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Legality and Safety Regulations of Electric Vehicle Batteries in Indonesia: Challenges and Implementation of National Standards

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Abstract: This study examines the legality and safety regulatory aspects related to the use of electric vehicle batteries in Indonesia, especially focusing on the risk of fire due to the failure of lithium-ion batteries which are often used as the main energy source. With the increasing adoption of electric vehicles, Indonesia is faced with the challenge of setting safety standards that are able to keep up with the development of battery technology and meet consumer expectations and international standards. In this study, an analysis of government policies, harmonization of international regulations, and the importance of battery testing as a risk mitigation measure was carried out. Battery testing is a vital component to ensure the safety and reliability of electric vehicles, involving procedures such as thermal resistance tests, short-circuit protection, and mechanical integrity testing. By applying normative juridical methods through conceptual approaches, laws and regulations, and international case studies, this study aims to provide recommendations for improvement of battery safety regulations and procedures in Indonesia to support the creation of a safer and more sustainable transportation environment.

Keyword: Electric Vehicles, Electric Batteries, Electric Vehicle Battery Testing.

INTRODUCTION

The transformation of the global automotive industry is undergoing a fundamental shift towards the era of sustainable mobility, with electric vehicles being the main catalyst in this transportation technology revolution. This significant shift is driven by global awareness of the impacts of climate change and the urgent need to create a more sustainable transportation system. The integration of electric vehicle technology in the automotive industry not only answers environmental challenges but also opens up new opportunities in the innovation and development of future transportation technology. This transition to sustainable mobility reflects a global commitment to reduce the carbon footprint of the transportation sector while fostering inclusive green economic growth. This is evidenced by the increasingly significant use of electric vehicles in Indonesia. It can be seen from the increasing number of electric vehicles, since November 2022 around 7.5 thousand electric cars, 58 electric buses, and 25

thousand electric bicycles have been registered in Indonesia. The government through the ministry of industry also targets that by 2025, around 20% of all vehicles in Indonesia will be environmentally friendly vehicles (green cars) (Ministry of Transportation, 2023). Policy and regulatory support is crucial in developing the electric vehicle industry. As stated by Wala & Rasji (2023), the lack of government outreach to the public regarding the importance of a policy, its benefits, and sanctions to be imposed for violations can hinder optimal policy implementation (Wala & Rasji, 2023). This principle also applies in the context of electric vehicle battery safety regulations, where clear communication about safety standards and compliance requirements is essential for effective implementation. This target is in line with the global trend towards sustainable mobility and focusing on reducing carbon emissions.

The growing development of electric vehicles around the world, including in Indonesia, is driven by the need to reduce carbon emissions and dependence on fossil fuels. Electric vehicles are considered a more environmentally friendly solution because they produce lower greenhouse gas emissions and better energy efficiency than conventional fuel-based vehicles. In Indonesia, government policies to support the development of the electric vehicle ecosystem, including charging infrastructure and incentives for consumers, are further accelerating the growth of this industry. Various incentives such as luxury goods tax exemption (PPnBM) and ease of licensing have encouraged massive investment in the electric vehicle industry. Several global and local automotive companies have started to produce and market electric vehicles to meet the growing demand, which is supported by the changing lifestyle trend of consumers who are increasingly concerned about environmental sustainability.

However, in the midst of this positive potential, safety issues in electric vehicles, especially those related to batteries, are increasingly becoming a public concern. Lithium-ion batteries, as the main component in electric vehicles. Lithium-ion batteries commonly used in electric vehicles have the potential to experience failures that can cause fires. This phenomenon is often triggered by several factors, such as extreme environmental conditions, hard impacts, or short circuits in the charging system. Therefore, it is important for manufacturers to pay attention to international safety standards in the design and construction of electric vehicles and their electrical systems. Cases of fires on electric vehicle batteries have been reported in several countries, such as the incident involving electric vehicle batteries in South Korea, which shows that these safety risks are not negligible. Advanced Battery Management System (BMS) technology has been developed to monitor battery temperature, voltage, and condition in real-time, although there are still safety challenges. In addition, the fast and repeated charging process over a long period of time can also accelerate the decline in battery performance and increase safety risks.

In Indonesia itself, several battery-related incidents in electronic devices such as smartphones and electric bicycles have begun to become the subject of serious discussion among the public and policymakers, which ultimately affects the perception of the safety of electric vehicles. Therefore, regulations related to battery safety for electric vehicles have begun to be designed to protect consumers and ensure high safety standards in the production and use of electric vehicles. The government, together with various related parties such as vehicle manufacturers and battery suppliers, is developing safety standards and risk mitigation guidelines to ensure that the potential risk of fire or battery malfunction can be minimized. With strict regulations and technological improvements, it is hoped that risks related to battery safety can be overcome so that electric vehicles can be more widely accepted by the public and contribute to the achievement of national and global sustainability goals.

An in-depth analysis of the regulation of the risk of battery fire in electric vehicles is urgently needed to ensure that the measures taken are not only effective but also comprehensive. This includes an evaluation of the effectiveness of current regulations as well as the identification of possible gaps in the regulatory system. Therefore, this study will discuss what are the

challenges in implementing regulations to reduce the risk of battery fires in electric vehicles, and how steps can be taken to improve or adjust regulations to be more effective in protecting the safety of electric vehicle users from the risk of battery fires.

METHOD

This study uses a normative juridical type of research with a focus on the analysis of positive legal principles. This study specifically examines various sources of legal norms, applicable legal provisions, and related legal sources that have relevance to the object of research. In its implementation, this study implements three methodological approaches, namely the statute approach, the historical approach, and the conceptual approach. The source of research data is secondary which consists of two types of legal materials, namely primary legal materials that include various applicable laws and regulations, and secondary legal materials that include law books, legal journals that contain basic principles, doctrines of legal experts, and relevant academic legal research results. This research data collection technique is also carried out through library research by collecting and analyzing various literature sources related to the research topic.

RESULTS AND DISCUSSION

Types of Batteries Used in Electric Vehicles in Indonesia

The development of battery technology for electric vehicles continues to take place at a rapid pace, presenting various innovations that are expected to improve durability, efficiency, and safety. However, behind this pace of innovation there are also major challenges for regulators in setting relevant security standards and keeping abreast of their developments. Battery technology, especially the types used in electric vehicles such as:

a. Lithium-ion (Li-ion)

Lithium-ion batteries are an innovation in the category of rechargeable batteries. This technology offers a more environmentally friendly solution than its predecessors such as NI-Cd and Ni-MH batteries, as it does not use harmful materials in its composition. The advantages of lithium-ion batteries include several important aspects, namely, having excellent energy storage stability (durability up to 10 years or more), high energy density, absence of memory effects, and lighter weight. (Fengky Adie Perdana, 2020) This is what makes this type of battery often used for electric vehicles. This Li-ion also includes several variants such as:

- LFP (Lithium Iron Phosphate): It is heat-resistant and has a long life cycle, making it reliable for the long term, although it has a slightly lower energy density than other variants.
- NCA (Nickel Cobalt Aluminum Oxide): Offers very high energy density and optimal efficiency, but is more expensive and tends to generate heat.
- LTO (Lithium Titanate): Has the longest life cycle and resistance to extreme temperatures, suitable for long-term repeated use.
- LMO (Lithium Manganese Oxide) and LCO (Lithium Cobalt Oxide) are also used in some applications due to their good stability and durability.

The advantages of Li-ion batteries are energy efficiency and stable performance in high temperature ranges. This battery also has main components, namely cathode, anode, electrolyte, and separator that help maintain performance and safety.

b. Nickel-metal Hydride (NiMH)

The working system of Nickel-metal Hydride batteries involves an electrochemical process where electron hydrogen (OH-) is released and absorbed through a combination of nickel oxide anode and metal-hydride cathode, resulting in an energy capacity of 50-70 Wh.kg-1. In the context of the development of electric vehicles, NiMH batteries are seen as a very promising alternative to replace lithium batteries. The significant advantage of these batteries lies in their

energy density which is twice as high as that of NiCd batteries, making them an efficient solution for electric automotive applications. (Dedy Ramdhani Harahap, 2017)

c. Lead-acid (SLA)

Lead-acid batteries belong to the category of rechargeable secondary batteries. This battery is PbO2 (Lead Proxide) as the cathode, Pb (Lead Sponge) as an anode, and H2SO4 (sulfuric acid) as the electrolyte. The advantages of lead acid batteries include lower maintenance costs compared to other types of secondary batteries, making them an ideal choice for industrial use. In addition, these batteries are available in large capacities and have high performance, and they still function well in both low and high temperatures. (Rahma Dini Barkah & Sahrul Hidayat, 2019)

d. Ultracapacitor

Ultracapacitors have a high power density and are able to provide large power in a short time, ideal as secondary energy storage. These batteries help recycle secondary energy. These batteries help recycle braking energy and add power when accelerating, although it is not used as a primary battery due to its low energy density. Nowadays ultracapacitor devices have been widely considered as an additional power source. These batteries also have a higher power density than batteries and have a long operational life that is usually not related to the number of charge/discharge cycles. (Makmu Saini Et. al., 2022)

e. Solis-state

Solid-state replaces the liquid electrolyte in Li-ion with a solid electrolyte, allowing the battery to be smaller but with a greater energy capacity. This battery is safer and is expected to be the future of electric cars because it is able to increase mileage with a more compact size.

f. Nickel Cadmium (Ni-Cd)

Ni-Cd batteries have a cell voltage of 1.2 Volts per cell and have an energy density that is twice as high as lead acid batteries. In this battery, the cathode uses nickel hydroxide (Ni(OH)2), while the anode is made of cadmium (Cd), with alkaline potassium hydroxide as the electrolyte. Nickel-cadmium batteries have low internal resistance, allowing the charging and discharging process to be carried out quickly. Based on PLN's SK520, nickel-cadmium (Ni-Cd) batteries are categorized as alkaline batteries with a capacity of 1.2 Volt per cell, and are often used by PT. PLN as a source of DC supply for protection systems, SCADA, and PLC. (Bambang Sri Kaloko & Lori Kusuma Dewi)

Each new development of this technology demands different safety testing, as each type of battery has different technical characteristics in terms of thermal resistance, resistance to overcharging, and response to physical impacts. Challenges arise when the prevailing safety standards are no longer in line with the latest technology used by electric vehicle manufacturers, so they become obsolete quickly and are less relevant in preventing the risk of battery fire or explosion.

Electric Vehicle Battery Regulation in Indonesia

The gap between regulation and the acceleration of technological development can lead to inconsistency of safety standards, both in the international context and at the manufacturer level. This phenomenon is reflected in the variety of regulatory initiatives implemented in various developed countries. As an illustration, since 2022 several US states have submitted various Bills related to electric vehicles. In this case, New Jersey is the region with the most submissions reaching 139 Bills, followed by Minnesota with 73 Bills, Massachusetts with 70 Bills, and California with 68 Bills. These diverse regulatory dynamics indicate the need for a more systematic and comprehensive harmonization of safety standards in the electric vehicle industry sector.

In response to this need, battery safety regulations in various countries have developed strict standards that refer to thorough durability tests to reduce the risk of fire and explosion in

electric vehicles. For example, the United Nations Economic Commission for Europe Regulation No. 100 ("UNECE R100") and the Federal Motor Vehicle Safety Standard No. 305 in the United States regulate the safety of electric vehicle batteries through testing to ensure the battery's resistance to extreme mechanical and thermal stress, as well as testing its resistance to impact, vibration, and temperature surges. Furthermore, regulations such as the Battery Directive 2006/66/EC in Europe and the GB/T 31485 standard in China require testing of battery chemicals to ensure that they are not flammable, in addition to additional isolation systems to prevent the risk of explosion.

Meanwhile, in Indonesia, which has currently issued Regulation of the Minister of Energy and Mineral Resources Number 1 of 2023 concerning the Provision of Charging Infrastructure for Battery-Based Electric Motorized Vehicles, where this regulation focuses on regulating charging infrastructure for battery-based electric motor vehicles ("KBLBB"), such as public electric vehicle charging stations ("SPKLU") and public electric vehicle battery swapping stations ("SPBKLU"). This regulation aims to support the charging ecosystem and accelerate the use of electric vehicles in Indonesia. However, this regulation still does not specifically regulate technical standards or testing of electric vehicle batteries themselves. The main focus of this regulation is the development of charging and power exchange infrastructure and operational procedures, which include aspects of placement, safety, and operating mechanisms of SPKLU and SPBKLU. More detailed provisions on batteries, such as safety and performance standards for batteries in electric vehicles, are usually regulated in other more technical regulations or in standards issued by national or international standards bodies.

Although in Indonesia it has not been fully realized in a single regulation that directly and in detail regulates electric car batteries, some of the relevant provisions for electric vehicle batteries are spread across several regulations, including:

1. Presidential Regulation Number 55 of 2019 concerning the Acceleration of the Battery-Based Electric Motorized Vehicle Program for Road Transportation. This Presidential Regulation contains general provisions regarding the electric vehicle ecosystem, including batteries, but does not specifically regulate the technical safety or performance of batteries.
2. Indonesian National Standard ("SNI") for Electric Vehicle Batteries. The National Standards Agency has established a number of SNIs related to batteries for electric vehicles. Some of them are:
   - SNI IEC 62660: Contains three sections governing secondary lithium-ion cells for electric vehicle propulsion, including test procedures and safety criteria.
   - SNI 8871:2019 : Regulating rechargeable electrical energy storage systems for motor vehicles in categories M and N,
3. Regulation of the Minister of Environment and Forestry related to the management of hazardous and toxic materials (B3) waste, which is relevant for the management of used or damaged batteries from electric vehicles. In this arrangement includes the processing and recycling of batteries. Considering that lithium battery components have dangerous properties when not handled properly.

In the face of the acceleration of electric vehicle adoption, there are a number of challenges in the implementation of regulations aimed at reducing the risk of fire in electric vehicle batteries. These challenges are not only technical, but also concern economic, infrastructure, and public awareness. Technically, the ever-evolving battery technology makes safety standards obsolete quickly, demanding dynamic regulations and being able to keep up with technological changes.

The Role of Battery Testing in Ensuring Product Quality and Safety

Battery testing is a fundamental aspect in ensuring the quality and safety of electric vehicles that rely on batteries as the main power source. As a vital component directly related to vehicle performance and power, comprehensive testing is necessary to minimize various unwanted

risks such as fire, explosion, or degradation of battery performance. Without adequate testing, the use of batteries under various operational conditions such as extreme temperatures, high speeds, or varying loads can increase the probability of failure potentially endangering user safety. This test also plays an important role in ensuring the durability and longevity of the product.

Optimal quality assurance can reduce the possibility of damage or deterioration of function in the final product, thereby helping manufacturers optimize cost efficiency related to repair or replacement due to product failure. Consumer confidence also depends heavily on the quality of battery testing. Consumers who feel safe and confident that electric vehicles meet safety standards will be more interested in switching to renewable energy vehicles. Therefore, battery testing is not only technically important but also plays a role in driving the automotive industry's change towards clean energy, making it the basis for the sustainable development of the electric vehicle industry and can ensure that the battery meets the set quality standards. This test consists of various stages, such as testing battery capacity, reliability, safety, and performance. By using reliable test equipment, manufacturers can ensure that their products meet strict criteria and are safe to use. (TÜV SÜD, 2022)Following this standard, TÜV SÜD, as an ISO 17025 certified battery testing laboratory, also conducts a series of tests to ensure that electric vehicle batteries meet the Rechargeable Energy Storage System (REESS) as stipulated in the third revision of ECE R100. For example:

- The Vibration Test is performed with sinusoidal vibrations over a frequency range repeated for three (3) hours to test battery durability in bumpy road conditions or extreme terrain.
- The Thermal Shock Test measures the ability of a battery to survive temperatures between -40°C to +60°C, simulating extreme temperature changes. To test the safety of the battery in the event of a collision, it is carried out
- Mechanical Shock and Mechanical Integrity, which measures the resistance of a battery to large impacts or stresses.
- The Fire Resistance Test evaluates the stability of the battery against direct exposure to fire that could be caused by an accident or fuel leakage.
- External Short Circuit Protection and Overcharge Protection testing ensures the battery has an automatic protection system to stop overcharging or discharging potentially causing overheating.

Through these tests, TÜV SÜD supports the harmonization of international safety standards and contributes to providing comprehensive protection for electric vehicle users around the world. (Septian Deny, 2024) As for Indonesia itself, it has also started to carry out tests on electric vehicle batteries which also presents international standard testing laboratories established through collaboration between research institutions and industry, such as those carried out by PT Carsurin Tbk ("Carsurin") and the National Battery Research Institute ("NBRI") which have announced the inauguration of the most complete electric vehicle battery testing facility in Indonesia. The presence of these two institutions has an important role in the development of batteries and electric vehicles in Indonesia, Carusin itself is a company engaged in testing, inspection, and certification services. This company has experience in providing services and in this scope includes several tests, namely:

- Vibration;
- Thermal Shock and Cycling;
- Mechanical Impact;
- Fire Resistance;
- External Short Circuit Protection;
- Overcharge Protection;
- Over-discharge Protection;

- Over-temperature Protection; and
- Emission. (Dio Dananjaya & Aditya Maulana, 2023)

Electric vehicle battery testing laboratories in Indonesia such as those established by Carsurin and NBRI provide direct access to local manufacturers to ensure that their battery products comply with global safety and performance requirements. In addition to supporting the quality of domestic products, this facility also encourages the acceleration of innovation in the electric vehicle sector. With the laboratory, Indonesia can conduct further research and development to understand the limitations and advantages of locally produced batteries in terms of durability, efficiency, and service life.

CONCLUSION

In the transformation of the automotive industry that focuses on sustainable mobility, electric vehicles play an important role in responding to climate challenges and supporting the development of a green economy. The integration of electric vehicle technology offers solutions to reduce carbon emissions and reduce dependence on fossil fuels. In Indonesia, the trend of increasing the use of electric vehicles reflects the efforts of the government and society in supporting global sustainability goals. The policies and incentives provided also accelerate the growth of this industry and encourage investment in supporting infrastructure such as charging stations. However, there are significant challenges in terms of safety, especially related to the risk of battery fire. Lithium-ion batteries, which are commonly used in electric vehicles, have potential risks if they are subjected to extreme conditions or impacts. Although Battery Management System (BMS) technology has been developed, there are still some risks that need to be considered. Several countries have implemented strict regulations related to battery safety, and Indonesia has begun to formulate similar regulations and build international standard testing facilities. The suggestions that can be given to the development of electric cars in Indonesia are:

1. Improving Safety and Infrastructure Standards: Accelerate the harmonization of regulations with international standards and build a safe charging infrastructure.
2. Strengthening Battery Technology Testing and Innovation: Provide international standard testing facilities and encourage the development of Battery Management System (BMS) technology to improve battery safety.

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