 5: Battery related serious electrical incidents in Queensland

The Australian Competition and Consumer Commission (ACCC) recently urged consumers to check if their LG, SolaX or Opal home energy solar systems utilise LG solar energy storage batteries which are under recall.[15][16] The ACCC recall required electrical safety regulators across Australia, to investigate the safety of the equipment and take suitable actions to reduce the risk. The LG battery equipment had various models, some operating at LV and some operating at ELV. The basis for the recall was concern around the potential for fire.

To reduce the risk of similar incidents in the future, it is important to consider the scope of the current ES framework and consider the most appropriate measures to control risks and reduce, or eliminate, the potential for harm. Options are considered at [3.1.3], below.

Rechargeable ELV batteries

Technological advancements have also seen rechargeable ELV battery technology develop and become more widely used. This newer form of rechargeable ELV battery technology enables greater energy storage, even when operating at ELV. In contrast, small, removeable batteries, such as AA batteries, have limited energy density/storage and are an example of ELV equipment that does not pose an electrical safety risk that requires consideration of a regulatory response by Government.

The growth of rechargeable ELV batteries has seen applications proliferate, including by use of rechargeable ELV batteries in e-bikes, e-scooters, robot vacuum cleaners, garden tools and power

[13] Battery energy storage systems | Electrical Safety Office
[14] Electrical Safety Office SEI Data 2010/11 to 2022/23
[15] ACCC warns consumers about potentially deadly solar batteries | ACCC
[16] Recall of LG Energy Solution Australia Pty Ltd ESS Home Energy Storage System Batteries | WorkSafe.qld.gov.au

tools. While some of the supply of rechargeable ELV batteries (including the design and manufacture of equipment) happens in Queensland, there is also a significant proportion of product coming from outside of Queensland and Australia.

Electrical safety risks and incidents

High-capacity batteries (of multiple battery cells) contain significant energy that, if released in an uncontrolled manner, can lead to explosion and fire.

Notably, there are categories of equipment containing lithium-ion battery packs that are commonly exposed to trauma which requires thought given this can lead to a higher risk of explosion, fire and the leaking of hazardous chemicals.

More specifically, there are several factors that are understood to have led to incidents already, including:

- continuously charging once the battery charge is at capacity
- getting the battery pack wet
- battery packs getting damaged
- using a different charger than the one supplied with the product.

Risks have been evidenced by recent media reports on explosions and fires associated with eScooters (battery packs).[17] At the most extreme end of the spectrum, a rechargeable ELV battery pack was associated with a tragic fatality in Queensland in March 2022, where a person died as a result of burns from an e-scooter lithium-ion battery fire that spread to a caravan. In January 2023, it was reported that in the six months prior, Queensland firefighters had been called to 24 house fires linked to lithium-ion batteries, with 48 callouts in 2021-22. These incidents are not captured by the existing ES framework due to the current ELV exclusion, despite the clear electrical risk.

Contributing to the contemporary ELV equipment risk landscape is the increase in cheaper products on the market that are sometimes poor quality. Purchasing these products online rather than in stores can make it difficult for consumers to be as informed about the safety of these products.

Connected ELV equipment

A further contributor to the potential for harm is the rise of consumers purchasing ELV equipment online and connecting and using multiple pieces of equipment together, based on advice or instruction from social media.[18] In doing so, these individuals may elevate the voltage of the installed equipment above ELV or have modified the equipment for a use not intended by the manufacturer. In both situations there is a risk of shock if the work is not performed correctly, or events of fire, burns or explosion and arc flash. This poses risk to both persons and property. Foundational causes of this include both the competency of those connecting the equipment, the accessibility of incomplete information online and the accessibility of poorly manufactured or defective ELV equipment online.

These risks and limitations with the current ES framework give rise to the question of the most appropriate measure to control risks and reduce or eliminate the potential for harm. Options are considered at [3.1.3] below.

Interjurisdictional analysis

[17] Second e-scooter house fire in a week leaves four Ipswich residents in hospital - ABC News; and Concerns over growing number of fires linked to lithium-ion batteries in e-scooters and e-bikes - ABC News

[18] Do It Yourself Solar Power? - Easy DIY Solar Panel Installation! - YouTube; and Battery BACKUP for Home - DIY Step by Step - YouTube

Across Australia, the regulation of electrical safety has many similarities, however, it is not a harmonised framework.

The model Work Health and Safety Regulation 2011 (model WHS Regulation), coordinated by Safe Work Australia, have been adopted by several states. The model WHS Regulation contains a part on electrical safety (Part 4.7). While the regulation of electrical safety is therefore to some degree uniform, even model jurisdictions depart in places from the model WHS Regulation and/or regulate electrical safety in other legislation. Queensland, while maintaining a framework with many similarities to those contained in the model WHS Regulation, departs from the harmonised approach through the establishment of a standalone ES framework that includes a dedicated Act and Regulation that goes beyond the workplace context.

The EESS operates in participating jurisdictions across Australia and New Zealand. The EESS is expected to be reviewed in the near future. Should ELV equipment be included in the scope of the EESS, it may still not apply in Queensland under the current electrical safety framework, as the current definition of electrical equipment commences at LV.

In relation to electrical equipment, Victoria is currently the only jurisdiction in Australia to have ELV equipment in scope for electrical safety legislation. However, in November 2022, New South Wales also issued a discussion paper on the statutory review of the *Gas and Electricity (Consumer Safety) Act 2017* (NSW), which sought feedback on a proposal for NSW to regulate ELV equipment. This proposal was made in response to industry concern over potential safety risks in some ELV equipment. Similar concerns were raised in Queensland's review. The NSW discussion paper also proposed an amendment to the definition of 'electrical equipment' to include 'a battery or energy storage system, operating at any voltage, which is used to supply an electrical installation'.

Further the NSW discussion paper raised the definition of 'electrical installation'. The paper discussed changes to the definition of 'electrical installation' to include generation, and ultimately to require people working on solar and wind farms to hold an electrical licence or be supervised by a person holding a licence. In the Australian Capital Territory, under the *Electrical Safety Act 1971* (ACT), generation technology is captured under the existing definition of 'electrical installation'.

3.1.2 Objective of Government action

- To reduce the risk of exposure to electrical risk to industry and the community posed by new and emerging electrical technologies whilst minimising regulatory burden.
- To ensure the framework can remain responsive and withstand the emergence of new technologies.
- To encourage technological growth and innovation, particularly of electrical technology contributing towards Government renewable energy targets whilst maintaining an effective and efficient electrical safety framework, preventing risk to life and property.

3.1.3 Consideration of options

A number of options have been discounted for consideration as they would either not meet the objective of Government action (see 3.1.2) or could lead to problems of inflexibility in the legislation in the face of future developments.

Options discounted on this basis include either the complete de-regulation or complete regulation of electrical equipment.

A further option discounted was that of changing the definition of 'electrical equipment' by removing the existing ELV threshold and replacing it with a different threshold. Substituting the existing ELV threshold with an alternative category (such a nominated number of watts) would create similar

problems to the current definition. An inflexible threshold could not align perfectly to risk and would also limit the Regulator's ability to be responsive to future technologies. This option was therefore not explored further.

A further option considered but not determined worthy of further analysis was that of abolishing a threshold altogether, and then excluding from the definition of 'electrical equipment' certain ELV equipment by exception. While flexible, this approach is deemed vulnerable to unintended consequences and excessive regulatory burden. Further, it would require frequent review and amendment as new technologies entered the market.

In contrast to these approaches, the options explored further below have been identified as feasible.

Table 2: Overview of options

Option	Description
Option 1	Status quo: • No change – emerging technologies continue to be regulated as they are currently, which is with some falling outside of the ES framework.
Option 2	Expand the definitions of 'electrical equipment' and 'electrical installation' in the Act to: • clearly incorporate new energy generation technologies (solar PV modules), energy generation systems (e.g., solar farms), and Battery Energy Storage Systems • incorporate particular forms of ELV equipment within the definitions where there is a demonstrated risk.
Option 3	Increase education and awareness, including: • increased Government communication and engagement with electrical workers, electrical contractors, persons conducting a business or undertaking (PCBUs), unlicensed workers, and the community, on risks of emerging technologies and approaches to risk management • Government promoting standards and training development • Government providing homeowner guidance as relevant.

3.1.4 Impact analysis of the options

Some of the benefits and costs that could be raised in response to this discussion paper are detailed in the table below. These do not represent the view of the Queensland Government and are provided for indicative and discussion purposes only.

Option 1: Status quo

Table 3: Summary of potential impacts posed by option 1 (status quo).

	Benefits	Costs
Unlicensed workers	• Workers without an electrical licence will be able to continue working on ELV technology.	• Any existing exposure to electrical hazards posed through work on ELV technology without specialist technical knowledge will remain.
Licensed electrical workers	• Nil.	• Nil.
Community	• Low costs as consumers.	• Any existing exposure to electrical hazards posed through work on certain ELV technology without specialist technical knowledge will remain. • Exposure to electrical hazards from certain ELV technology through an absence of electrical safety supply chain duties will remain.
PCBUs	• No additional labour costs are required.	• Any existing exposure to electrical hazards posed through work on ELV technology without specialist technical knowledge will remain.
Electrical contractors	• Nil.	• Nil.
Supply chain	• Supply chain supplying certain ELV technology can continue without any additional regulatory burden.	• Nil.
Queensland Government	• Does not limit work opportunities for unlicensed workers. • Maximises the workforce able to work towards a net zero economy.	• Any existing exposure to electrical hazards posed through work on certain ELV technology without specialist technical knowledge will remain. • Exposure to electrical hazards from certain ELV technology through an absence of electrical safety supply chain duties will remain.

Option 2: Expand the definition of electrical equipment and electrical installation to encompass:

- ELV Solar PV Panels that are combined to reach a combined voltage of above ELV
- ELV Battery Energy Storage Systems (BESS)
- Solar PV panels on caravans
- ELV Battery packs (rechargeable battery packs for insertion into equipment or integral within equipment
- Solar farms

Table 4: Summary of potential impacts posed by option 2 (legislative change).

	Benefits	Costs
Unlicensed workers	• Mitigate exposure to electrical hazards.	• Reduced working opportunities. • Requirement to complete a formal training pathway that may include 4-year apprenticeship.
Licensed electrical workers	• Increased scope of work. • Reduced exposure to electrical hazards. • Clarity regarding licensed and unlicensed work.	Requirement to report incidents to the Regulator.
Community	• Reduced exposure to fire and shock. • Continued benefit of emerging technologies • Clarity regarding licensed and unlicensed work	• Limits the scope of DIY work. • Cost for work on equipment.
PCBUs	• Reduced exposure to electrical hazards. • Clarity regarding licensed and unlicensed work.	• Increased labour costs. • Requirement to have an electrical contractor licence (potential). • Requirement to report incidents to the Regulator.
Electrical contractors	• Increased scope of work. • Reduced exposure to electrical hazards.	• Requirement to report incidents to the Regulator.
Supply chain	• Reduced community exposure to electrical hazards.	• Increased duties, posing administrative costs.
Queensland Government	• Maintained community confidence and uptake of emerging technologies.	• Awareness and education campaign costs to disseminate information to industry

	• Contributes towards Government Renewable Energy targets. • Contributes towards broader Government objective of "keeping Queenslanders safe". • Incident data collection. • Recall powers to be responsive to risks.	and the community on new legislative requirements. • Increased compliance costs given increased regulatory oversight.

Option 3: Awareness and Education

Table 5: Summary of potential impacts posed by option 3 (awareness and education)

	Benefits	Costs
Unlicensed workers	• Increased awareness and understanding of risks and safe work practices.	• Time to engage with information and guidance material and where necessary adjust work practices.
Licensed electrical workers	• Increased awareness and understanding of risks and safe work practices.	• Time to engage with information and guidance material and where necessary adjust work practices.
Community	• Increased awareness and understanding of risks and safe work practices.	• Time to engage with information and guidance material and where necessary adjust practices.
PCBUs	• Increased awareness and understanding of risks and safe work practices.	• Time to engage with information and guidance material and where necessary adjust work practices.
Electrical contractors	• Increased awareness and understanding of risks and safe work practices.	• Time to engage with information and guidance material and where necessary adjust work practices.
Supply chain	• Increased awareness and understanding of risks and safe work practices.	• Time to engage with information and guidance material and where necessary adjust work practices.
Queensland Government	• Increases awareness of risks and educates industry, workers and the communities on safe practices and mitigation of exposure to electrical risk.	• Education and awareness activities for informing industry about risk and safe practices.

3.1.5 Consultation

Electrical equipment, particularly in relation to solar technology, was the subject of consultation during the 2019 Solar Farm Roundtable process. A summary of the consultation in relation to electrical equipment in the context of large-scale solar farms from the Commissioner's Report is included below (pages 13-15):

During the conduct of the Industry Roundtable, the MEA and ETU shared a proposal in relation to amending the definition of 'electrical equipment' under the ES Act.

The proposal of the MEA and ETU was to insert:
"sub-section 14(1)(e) - an individual solar module connected to other modules with the purpose of generating power collectively above extra low voltage either grid connected or stand alone; and sub-section 14(1)(f) - an individual battery cell connected to other cells with the purpose of storing and releasing power collectively above extra low voltage either grid connected or stand alone."

The Industry Roundtable noted that if this proposal was adopted definitions of terms such as 'solar module', 'individual battery cell', 'grid connected' and 'stand-alone' would require more detailed consideration. Additionally, it is noted that in June 2017 the Electrical Equipment Committee (EEC) recommended that the ESB review adding extra low voltage energy storage equipment into the definition of electrical equipment. The EEC considered this would, *"ensure that the installation of multiple battery cells, or the installation of battery systems is required to be done by licensed electricians and further by suitably qualified persons".*

The EEC made this recommendation after reviewing evidence of safety issues with solar PV module systems, including fires to DC isolators and other installation issues.

This report considers that in effect proposed sub-section 14(1)(e) would result in individual solar PV modules being a form of electrical equipment. This would have the flow-on effect of clarifying and meaning that, for example, connecting or disconnecting supply wiring in solar farms would constitute "electrical work" (section 18(1)(a)), as well as installing the individual solar PV modules (section 18(1)(b)). These forms of work (i.e., connecting or disconnecting supply wiring) would require an electrical work licence, restricting work to these workers (and apprentices under supervision). Sub-section 14(1)(f) would have a similar practical result for work on large-scale batteries. Note: Section 18(g) of the ES Act allows for an unlicensed electrical worker to carry out work on electrical equipment under the direct supervision of the electrical worker, if the assistance does not involve physical contact with any energised electrical equipment – this would include locating, mounting and fixing of these solar PV modules).

It is acknowledged that limitations of this recommendation include:

- use of specific terms such as "solar module" and "battery" may not cover similar emerging forms of generation and storage (e.g. ultra-capacitors) when they arise into the future and may not 'future proof' the electrical safety legislation; and
-
- the suggested changes are not likely to capture other renewable energy technologies broadly.

Importantly, the consequence of this definitional change is that it would apply to installation of solar PV modules on domestic residences. Current industry practice for installation on domestic residences is that individual solar PV modules may be separately mounted in position beside another solar PV module, and a row of solar PV modules may all be mounted, by a person who does not hold an electrical work license. However, a key requirement of the proposed recommendation is that work can only be undertaken under the direct supervision of a licensed electrical worker. This report considers the close geographical proximity of work undertaken on domestic installations lessens the unintended

regulatory burden as current practice indicates that a licensed electrical worker is typically in the immediate vicinity to perform the connections and final safety checks.

I am aware businesses in this industry have previously raised concerns about the unintended consequences of any regulatory proposal to address safety risks at solar farms that incidentally applies to the rooftop installation of solar PV modules. This includes concerns over extra costs, job losses and impacts on business viability.

An unintended consequence of this recommendation is that it may also capture solar PV modules used by individuals for camping or used in the manufacturing of caravans. Implementation of this recommendation should also include detailed consideration of these impacts.

However, after balancing the unintended consequences of this proposal against the need to provide industry with certainty on this issue, it is recommended the Queensland Government amend the meaning of 'electrical equipment' to make clear that both individual solar PV modules designed to be connected to other solar PV modules with the purpose of generating power collectively above extra low voltage (either grid connected or stand-alone) and individual battery cells connected to other cells with the purpose of storing and releasing power collectively above extra low voltage (either grid connected or stand-alone) are considered 'electrical equipment'.

This report also acknowledges the ES Act provides for a number of other definitions beyond 'electrical work' and 'electrical equipment'. Given the rate of change in the area of energy technology, it is recommended the review of the ES Act include a review of all definitions under the ES Act to ensure they are relevant and effective.

Additionally, the CEC noted that while:
"there may be merit in such additions to the Act at some time in the future, we caution any haste in recommending or pursuing these changes until broad industry and public consultation has taken place."

This report shares similar concerns and notes the need to ensure all affected stakeholders are aware of the impacts of proposed changes and, where possible, actions are taken to minimise or avoid unintended consequences. Consequently, it is recommended that implementation of this recommendation should occur as part of the review of the ES Act to ensure thorough consultation occurs.

The Commissioner went on to make the following recommendation in relation to the definition of 'electrical equipment' in the context of solar (page 16 Commissioner's Report):

Recommendation 3

In undertaking the review of the Electrical Safety Act 2002 (Qld), the following should be considered 'electrical equipment'

- individual solar PV modules designed to be connected to other solar PV modules with the purpose of generating power collectively above extra low voltage (either grid connected or stand-alone); and
- individual battery cells connected to other cells with the purpose of storing and releasing power collectively above extra low voltage (either grid connected or standalone).

Work undertaken to implement this recommendation should include:

- careful consideration and evaluation of unintended consequences on the broader industry and community; and
-

- a review of all definitions under the Act to ensure relevance and effectiveness; and future proofing the Act for other emerging renewable energy and energy storage devices.

Electrical equipment, and managing the risks posed by emerging electrical technologies, was raised during the Review. This was captured by the following terms of reference (page 13 Review Final Report):

- all definitions under the Act to ensure relevance and effectiveness.
- how the Act can be future proofed for other emerging energy technologies, including renewable energy generation and storage devices.

In the public issues paper, the following question was posed to industry, workers and the community for feedback (page 27 Review Final Report):

- If any, what changes should be made to the scope of 'electrical equipment' and the related definitions of 'electrical installation' and 'electrical work' under the Act, considering technological changes over time?
- More broadly, if relevant, how should the Act be changed to ensure new technologies for generating, distributing and supplying electricity are captured within key definitions, reflected in the scope of 'electrical work', and also reflected in key duties to ensure electrical safety?

In relation to managing the risks posed by emerging technologies, particularly relating to the relevance and effectiveness of the existing "electrical equipment" definition, the Review received feedback from a broad range of interested parties. An excerpt from the Review Final Report summarising this feedback is provided below:

In the context of solar and battery technology (pages 40-41 Review Final Report):

In line with the Commissioner's Report, stakeholders broadly considered that this must extend to solar PV panels, as well as batteries, at a certain threshold. NECA broadly advocated for including solar panel and battery storage system regulations within the Act and Regulations. Both the ETU and Energy Queensland did likewise, offering specific details. The ETU advocated for solar PV panels to be deemed "electrical equipment" where "installed in an array, either grid connected or stand alone". Energy Queensland recommended including within the "electrical equipment" definition "solar photovoltaic modules (where potential above extra low voltage exists), inverters and other electrical equipment (including protection devices, energy monitoring devices, etc)", as well as "battery system[s] (where potential above 4cal / cm2 exists)" within the definition of electrical equipment.

To the same effect as the specific proposals by the ETU and Energy Queensland, Stanwell Corporation proposed a specific amendment to the section 14 definition of "electrical equipment". However, Stanwell Corporation offered a more general concept of "an individual generating source when connected to other generating sources with the purpose of generating power collectively above extra low voltage, either grid connected or stand alone". This would encapsulate solar PV panels, but potentially provide broader future proofing. Likewise, as an alternative to direct reference to batteries, Stanwell Corporation suggested "an individual energy storage device when connected to other energy storage devices with the purpose of storing and releasing power collectively above extra low voltage either grid connected or stand alone." Regarding terminology, and aligning with Stanwell Corporation's suggested concept of an "energy storage device", the CEC noted "the term 'battery' may be too narrow in the long-term and we suggest that the use of a term such as 'energy storage device' may be more appropriate."

Origin noted "increased inverter-based technologies in the grid present a challenge in the management of risk, both of static discharge and earthing potential", concluding that therefore the "electrical equipment" definition "may need to be broadened". From the perspective of avoiding over-regulating, the CEC recommended excluding items such as "single batteries" from the definition of electrical equipment, to avoid actions such as replacing a smoke detector battery being considered "electrical work".

In relation to ELV technology (pages 45-46 Review Final Report):

Regarding standalone or “off-grid” generation, such as by solar power systems not connected to the grid, the ETU recommended that ELV sources be included by reference not to voltage, but to wattage (electrical power expressed in watts). Specifically, the ETU suggested 80,000 watts, or 80 kilowatts (kW), should be the relevant threshold for the definition of “electrical equipment”. The ETU also sought the inclusion of ELV solar power systems that are connected to the grid. Similarly, MEA recommended capturing extra low voltage generation technology within the definition of electrical equipment.

Energy Queensland noted the potential for energy storage at extra low voltage to entail electrical risks and threat to human life. With these risks in mind, Energy Queensland recommended the Act capture ELV systems with high arc fault levels, with attendant licensing and electrical work requirements. Differently, but also recognising the limitations of a voltage threshold, the Clean Energy Council sought an intent or purpose-based definition of electrical equipment excluding reference to voltage, as per the definition in AS 3000. Aurizon’s submission to the Review also recognised the risk posed by extra low voltage equipment, noting its exclusion from the “electrical equipment” definition. Aurizon suggested the alternative of a current-based threshold, being the *amount* of electricity in a circuit measured in amperes (amps).

In relation to relevance and effectiveness of the definition of “electrical equipment” in the context of emerging technologies the following recommendations were made by the Reviewer:

Recommendation 1: It is recommended that modernising the scope of the Act to ensure new and emerging energy generation and storage technologies are incorporated, whether or not they are connected to the grid or stand-alone in nature, by including in the definition of electrical equipment/electrical installation:

a) solar PV modules, designed to be connected to other solar PV modules and when connected be of a combined voltage of greater than extra low voltage; and

b) battery cells, when connected to other cells for the purpose of storing and releasing power of a combined voltage of greater than extra low voltage.

Recommendation 4: To ensure the Act keeps pace with technological change, consider creating a general category of exception to the “extra low voltage” threshold for the definition of “electrical equipment”, to reflect risk to life and property by ELV electrical equipment.

Recommendation 13 (part): Clarify that off-grid systems are captured within the meaning “electrical equipment” and are therefore within the definitions of Serious Electrical Incident and Dangerous Electrical Event (Act, ss 11-12), giving rise to duties to notify the Regulator and otherwise respond to such incidents (Regulations, Part 14).

3.1.6 Questions seeking feedback

- How are you, your organisation or your stakeholders affected by the problems identified and to what extent?
- Do you agree with the assessment of the problem identified, and are there any other elements to the issue that you think have not been captured? If yes, what are they and can you provide examples of these issues?
- What practical impact in the form of *benefits* would the options proposed in the Discussion Paper have on you, your organisation, the workforce or the community? Please provide examples where possible, including for new and emerging technologies and ELV equipment.
- What practical impact in the form of *costs*, would the options proposed in the Discussion Paper have on you, your organisation, the workforce or the community? Please provide examples where possible, including for new and emerging technologies and ELV equipment.
- What is your preferred option for the various ELV discussed and why will it be best for you, your organisation and your stakeholders?
- If you prefer Option 1 (status quo), how would the potential electrical safety risks of newer ELV technologies be minimised or eliminated?
- Do you have suggestions for other options to address the problems identified? Please provide examples (including costs where appropriate) of your suggested options, including how it would ensure the workforce are electrically safe and conduct electrically safe work for community safety.
- Are you aware of evidence of the dangers of particular forms/categories of ELV equipment? If so, what evidence is available?
- Should certain ELV equipment be included in the scope of the Act's regulatory reach that are not currently covered?
- What approach to including ELV equipment within the scope of the ES framework should be adopted in Queensland?
- Should a measure of energy density/capacity be adopted? If so, which measure and what amount (e.g., how many watts per hour)?
- Are you aware of evidence of the dangers of particular forms/categories of ELV equipment? If so, what evidence is available?

3.2 Changing landscape of electricity and the workforce

3.2.1 Problem identification

How electrical work has changed

Since the Act commenced, the nature of electrical work has changed significantly. Changing technologies and the way people interact with this technology at work has accelerated the pace of change.

The Review identified several themes in relation to the changing uses of electricity and how it affects electrical work. These themes can be split into the following three topic areas:

- the emergence of renewable energy generation and storage technology
- the decentralisation of energy generation entities
- the changing nature of the workforce.

The emergence of renewable energy generation and storage technology

The emergence of renewable energy generation technology in the last 20 years has changed the electrical landscape. For example, the concept of solar farms – which emerged with Australia's first solar farm in Western Australia in 2012 – was not contemplated when the Act commenced in 2002.[19]

Between December 2021 and November 2022, approximately 6.8 per cent of the energy consumed by Queenslanders was from solar farms and 9.4 per cent from rooftop PV. As of February 2023, there were over 120 solar farms in Queensland with a combined generation capacity of 20,401MW. In November 2022, 22.7 per cent of the energy used in Queensland was renewable energy. With a target of 80 per cent renewal energy use by 2035, a significant increase in renewable energy generation technology is anticipated.

The development of renewable energy generation and storage technology has seen new job roles emerge. As discussed at Part 3.1, renewable energy generation and storage technology – including BESS and solar PV panels – has resulted in several new job roles being created in the sector, including:

- Supply chain roles (designing, manufacturing, importing, supplying)
- Fixing, mounting and locating of the technology
- Electrical connection of the technology within the energy generation/storage system
- Ongoing maintenance of the technology
- Dismantling and disposal of the technology.

It is likely that work related to renewable energy generation and storage technology extends beyond the existing definition of 'electrical work' in the Act. The ESO welcomes feedback from industry and the community about the extent to which this is the case. The Queensland Government is committed to maintaining community and industry benefits from these technologies, while noting safe interaction with the technology is paramount.

[19] Queensland's renewable energy target | Department of Energy and Public Works (epw.qld.gov.au).

Decentralisation of energy generation and increase in electricity entities

The emergence of renewable energy generation technology has dramatically transformed the energy generation landscape. In the last 20 years, electricity generation has moved from a reliance on fossil fuels by a small number of Government Owned Corporations (a centralised model) to a growing and diverse field of energy entities, including many private organisations (a decentralised model). For example, there was a 19 per cent increase in the number of electricity entities registered with the Queensland Department of Energy and Public Works from 2017 to 2022. These private electricity entities generate, transmit or distribute electricity.

There is a risk that these new entrants into the renewable energy market do not have a comprehensive understanding of the electrical safety requirements in Queensland.

Changing nature of the workforce

Just as the nature of electrical work has significantly changed over the past 20 years, so has the workforce that carries out electrical work.

For example, subcontracting arrangements are common in the electrical sector for tasks that fall outside of the remit of ‘electrical work’. This work is undertaken by labourers who do not hold an electrical licence.

The growth of labour hire working arrangements and the gig economy has also increased risks for workers in the sector. Labour hire is a working arrangement where workers are directly employed by an agency which then ‘on-hires’ them to perform work for a third-party employer. The agency is responsible for paying the worker and providing other employee entitlements while the third-party employer directs the worker to complete specific tasks. Gig economy workers are often unaware of the risks of completing electrical work without a licence.

These working arrangements pose specific risks to workers and highlight the importance of ensuring that the electrical safety framework adequately addresses the changing nature of work in the sector.

Current regulatory framework

What is electrical work?

The term 'electrical work’ is fundamental to the ES framework in Queensland.

Section 18 of the Act defines ‘electrical work’ as:

- connecting electricity supply wiring to electrical equipment or disconnecting electricity supply wiring from electrical equipment, or
- manufacturing, constructing, installing, removing, adding, testing, replacing, repairing, altering or maintaining electrical equipment or an electrical installation.

Examples of electrical work include installing low voltage electrical wiring in a building or maintaining an electricity entity’s overhead distribution network.

What is not electrical work?

The Act also defines what is *not* ‘electrical work’; these tasks are generally lower risk.
Section 18(2) of the Act lists 15 exclusions that are not considered ‘electrical work’, including:

- connecting electrical equipment to an electricity supply using a flexible cord plug and socket outlet, for example, plugging in an appliance

- work on a non-electrical component of electrical equipment, for example, painting electrical equipment covers
- replacing electrical equipment if that task can be safely performed by a person who does not have expertise in carrying out electrical work, for example, replacing a light bulb.

Electrical licences

Electrical work is high risk work. Due to the risks involved, people working in the electrical trades must hold an appropriate licence to carry out electrical work.

Section 55 of the Act requires people who perform or supervise electrical work to hold a current electrical work licence which authorises them to perform the work.

Queensland's ES framework has six different classes of electrical work licences as follows:[20]

1. **Electrical mechanic** – can perform all electrical work
2. **Electrical linesperson** – can perform all electric line work
3. **Electrical fitter** – can perform electrical equipment work
4. **Electrical jointer** – can perform limited specialist work including installing, jointing and terminating electrical cables
5. **Restricted electrical work licence** – can only perform specific electrical work associated with work from another trade or calling (such as plumbers or refrigeration mechanics), and
6. **Electrical work training permit** – can only perform restricted work under specified conditions while being trained.

Queensland's electrical licensing system covers approximately 14,000 electrical contractors and 56,000 electrical workers. Between 2007 and 2022, the number of electrical contractors grew by 82 percent while the number of electrical workers grew by 58 percent. This growth is expected to continue into the future in line with the anticipated growth in the renewable energy sector.

To ensure community confidence, it is essential that only suitable individuals who have completed the required training be granted a licence. The strength of the licensing framework is essential to ensuring high standards of electrical safety are maintained across Queensland.

Relevant electrical training

Electrical training, such as an electrical apprenticeship, is an important step on the pathway to becoming a qualified electrical mechanic in Queensland. The apprenticeship framework combines on-the-job training with off-the-job formal study to achieve a nationally recognised qualification and trade certificate. The electrical apprenticeship usually takes four years to complete. It consists of a significant number of technical and safety units of competency, as well as rigorous on-the-job training. Once the apprenticeship is completed, an individual is awarded a Certificate III qualification. This allows a person to apply for an electrical work licence to carry out work as an electrical mechanic.

Apart from an electrical apprenticeship, other pathways to becoming qualified include obtaining a restricted licence and obtaining on-the-job training through, for example, air conditioning work.

[20] Classes of licences | WorkSafe.qld.gov.au

Electrical Safety considerations from the changing nature of electrical work

The Review identified three areas of risks resulting from the changing nature of electrical work. These were:

1. Fixing, mounting and locating of renewable energy generation and storage technology (such as solar PV panels)
2. Mechanical cable protection work
3. Laying, cutting or sealing underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source.

Feedback is welcomed on the magnitude of these three risk areas, in addition to feedback on the sufficiency of existing duties and subsequent penalties.

Fixing, mounting and locating of renewable energy generation and storage technology

Renewable energy generation and storage technologies create specific safety risks when workers undertake fixing, mounting and locating work. For example, safety risks identified with this type of work on PV solar panels include:

- PV modules generating electricity the moment sunlight is on the surface and that the module and its associated wiring is not able to be isolated from electricity unless it is covered to prevent exposure to light
- the proximity of other existing arrays of PV modules with high direct current voltages posing an electrical safety risk during fixing, mounting, locating or removal work
- unsafe removal and replacement of PV modules without proper electrical isolation first.

In addition to the specific risks that apply to solar PV panels, the following electrical risks apply to the fixing, mounting and locating of all renewable energy generation and storage technology:

- crushing or damage of cable which elevates risk of electric shock, fire and arc flash during connection of the technology, maintenance or dismantling
- for battery technologies, damage to the integrity of the technology which poses a risk of exposure to hazardous chemicals or explosion.

The Review identified different groups of people at risk from this technology include:

- workers completing this work in the course of their employment
- members of the public completing this work in their home
- the general community, where there is an elevated risk of fire from using this technology.

These risks may be heightened further because of the increase of renewable energy generation and storage technology work being undertaken. Anecdotal feedback from the Review indicated that labourers without licences and members of the community were often completing these tasks.

Renewable energy generation and storage technologies consist of a diverse spectrum of items ranging from single solar PV panels (operating at ELV) to domestic battery energy storage systems to community battery systems operating at HV.

The way these technologies are dealt with by the Act varies based on the voltage of the equipment, as noted in Part 3.1. Despite the Act applying different levels of regulation to these technologies based on their voltages, the requirements for mounting, fixing and locating this technology is consistent across the electrical safety framework.

However, section 18(2) of the Act provides two exceptions for work that is not considered 'electrical work' related to fixing, mounting and locating work, as follows:

- locating or mounting electrical equipment, or fixing electrical equipment in place, if this task is not performed in relation to the connection of electrical equipment to an electricity supply
- locating, mounting or fixing in place electrical equipment, other than:
    - making or terminating electrical connections to the equipment, or
    - installing supply conductors that will connect the equipment to a supply of electricity.

These provisions exclude the locating, mounting and fixing of electrical equipment from the definition of 'electrical work'. Therefore, regardless of the voltage of renewable energy generation and storage technology, the fixing, locating and mounting of electrical equipment – where it is not in relation to connection of the equipment – is not electrical work and does not require a licence.

Mechanical cable protection work

Work to install, build and repair mechanical cable protection was raised during the Review, due to its potential to pose electrical risk. This can occur when the integrity of the cable insulation is compromised, which typically occurs due to mishandling or incorrect installation.

This likelihood of risks eventuating has the potential to be increased through working arrangements such as subcontracting and the use of labour hire workers to complete this work. This is because these workers may not always be well-equipped with sufficient knowledge about the risks of faulty mechanical cable protection work.

Section 18(2) of the Act provides that 'electrical work' does not include building or repairing ducts, conduits or troughs (channels) where electrical wiring will be or is installed, if:

- the channels are not intended to be earthed; and
- wiring installed in the channels is not energised; and
- the work is done under the supervision of a person licenced to perform electrical installation work.

Laying, cutting or sealing underground cables (electricity entities)

The Review identified the laying, cutting, or sealing of underground cables that are part of the works of an electricity entity (before the initial connection of the cables to an electricity source) as work that poses safety risks.

As detailed above, the decentralisation of energy generation has increased the number of electricity entities undertaking this work. The profile of these entities has shifted from a handful of Government Owned Corporations to a large and diverse range of private sector businesses. Many of these new private sector businesses may not be well-equipped to manage the risks associated with high-risk electrical work.

While the act of laying, cutting and sealing underground cables prior to their initial connection does not pose significant immediate electrical risk, where the cables are incorrectly laid, cut or sealed, this poses an electrical risk to workers who are later responsible for connecting the cables.

The current definition of 'electrical work' provides several exceptions for electricity entities (as approved by the Department of Energy and Public Works) that do not otherwise apply to other PCBUs carrying out electrical work. Laying, cutting and sealing underground cables as part of the works of an electricity entity before the initial connection of the cables to an electricity source is excluded from being 'electrical work'.

A number of other activities under the Act do not require an electrical licence where the work is carried out on the works of an electricity entity, including:

- Building, under the supervision of an electricity entity, an overhead electric line on structures that do not already carry an energised overhead electric line
- recovering underground cables that are part of the works of an electricity entity after disconnection from an electricity source, and
- altering, repairing, maintaining or recovering an overhead electric line that is part of the works of an electricity entity, if the work is performed under the entity's supervision and:
  - if the line is not on supports holding another electric line—the line has been isolated from an electricity source so that the closure of a switch cannot energise the section of the line where work is being done; or
  - if the line is on supports holding another electric line—both lines have been isolated from an electricity source so that the closure of a switch cannot energise the section of the line where the work is being done or an adjacent section of the other line.

Historically, these exemptions applied to distribution and transmission entities like Energex, Ergon and Powerlink. One reason for their exemption is that these 'traditional' electricity entities have the expertise to design, construct, operate and maintain their networks safely. Under the *Electrical Safety Regulation 2013*, these entities are also required to also have safety management systems to comprehensively manage any risks posed by the work they complete.

However, the growing number of renewable energy operations means that the number of PCBUs considered to be an electricity entity has also expanded. Unlike the large 'traditional' energy entities, newer entities may not have the same level of expertise, exposure or experience with electrical safety risks. In addition, because they are not prescribed entities under Queensland's electrical safety framework, they are also not subject to the same safety management system requirements to comprehensively manage risk.

Interjurisdictional comparison

Electrical safety legislation is not uniform amongst jurisdictions in Australia. However, the model *Work Health and Safety Regulations 2011* (model WHS Regulations) – coordinated by Safe Work Australia – includes prescribed requirements for general electrical safety in workplaces and energised electrical work. While not all jurisdictions have adopted the harmonised WHS legislation, many are closely aligned in their respective electrical safety laws.

Section 146 of the model WHS Regulations provide that the following activities are not electrical work:

- work that involves connecting electrical equipment to an electricity supply by means of a flexible cord plug and socket outlet
- work on a non-electrical component of electrical equipment, if the person carrying out the work is not exposed to an electrical risk
- replacing electrical equipment or a component of electrical equipment if that task can be safely performed by a person who does not have expertise in carrying out electrical work
- assembling, making, modifying or repairing electrical equipment as part of a manufacturing process
- building or repairing ducts, conduits or troughs, where electrical wiring is or will be installed if:
  - the ducts, conduits or troughs are not intended to be earthed, and
  - the wiring is not energised, and
  - the work is supervised by a [licensed or registered] electrical worker

- locating or mounting electrical equipment, or fixing electrical equipment in place, if this task is not performed in relation to the connection of electrical equipment to an electricity supply
- assisting a [licensed or registered] electrical worker to carry out electrical work if:
  - the assistant is directly supervised by the [licensed or registered] electrical worker; and
  - the assistance does not involve physical contact with any energised electrical equipment
- carrying out electrical work, other than work on energised electrical equipment, in order to meet eligibility requirements in relation to becoming a [licensed or registered] electrical worker.

Under the New South Wales *Work Health and Safety Regulation 2011* (NSW), the definition of 'electrical work' is currently consistent with the model definition. However, a discussion paper published by the New South Wales Government in November 2022 proposes changes to the definition of 'electrical work' in response to risks posed by emerging technologies.

South Australia and the Australian Capital Territory also adopted the 'electrical work' definition in the model WHS Regulations in their respective work health and safety regulations. Victoria, Tasmania, and the Northern Territory all depart from the model WHS Regulations while maintaining similar intent.

Queensland did not initially adopt part 4.7 of the model WHS Regulations. However, at a later stage, Queensland modified the 'electrical work' definition in the Act to more closely align with the model definition.

3.2.2 Objective of Government action

- To reduce electrical risks to workers, industry and the community from work in relation to electrical technologies whilst minimising regulatory burden.
- To encourage technological growth and innovation – particularly of electrical technology contributing towards Government renewable energy targets – whilst maintaining an effective and efficient electrical safety framework, preventing risk to life and property.

3.2.3 Consideration of options

Options were considered that would achieve the objectives of Government action and which are effective, efficient, and feasible. A self-regulatory approach was considered but deemed inappropriate given the scope of regulatory controls that are already in place for electrical work. The four options identified are as follows:

Table 6: Options overview

Options	Description
Option 1	Status quo
Option 2	Expand the definition of electrical work by reducing scope of existing exclusions (legislative response)
Option 3	Increase supervision requirements for certain activities excluded from the electrical work definition (legislative response)
Option 4	Education and awareness (non-legislative response)

Any changes to the 'electrical equipment' definition as canvassed in Topic 1 will impact the scope of electrical work.

3.2.4 Impact analysis of the options

Some of the benefits and costs that could be raised and detailed in response to this discussion paper are provided in the table below. These potential costs and benefits are not the view of the Queensland Government and are provided for indicative and discussion purposes only.

Locating, mounting and fixing renewable energy generation and storage technology

Option 1: Status quo

Table 7: Summary of potential impacts posed by option 1 (status quo)

Stakeholder	Impact
Unlicensed workers	Advantages • Unlicensed workers can continue complete this work. Disadvantages • Nil. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents.
Licensed electrical workers	Advantages • Nil Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents.
Community	Advantages • This task remains in the remit of DIY; therefore, no additional costs are posed to community seeking to do these tasks. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents. • An increase in incidents in relation to renewable energy generation and storage technology may lower community confidence in renewable technology contributing to a net zero economy. This may stifle the transition to net zero economy.
PCBUs	Advantages • Unlicensed workers can continue to complete this work, posing no additional labour costs. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks

	• Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents.
Queensland Government	Advantages • Nil Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents. • An increase in incidents in relation to renewable energy generation and storage technology may lower community confidence in renewable technology contributing to a net zero economy. This may stifle the transition to net zero economy.

Option 2: Requiring supervision by a licensed electrical worker for the locating, mounting and fixing renewable energy generation and storage technology

Table 8: Summary of potential impacts posed by option 2 (legislative change)

Stakeholder	Impact
Unlicensed workers	Advantages • Supervision by a licensed electrical worker intends to ensure safe work practice and ensures the end result does not pose risks to workers working on the equipment subsequently. Disadvantages • Nil. Risks • Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker however given they are not performing the work still relies partially on the worker (unlicensed).
Licensed electrical workers	Advantages • Increases work opportunities through the provision of supervision. • Reduces likelihood of exposure to electrical hazard when working on equipment mounted, fixed or located by a worker without a licence. Disadvantages • Nil Risks • Nil.
Community	Advantages • Reduces likelihood of exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work.

	• Reduces any anxiety in the community around the safety of energy generation and storage technologies due to a reduction in incidents involving shock and fire. Disadvantages • Increases cost for the completion of certain work tasks that may have previously been able to be completed as DIY or by an unlicensed worker. Risks • Potential to reduce licensed electrical worker availability resulting in challenges for the community to access licensed electrical workers.
PCBUs	Advantages • Reduces workers' exposure to electrical hazards that arises through erroneous locating, mounting and fixing of energy generation and storage technology. • Reduces community exposure to electrical hazards that arises through erroneous locating, mounting and fixing of energy generation and storage technology. Disadvantages • Increased labour costs for licensed electrical worker to provide supervision to unlicensed workers. Risks • Increases in labour costs for work of this nature may increase the cost of large-scale infrastructure projects contributing to the transition to a net-zero economy. • Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker however given they are not performing the work still relies partially on the worker (unlicensed). Where the risk is significant, this approach may still result in exposure to risk and incidents.
Queensland Government	Advantages • Reduces likelihood of worker exposure to electrical hazards when working on equipment mounted, fixed or located by a worker without a license. • Reduces likelihood of community exposure to electrical hazards and risk of electric shock and fire because of erroneous work. • Reduces any anxiety in the community around the safety of energy generation and storage technologies due to a reduction in incidents involving shock and fire. • Contributes to a safe transition to a net zero economy. Disadvantages • Increase in compliance costs given expanded regulatory oversight. • Costs posed by education and awareness activities required to inform industry and the community about legislative change. Risks • Potential to contribute to a skills shortage in licensed electrical workers. • Potential to limit infrastructure growth contributing to a net zero economy through increased labour costs and potential exacerbation of a skills shortage. • Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical

	worker however given they are not performing the work still relies partially on the worker (unlicensed). Where the risk is significant this approach may still result in exposure to risk and incidents.

Option 3: Requiring a licensed electrical worker to locate, mount and fix renewable energy generation and storage technology

Table 9: Summary of potential impacts posed by option 3 (legislative change).

Stakeholder	Impact
Unlicensed workers	Advantages • Nil. Disadvantages • Reduces work opportunities for unlicensed workers. • Requirement to gain an electrical work license to continue to complete work. Risks • Nil.
Licensed electrical workers	Advantages • Reduces likelihood of exposure to electrical hazard when working on energy generation or storage technology that has been mounted, fixed or located. • Increases work opportunities for licensed electrical workers through expanding the scope of licensed electrical work. Disadvantages • Nil. Risks • Nil.
Community	Advantages • Reduces likelihood of exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. • Reduces any anxiety in the community around the safety of energy generation and storage technologies due to a reduction in incidents involving shock and fire. Disadvantages • Increases cost for the completion of certain work tasks that may have previously been able to be completed as DIY or by an unlicensed worker. Risks • Potential to reduce licensed electrical worker availability resulting in challenges for the community to access licensed electrical workers.
PCBUs	Advantages • Reduces workers' exposure to electrical hazards that arises through erroneous locating, mounting and fixing of energy generation and storage technology. • Reduces community exposure to electrical hazards that arises through erroneous locating, mounting and fixing of energy generation and storage technology. Disadvantages • Increased labour costs for licensed electrical workers where work was previously completed by unlicensed workers. Risks

	• Increases in labour costs for work of this nature may increase the cost of large-scale infrastructure projects contributing to the transition to a net-zero economy.
Queensland Government	Advantages • Reduces likelihood of worker exposure to electrical hazards when working on equipment mounted, fixed or located by a worker without a licence. • Reduces likelihood of community exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. • Reduces any anxiety in the community around the safety of energy generation and storage technologies due to a reduction in incidents involving shock and fire. • Contributes to a safe transition to a net zero economy. Disadvantages • Increase in compliance costs given expanded regulatory oversight. • Costs posed by education and awareness activities required to inform industry and the community about legislative change. Risks • Potential to contribute to a skills shortage in licensed electrical workers. • Potential to limit infrastructure growth contributing to a net zero economy through increased labour costs and potential exacerbation of a skills shortage.

Option 4: Awareness and education – electrical safety considerations of locating, mounting and fixing of renewable energy generation and storage technology

Table 10: Summary of potential impacts posed by option 4 (awareness and education)

Stakeholder	Impact
Unlicensed workers	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • ESO have a database of licensed electrical workers and contractors they can contact to provide key communications, however those without a licence are far more challenging to reach. There is a risk an awareness and education campaign does not reach all parties undertaking this work. • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.

Licensed electrical workers	Advantages • Potential for reduced exposure to electrical hazards when working on energy generation or storage technology that has been mounted, fixed or located. Disadvantages • Nil. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Community	Advantages • Increased awareness and understanding of risk and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this option in educating the community requires the community to engage in the information and change behaviours accordingly. There is a risk that awareness and engagement activities in the community will not be effective where community members elect not to engage. • ESO have a database of licensed electrical workers and contractors they can contact to provide key communications, however those without a licence are far more challenging to reach. There is a risk an awareness and education campaign does not reach all parties completing these activities.
PCBUs	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Queensland Government	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages

	• Costs incurred for education and awareness activities. Additional costs incurred for broad reaching awareness and education campaign as opposed to targeted with licence holders. Risks • ESO have a database of licensed electrical workers and contractors they can contact to provide key communications, however those without a licence are far more challenging to reach. There is a risk an awareness and education campaign does not reach all parties undertaking this work. • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.

<u>Laying, cutting and sealing of underground cables where cables are works of an electricity entity prior to connection</u>

Option 1: Status quo

Table 11: Summary of potential impacts posed by option 1 (status quo)

Stakeholder	Impact
Unlicensed workers	Advantages • Unlicensed workers can continue complete this work. Disadvantages • Nil. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents.
Licensed electrical workers	Advantages • Nil Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents.
Community	Advantages • Nil. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases.

	This increased hazard exposure may result in increased incidents.
Electricity Entities	Advantages • Unlicensed workers can continue to complete this work, posing no additional labour costs. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents. Where incidents occur, this may lower community confidence in the safety of electricity entity infrastructure.
PCBUs	Advantages • Unlicensed workers can continue to complete this work, posing no additional labour costs. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents.
Queensland Government	Advantages • Unlicensed workers can continue to complete this work, posing no additional labour costs. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will increase as the prevalence of work increases. This increased hazard exposure may result in increased incidents. • Where incidents occur, this may lower community confidence in the safety of electricity entity infrastructure.

Option 2: Requiring supervision by a licensed electrical worker for laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source, where the entity is not a prescribed electricity entity

Table 12: Summary of potential impacts posed by option 2 (legislative change)

Stakeholder	Impact
Unlicensed workers	Advantages • Supervision by a licensed electrical worker results in safe work practices and ensures the work carried out does not pose risks to workers that subsequently work on the equipment. Disadvantages • Nil. Risks • Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker, however given they are not performing the work, unlicenced workers are still exposed to some risk.
Licensed electrical workers	Advantages • Increases work opportunities through the provision of supervision. • Reduces likelihood of exposure to electrical hazard when working on equipment mounted, fixed or located by a worker without a licence. Disadvantages • Nil. Risks • Nil.
Community	Advantages • Reduces likelihood of exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. Disadvantages • Nil. Risks • Potential to contribute to a skills shortage and contribute to availability issues for community members seeking electrical workers to complete work.
Prescribed electricity entities	Advantages • Maintains public confidence in safety of electricity entity infrastructure. Disadvantages • Nil. Risks • Nil.
Electricity entities (not prescribed)	Advantages • Reduces workers' exposure to electrical hazards that arises through erroneous laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. • Reduces community exposure to electrical hazards that arises through erroneous laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. Disadvantages

	• Increased labour costs for licensed electrical workers to provide supervision to unlicensed workers. Risks • Increases in labour costs for work of this nature may increase the cost of large-scale infrastructure projects contributing to the transition to a net-zero economy. • Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker, however given they are not performing the work, unlicensed workers are still exposed to some risk. Where the risk is significant, this approach may still result in exposure to risk and incidents.
PCBUs	Advantages • Reduces workers' exposure to electrical hazards that arises through erroneous laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. • Reduces community exposure to electrical hazards that arises through erroneous laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. Disadvantages • Increased labour costs for licensed electrical workers to provide supervision to unlicensed workers. Risks • Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker, however given they are not performing the work, unlicensed workers are still exposed to some risk. Where the risk is significant, this approach may still result in exposure to risk and incidents.
Queensland Government	Advantages • Reduces likelihood of community exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. Disadvantages • Increase in compliance costs given expanded regulatory oversight. • Costs posed by education and awareness activities required to inform industry and the community about legislative change. Risks • Potential to contribute to a skills shortage in licensed electrical workers. • Potential to limit infrastructure growth contributing to a net zero economy through increased labour costs and potential exacerbation of a skills shortage. • Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker, however given they are not performing the work , unlicensed workers are still exposed to some risk. Where the risk is significant, this approach may still result in exposure to risk and incidents.

Option 3: Requiring a licensed electrical worker to lay, cut and seal underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source, where the entity is not a prescribed electricity entity

Table 13: Summary of potential impacts posed by option 3 (legislative)

Stakeholder	Impact
Unlicensed workers	Advantages • Nil. Disadvantages • Reduces work opportunities for unlicensed workers. • Requirement to gain an electrical work licence to continue to complete work. Risks • Nil.
Licensed electrical workers	Advantages • Reduces likelihood of exposure to electrical hazard when working on underground cables that have been laid, cut or sealed as works of an electricity entity prior to initial connection of cables to an electricity source. • Increases work opportunities for licensed electrical workers through expanding the scope of licensed electrical work. Disadvantages • Nil. Risks • Nil.
Community	Advantages • Reduces likelihood of exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. Disadvantages • Increases cost for the completion of certain work tasks that may have previously been able to be completed as DIY or by an unlicensed worker. Risks • Potential to reduce licensed electrical worker availability resulting in challenges for the community to access licensed electrical workers.
Non-prescribed electricity entities	Advantages • Reduces likelihood of worker exposure to electrical hazards when laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. • Reduces likelihood of community exposure to electrical hazards when laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. Disadvantages • Increased labour costs for licensed electrical workers where work was previously completed by unlicensed workers. Risks • Increases in labour costs for work of this nature may increase the cost of large-scale infrastructure projects contributing to the transition to a net-zero economy.

Prescribed electricity entities	Advantages • Reduced likelihood of reduced community confidence in entity infrastructure. Disadvantages • Nil. Risks • Nil.
PCBUs	Advantages • Reduces likelihood of worker exposure to electrical hazards when laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. • Reduces likelihood of community exposure to electrical hazards when laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. Disadvantages • Increased labour costs for licensed electrical workers where work was previously completed by unlicensed workers. Risks • Increases in labour costs for work of this nature may increase the cost of large-scale infrastructure projects contributing to the transition to a net-zero economy.
Queensland Government	Advantages • Reduces likelihood of worker exposure to electrical hazards when laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. • Reduces likelihood of community exposure to electrical hazards when laying, cutting and sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source. • Contributes to a safe transition to a net zero economy. Disadvantages • Increase in compliance costs given expanded regulatory oversight. • Increased cost for work of this nature, as a result of increased labour costs. • Costs posed by education and awareness activities required to inform industry and the community about legislative change. Risks • Potential to contribute to a skills shortage in licensed electrical workers. • Potential to limit infrastructure growth contributing to a net zero economy through increased labour costs and potential exacerbation of a skills shortage.

Option 4: Awareness and education - electrical safety considerations of laying, cutting and sealing of underground cables (electricity entities)

Table 14: Summary of potential impacts posed by option 4 (awareness and education)

Stakeholder	Impact
Unlicensed workers	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Licensed electrical workers	Advantages • Potential for reduced exposure to electrical hazards. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Community	Advantages • Increased awareness and understanding of risk and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Nil. Risks • The effectiveness of this technique in educating the community requires the community to engage in the information and change behaviours accordingly. There is a risk that awareness and engagement activities in the community will not be effective where community members elect not to engage.
Electricity entities	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages

	• Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
PCBUs	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Queensland Government	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Costs incurred for education and awareness activities. • Additional costs incurred for broad reaching awareness and education campaign as opposed to targeted with licence holders. Risks • ESO have a database of licensed electrical workers and contractors they can contact to provide key communications however those without a licence are far more challenging to reach, there is a risk an awareness and education campaign does not reach all parties undertaking this work. • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.

Mechanical cable protection (building or repairing ducts, conduits or troughs (channels) where electrical wiring will be or is installed, if the channels are not intended to be earthed and wiring installed in the channels is not energised)

Option 1: Status quo

Table 15: Summary of potential impacts posed by option 1 (status quo).

Stakeholder	Impact
Unlicensed workers	Advantages • Unlicensed workers can continue complete this work with supervision. Disadvantages • Erroneous work by unlicensed workers may expose licensed electrical workers to electrical hazards, risking harms including electric shock and fire. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will continue, which will likely result in incidents.
Licensed electrical workers	Advantages • Nil Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will continue, which will likely result in incidents.
Community	Advantages • This task remains in the remit of DIY; therefore, no additional costs are posed to community seeking to do these tasks. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will continue, which will likely result in incidents.
PCBUs	Advantages • Unlicensed workers can continue to complete this work with supervision, posing no additional labour costs. Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks • Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will continue, which will likely result in incidents.
Queensland Government	Advantages • Nil Disadvantages • Existing exposure to electrical hazards and risks such as fire and electric shock remains unchanged. Risks

	• Where significant risks are posed by erroneous work and competency poses a barrier to safe work practices, exposure to hazards will continue, which will likely result in incidents.

Option 2: Requiring direct supervision by a licensed electrical worker for building or repairing ducts, conduits or troughs (channels) where electrical wiring will be or is installed, if the channels are not intended to be earthed, and wiring installed in the channels is not energised

Table 16: Summary of potential impacts posed by option 2 (legislative)

Stakeholder	Impact
Unlicensed workers	Advantages • Supervision by a licensed electrical worker results in safe work practices and ensures the work carried out does not pose risks to workers that subsequently work on the equipment. Disadvantages • Nil. Risks • Direct Supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker, however given they are not performing the work, unlicensed workers are still exposed to some risk).
Licensed electrical workers	Advantages • Increases work opportunities through the provision of direct supervision, which requires a smaller ratio of unlicensed workers to licensed workers than supervision generally. • Reduces likelihood of exposure to electrical hazard as a result of erroneous mechanical cable protection work. Disadvantages • Nil Risks • Nil.
Community	Advantages • Reduces likelihood of exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. Disadvantages • Increases cost for the completion of certain work tasks due to the increased supervision requirement. Risks • Potential to reduce licensed electrical worker availability resulting in challenges for the community to access licensed electrical workers.
PCBUs	Advantages • Reduces workers' exposure to electrical hazards that arises through erroneous mechanical cable protection work. • Reduces community exposure to electrical hazards that arises through erroneous mechanical cable protection work. Disadvantages • Increased labour costs for licensed electrical worker to provide direct supervision to unlicensed workers. Risks

	• Increases in labour costs for work of this nature may increase the cost of large-scale infrastructure projects contributing to the transition to a net-zero economy. • Direct supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker, however given they are not performing the work, unlicenced workers are still exposed to some risk). Where the risk is significant, this approach may still result in exposure to risk and incidents.
Queensland Government	Advantages • Reduces likelihood of worker exposure to electrical hazards as a result of erroneous mechanical cable protection work. • Reduces likelihood of community exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. Disadvantages • Costs posed by education and awareness activities required to inform industry and the community about legislative change. Risks • Potential to contribute to a skills shortage in licensed electrical workers. • Potential to limit infrastructure growth contributing to a net zero economy through increased labour costs and potential exacerbation of a skills shortage. • Direct supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker however given they are not performing the work still relies partially on the worker (unlicensed). Direct supervision moves some of the responsibility for the management of risks to the supervising licensed electrical worker, however given they are not performing the work, unlicensed workers are still exposed to some risk). Where the risk is significant, this approach may still result in exposure to risk and incidents.

Option 3: Requiring a licensed electrical worker for building or repairing ducts, conduits or troughs (channels) where electrical wiring will be or is installed, if the channels are not intended to be earthed, and wiring installed in the channels is not energised

Table 17: Summary of potential impacts posed by option 3 (legislative)

Stakeholder	Impact
Unlicensed workers	Advantages • Nil. Disadvantages • Reduces work opportunities for unlicensed workers. • Requirement to gain an electrical work licence to continue to complete work. Risks • Nil.
Licensed electrical workers	Advantages • Reduces likelihood of exposure to electrical hazards as a result of erroneous mechanical cable protection work.

	• Increases work opportunities for licensed electrical workers through expanding the scope of licensed electrical work. Disadvantages • Nil. Risks • Nil.
Community	Advantages • Reduces likelihood of exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. Disadvantages • Increases cost for the completion of certain work tasks that previously were able to be completed by an unlicensed worker with supervision. Risks • Potential to reduce licensed electrical worker availability resulting in challenges for the community to access licensed electrical workers.
PCBUs	Advantages • Reduces workers' exposure to electrical hazards that arises as a result of erroneous mechanical cable protection work. • Reduces community exposure to electrical hazards that arises through erroneous mechanical cable protection work. Disadvantages • Increased labour costs for licensed electrical workers where work was previously completed by unlicensed workers with supervision. Risks • Increases in labour costs for work of this nature may increase the cost of large-scale infrastructure projects contributing to the transition to a net-zero economy.
Queensland Government	Advantages • Reduces likelihood of worker exposure to electrical hazards as a result of erroneous installation of mechanical cable protection. • Reduces likelihood of community exposure to electrical hazards and risk of electric shock and fire as a result of erroneous work. Disadvantages • Increase in compliance costs given expanded regulatory oversight. • Costs posed by education and awareness activities required to inform industry and the community about legislative change. Risks • Potential to contribute to a skills shortage in licensed electrical workers. • Potential to limit infrastructure growth contributing to a net zero economy through increased labour costs and potential exacerbation of a skills shortage.

Option 4: Awareness and education- electrical safety considerations of mechanical cable protection work

Table 18: Summary of potential impacts posed by option 4 (awareness and education)

Stakeholder	Impact
Unlicensed workers	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • ESO have a database of licensed electrical workers and contractors they can contact to provide key communications, however those without a licence are far more challenging to reach. There is a risk an awareness and education campaign does not reach all parties undertaking this work. • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Licensed electrical workers	Advantages • Potential for reduced exposure to electrical hazards. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Community	Advantages • Increased awareness and understanding of risk and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Nil. Risks • The effectiveness of this technique in educating the community requires the community to engage in the information and change behaviours accordingly. There is a risk that awareness and engagement activities in the community will not be effective where community members elect not to engage. • ESO have a database of licensed electrical workers and contractors they can contact to provide key communications however those without a licence are far more challenging to

	reach, there is a risk an awareness and education campaign does not reach all parties completing these activities.
PCBUs	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Cost of time taken to engage with material and potentially change practices. Risks • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.
Queensland Government	Advantages • Increased awareness and understanding of risks and safe work practices. • Potential for a reduction in erroneous work reducing the likelihood of exposure to electrical hazards and risk of electric shock and fire. Disadvantages • Costs incurred for education and awareness activities. • Additional costs incurred for broad reaching awareness and education campaign as opposed to targeted with licence holders. Risks • ESO have a database of licensed electrical workers and contractors they can contact to provide key communications, however those without a licence are far more challenging to reach. There is a risk an awareness and education campaign does not reach all parties undertaking this work. • The effectiveness of this approach relies on workers taking time to engage with awareness and education material and adjust work practices. Where workers do not engage with the material, work practices resulting in erroneous work may not change.

3.2.5 Consultation

The definition of 'electrical work' was the subject of consultation during the 2019 Solar Farm Roundtable.

A summary of the consultation in relation to electrical work at large scale solar farms – extracted from the Commissioner's Report (page 13) – is included below:

2.3 Work requirements at large scale solar farms

The Industry Roundtable acknowledged there is a clear gap in the electrical safety legislative framework as it relates to locating, mounting, or fixing solar PV modules in place at solar farms. There was consensus this generated confusion within industry about when a licenced electrical worker is required. However, views differed on what work can be performed by unlicenced workers on solar farms.

The Electrical Trades Union (ETU) submitted:
"Solar panels are different to other pieces of electrical equipment. Unlike a light fitting, or switchboard, these solar panels are generating voltage as soon as they are exposed to sunlight. In fact, these PV Modules are generating power, rather than connected to supply. They are the supply.

When a number of panels are connected the total voltage then becomes higher than the extra low voltage requirements. Hence when these panels, when installed, must be considered electrical equipment and installed by a licenced electrical worker. The Queensland Government cannot afford to have a Home Insulation Fatality due to unsafe work practices by unlicenced workers installing PV modules."

Accordingly, the ETU strongly recommended:
"A change to section 18 of the Act to ensure that when it comes to the installation of panels that this work be undertaken by a licenced electrical worker or by a unlicenced electrical worker who is directly assisting in accordance with section s18(2)g."

Section 18(2)(g) of the ES Act allows for an unlicenced electrical worker assisting a licenced electrical worker to carry out electrical work, on electrical equipment under the direct supervision of the electrical worker, if the assistance does not involve physical contact with any energised electrical equipment.

Master Electricians Australia (MEA) recommended:
"non-electrical workers should be able to undertake the mounting and fixing of solar panels provided there are safe systems of work and the worker is provided with appropriate training."

The Clean Energy Council (CEC) recommended that:
"Solar PV panels are fully insulated (and in most cases, double insulated), extra-low voltage equipment··it would be practically impossible for a worker to suffer shocks or electrocution from handling an unconnected panel. The CEC position is that the task of mounting and fixing solar panels onto a frame is not electrical work. The task only becomes electrical work in the act of making the wiring connections between the extra-low voltage panels."

Requirements for generation entities was also raised for consideration in the Commissioner's Report (pages 23-24):

Currently in Queensland the electrical safety legislative framework places various specific requirements on electricity entities. However, generating entities appear to mainly have the overriding duty of an electricity entity to ensure its works are electrically safe and operated in

a way that is electrically safe.

In recent years the transitioning energy market and development of new technologies has resulted in some businesses, or even households, generating electricity and using and storing it in the form of batteries, effectively becoming generating entities. This raises questions if new technology generation, for example solar and wind farms, are adequately addressed by the ES Act in terms of ensuring high safety standards. For example, a generating entity is not a prescribed electricity entity and consequently does not have to have a safety management system in place.

This report considers that the linear concepts of the ES Act has created a gap in coverage in this respect. It is recommended that consideration should be given to whether the duties of electricity entities should be extended to encompass these situations, or if it would be more appropriate to develop separate tailored regulations.

The Commissioner's Report made the following recommendations in relation to the changing nature of electricity, the electrical workforce, and its impacts on electrical work:

Part 1: Clarity around existing legislative provisions of the Electrical Safety Act 2002 (Qld) Recommendation 1

In light of the recent court ruling regarding section 73A, the Queensland Government should undertake a review of the *Electrical Safety Act 2002* (Qld), including the objects of the Act and the regulation-making powers, to ensure it is fit for purpose and can keep pace with new and emerging technologies.

Part 2: Options for legislative amendment to definitions of the Electrical Safety Act 2002 (Qld) Recommendation 2

In relation to the mounting, fixing and locating of solar PV modules on solar farms it is recommended that:

- competent workers (i.e. unlicenced) can install array support structures for solar PV modules, including support structures that may provide an earth path as part of the approved earthing design (e.g. footings and steel support frames as part of civil and mechanical works)
- the mounting, fixing and locating of solar PV modules and arrays by competent workers (i.e. unlicenced) must be directly supervised by a competent licenced electrical worker; and
- all earth cabling and connections, and module cabling and connections, must be installed, inspected and tested by competent licenced electrical workers.

Electrical work was also raised during the Review. The definition of 'electrical work' and the impacts of the changing nature of electricity and the workforce was captured by the following two terms of reference (page 13, Review Final Report):

- to review all definitions under the Act to ensure relevance and effectiveness, and
- to review how the Act can be future-proofed for other emerging energy technologies, including renewable energy generation and storage devices.

In the public issues paper for the Review, the following questions were put to industry, workers and the community (page 27, Review Final Report):

- What changes, if any, should be made to the scope of 'electrical equipment' and the related definitions of 'electrical installation' and 'electrical work' under the Act, considering technological changes over time?

- More broadly, if relevant, how should the Act be changed to ensure new technologies for generating, distributing and supplying electricity are captured within key definitions, reflected in the scope of 'electrical work', and also reflected in key duties to ensure electrical safety?

The Review received feedback from various stakeholders about the changing nature of electricity and the emergence of technologies such as solar and BESS. An excerpt from the Final Report summarising this feedback is included below (page 48, Review Final Report):

Solar PV panels

The Review received various views from stakeholders on precisely what kinds of work on solar panels should fall within the definition of 'electrical work'. Reflecting a general need, NECA noted that it should be made clear in the Act and Regulations what is *electrical work* and what is *construction work* (not electrical work) for solar installations on rooftops and in solar farms.

As a starting-point, and in line with the standard definition of 'electrical work', the consequence of defining solar PV modules, when connected to be of a combined voltage of greater than extra low voltage, to be 'electrical equipment' is to require all connections of cabling, including earthing and bonding work, to be performed by a licenced electrical worker.

Beyond this central area, there were opposing views on the requirements that should be attached to other forms of work. The CEC recommended excluding heavy lifting, locating, mounting or fixing of solar PV panels from the definition of 'electrical work', noting the consistency of this approach with current Queensland Building and Construction Commission legislation. The CEC noted this would align with exemptions in section 18(2). In contrast, the ETU expressed concern with work being done by unlicenced workers or without the direct supervision of licenced workers. Similarly, the Commissioner advocated for strictly regulating connecting or disconnecting supply wiring, as well as locating, mounting and fixing of solar PV panels. The Review is satisfied that these ancillary activities should, at a minimum, be carried out under the supervision of licenced workers. Requirements of supervision are considered in detail at 6.5(B) of this Report.

The Review received feedback relating to the risks posed by mechanical cable protection work. These were summarised in the final report as follows (page 49, Review Final Report):

The application of the scope of electrical work was raised during consultation by NECA. NECA sought clarity on laying of conduit in pits; installing cable trays and what is meant by supervision of non-licenced workers and how much supervision is required. NECA also noted members expressed views that laying conduit in pits and installing cables trays was not electrical work but required supervision. Also noted in the NECA submission was confusion around this matter for contractors, workers and apprentices.

In relation to the changing nature of electricity and the workforce and the impact on electrical work, the following recommendations were made by the Reviewer:

Recommendation 5

For solar PV panels falling within the definition of electrical equipment (see Recommendation 1), consider ensuring that the resultant 'electrical work' definition is amended as needed to require:

(a) all connections and testing of PV module cabling as well as earthing and bonding work be performed by competent licenced electrical worker/s; and

(b) installation of cabling to be carried out by a licenced electrical worker or an unlicenced person assisting a licenced electrical worker and working under their direct supervision; and

(c) the mounting, fixing, and locating of solar PV modules and arrays to be carried out by competent persons under the direct supervision (Recommendation 16) of a licenced electrical worker (Act s 18(2)(f)).

Recommendation 6

Consider including within the definition for ‘electrical work’ that the electrical aspects of air conditioning/mechanical services work is electrical work and the tasks of fixing, installation of brackets/mounting of equipment and mechanical cable protection is ancillary to the complete installation.

Recommendation 7

Ensure the installation of mechanical protection for cables, including but not limited to conduit (both plastic and metal), cable racks and trays, skirting, troughs etc., and the installation of cabling into these protection components is the work of licenced electrical workers or to be performed under the direct supervision of a licenced electrical worker. Associated with this work is earthing and bonding work, to be defined as electrical work (recommendation 5) and must only be performed by competent licenced electrical worker/s.

Recommendation 17(a)

Inserting the word ‘direct’ before ‘supervision' in section 18(2)e(iii).

Recommendation 17 (c)

Requiring direct supervision for a person directly assisting the licenced electrical worker in the laying, cutting or sealing underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source (s 18 (2)(j)).

3.2.6 Questions seeking feedback

1. How are you, your organisation, the workforce and the community affected by the issues posed by the changing landscape of electrical work? To what extent?
2. How many workers have been impacted by the identified hazards or are exposed to such hazards and might be exposed in the future? Which workers/ businesses/ households are impacted by the problem?
3. Which are the key industries in which these tasks take place and how large are they?
4. Do you agree with the assessment of the issues identified with the changing nature of electrical work, are there any other elements to the issue that you think have not been captured? If possible, please share examples of your experience with these issues.
5. What practical impacts – including costs and benefits – would each option have on you, your organisation, the workforce and the community? Please share examples of impacts and experiences of impacts, where possible.
6. In relation to the following three risks considered, which of the four options do you think is best and why?
    a. Fixing, mounting and locating of renewable energy generation and storage technology (such as solar PV panels)
    b. Mechanical cable protection work,
    c. Laying, cutting or sealing underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source.
7. Do you have suggestions for other options to address the issues identified? Please provide examples (including costs) on the impacts of your suggested options, including how it would ensure the workforce is electrically safe and conduct electrically safe work.
8. The Review identified risks with the locating mounting and fixing of energy generation and storage electrical equipment. Do you agree that the risks identified are limited to this equipment? If not, what do you consider the scope of these risks to be?

9. The Review identified risks from the laying, cutting or sealing of underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source (section 18(2)(j) of the Act). Other exclusions for electricity entities also exist in section 18(2) of the Act. Has the decentralisation of energy generation had a similar impact on the risk profile of these exclusions? Please provide examples where possible.

3.3 Electrical safety and electric vehicles

3.3.1 Problem identification

Electric vehicles

An electric vehicle is a vehicle with a motor powered by electricity rather than a fossil fuel, such as petrol. There are currently four main types of electric vehicles:

- Battery Electric Vehicles (BEVs): fully electric, powered by a battery that is connected to an external charging outlet when charging the battery; does not use any other source of fuel.
- Plug-in Hybrid Electric Vehicles (PHEVs): powered by a combination of fuel and battery. Can be connected to an external charging outlet to recharge a battery as well as refuelling a fuel tank.
- Fuel Cell Electric Vehicles (FCEVs): use a fuel cell rather than a battery cell, or in combination with a battery or supercapacitor to power the vehicle. The most common are typically fuelled by hydrogen.
- Non-Plug-In Hybrid Electric Vehicles (HEVs): in place of an external charging outlet, electricity generated by the HEVs braking system is used to recharge the battery, termed ‘regenerative braking’ is also used in BEVs, PHEVs and FCEVs.

For the purpose of this paper, ‘electric vehicles’ refers only to motorcycles, cars, trucks and buses. Excluded from consideration in this Part are:

- E-scooters and e-bikes, generally, which are explored in Part 3.1.
- Electric mining vehicles, which require full licensing at present, in line with government and industry expectations.
- Hydrogen-powered electric vehicles.
- Trains and trams.

Scope: propulsion components of an electric vehicle

The options explored in this paper only consider the components forming the propulsion of an electric vehicle, being:

- the motor
- lithium-ion battery that powers the motor.

Non-propulsion components that are not in scope include:

- Electrical components powered by a petrol-powered internal combustion engine (ICE), such as headlights, starter motors, heating, ventilation and air conditions (HVAC).
- Other electrical components of the vehicle (e.g., an outlet socket) powered by a lithium-ion battery.

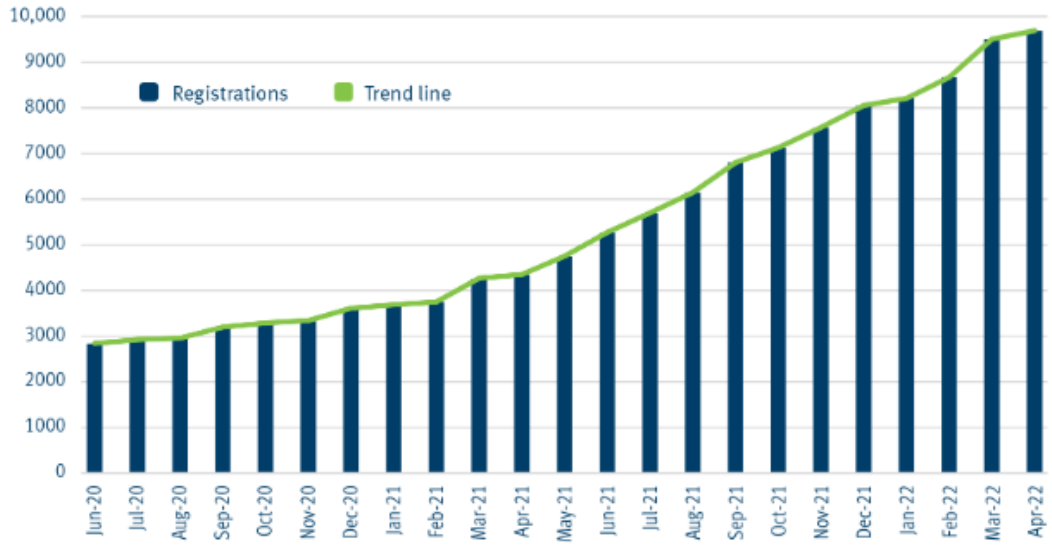
The scope of this paper aligns with the Review, which does not seek to amend the current exclusions for these electrical parts of vehicles or amend the current requirements in the ES legislation for a ’restricted electrical work licence’ for working on non-propulsion components operating above ELV.

It should be noted that lithium-ion batteries can form part of the propulsion components as well as supplying power to non-propulsion components. However, it is the intention that the current licence

requirements for working on non-propulsion components remain, irrespective of whether the battery is the same one that provides propulsion to the vehicle.

Changing landscape for vehicles

With improvements to efficiency and developing electricity infrastructure, the growth in uptake of electric vehicles is increasing substantially. Trends indicate a steady increase of registrations of electric vehicles over the last three years.[21] In Queensland, electric vehicles are becoming increasingly popular, with 9,701 BEVs registered in April 2022 (including passenger cars, light vans, motorcycles, buses and trucks).[22]



Registered battery electric vehicles include passenger cars, light vans, motorcycles, buses and trucks. Registration data includes private ownership, commercial fleet, and commercial dealership registrations.

Figure 6: BEVs registered in Queensland (snapshot as of 30 April 2022), Source [23]

This trend is predicted to continue with State and Federal Governments offering and implementing a myriad of initiatives to encourage and support the growth of the electric cars in Australia, many of which feature in Queensland's Zero Emission Vehicle Strategy 2022-2032 and the QEJP. These include:[24]

- 50 percent of new passenger vehicles sales to be zero emission vehicles by 2030
- 100 percent of new passenger vehicle sales to be zero emission vehicles by 2036
- 100 per cent of eligible QFleet passenger vehicles to be zero emissions vehicles by 2026
- Every new TransLink funded bus added to the fleet to be a zero-emission bus from 2025 in South-East Queensland and from 2025-2030 across regional Queensland.

Homeowners are now able to consider their home as an energy generation and storage hub, whereby their rooftop solar (PV panels) can generate energy that is stored in a home BESS for later use. The residence's PV panels, or BESS can be used to charge an electric vehicle.

[21] Electric vehicle snapshot April 2022 | Transport and motoring | Queensland Government (www.qld.gov.au)
[22] Electric vehicle snapshot April 2022 | Transport and motoring | Queensland Government (www.qld.gov.au)
[23] Electric vehicle snapshot April 2022 | Transport and motoring | Queensland Government (www.qld.gov.au)
[24] Queensland's new Zero Emission Vehicle Strategy | Transport and motoring | Queensland Government (www.qld.gov.au).

Advancements in technology means that bidirectional charging (where an electric vehicle can both draw from and contribute to the electricity grid) may also grow in prevalence. Some providers, such as the Volkswagen Group, Ford and Volvo already support bidirectional functionality. Tesla has also indicated bidirectional charging will be a reality with its products by 2025. Though further steps in infrastructure and design are required before these technologies become commonplace, it does indicate that these changes are coming. It should be noted that battery chargers are already covered under the Act.

For those who do not have home charging, the number of commercial charging stations are increasing, both commercially at locations such as shopping centres and workplaces, as well as publicly through the Queensland Electric Super Highway, which will deliver 55 fast charging stations throughout Queensland.[25] The development of this infrastructure will assist in the uptake of these vehicles.

Electrical safety considerations

Safety risks arising from a lithium-ion battery at present include: the risk of physical injury or death through fire, explosion, toxic gases, electric shocks, arc flashes or exposure to battery electrolytes. These risks are increased by factors such as impact from collision, incorrect charging and faulty products.

These risks pose a threat to both persons, including life threatening burns and death, as well as damage to property. Risks presenting from electric vehicles can occur in several settings, including in:

- domestic settings (e.g. a house)
- workplace settings (e.g. while work is being undertaken on a car)
- public settings (e.g. public roads).

With further technological developments, there is the possibility of new and unanticipated risks. For example, with the growing possibility of bidirectional electric vehicles, the vehicle sector is increasingly tied to other equipment being used and installed in the home.

Currently, many electric vehicles on Queensland roads are new and well within their original warranty period and, therefore, consumer relationships with Original Equipment Manufacturers (OEMs) are strong.

However, as electric vehicles age, the growth of purchases in the second-hand market will change the degree to which vehicle owners are involved with OEMs. This is expected to lead to growth in work for mechanics outside of the OEM. It may also lead to more vehicle owners working on their own electric vehicles (whether on propulsion components or otherwise). Therefore, the risk profile for work on electric vehicles may evolve in the years ahead.

Voltage differences in standard and electric vehicles

Electric vehicles currently use lithium-ion batteries that operate at DC voltage and above ELV. It is projected that the voltage of electric vehicles will continue to increase as higher voltage batteries support faster charging and longer distance travel.

For example, common electric passenger cars, such as a Tesla, tend to operate in the 350-400V range.[26] However, the Hyundai Ioniq 5, Genesis G80 EV and Kia EV6 are among those that can

[25] Queensland's Electric Super Highway powers up out west - Ministerial Media Statements.
[26] 400v vs 800v Charging - What's the Difference? Electric Car Battery Voltage Explained | CarsGuide.

charge up to 800V.[27] By comparison, lead acid batteries (not powering the motor) in ICE vehicles operate at 12V.

The voltage of electric vehicles differs greatly based on the class of vehicle. For example, electric motorcycles have a significantly lower voltage (48-52V) compared to that of an electric heavy truck (800-900V). The difference in voltage can be attributed to the weight and size of the vehicle.

In comparison, the Act captures electrical equipment commonly used in domestic settings (such as televisions, fridges and ovens) which operate at LV. Work on these pieces of electrical equipment is typically done under either an electrical fitter licence or a restricted electrical licence for specific types of electrical equipment.

Table 19: Comparison of voltage for electric vehicle classes

Electric motorcycles	48 to 52V
Electric cars	200 to 800V
Electric passenger buses	380 to 800V
Electric heavy trucks	800 to 900V
Electric mining vehicles	3000V+

Note: the level of voltage identified in the table is for discussion purposes only, and vehicle models can operate at different voltages even within the same class of vehicle.

Incidents and queries

It is difficult to predict the extent of risks posed by electric vehicles as they increase in number. Most incidents involving electric vehicles at this time appear to occur during the charging of batteries or following a collision. Neither of these events are within the scope of either the WHS or ES reporting frameworks. As a result, there is little data on the frequency of incidents available to ESO. Existing analysis has relied on media accounts and the work of organisations such as EV FireSafe; a private company that provides material on electric vehicle risks and incidents.[28]

In relation to BEV and PHEV passenger electric vehicles, EV FireSafe's research teams have identified 337 verified electric vehicle traction battery fires globally, with a further 48 unverified incidents and 34 ongoing investigations.[29] The research teams have also categorised the causes of verified incidents, as presented in Figure 7:

[27] EV industry seen shifting to 800 volt technology | Automotive News (autonews.com).
[28] See, source: evfiresafe.com, https://www.evfiresafe.com/what-is-ev-firesafe.
[29] Source: evfiresafe.com, *PASSENGER EV LIB FIRE INCIDENTS, Global as of 21 December 2022*. https://www.evfiresafe.com/ev-battery-fire-overview, https://www.evfiresafe.com/_files/ugd/8b9ad1_4dc7eb412c1e42d487f74c4cc7274e1e.pdf

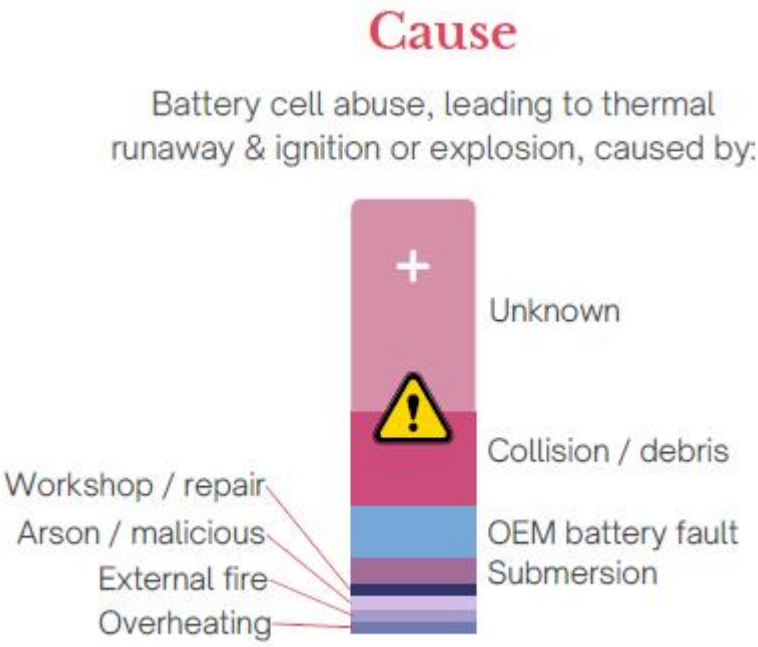


Figure 7: Problem definition, causes of electric vehicle incidents.

Source: evfiresafe.com

While the data is limited to BEV and PHEV incidents, it does indicate that the key causes of incidents are collision and debris. Unfortunately, it is not possible to ascertain the number of incidents specific to Queensland and their causes.

Significantly, EV FireSafe's data found that some incidents have occurred in a workshop or during repair. Under the WHS framework, PCBUs are expected to report incidents of this nature as they occur in a workplace. However, OIR believes there is a lack of understanding of notifiable incident requirements and underreporting is likely.

Of the queries OIR received from this sector, many are in relation to whether the work relating to the battery and/or vehicle charging device is licensed electrical work, as well as some reports of shocks while working on electric vehicles and charging infrastructure. There are also reports of fires while maintaining and charging electric vehicles.[30]

Enhancing electrical safety

Steps are being taken by both industry and government to recognise and mitigate risks presented by electric vehicles to enhance electrical safety.

A desktop review of electrical vehicles for sale in Queensland indicates that the industry provides clear safety instructions to purchasers of electric vehicles at the time of purchase and provides a detailed owner's manual to refer to post-purchase. Manuals typically include a dedicated electric vehicle battery section that highlights risks and provides guidance on what to do should there be a technical issue or an emergency.

[30] Office of Industrial Relations, Work Health and Safety and Electrical Safety Office incident data review.

Clearly, companies that manufacture and import electric vehicles have an incentive to ensure safety is paramount. However, standards differ from manufacturer to manufacturer, including assumptions the industry may make about country-specific infrastructure and the implications of this for safety.

Government has taken steps to raise community awareness on electric vehicle safety in Queensland. In October 2021, the Department of Transport and Main Roads introduced an electric vehicle label for electric vehicles, hybrid vehicles and hydrogen fuel cell vehicles. This assists first responders and the community to know that the vehicle is an electric vehicle in order for them to more safely manage an emergency situation.

Queensland Fire and Emergency Services has also released guidance regarding electric vehicle accidents and incidents. This guidance material includes directions to community to:

- ensure that electric vehicle remote ignition keys are at least 30 meters away from the vehicle, as these can inadvertently start the vehicle
- not charge a vehicle after an accident/incident until it has been inspected and approved by a technician
- ensure damaged electric vehicles are kept in an open area at least 30 metres from other vehicles, buildings, and/or other exposures.[31]

The Government also requires that when installing charging equipment, steps are taken to ensure the charging cable and/or unit is electrically compliant and installed by an electrician as outlined in the Wiring Rules, Appendix P Guidance for Installation and Location of Electrical Vehicle Socket-Outlets and Charging Stations. The act of plugging in an electric vehicle to a charging station is not regulated under the ES framework.

However, there is a need to consider practices related to electric vehicles in domestic settings. This includes safe charging processes, such as not running of extension leads that are designed for indoor use across public pathways to electric vehicles parked in a street, charging leads sitting in water or obstructing fire protection installation. The parking and storage of an electric vehicle may also impact fire safety measures within a structure, however, changes to regulation outside of the electrical safety framework, such as the National Construction Code (for new buildings), are likely required to address this issue.

Workers

Note: workers here refers to those undertaking work on the electric vehicle, and not those operating an electric vehicle for the purpose of work (e.g. bus or truck driver).

Workers are exposed to risks in two separate situations:

1. general maintenance of an electric vehicle
2. repairing damaged propulsion components of an electric vehicle.

Risks to workers are currently addressed through job training and the use of PPE. These mitigation measures should be consistent with the requirements under the WHS and ES framework. Under the WHS Act, duties include a PCBU's responsibility to ensure that as far as is reasonably practicable, workers are provided a safe work environment, including the provision of training and instruction, and supervision.[32] Further, under section 30(1) of the Act a PCBU must ensure the person's business or undertaking is conducted in a way that is electrically safe. Section 30(2)(c) clarifies that "if the

[31] Electric Vehicle Fire Safety | Queensland Fire and Emergency Services (qfes.qld.gov.au).
[32] Section 19 of the WHS Act.

person's business or undertaking includes the performance of work, whether or not electrical work, involving contact with, or being near to, exposed parts, ensuring persons performing the work are electrically safe.*"*

Training in Queensland

Currently in Queensland, work undertaken on ICE and electric vehicles is largely carried out by motor mechanics and OEMs. Like other trades, an apprenticeship pathway exists for motor mechanics and auto electricians. Between 2019-20 and 2020-21, [33] the number of people commencing an apprenticeship pathway for motor mechanics has grown by over 40 percent. In 2021-22, there were 4,591 commencements of automotive-related apprenticeships and traineeships.[34]

Risks are being mitigated in these workplaces through the development and delivery of independent training specific to work on electric vehicles. This includes the provision of training specific to a brand. For example, Tesla provides its own electric vehicle training to its technicians. This training among OEMs is considered to be of high quality. However, it is unclear whether smaller mechanic businesses in Queensland will be competitive in providing services for electric vehicles and, if so, how they will access specialist training. Smaller businesses face the additional challenge that they typically service a wider range of vehicles than those of one manufacturer.

Non-accredited training is widely used by the automotive industry. As an example, the Motor Trades Association (MTA) Queensland provide micro-credentials such as the HEV/BEV Light and Commercial Vehicle Technician Safety Micro-credential, that explores the safety aspects and risks associated with the high voltages used in electric drive vehicles.[35] TAFE Queensland also launched an electric vehicle training facility in 2022, providing training for the automotive industry on electric vehicles, including additional training for apprentices and post-trade training for tradespersons.

In June 2022, the Automotive Retail, Service and Repair Training Package added a qualification (AUR32721 - Certificate III in Automotive Electric Vehicle Technology) which will likely be adopted as an apprenticeship pathway for motor mechanics in the near future.

Regulatory considerations

An important implication in not having a licensing framework for particular work on electric vehicles is that Government does not therefore have responsibility for the development, delivery, record keeping and oversight of training. This is not to assume that Government automatically undertakes these responsibilities better than the private market, but it is to note that without a licensing framework the community must be confident that these elements are being properly managed. The consideration of the regulatory options begins with an understanding of the multiple regulators concerned with vehicles and what activities are out of scope for the ES framework. The diagram below indicates two points of risk at which such regulatory intersection could be considered:

[33] DESBT Apprentice and Trainee Participation Activity Data and Statistics accessed 7 February 2023.
[34] Apprentice and trainee participation activity data and statistics | Department of Employment, Small Business and Training (desbt.qld.gov.au).
[35] MICRO-CREDENTIALS | MTA Queensland.

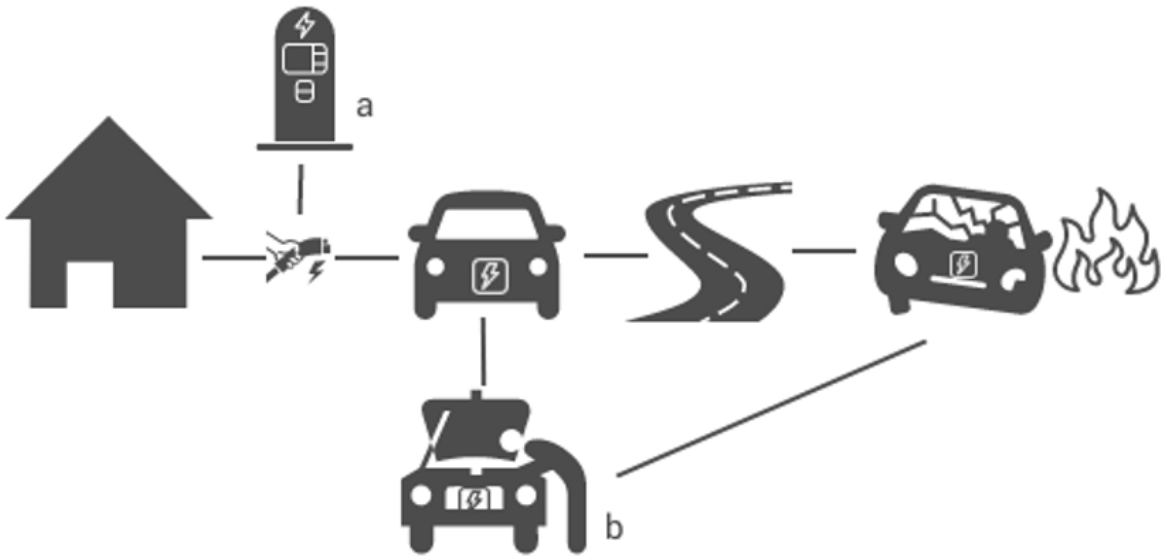


Figure 8: Electric vehicle points of regulatory intersection

***a**: The installation of electric vehicle charging stations is already regulated under the Act. However, the day-to-day operation of a charging station, for example plugging in the charging cord to the electric vehicle, remains the task of the vehicle operator.*

***b**: Indicates persons working on electric vehicles. As discussed above, WHS Act duties and the general duty under the Act apply to workplaces. The workplace is an area that ESO could provide oversight of through the introduction of some form of licensing. The options explored below focus on mitigating risks encountered when working on electric vehicles. Consideration is also given as to what role ESO and the WHS Regulator, more broadly, could play outside of a licensing framework.*

Current regulatory framework

Under section 14(2) of the Act, any equipment forming a part of a unit providing for the propulsion of a vehicle is explicitly excluded from the definition of 'electrical equipment', and therefore excluded from being regulated under ES framework.

Section 14 Meaning of *electrical equipment*

(2) Electrical equipment does not include any apparatus, appliance, cable, conductor, fitting, insulator, material, meter or wire that is part of a vehicle if:
(a) the equipment is part of a unit of the vehicle that provides propulsion for the vehicle, or
(b) the electricity source for the equipment is a unit of the vehicle that provides propulsion to the vehicle.

Examples of things that, under subsection (2), are not electrical equipment:

- the headlights of a vehicle
- ignition spark plugs of a motor vehicle
- the interior lighting system of a vehicle, if powered from a battery charged by the engine that drives the vehicle or by the vehicle's movement.

Examples of things that are not prevented by subsection (2) from being electrical equipment:

- interior lighting or a socket outlet in a caravan, if the lighting or outlet is operated by a low voltage generating set or connected to low voltage supply
- a refrigeration unit in a food delivery vehicle operating at low voltage from a source separate from the propulsion unit for the vehicle.

The exception to this general situation is for mining vehicles under section 73 of the Regulation. For the last 20 years, electric mining vehicles have been subject to a full licensing requirement. However, as technology changed over this time, the Regulation could now be interpreted as capturing trucks and buses. Given its inconsistency with longstanding policy intent, section 73 is not currently being enforced as applying to trucks and buses, as Government seeks community input on updating the ES framework in the form of this discussion paper.

Section 73 Work involving electric motor forming part of vehicle

(1) A person must not perform work on an electric motor forming part of a vehicle unless—
(a) the person is a licensed electrical worker; and
(b) the work performed is work that the person would be authorised to perform on the electric motor under the person's electrical work licence if the electric motor were electrical equipment.
Maximum penalty—40 penalty units.

(2) If a business or undertaking includes the performance of work on an electric motor, a person conducting the business or undertaking must ensure that, in the conduct of the business or undertaking, a person does not perform work in contravention of subsection (1).
Maximum penalty—40 penalty units.

(3) In this section—
electric motor means an electric motor that is electrical equipment within the meaning of section 14(1) of the Act but is not electrical equipment under the Act because of the operation of section 14(2) of the Act.

- Vehicle does not include a car or motorbike under the Transport Operations (Road Use Management) Act 1995.
- Work, on an electric motor, means work on the electric motor that would be electrical work if the electric motor were electrical equipment.

Given that electric vehicles (other than mining vehicles) are not captured under the framework, the powers of the ESO and the Minister, in terms of recalls, inspection and compliance powers do not apply.

Interjurisdictional analysis

Currently, no Australian jurisdiction specifically licenses work on electric vehicles. However, both NSW and WA have existing licensing requirements for motor mechanics more generally. Recognising the growing prevalence of electric vehicles, NSW released a consultation paper in November 2022 seeking feedback on proposed light and heavy electric vehicle licences. While no legislation has been announced, it is indicative of growing interest in the management of safety risks associated with electric vehicles.

Federal regulation

The Federal Government administers the *Road Vehicle Standards Act 2018* (Cth) (RVS Act). The RVS Act is incrementally implementing nationally consistent standards[36] for motor vehicles including electric vehicles.[37] The RVS Act regulates the entry of road vehicles into Australia and provides tools such as authorised vehicle verifiers, as well as a framework to recall road vehicles.

[36] Road Vehicle Standards laws | Department of Infrastructure, Transport, Regional Development, Communications and the Arts; Australian Standard AS 5732:2015 Electric vehicle operations – Maintenance and repair.
[37] Section 5 of the *Road Vehicle Standards Act 2018* (Cth).

The Federal Government also administers the Australian Design Rules; national standards for vehicle safety, anti-theft and emissions.[38] In early 2023, the Federal Government consulted on proposed requirements for electric powertrain safety and hydrogen fuelled vehicle safety related performance.[39] The outcome of this consultation is yet to be released. The purpose of such standards would be to address the following safety concerns for road users, first responders and the community[40]

- direct contact with high voltage live parts and battery electrolyte leakage in EVs in the event of a vehicle crash
- compressed hydrogen storage systems in the event of a vehicle crash
- specific components for compressed hydrogen systems, including safety protection with automatic shut-off valves for hydrogen-fuelled vehicles.

Australian Standards are also relevant in this space, as they assist in establishing a standard of work for electric vehicles.[41] However, standards are not mandatory unless called up in legislation.

Further, the Australian Government released its *Motor Vehicle Service and Repair Information Sharing Scheme* (the scheme), which will come into effect on 1 July 2022 and seek to improve access to vehicle safety information.[42] The scheme is supported by the Australian Automotive Service and Repair Authority and the ACCC and provides access to car service and repair information for repairers and registered training organisations. This scheme is not open to individuals who repair their own vehicles, though car manufacturers are not prevented from sharing information with consumers.[43]

3.3.2 Objective of Government action

The objective of Government action is to minimise the risk of harm to persons and property by balancing regulation with industry self-regulation, in line with the purpose of the Act.

A second objective of Government action is to encourage a transition to a net-zero economy while minimising risk to persons and property presented by electric vehicles in line with the purpose of the Act.

3.3.3 Consideration of options

Table 20: Options overview

Options	Description
Option 1	Status quo. • Industry undertakes self-regulation on training requirements for work on electric vehicles.
Option 2	Legislative change. • Capture work on electric motors within the definitions of ‘electrical equipment’ and ‘electrical work’, for the purposes of a licensing requirement.
Option 3	Awareness and Education. • Produce an awareness and education campaign to address concerns regarding electric vehicles generally, including work.

[38] Australian Design Rules | Department of Infrastructure, Transport, Regional Development, Communications and the Arts.
[39] National safety standards for electric and hydrogen-fuelled vehicles | Department of Infrastructure, Transport, Regional Development, Communications and the Arts
[40] National safety standards for electric and hydrogen-fuelled vehicles | Department of Infrastructure, Transport, Regional Development, Communications and the Arts.
[41] Australian Standard AS 5732:2015 Electric vehicle operations – Maintenance and repair.
[42] Motor vehicle information scheme (MVIS) | ACCC.
[43] Motor vehicle information scheme (MVIS) | ACCC.

Note: First respondents, such as QFES officers, are not intended to be subject to any licensing requirement under Option 2. OIR will work separately with QFES to determine appropriate training requirements to address the risks in responding to fires involving electric vehicles.

3.3.4 Impact analysis of the options

Some of the benefits and costs that could be raised and detailed in response to this discussion paper are provided in the table below. These potential costs and benefits are not the view of the Queensland Government and are provided for indicative and discussion purposes only.

Option 1: Status quo

Table 21: Summary of potential impacts posed by option 1 (status quo)

Stakeholder	Benefits	Costs
Unlicensed workers (mechanics and others)	• Those workers without an electrical licence can continue to work on EVs.	• Any exposure to electrical hazards experienced by unlicensed workers due to an absence of specialist technical knowledge (electrical) will remain.
Licensed electrical workers	• Nil.	• Nil.
Community	• Maintained accessibility to workers to operate as needed on EVs.	• Any community exposure to electrical hazards, resulting from workers operating on EVs who are not equipped with specialist technical knowledge (electrical), will remain.
PCBUs	• Does not limit work opportunities for unlicensed workers currently completing this work.	• Any exposure to electrical hazards experienced by unlicensed workers due to an absence of specific technical knowledge (electrical) will remain.
Manufacturers and suppliers	• Nil.	Where OEMs are providing maintenance to vehicles, costs listed under unlicensed workers may apply.
Queensland Government	• Does not limit work opportunities for unlicensed workers currently completing this work. • Maximises the workforce able to work on EV, encouraging uptake and industry in Queensland.	• Any exposure to electrical hazards experienced by unlicensed workers due to an absence of specific technical knowledge (electrical) will remain.

Option 2: Capture work on electric motors within the definitions of 'electrical equipment' and 'electrical work', for the purposes of a licensing requirement.

Table 22: Summary of potential impacts posed by option 2 (legislative)

Stakeholder	Benefits	Costs
Unlicensed workers (mechanics and others)	• Reduced risks of harm resulting from poorly managed/maintained electrical equipment.	• Cost to individuals to upskill (training or licensing process). • Increased barrier to enter the industry.
Licensed electrical workers	• Potential increased scope of work.	• Requirement to undertake appropriate training to understand the nuance of EVs.
Community	• Reduced risks of harm resulting from poorly managed/maintained electrical equipment. • Confidence in work undertaken on vehicles. • Confidence to purchase EVs.	• Increased costs faced by business resulting in increased costs for services. • Potential to reduce licensed electrical worker availability due to an increased scope of work resulting in challenges for the community to access licensed electrical workers.
PCBUs	• Reduced risks of harm resulting from poorly managed/maintained electrical equipment.	• Potential need to change business structure and administrative requirements. • Potential increased costs to pay the wage of a 'higher skilled' worker. • Increased costs to pay or support workers transition their skillset.
Manufacturers and suppliers	• Current exemption in the Act would apply, therefore no licensing requirement is suggested.	• Potential administrative costs for complying with duties (e.g., to make an incident notification). • Where OEMs provide maintenance and are not licensed, costs as listed under 'unlicensed workers' would apply.
Queensland Government	• Appropriate oversight, powers and confidence to ensure appropriate training for all undertaking work on EVs. • Contributes to minimisation of harm to persons and property, in line with the objectives of the Act.	• Development of a licensing program or outsourced to Registered Training Organisations. • Operational costs projected for: - assessing and issuing licences - maintaining register - inspecting incidents; and - compliance and adversarial processes.

	• Cost recovery of expanded regulatory functions through licence fees. • Potential for enhanced enforcement with proactive capacity for compliance activity. • Increased public confidence in electric vehicles, resulting in support for transition to net-zero.	• Develop resources to support engagement with the public for regulation implementation.

Option 3: Education and Awareness

Table 23: Summary of potential impacts posed by option 3 (awareness and education)

Stakeholder	Benefits	Costs
Community	• Empowering the general public to be proactive in assessing and taking steps to mitigate risks which may reduce the overall risk of exposure to harm in work and domestic settings.	• Time to engage with awareness and educational material.
Unlicensed workers (mechanics and others)	• Empowers unlicensed workers to be proactive in assessing and taking steps to mitigate risks which may reduce the overall risk of exposure to electrical hazards.	• Time to engage with awareness and educational material.
Licensed electrical workers	• Nil.	• Nil.
PCBUs	• Empowers industry to be proactive in assessing and taking steps to mitigate risks which may reduce the overall risk of exposure to electrical hazards.	• Time to engage with awareness and educational material.
Manufacturers and suppliers	• Nil.	• Nil.
Queensland Government	• Contributes to the minimisation of the risk of harms to persons and property, in line with the objectives of the Act.	• Develop and deliver education and awareness resources, including social media campaign and community forum(s).

3.3.5 Consultation

The Review offered the public the opportunity to provide submissions on a variety of topics, including electric vehicles.

The Review identified the following feedback from the Electrical Safety Board, Electrical Committee and Ergon (page 42 Review Final Report):

… the ESB and Committees noted in relation to vehicles, including based on input from Ergon, that:

"Batteries and some energy storage devices have electrical risk which could be far greater than licensed electrical AC work, say for domestic switchboards, that are currently only captured as Electrical Equipment where the DC voltages are above 120V. To some degree, voltage is almost irrelevant in assessing the nature of the danger for batteries. Arc flash potential for batteries can be significant – for example – a 24V DC battery bank in an enclosure may have the potential for a 30kA short circuit current (typically where parallel battery banks are used) which could result in an arc flash energy of 10.7cal/cm2 and an arc flash boundary of over 1.3 metres."

The ETU and NECA also suggested to the Review that those with a licence under the Act be responsible for work on electric vehicles (page 50 Review Final Report):

The ETU advocated for the involvement of electrical fitter mechanics in manufacturing of electric vehicles in Queensland. NECA recommended restricting work on both electric vehicles and charging stations to be limited to electrical workers.

Training requirements were also raised in the Review by NECA and Energy Queensland (page 50 Review Final Report):

NECA also noted that specialist training and licensing requirements should be introduced to cater to the specialist nature of electric vehicles and the risks involved. Training and licensing requirements for those who work on relevant equipment in connection of electric vehicles was also raised by Energy Queensland for consideration.

The Review made several recommendations in relation to electric vehicles:

Recommendation 2: Review the electrical safety risks presented in electric vehicles and consider their inclusion in the scope of regulation by the Act. It is further recommended that the Electrical Safety Office engage with other relevant Queensland and Australian regulators as needed to ensure appropriate scope and to avoid both regulatory gaps and duplication.

Recommendation 8: For electric vehicles (or parts thereof) falling within the definition of "electrical equipment" (see Recommendations 2 and 4), consider requiring:

(a) appropriately licensed electrical workers to carry out the electrical work on the electrical components when the vehicle is serviced and or repaired, to ensure the safety of owners/operators and community; and
(b) appropriately licensed electrical workers carry out the electrical work on the electrical components of the vehicle when an electric vehicle requires on-road break-down work to ensure safety of owners/operators, the community and first responders.

Recommendation 74(c): Consider clarifying and enhancing standards that apply to electrical installations (Regulations, Part 6), including by considering:

(c) ensuring there is a legislative basis in the Act for regulations concerning work involving water equipment (s 72), and, if it is to be maintained, work involving electric motors (s 73).

OIR has also received correspondence from various interested parties regarding the regulation of electric buses and trucks. These parties indicate that industry is already developing and delivering training to address the risks identified in the problem definition.

3.3.6 Questions seeking feedback

1. How are you, your organisation, the workforce or community affected by the problems identified and to what extent?

2. Do you agree with the assessment of the problem identified, and are there additional risks presented by electric vehicles that have not been identified? If yes, what are they and can you provide examples of these issues?

3. What practical impact, including the costs and benefits, would the options proposed in the Discussion paper have on you, your organisation, the workforce or the community? Please provide examples where possible.

4. What is your preferred option and why would it be best for you, your organisation and your stakeholders?

5. If a licensing framework was introduced:

    a. Should any specific type of vehicle be excluded for the requirement (e.g., motorcycles, cars, buses, trucks)? If so, what are they and why?

    b. Is a restricted licence (specified training) or full licence (full apprenticeship) suitable? If so, why?

    c. Should the licence type be determined based on the type of vehicle? If so, what would you suggest and why?

    d. What types of work or occupations should be excluded from a licensing requirement? Or alternatively, what types of work or occupations should have specific licensing requirements (e.g., on-road works, general maintenance and check-ups, and/or removal and disposal)?

    e. Are there any elements under the Act which should not apply? Which sections and why?

    f. Are there situations in which a disconnect and connect restricted licence for performing work on non-propulsion components of a vehicle would be appropriate?

6. Do you have suggestions for other options to address the problems identified? Please provide examples (including costs where appropriate) of your suggested options, including how it would ensure the workforce are electrically safe and conduct electrically safe work for community safety.

4.0 Appendix

4.1 Abbreviations

Table 24: Table of abbreviations used throughout the Discussion Paper

Term	Definition
AC	Alternating current
ACCC	Australian Competition and Consumer Commission
BESS	Battery energy storage systems
CEC	Clean Energy Council
CSQ	Construction Skills Queensland
DC	Direct current
DEE	Dangerous electrical event
DIY	Do it yourself
EESS	Electrical Equipment Safety System
ELV	Extra low voltage
EQ	Energy Queensland
ERAC	Electrical Regulatory Authorities Council
ES framework	Electrical safety framework
ESO	Electrical Safety Office
EV	Electric vehicle
HV	High voltage
kW	Kilowatt
LV	Low voltage
Model WHS Regulations	the model Work Health and Safety Regulations 2011
MW	Megawatt
NECA	National Electrical and Communications Association
OEM	Original Equipment Manufacturer
OIR	Office of Industrial Relations
PCBU	Person conducting a business or undertaking
PV	Photovoltaic
QEJP	Queensland Energy and Jobs Plan (2022-2025)
QFES	Queensland Fire and Emergency Services
SEI	Serious electrical incident
the Commissioner	The Commissioner for Electrical Safety
the Commissioner's Report	2020 Improving Electrical Safety in Queensland: A Report by the Commissioner for Electrical Safety
the Act	*Electrical Safety Act 2002* (Qld)
the Minister	The Minister for Education, Minister for Industrial Relations and Minister for Racing
The Olympics	2032 Olympic and Paralympic Games
The QRF Report	Construction Skills Queensland - Queensland's Renewable Future Report (2022)
the Regulator	Electrical Safety Office
the Regulation	Electrical Safety Regulation 2013 (Qld)
the Review	*Review of Queensland's Electrical Safety Act 2002*
V	volts
WHS Act	*Work Health and Safety Act 2011* (Qld)
WHS framework	Work health and safety framework
Wiring Rules	AS/NZS3000:2018 Electrical installations

4.2 In scope recommendations - *Review of Queensland's Electrical Safety Act 2002*

Recommendation 1: It is recommended that modernising the scope of the Act to ensure new and emerging energy generation and storage technologies are incorporated, whether or not they are connected to the grid or stand-alone in nature, by including in the definition of electrical equipment/electrical installation:

(a) solar PV modules, designed to be connected to other solar PV modules and when connected be of a combined voltage of greater than extra low voltage; and
(b) battery cells, when connected to other cells for the purpose of storing and releasing power of a combined voltage of greater than extra low voltage.

Recommendation 2: Review the electrical safety risks presented in electric vehicles and consider their inclusion in the scope of regulation by the Act. It is further recommended that the Electrical Safety Office engage with other relevant Queensland and Australian regulators as needed to ensure appropriate scope and to avoid both regulatory gaps and duplication.

Recommendation 4: To ensure the Act keeps pace with technological change, consider creating a general category of exception to the "extra low voltage" threshold for the definition of "electrical equipment", to reflect risk to life and property by ELV electrical equipment.

Recommendation 5: For solar PV panels falling within the definition of electrical equipment (see Recommendation 1), consider ensuring that the resultant "electrical work" ' definition is amended as needed to require:

(a) all connections and testing of PV module cabling as well as earthing and bonding work be performed by competent licensed electrical worker/s; and
(b) installation of cabling to be carried out by a licensed electrical worker or an unlicensed person assisting a licensed electrical worker and working under their direct supervision; and
(c) the mounting, fixing, and locating of solar PV modules and arrays to be carried out by competent persons under the direct supervision (Recommendation 16) of a licensed electrical worker (Act s 18(2)(f)).

Recommendation 6: Consider including within the definition for Electrical Work that the electrical aspects of air conditioning / mechanical services work is electrical work and the tasks of fixing, installation of brackets/mounting of equipment and mechanical cable protection is ancillary to the complete installation.

Recommendation 7: Ensure the installation of mechanical protection for cables, including but not limited to conduit (both plastic and metal), cable racks and trays, skirting, troughs etc., and the installation of cabling into these protection components is the work of licensed electrical workers or to be performed under the direct supervision of a licensed electrical worker. Associated with this work is earthing and bonding work, to be defined as electrical work (recommendation 5) and must only be performed by competent licensed electrical worker/s.

Recommendation 8: For electric vehicles (or parts thereof) falling within the definition of "electrical equipment" (see Recommendations 2 and 4), consider requiring:

(a) appropriately licensed electrical workers to carry out the electrical work on the electrical components when the vehicle is serviced and or repaired, to ensure the safety of owners/operators and community; and

(b) appropriately licensed electrical workers carry out the electrical work on the electrical components of the vehicle when an electric vehicle requires on-road break-down work to ensure safety of owners/operators, the community and first responders.

Recommendation 13: Clarify that off-grid systems are captured within the meaning "electrical equipment" and are therefore within the definitions of Serious Electrical Incident and Dangerous Electrical Event (Act, ss 11-12), giving rise to duties to notify the Regulator and otherwise respond to such incidents (Regulations, Part 14).

Recommendation 17(a)&(c): Consider clarifying miscellaneous requirements related to supervision, by:

(a) inserting the word "direct" before "supervision" in section 18(2)(e)(iii); and,

(c) requiring direct supervision for a person directly assisting the licensed electrical worker in the laying, cutting or sealing underground cables that are part of the works of an electricity entity before the initial connection of the cables to an electricity source (s 18(2)(j)).

Recommendation 74(c): Consider clarifying and enhancing standards that apply to electrical installations (Regulations, Part 6), including by considering:

(c) ensuring there is a legislative basis in the Act for regulations concerning work involving water equipment (s 72), and, if it is to be maintained, work involving electric motors (s 73).