Policy Brief

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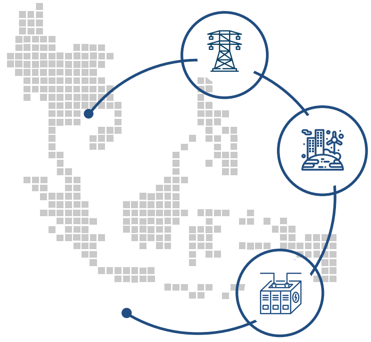
Mapping the Current State of Electrical Safety Regulations in ASEAN: Preliminary Assessment of Electrical Safety Standards and Practices for Solar Photovoltaics (PV) and Battery Energy Storage Systems (BESS)



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Highlights

- As ASEAN countries increasingly adopt Solar PV and BESS technologies, implementing robust electrical safety standards is crucial, as it will protect infrastructure, safeguard users, and support the sustainable growth of renewable energy sectors across the region.
- Solar PV systems and Battery Energy Storage Systems (BESS) present specific safety hazards, including electrical fires, thermal runaway, and potential electrical shocks. Key safety features for Solar PV include stringent installation standards to prevent overloading and DC arc faults from improper inverter connection, while BESS safety focuses on thermal management and fire prevention through robust casing and monitoring systems.
- ASEAN countries exhibit varied levels of adoption and enforcement of electrical safety standards for Solar PV and BESS. Several countries have adopted national standards for Solar PV based on the International Electrotechnical Commission (IEC) standards, while safety standards for BESS are even more fragmented, with some nations lacking clear guidelines.
- Regional cooperation in developing and enforcing comprehensive electrical safety standards is limited. Only a few ASEAN countries have undergone thorough safety assessments for renewable energy technologies. Enhanced regional coordination is essential for establishing uniform standards and improving safety outcomes.
- ASEAN countries should strengthen and harmonise national safety standards for Solar PV and BESS by adopting international frameworks such as IEC 61730, IEC 61215, IEC 62619, IEC 63056 and IEC 62933-5-2. To enhance safety and reliability, capacity-building programmes for stakeholders should be implemented, and a regional working group should be established to coordinate the development and enforcement of uniform safety protocols across the region.

1. Introduction

The ASEAN region, with its diverse and rapid economic growth, is experiencing a surge in electricity demand. According to the 7th ASEAN Energy Outlook (AEO7), the region is looking into a tripling of energy demand by 2050, from the 2020 level [1]. In an effort to satisfy the rapid increase in electricity demand, the ASEAN Member States (AMS) introduce cleaner and more sustainable energy sources into the electricity mix, through the integration of solar and wind technologies into the grid. As of 2022, the region achieved around 33.3% of renewable energy share in installed capacity and is projected to reach 49.3% by 2050 based on the ASEAN Target Scenario of AEO7 [2].

The integration of renewables, such as solar photovoltaic (PV), wind, and emerging technologies like battery energy storage systems (BESS), into the ASEAN energy mix presents both advantageous opportunities and challenges. While these technologies offer significant benefits in terms of sustainability and energy security, specialised safety measures to mitigate potential electrical hazards become necessary in order to ensure the safety and security of clean electricity supply to consumers. Inadequate electrical safety standards and non- compliance from the stakeholders may lead to accidents, equipment failures, and disruptions to the supply of power, hindering the region's progress towards a sustainable energy future.

In helping the region understand the current state of electrical safety in ASEAN, this policy brief will dive deep into the existing standards and regulations governing the design, installation, operation, and maintenance of the electrical system. It covers the technical aspects of solar PV technology and the BESS system to further assist the regulators and policymakers in formulating suitable safety standards for renewable energy technologies. Furthermore, it will identify the key gaps and challenges in electrical safety governance and propose recommendations for strengthening the standards.

2. Electrical Safety Issues, Features, and Technical Standards

2.1 Safety Hazards and its Effect

As previously mentioned, the growing integration of renewable energy needs to be accompanied by a set of rules to ensure the safety of installation and operation of the technology. The International Electrotechnical Commission (IEC), an international organisation which publishes international standards on electrical, electronic, and related technologies, released a specific standard on the safety of power converters in PV systems in the IEC 62109-1:2010, providing the general requirements for the design and manufacture of power converters for protection against electrical shock, thermal, mechanical, and other hazards [3].

Various prominent references explained in detail the mentioned hazards that typically occur in solar PV installation and operation. Electrical shock or electrocution mainly occurs due to direct contact with "live" parts, caused by damaged or inadequate equipment insulation which creates a least-electrical resistance path between the conductor and the ground through the human body [4]. From ventricular fibrillation to third-degree burns, electrical shock may cause severe damage to the human body in the event of direct contact with live parts [5]. In regard to the thermal issues, overloading of the equipment and electrical arcing due to a short-circuit event may lead to the ignition of flammable materials, such as gas insulation and nearby combustibles. Thermal runaway, a phenomenon when heat generation exceeds the battery's ability to dissipate the heat which is mainly caused by internal short-circuit and mechanical damages, poses the risk of fire developing from the equipment [6]. Understanding the detailed technical specifications of Solar PV and BESS technology and the risks that may entail based on the existing international best practices and standards would benefit ASEAN regulators in forming the right regulations for higher renewable energy deployment. A hybrid solar PV system mainly consists of three components: PV modules, batteries, and hybrid inverters. In this section, we will delve into the product standards for the battery energy storage system and the inverter.

2.2 PV Hybrid Inverters Features and Standards

A PV inverter works through a rapid switching mechanism by the embedded power electronics (IGBT), enabling the linear/ direct current input, which is produced by the solar cells, to be transformed into a stepped sinusoidal wave of alternating electricity current as the output [7]. In its installation and operation, safety hazards may occur due to mechanical/ thermal or electrical issues, as previously explained. Those issues would impact the overall conversion efficiency of an inverter, posing higher equipment losses and reducing the energy output. Hence, several standards were established to ensure the reliable operation of a solar inverter.

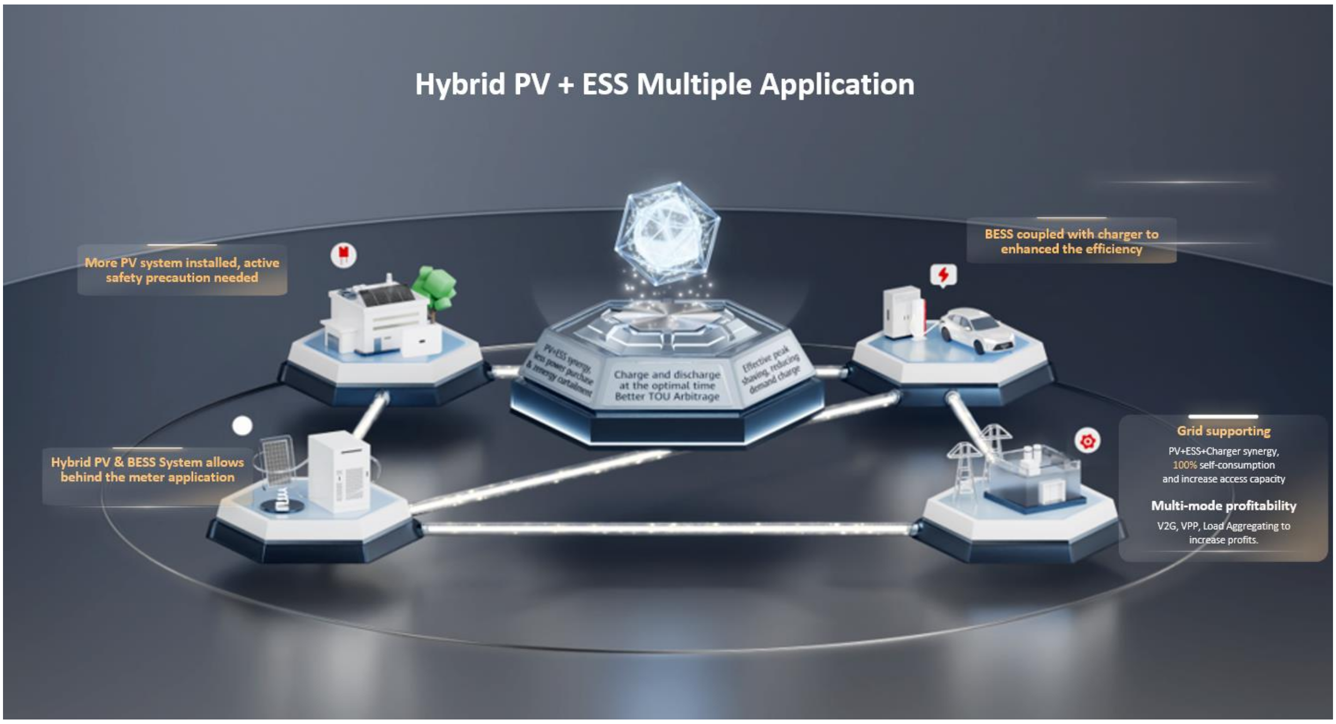
In summary, solar cells and arrays generate direct current (DC) electricity from photon absorption, while motors, lamps, and other electrical loads mainly consume alternating current (AC) electricity. DC electricity generation may introduce unique safety concerns, such as the risk of DC arc faults due to the high operational voltage. To mitigate such hazards, safety measures through arc fault interrupters (AFCI) and rapid shutdown devices (RSD) can be implemented to reduce potential risks under various scenarios [8].

2.3 Battery Energy Storage System Safety Features and Standards

In designing a battery energy storage system, one should take into account the architecture of the battery cell, the choice of technology, and the thermal management factor to prevent any electrical or thermal hazards from happening. Numerous standards have been established and recognised to ensure the safety integration of the battery into the PV system, with the IEC standards widely referenced in the ASEAN region's electrical safety standards. IEC 62619, IEC 63056 and IEC 62933-5-2 define a comprehensive framework for ensuring the safe design, installation, operation, and maintenance of battery energy storage systems (BESS) [9], [10]. These standards cover a variety of aspects of BESS safety, including:

- Battery design and manufacturing: The standards for battery design, manufacture, and testing ensure safety and performance. This covers advice for avoiding thermal runaway, providing proper ventilation, and reducing the risk of battery fires. Adhering to these guidelines allows manufacturers to make BESS that are intrinsically safer and more.
- Battery installation and operation: The standards guide the safe installation and operation of BESS, including requirements for location, ventilation, fire protection, and monitoring procedures. By following these guidelines, installers and operators can minimise the risk of hazards such as thermal runaway and fire spread and ensure that BESS are operated safely and efficiently.

In addition to the above, IEC 62933-5-2 also specify emergency procedures for handling battery failures, fires, and other hazards. This helps to minimise the impact of incidents and protect personnel and equipment [9, p. 62]. By implementing these procedures, stakeholders can be better prepared to respond to emergencies and mitigate potential risks.



3. Overview of Existing Electrical Safety Standards and Regulations in ASEAN Countries

3.1 Existing Electrical Safety Standards on Regional Level: ASEAN Harmonized Electrical and Electronic Equipment Regulatory Regime (AHEEERR)

The ASEAN Harmonized Electrical and Electronic Equipment Regulatory Regime (AHEEERR) aims to standardise regulations for electrical and electronic equipment across ASEAN Member States. Covering equipment operating within 50-1000 volts AC and 75-1500 volts DC, AHEEERR establishes essential safety and Electromagnetic Compatibility (EMC) requirements to protect human health, safety, and the environment. A core component of AHEEERR is the Conformity Assessment, which outlines procedures for verifying compliance through testing, certification, and factory inspections. This ensures that products meet safety and EMC standards before entering the market. Additionally, the regime supports Mutual Recognition Agreements (MRA), allowing ASEAN nations to mutually recognise test reports and certifications, simplifying trade and regulatory compliance within the region.

However, solar PV systems and battery energy storage systems (BESS) are not yet classified as standard electrical products under AHEEERR. As these technologies expand, there is a need to develop specific regional safety standards for these emerging technologies and ensure that installation and operational guidelines are in place. This will help create a fully harmonised framework for electrical safety across ASEAN, addressing emerging technologies and enhancing regional cooperation in energy management.

3.2 Highlights of key regulations, standards, and stakeholders related to electrical safety across ASEAN Member States

3.2.1 Brunei Darussalam

Electricity management in Brunei Darussalam is overseen by the Department of Electrical Services (DES), under the Department of Energy, and the Autoriti Elektrik Negara Brunei Darussalam (AENBD), which regulates electrical standards. DES handles electrical policy and electro-mechanical maintenance, while AENBD enforces the Electricity Act, covering safety standards for installations, appliances, and systems [11], [12]. These standards align with international frameworks, such as the IEC. In 2023, Brunei established the Electrical Safety Committee (ESCOM), co-chaired by the Safety, Health and Environment National Authority (SHENA) and AENBD, which aims to promote compliance and elevate safety standards across sectors [13].

Key regulated areas of electrical safety include Low Voltage (LV) wiring, electrical appliance safety, portable appliance testing, and public lighting for residential and industrial settings [13]. Recently, Brunei introduced the Guidebook for Solar PV Rooftop and Net-metering Programme, offering safety guidelines for the installation and operation of solar PV systems [14]. Additionally, Codes of Practice for large-scale solar PV grid connections ensure compliance with safety regulations under the Electricity Act [15].

3.2.2 Cambodia

Cambodia's electricity management is regulated by the Ministry of Mines and Energy (MME) and the Electricity Authority of Cambodia (EAC), with compliance or benchmarking to international standards such as IEC. The Electricity Law and associated proclamations (Prakas) form the legal framework, including technical standards for thermal generating facilities, transmission, and distribution systems [16]. In terms of electric appliances, Cambodia has an extensive legislative framework which is regulated by the Institute of Standards of Cambodia (ISC) under the Ministry of Industry, Science, Technology & Innovation (MISTI) [17].

In 2018, EAC introduced regulations for the installation and operation of solar PV systems, focusing on technical aspects like system synchronisation, grid connection, and safety measures to prevent hazards such as DC power injections and harmonic distortions [18]. In 2023, the MME issued Prakas No. 0159, launching the Principles for Permitting the Use of Rooftop Solar Power, which outlines safety standards for electrical, structural, and metering components, including grounding and lightning protection for both grid-connected and standalone systems [19].

3.2.3 Indonesia

Indonesia's electricity management involves key stakeholders including the Ministry of Energy and Mineral Resources (MEMR), the National Standardisation Agency of Indonesia (BSN), and the State Electricity Company (PLN) [20]. The Directorate General of Electricity, under MEMR, establishes the regulatory framework, including the Electricity Law, which enforces electrical safety standards across power generation, transmission, and distribution sectors. The BSN is responsible for developing and maintaining Standar Nasional Indonesia (SNI), including electrical safety standards for appliances, industrial systems, and both low- and high-voltage installations, ensuring alignment with international standards such as those from the IEC. PLN, as the state-owned utility, has its own operational standards to comply with regulations in power generation and distribution.

In 2021, Indonesia introduced a new certification standard for Solar PV (SNI IEC 61215) under the Minister of Energy and Mineral Resources Regulation No. 2 [21]. The Directorate General of Electricity (DGE) also mandates that any Solar PV installation connected to the grid must secure an SLO (Operation Worthiness Certificate) from accredited institutions to meet safety requirements [22]. Additionally, private institutions and DGE provide services for Solar PV quality assurance, including inspection and commissioning processes [23].

3.2.4 Lao PDR

Lao PDR enforces electricity management standards through the Ministry of Energy and Mines (MEM) and Electricité du Laos (EdL). The regulatory framework is outlined in the Lao PDR Law on Electricity and the Lao Electric Power Technical Standard, which adapts international standards, particularly from the IEC, to meet local requirements [20], [24].

Electrical standardisation for consumer products, energy efficiency, and labelling is primarily handled by the Ministry of Industry and Commerce (MOIC) and the Ministry of Science and Technology (MOST) [25]. Publicly available information on Solar PV and BESS safety standards in Lao PDR is limited. However, general safety and installation requirements for Solar PV systems are integrated into the Law on Electricity and the Lao Electric Power Technical Standard, though no explicit standalone regulations for these systems have been published yet.

3.2.5 Malaysia

In Malaysia, electrical safety regulation varies by state. In Peninsular Malaysia, the Energy Commission (Suruhanjaya Tenaga) is responsible for enforcing electricity management standards, guided by the Electricity Supply Act and the Efficient Management of Electrical Energy Regulations [26]. These regulations cover installations, energy usage, and consumer awareness through mechanisms like mandatory energy labelling. Recent initiatives promote renewable energy adoption, including the Net Energy Metering scheme and the NOVA Programme [27], [28]. For PV system standardisation, Malaysia adopts IEC standards, with certification managed by the Department of Standards Malaysia and SIRIM Berhad [29], [30].

In Sabah, the Energy Commission of Sabah (ECoS) regulates energy supply, including the licensing of electricity and gas entities. This role was previously under the national Energy Commission but is now fully managed by ECoS [31]. In Sarawak, energy regulation is managed by the Ministry of Utilities and Telecommunication (MUT), specifically through the Electricity Supply Division (ESD). Compliance with safety standards is ensured by Sarawak Energy Berhad (SEB), as outlined in the Electricity Rules [32]. Despite regional differences, Malaysia's overall electrical standards align with international frameworks like IEC and British Standards (BS) [33].

3.2.6 Myanmar

Myanmar's electricity management standards are enforced by the Ministry of Electricity and Energy (MOEE) under the National Electricity Law, which establishes the regulatory framework, including licensing and inspection protocols [34]. Key stakeholders involved in electrical safety include the Directorate of Industrial Supervision and Inspection (DISI) and the Myanmar Standards Department, with many standards adopted from the IEC [35]. For the residential and industrial sector, Myanmar set the National Building Code for electrical wiring installations standard and promote the inspection of electrical safety in factories, industries, public buildings, and particularly in high-voltage facilities [36]. While specific electrical safety standards for Solar PV and BESS are not yet publicly available, Myanmar is actively developing its renewable energy sector, including relevant standards for operation and application.

3.2.7 Philippines

The Philippines manages its electricity standards for their electricity facilities through the Department of Energy (DOE), with a comprehensive framework aimed at promoting efficiency and competition. The Energy Regulatory Commission (ERC) enforces these standards, complemented by the Philippine Electrical Code (PEC), which heavily based on the National Electrical Code (NEC) of the USA with considerations of IEC standards [37]. The PEC covers essential categories of electrical safety, including wiring methods, grounding systems, overcurrent protection, and workplace occupational safety [38].

Electrical and electronic product regulations are overseen by the Bureau of Philippine Standards (BPS), with the Consumer Act of the Philippines serving as the regulatory framework for safety certifications [39]. Recent updates to the PEC include provisions for renewable energy systems such as solar photovoltaic (PV) facilities and energy storage systems (ESS). Notably, Article 6.91 addresses large-scale solar PV installations, while Article 7.6 outlines the risks associated with batteries and energy storage [40].

3.2.8 Singapore

In Singapore, electrical safety standards are rigorously enforced through frameworks managed by the Energy Market Authority (EMA) and Enterprise Singapore. Supported by the Electricity Act and Energy Conservation Act, these frameworks establish comprehensive technical and safety standards [41]. The core regulation, Singapore Standard SS 638:2018, governs electrical installations, ensuring safe design, operation, and maintenance. It incorporates international standards like British Standards (BS 7671), with modifications for Singapore's specific needs [42].

For electrical facilities and electricity production, EMA adopts several specific national standards and technical references including the Singapore Standardisation Programme and technical guidelines for electrical installations and energy storage systems. These are overseen by the Singapore Standards Council [43]. EMA also provides guidelines for the safe installation and operation of solar PV systems [7].

3.2.9 Thailand

In Thailand, electrical safety standards are primarily overseen by the Thai Industrial Standards Institute (TISI), with contributions from the public utilities like the Electricity Generating Authority of Thailand (EGAT) [44]. The regulatory frameworks for the energy sector, including electrical safety, is governed by the

Ministry of Energy and regulatory bodies like the Energy Regulatory Commission (ERC). The ERC focuses on regulating energy providers to ensure electricity production and distribution comply with safety standards, working closely with TISI to enforce these regulations.

The regulatory framework is grounded in national standards and international benchmarks, such as those from the IEC, the Energy Conservation Promotion Act, and the Energy Industry Act. TISI has also established guidelines for solar PV systems aligned with IEC standards, ensuring safe installation and operation. For battery energy storage systems (BESS), standards are being developed based on international models such as UL 9540 and NFPA 855 to manage risks like fire hazards and thermal runaway [45].

3.2.10 Viet Nam

Viet Nam's Ministry of Industry and Trade (MOIT), along with the Electricity Regulatory Authority of Viet Nam, enforces electricity standards that align with IEC regulations. The legal framework, as outlined in the Electricity Law and related decrees, prioritises safety, efficiency, and reliability. Key areas of focus include standards for high- and low-voltage equipment, worker safety, and public safety in electrical operations [46], [47], [48]. Specific regulations for solar PV and battery energy storage systems (BESS) are governed by the Law on Technical Standards and Regulations, which manages installation and grid connection standards. For BESS, safety standards are currently still being developed based on international best practices. And as Viet Nam's first BESS pilot projects are underway, it marks a shift toward formalised safety standards for energy storage [49].

4. Assessment of the Current Regulatory Environment for Electrical Safety

To assess the current regulatory landscape for electrical safety, particularly for solar PV and BESS installation and operation standards, a summary table was created. This table synthesizes key findings from Section 3 and integrates evaluations of each country's electrical safety environment, as assessed by the Safety Barometer endorsed by global experts and the International Federation for the Safety of Users of Electricity (FISUEL) [50].

Table 1. Current Regulatory Environment for Solar PV and BESS Electrical Safety Standards in ASEAN Countries

Country	Related Regulator for Electrical Safety for Energy Sector	Dedicated Institution for Electrical Safety	Specific Safety Standard for Solar PV & BESS	Guidance or Protocol for Periodic Inspections	Specific Protocol or qualification for inspector
Brunei Darussalam	Autoriti Elektrik Negara Brunei Darussalam (AENBD)	Electrical Safety Committee (ESCOM)	No specific regulation, only guidebook for Solar PV Rooftop Installations & Operations	Unknown	Unknown
Cambodia	Electricity Authority of Cambodia (EAC); Institute of Standards of Cambodia (ISC) (for consumer products)	Not available	Available for Solar PV under the Prakas No. 0159; no specific regulation for BESS	Unknown	Unknown
Indonesia	Directorate General of Electricity	Not available	Only have certification standard for PV modules, unknown standard or regulation for solar PV & BESS installations and operation	Not met	Partially fulfilled

Lao PDR	Ministry of Energy and Mines (MEM)	Not available	No specific regulation for solar PV and BESS	Unknown	Unknown
Malaysia – Peninsular	Energy Commission (Suruhanjaya Tenaga)	Not available	No specific regulation, only guidebook for Solar PV Installations & Operations under each initiative or programme	Not met	Partially fulfilled
Malaysia – Sarawak	Electricity Supply Division (ESD)	Not available	No specific regulation	Unknown	Unknown
Malaysia – Sabah	Energy Commission of Sabah (ECoS)	Not available	No specific regulation	Unknown	Unknown
Myanmar	Ministry of Electric Power (MOEP); Directorate of Industrial Supervision and Inspection (DISI) (for consumer products)	Not available	No specific regulation	Unknown	Unknown
Philippines	The Energy Regulatory Commission (ERC)	Not available	Potential risks associated to Solar PV and Energy Storage Systems are addressed in the Philippine Electrical Code (PEC)	Unknown	Unknown
Singapore	Energy Market Authority (EMA); Enterprise Singapore (for consumer products)	Not available	No specific regulation, only guidelines for Solar PV Installations & Operations	Not met	Not met
Thailand	Energy Regulatory Commission (ERC); Thai Industrial Standards Institute (TISI) (for electrical products)	Not available	No specific regulation, only guidelines for Solar PV Installations & Operations and follows international standards for BESS	Not met	Not met
Viet nam	Electricity Regulatory Authority of Vietnam	Not available	No specific regulation	Not met	Not met

Table 1 presents an overview of the relevant stakeholders and regulators responsible for enforcing electrical safety standards across ASEAN countries. While most countries have distinct regulatory bodies overseeing electrical product standards, installations, and operations, Brunei Darussalam stands out as the only country with a dedicated institution tasked with managing the implementation and compliance of electrical safety standards. Although other nations' regulators conduct regular monitoring, the presence of a specialised institution is crucial given the wide scope of electrical safety, spanning residential, industrial, and generation sectors. Countries such as Japan and South Korea, through JET and

KESCO respectively, exemplify the benefits of a centralised body in ensuring consistent enforcement, public education, and adaptation to new technologies.

The findings also reveal that while several ASEAN countries have developed guidelines for solar PV, key safety components—such as BESS integration, fire safety, smart system data security, and monitoring processes—are often absent. Establishing a legal regulatory framework that specifically addresses these emerging technologies would improve oversight and compliance. Additionally, detailed regulations for periodic inspections and inspector qualifications should be embedded within national electricity laws. Expertise in these areas is essential for adapting to evolving standards, mitigating electrical hazards, and ensuring the reliability and safety of renewable energy systems.

Further analysis by FISUEL and international experts revealed that only five ASEAN countries—Indonesia, Malaysia, Singapore, Thailand, and Viet Nam—have been fully assessed for electrical safety standards [51]. This incomplete coverage highlights significant gaps in regional cooperation and the absence of representation from all ASEAN countries at global forums. Despite national regulations in place, inconsistencies remain in areas such as initial inspections, reporting protocols, and installer qualifications. Notably, none of the assessed countries have enforced specific standards for electrical installations and verifications, presenting a critical need for enhanced regulatory frameworks, particularly for renewable energy technologies like solar PV and BESS.

5. Conclusion & Recommendations

With the growing need for renewable energy becoming more imminent, electrical safety standards are crucial in supporting the deployment of renewable energy to ensure the secure and safe distribution of clean electricity to consumers. Acute comprehension and technical expertise in the design of solar PV and BESS allow the regulators to formulate suitable and effective technical safety standards and regulations. The IEC has established various technical standards and guidance on solar PV and BESS installation, operation, and maintenance, which the ASEAN Member States have used as the main technical reference in developing each nation's electrical safety standards.

Upon close examination and analysis, the authors suggest the following recommendations to support the current efforts of the ASEAN Member States in enhancing the electrical safety standards for safer solar PV and BESS installation and operation:

1. Improve the adherence of the national electrical safety standards to the international technical standards on PV and BESS installations, such as the IEC as the main technical reference, to minimise risks of hazards, ensure reliability of equipment, and promote interoperability between equipment from different manufacturers.
2. Increase the opportunities for regulatory improvement and harmonisation across the region for electrical safety standards on PV and BESS through capacity-building initiatives and stakeholder coordination.
3. Develop a specific talent pool/ working group on electrical safety standards which includes the power utilities and regulators to enable coordination interface on electrical safety standards in the region.

References

[1] ACE, The 7th ASEAN Energy Outlook, vol. 7. Jakarta: ASEAN Centre for Energy, 2022. [Online]. Available: https://aseanenergy.sharepoint.com/PRA/ASEAN%20Energy%20Outlook/Forms/AllItems.aspx?id=%2FPRA%2FASEAN%20Energy%20Outlook%2FThe%207th%20AEO%2FEvents%2FLaunching%20Event%2F%5B2%5D%20AMEM%2FMedia%20Kit%2F1%2E%20Report%20and%20Executive%20Summary%2FThe%207th%20ASEAN%20Energy%20Outlook%20%282022%29%2Epdf&parent=%2FPRA%2FASEAN%20Energy%20Outlook%2FThe%207th%20AEO%2FEvents%2FLaunching%20Event%2F%5B2%5D%20AMEM%2FMedia%20Kit%2F1%2E%20Report%20and%20Executive%20Summary&p=true&ga=1

[2] ACE, "ASEAN Power Updates 2023," ASEAN Centre for Energy, Jakarta, Nov. 2023. [Online]. Available: https://aseanenergy.sharepoint.com/PublicationLibrary/Forms/AllItems.aspx?id=%2FPublicationLibrary%2F2023%2F02%2E%20External%20Communications%2F04%2E%20Report%2FASEAN%20Power%20Updates%202023%20%2Epdf&parent=%2FPublicationLibrary%2F2023%2F02%2E%20External%20Communications%2F04%2E%20Report&p=true&ga=1

[3] IEC, Safety of power converters for use in photovoltaic power systems. Part 1, General requirements, Edition 1.0 2010-04. in 62109, no. 1. Geneva: International Electrotechnical Commission, 2010.

[4] N. Noorzad and S. S. Gürleyük, "Effects of Electrical Current Passing Through the Human Body and Safety Requirements," in 6th International Students Science Congress Proceedings Book, Izmir International Guest Student Association, Sep. 2022. doi: 10.52460/issc.2022.051.

[5] R. M. Fish and L. A. Geddes, "Conduction of Electrical Current to and Through the Human Body: A Review," vol. 9, 2009.

[6]]D. Wei et al., "Study on Thermal Runaway Behavior of Li-Ion Batteries Using Different Abuse Methods," Batteries, vol. 8, no. 11, p. 201, Oct. 2022, doi: 10.3390/batteries8110201.
[7] EMA, "Handbook for Solar Photovoltaic (PV) Systems," 2011.
[8] C. Huawei, "Arc Fault Circuit Interrupter (AFCI) for PV Systems - Technical White Paper." Huawei Technologies Co., Ltd., Aug. 2020. [Online]. Available: https://solar.huawei.com/en-GB/download?p=%2F-%2Fmedia%2FSolar%2Fnews%2Fwhitepaper%2FAFCI-whitepaper.pdf
[9] IEC, Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems, vol. 2. in IEC 62933, no. 5, vol. 2. Geneva: IEC Secretariat, 2020.
[10] IEC, "Secondary cells and betteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications." IEC Secretariat, May 2022. [Online]. Available: https://cdn.standards.iteh.ai/samples/102658/921553c48a634ba292a91f563b8c7aec/IEC-62619-2022.pdf
[11] AENBD, "Electricity Act," Edition 2021., 2021.
[12] Department of Electrical Services (DES), "Department of Electrical Services." Accessed: Sep. 10, 2024. [Online]. Available: https://www.energy.gov.bn/SitePages/Pages/Department%20of%20Electrical%20Services.aspx
[13] [13]ESCOM, "GUIDELINES AND BEST PRACTICES FOR LOW VOLTAGE (LV) WIRING AND ELECTRICAL APPLIANCE SAFETY," May 2024.
[14] [14]Department of Energy, "Announcements - Rooftop Solar PV Guidebook." Accessed: Sep. 10, 2024. [Online]. Available: https://www.energy.gov.bn/Lists/Announcements/View.aspx?ID=10
[15] [15]AENBD, Code of Practice for Large Scale Solar PV Connection to Distribution Grid. 2020.
[16] MME Cambodia, "PROKAS ON ESTABLISHMENT OF SPECIFIC REQUIREMENT OF ELECTRIC POWER TECHNICAL STANDARDS OF THE KINGDOM OF CAMBODIA," 2007.
[17] ASEAN, "CAMBODIA'S MANDATORY STANDARDS FOR GOVERNMENT PROCUREMENT ON ELECTRICAL APPLIANCES," 2012.
[18] D. Hiel, "Regulations clarifying the use of solar PV in Cambodia," pv magazine International. Accessed: Sep. 10, 2024. [Online]. Available: https://www.pv-magazine.com/2018/03/15/regulations-clarifying-the-use-of-solar-pv-in-cambodia/
[19] D. S. Burlinson Simon, "Cambodia Launches Principles for Permitting the Use of Rooftop Solar Power," DFDL. Accessed: Sep. 10, 2024. [Online]. Available: https://www.dfdl.com/insights/legal-and-tax-updates/cambodia-launches-principles-for-permitting-the-use-of-rooftop-solar-power/
[20] JICA, "THE STUDY ON DEVELOPMENT OF TECHNICAL STANDARDS AND COMPETENCY STANDARDS IN ELECTRICAL POWER SECTOR IN INDONESIA," 2010.
[21] EBTKE, "Direktorat Jenderal EBTKE - Kementerian ESDM." Accessed: Sep. 11, 2024. [Online]. Available: https://ebtke.esdm.go.id/post/2021/09/08/2957/telah.terbit.sertifikat.sni.modul.fotovoltaik.pertama.di.indonesia
[22] A. L.-T. Priscilla, T. P. Ogilvie, and A. D. Saraswati, "Electricity Regulation in Indonesia," Lexology. Accessed: Sep. 11, 2024. [Online]. Available: https://www.lexology.com/library/detail.aspx?g=6d600dd6-9154-4590-ad3c-63ecd042c699
[23] AESI, "Kualitas dalam Sistem Fotovoltaik (PV) – Penyedia layanan yang relevan," AESI. Accessed: Sep. 11, 2024. [Online]. Available: https://aesi.or.id/quality-in-pv-systems-relevant-service-providers-2
[24] MEM Lao PDR, "Law on Electricity (2017 Ed.)." Accessed: Sep. 11, 2024. [Online]. Available: https://policy.asiapacificenergy.org/node/532
[25] Kullakant, "Lao PDR to Develop an Energy Standards & Labelling Program," International Institute for Energy Conservation (IIEC). Accessed: Sep. 11, 2024. [Online]. Available: https://www.iiec.org/news/568-lao-pdr-to-develop-an-energy-standards-labelling-program
[26] Suruhanjaya Tenaga, "GUIDELINE ON ELECTRICAL SAFETY MANAGEMENT PLAN AND PROGRAMME," 2017.
[27] Suruhanjaya Tenaga, "Guidelines for Solar Photovoltaic Installation on Net Energy Metering Scheme," 2018.
[28] Suruhanjaya Tenaga, "GUIDELINES FOR SOLAR PHOTOVOLTAIC INSTALLATION UNDER NOVA PROGRAMME IN PENINSULAR MALAYSIA," 2023.
[29] Department of Standards Malaysia, "Malaysia Standards: Photovoltaic (PV) Systems - Characteristics of the Utility Interfance," 2015.
[30] SIRIM Berhad, "Photovoltaic (PV) Module," SIRIM QAS International Sdn. Bhd. Accessed: Sep. 11, 2024. [Online]. Available: https://www.sirim-qas.com.my/our-services/product-certification/photovoltaic-module-certification-scheme/
[31] Borneo Post, "ECoS officially takes over regulatory authority of electricity supply in Sabah," Borneo Post Online. Accessed: Sep. 11, 2024. [Online]. Available: https://www.theborneopost.com/2024/01/03/ecos-officially-takes-over-regulatory-authority-of-electricity-supply-in-sabah/
[32] MUT Sarawak Malaysia, "THE ELECTRICITY ORDINANCE," 1999.
[33] AFEO, "Feasibility Study – White Paper on Electrical Installation Standards in Buildings amongst ASEAN Countries," 2019.
[34] ESCAP, "Electricity Law 2014 (Law No. 44 of 2014) | ESCAP Policy Documents Managment." Accessed: Sep. 11, 2024. [Online]. Available: https://policy.asiapacificenergy.org/node/1546
[35] National Standards Council Myanmar, "Endorsement of Myanmar Standards Adoption," 2020.
[36] MNBC, "Myanmar National Building Code," 2012.

[37] V. Pangonilo, "Philippine Electrical Code (PEC) – A Primer – Filipino Engineer." Accessed: Sep. 11, 2024. [Online]. Available: https://filipinoengineer.com/blog/2023/06/philippine-electrical-code-pec-a-primer.html

[38] Electrician Philippines, "Philippine Electrical Code: Mandatory Rules, Permissive Rules, Explanatory Rules, and Appendices | Electrician Philippines." Accessed: Sep. 11, 2024. [Online]. Available: https://electricianphilippines.com/philippine-electrical-code-mandatory-rules-permissive-rules-explanatory-rules-and-appendices/

[39] T. Rheinland, "Philippines - Philippine Standard (PS) Safety Certification." Accessed: Sep. 11, 2024. [Online]. Available: https://www.tuv.com/market-access-services/en/certification-filter/philippines-philippine-standard-(ps)-safety-certification-mark-licensing-scheme-for-electrical-and-electronic-products.html

[40] IIEE Philippines, "Philippine Electrical Code 2017 Part 1/Preface - Filipino Engineer Wiki." Accessed: Sep. 11, 2024. [Online]. Available: https://filipinoengineer.com/wiki/Philippine_Electrical_Code_2017_Part_1/Preface

[41] SSO, "Electricity (Electrical Installations) Regulations - Singapore Statutes Online." Accessed: Sep. 11, 2024. [Online]. Available: https://sso.agc.gov.sg:5443/SL/EA2001-RG5

[42] Enterprise Singapore, "SINGAPORE STANDARD - Code of practice for electrical installations," 2018.

[43] EMA, "EMA | Singapore Standards and Technical References." Accessed: Sep. 11, 2024. [Online]. Available: https://www.ema.gov.sg/regulations-licences/regulations/standards-guidelines/singapore-standards-and-technical-references

[44] UL Solutions, "Thailand, New TISI and EGAT Requirement for Electrical Household Appliances," UL Solutions. Accessed: Sep. 11, 2024. [Online]. Available: https://www.ul.com/news/thailand-new-tisi-and-egat-requirement-electrical-household-appliances

[45] NREL, "KEY CONSIDERATIONS FOR ADOPTION OF TECHNICAL CODES AND STANDARDS FOR BATTERY ENERGY STORAGE SYSTEMS IN THAILAND - NREL," 2021. Accessed: Sep. 11, 2024. [Online]. Available: https://www.readkong.com/page/key-considerations-for-adoption-of-technical-codes-and-3712601

[46] MOIT Vietnam, "12/2008/QD-BCT in Vietnam, Decision No. 12/2008/QD-BCT national technical regulation on electrical safety in Vietnam," THƯ VIỆN PHÁP LUẬT. Accessed: Sep. 11, 2024. [Online]. Available: https://thuvienphapluat.vn/van-ban/EN/Thuong-mai/Decision-No-12-2008-QD-BCT-national-technical-regulation-on-electrical-safety/196576/tieng-anh.aspx

[47] MOIT Vietnam, "31/2014/TT-BCT in Vietnam, Circular No. 31/2014/TT-BCTcertain details of electrical safety in Vietnam," THƯ VIỆN PHÁP LUẬT. Accessed: Sep. 11, 2024. [Online]. Available: https://thuvienphapluat.vn/van-ban/EN/Xay-dung-Do-thi/Circular-No-31-2014-TT-BCTcertain-details-of-electrical-safety/308157/tieng-anh.aspx

[48] MOIT Vietnam, "39/2020/TT-BCT in Vietnam, Circular 39/2020/TT-BCT introducing National Technical Regulation electric safety in Vietnam," THƯ VIỆN PHÁP LUẬT. Accessed: Sep. 11, 2024. [Online]. Available: https://thuvienphapluat.vn/van-ban/EN/Linh-vuc-khac/Circular-39-2020-TT-BCT-introducing-National-Technical-Regulation-electric-safety/560362/tieng-anh.aspx

[49] S. Dubey and H. Lee, "Pioneering Innovation with Vietnam's BESS Pilot Project," Global Energy Alliance for People and Planet. Accessed: Sep. 11, 2024. [Online]. Available: https://energyalliance.org/pioneering-innovation-with-vietnams-bess-pilot-project/

[50] Fisuel, "Safety Barometer." Accessed: Sep. 12, 2024. [Online]. Available: https://www.safetybarometer.org/

[51] European Copper Institute, "Asia – Safety Barometer." Accessed: Sep. 12, 2024. [Online]. Available: https://www.safetybarometer.org/barometer/asia/

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