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Technologies for decarbonizing transport systems

UNITED NATIONS
ESCAP
Economic and Social Commission for Asia and the Pacific
Asian and Pacific Centre for Transfer of Technology (APCTT)

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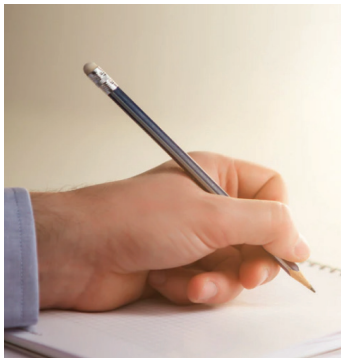

Introductory Note

Reducing transportation-related greenhouse gas (GHG) emissions through deep decarbonization has a critical role to play in achieving the goals under the Paris Agreement and the Sustainable Development Goals (SDGs). While there has been a momentum to shift towards cleaner fuels, there is still a huge reliance on fossil fuels in the transportation sector, particularly in the Asia-Pacific. According to the theme study for the 79th Session of the Economic and Social Commission for the Asia and the Pacific, "The race to net zero: accelerating climate action in Asia and the Pacific", transport carbon dioxide emissions constitute 27 per cent of the A-P region's total emissions and are above the global average. Due to the high dependence of the transport sector on fossil fuels, as well as the expanding demand, CO2 emissions from transport are growing.

To achieve rapid, deep decarbonization of the transportation sector, a multi-pronged strategy reliant on using abundant sources of renewable energy coupled with diverse energy storage solutions will be required. Enhancing the development and transfer of new and emerging technologies is a key pillar for transition to low carbon mobility, by increasing their dissemination and adoption at a wide scale. The success of this low carbon transition depends on the strength of national policy and regulatory environments and capacities to absorb, deploy and improve the technologies appropriate to local circumstances. Innovative transport technologies, including passenger information systems, automatic toll payment, congestion charging, digitally enabled real-time route planners, and contactless and paperless border crossing are helping in low carbon transition of the transport sector. For instance, the electrification of vehicles is growing across Asia-Pacific, with governments taking strategic actions to decarbonize the transport sector.

Aligning with the 79th session of the Economic and Social Commission for Asia and the Pacific (ESCAP), to be held from 15th to 19th May 2023 on the theme of 'Accelerating climate action in Asia and the Pacific for sustainable development', this Tech Monitor issue discusses select emerging technologies, challenges, opportunities, strategies and good practices, to enable transition to low carbon technologies for transport systems in the Asia-Pacific region. It includes an article discussing the shift to electric cars in road transport, focusing on the impact of Zero Emission Vehicle (ZEV) adoption on the fuel and the vehicle cycles. The issue also features a case study on the policy landscape supporting the electric two-wheelers transition across three emerging electric vehicle (EV) markets in Asia – India, Indonesia, and Viet Nam. We hope that the issue will enhance insights on the crucial topic of technologies for decarbonization in the transport sector and contribute towards strengthening regional cooperation on climate change.

Preeti Soni
Head, APCTT

INTERNATIONAL

Patent filings hit a record high in 2022

According to the World Intellectual Property Organization (WIPO), Chinese telecoms giant Huawei remained by far the most prolific patent filer in 2022, with well over 7,600 to its name.

South Korea's Samsung came in second, followed by Qualcomm of the US, Mitsubishi of Japan, and Ericsson of Sweden.

Record applications

Globally, patent applications rose slightly to more than 278,000 in 2022 – the highest number ever recorded in a single year – despite the huge economic challenges due to Russia's invasion of Ukraine, the continuing COVID pandemic, rising inflation and supply chain woes.

In India, patent registrations shot up by 25.4 per cent, and South Korea saw sharp growth of just over six per cent. However, the overall picture was of more modest growth, said Carsten Fink, WIPO Chief Economist.

"On the one hand, this represents the 13th year of uninterrupted growth", he said, "which I think is quite noteworthy, on the other hand, of course 0.3 per cent is relatively modest growth rate which we attribute to the challenging global economic conditions that prevailed in 2022."

Asia in the lead

By region, Asia saw the fastest growth in patent filings while also increasing its overall share by half a per cent, to 54.7 per cent in 2022.

Demand for design protection saw double-digit growth with China's accession to become part of the international design registration system, powering a surge in international design applications.

WIPO's Hague System for the International Registration of Industrial Designs saw an 11.2 per cent rise in the number of designs included in international applications – climbing to just over 25,000.

Trademark protection

After what WIPO described as "exceptional growth" in 2021 of 15 per cent, the use of the international trademark system for protecting brands during 2022 fell by –6.1 per cent, which is the biggest drop since 2009, when the world was reeling from the financial crash.

2021's growth was fuelled by the introduction of new goods and services in response to the shock of the COVID-19 pandemic, and although 2022 saw a major fall, WIPO pointed out that the total number of applications filed was still eight per cent higher than in 2020.

https://news.un.org/

Hydrogen patents indicate shift towards clean technologies

Technologies motivated by climate change concerns accounted for nearly 80% of all patents related to hydrogen production in 2020. According to a joint study of patents by the European Patent Office (EPO) and the International Energy Agency (IEA), hydrogen technology development is shifting towards low-emissions solutions such as electrolysis.

The report is the first of its kind and uses global patent data to analyze innovation in all hydrogen technologies comprehensively. It covers the full range of technologies, from hydrogen supply to storage, distribution, transformation and end-user applications.

"Hydrogen from low-emissions sources can play an important role in clean energy transitions with potential to replace fossil fuels in industries where few clean alternatives exist, like long-haul transport and fertilizer production," said IEA Executive Director Fatih Birol. "This study shows that innovators are responding to the need for competitive hydrogen supply chains, but also identifies areas – particularly among end-users – where more effort is required. We will continue to help governments spur innovation for secure, resilient and sustainable clean energy technologies."

"Harnessing the potential of hydrogen is a key part of Europe's strategy to achieve climate neutrality by 2050," said EPO President António Campinos. "But if hydrogen is to play a major role in reducing CO_2 emissions, innovation is urgently needed across a range of technologies. This report reveals some encouraging transition patterns across countries and industry sectors, including Europe's major contribution to the emergence of new hydrogen technologies. It also highlights the contribution of start-ups to hydrogen innovation, and their reliance on patents to bring their inventions to market."

The study presents the major trends in hydrogen technologies from 2011 to 2020, measured in terms of international patent families (IPFs), each of which represents a high-value invention for which patent applications have been filed at two or more patent offices worldwide. The report finds that global patenting in hydrogen is led by the European Union and Japan, which account for 28% and 24%, respectively, of all IPFs filed in this period, with significant growth in the past decade. The leading countries in Europe are Germany (11% of the global total), France (6%), and the Netherlands (3%).

The United States, with 20% of all hydrogen-related patents, is the only major innovation centre to see international hydrogen patent applications decline in the past decade. International patenting activity in hydrogen technologies remained modest in South Korea and China but is on the rise. In addition to these five main innovation centres, other countries generating significant volumes of hydrogen patents include the United Kingdom, Switzerland and Canada.

Hydrogen production technologies accounted for the largest number of hydrogen patents over the 2011–2020 period. While global hydrogen production is almost entirely fossil-based, the patenting data shows that low-emissions innovations generated more than twice the number of international patents across all segments of the hydrogen value chain than established technologies.

Technologies motivated by climate concerns accounted for nearly 80% of all patents related to hydrogen production in 2020. Growth was driven chiefly by a sharp increase in innovation in electrolysis.

Among hydrogen's many potential end-use applications, the automotive sector has long been the focus of innovation, and patenting in this sector continues to grow, led mainly by Japan. Despite concerted policy and media attention in recent years on hydrogen's potential to decarbonise long-distance transport, aviation, power generation and heating, similar momentum is not yet visible in other end-use applications.

The study finds that overhalf of the USD 10 billion of venture capital investment into hydrogen firms in 2011–2020 went to start-ups with patents, despite making up less than a third of the start-ups in the report's data set. Holding a patent is a good indicator of whether a start-up will keep attracting finance: more than 80% of late-stage investment in hydrogen start-ups in 2011-2020 went to companies that had already filed a patent application in areas such as electrolysis, fuel cells, or low-emissions methods for producing hydrogen from gas.

https://www.iea.org/

International IP SME Helpdesks

The new edition of the Intellectual Property ('IP') SME Helpdesks for China, South-East Asia, Latin America, and India was just launched by the European Commission.

The new edition, launched by the Directorate General Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA) of the European Commission, complements the European IP Helpdesk and the African IP Helpdesk.

The new edition of the Intellectual Property Helpdesks intends to provide free-of-charge assistance relating to intellectual property issues to SMEs doing business with or in the target markets based in the EU and Single Market Programme (SMP) countries.

This service provides 'first-line' assistance, which does not extend, for instance, to drafting patent applications or contracts so as not to compete with existing law firms or other operators.

How to reach out to potentially interested SMEs?

The main targets of the new edition of the Helpdesk are SMEs doing business with or the target markets established in EU Member States and in SMP countries.

Relevant communication channels, therefore, include, amongst others:

- chambers of commerce and industry federations of these countries,
- Member States' embassies,
- the EU Delegations to the relevant countries,
- relevant European Commission websites and newsletters,
- Enterprise Europe Network

The India Helpdesk, launched only in November 2020, was able to reach comparable results to the existing China, South-East Asia, and Latin America Helpdesks.

https://eismea.ec.europa.eu/

ASIA-PACIFIC

New center of excellence on climate-smart agriculture

In efforts to enhance agricultural productivity, improve farmers' profits, and reduce greenhouse gas (GHG) emissions in the sector regionwide, the Asian Productivity Organization (APO) announced the designation of the National Agriculture and Food Research Organization (NARO) of Japan as its new Center of Excellence on Climate-smart Agriculture (COE on CSA). This results fromthe long-term partnership between the two institutions in disseminating know-how in the focus area of the new COE.

The APO COE Program showcases excellence in specific productivity fields to promote the adoption of the know-how and best practices of one member by others while adapting them to suit local contexts. The COE on CSA will focus on deployingclimate change mitigation and adaptation technologies, know-how, and frameworks for low-carbon rice, wheat, and soybean production as staple foods in the Asia-Pacific. Specific focus areas will be sharing technical knowledge and methods to reduce methane emissions from paddy fields, adoption of agricultural weather data systems for rice, wheat, and soybean production, web-based soil carbon sequestration visualization tools for GHG reductions in various crops such as rice, wheat and soybean, application of biochar and development of carbon credit methodologies, and water management practices in rice cultivation and treatment of livestock waste.

The COE on CSA will start its activities from April 2023, including a need and readiness assessment of APO members for implementing climate-change mitigation and adaptation technologies, two international conferences on CSA and other COE focus areas, and pilot projects to apply technologies developed by the COE on CSA starting from 2024 as well as seminars, study missions, workshops, and on-site training for customizing the know-how to meet local needs in APO members.

The COE on CSA may provide technical knowledge and skills such as technologies to reduce methane emissions from paddy fields, agricultural weather data systems for rice, wheat and soybean production, web-based soil carbon sequestration visualization tool for greenhouse gas reduction in various crops such as rice, wheat, and soybean.

https://www.valdostadailytimes.com/

BANGLADESH

Circular on intellectual property right protection

Against the backdrop of Intellectual Property Right (IPR) protection and enforcement in the garments industry to prevent

the manufacturing of counterfeit goods, the Bangladesh Garment Manufacturers and Exporters Association (BGMEA) has issued a circular to the BGMEA member factories for their awareness and stand against manufacturing counterfeit goods.

The circular, signed by BGMEA President Faruque Hassan, refers to the USTR's Special 301 Review on Intellectual Property Rights (IPR) Protection and Enforcement in Bangladesh in media reports.

The American Apparel and Footwear Association (AAFA) and the Paris-based Union des Fabricants (UNIFAB) submittedto the United States Trade Representative (USTR) to include Bangladesh, China, and the European Union in the priority watch list of USTR's Special 301 Review for alleged involvement in exporting counterfeit goods, including clothing.

In its submission, AAFA mentioned that "while being an important legitimate sourcing country for the industry, counterfeits from Bangladesh are being seized at an increasing rate globally as counterfeit production is growing." AAFA also said that "well-organised Bangladeshi-run counterfeiting networks effectively exported counterfeits for sales to consumers in the United Kingdom, the Philippines, Malaysia and other countries".

BGMEA will take up awareness and capacity-building programmes around this issue, including raising awareness, disseminating relevant knowledge and information, and so on.

"We should commit ourselves to say no to any business that involve violation of IPR. If we can do so, it will give us an extra edge as we are transitioning to a middle income country. On the other hand, we will be able to retain the trust and confidence of our valued customers which we have built over more than 40 years," the BGMEA president urged.

https://www.tbsnews.net/

CHINA

Spending on R&D

China spent a record 3.09 trillion yuan ($443 billion) on research and development in 2022, a 10.4 percent year-on-year increase from the nation's accelerated efforts to enhance its innovation capability for more breakthroughs.

The National Bureau of Statistics said that China's R&D expenditures accounted for 2.55 percent of the GDP last year, which is 0.12 percentage points higher than the previous year.

That percentage of R&D spending is close to the average of 2.67 percent among OECD (Organization for Economic Co-operation and Development) economies. It moved China to 12th place globally, ahead of France's 2.35 percent and the Netherlands' 2.32 percent.

"Despite multiple unfavorable factors, China's R&D expenditure continued to soar and injected strong vitality into the nation's innovative development. Notably, the investment in basic research continued to grow rapidly," said Li Yin, the chief NBS statistician.

Last year, the country spent some 195.1 billion yuan on basic research, a year-on-year increase of 7.4 percent. "Accelerated efforts will be made this year to again beef up R&D expenditure, especially in some self-developed innovations, and meanwhile to improve the quality of the overall R&D, so as to offer stronger support for tech breakthroughs," Li said.

According to China's 14th Five-Year Plan (2021-25), the country will scale up spending on R&D by more than 7 percent annually during the period to drive more technological breakthroughs.

Consultancy McKinsey and Co said in a report that such a growth target would set the country on the path to becoming the world's largest spender on R&D.

In the first three quarters of last year, Contemporary Amperex Technology Co Ltd, China's largest electric vehicle battery maker, spent 10.58 billion yuan on R&D, representing a 130 percent increase.

It was also the first time that the battery maker spent 10 billion yuan on R&D - in 2021, it had spent 7.69 billion yuan.

"R&D investment will remain a priority for CATL. We will continue to invest heavily in the R&D of power batteries for more innovations to help drive the electric vehicle sector," said Meng Xiangfeng, an assistant to the company's chairman.

https://www.chinadaily.com.cn/

Oil giants to invest over $14bn in renewables by 2025

China's three state-owned energy majors plan to invest a combined 100 billion yuan ($14.5 billion) or more in renewable energy through 2025, diversifying their business as Beijing pushes to achieve net-zero carbon dioxide emissions by 2060.

Sinopec, as the company is commonly known, is China's largest oil refiner, with over 30,000 gas stations nationwide. It plans to tap its existing infrastructure to set up more hydrogen stations for fuel cell vehicles.

The Chinese government wants at least 50,000 fuel-cell vehicles on the road by 2025, up from around 12,000 at the end of 2022. Sinopec plans to expand its network of hydrogen stations to 1,000 locations by the end of 2025 from 98 at the end of 2022, including through partnerships with automakers.

Sinopec has also begun constructing a 5.7 billion yuan green hydrogen facility in Inner Mongolia to fuel a nearby coal-processing plant. The project is seen reducing the coal plant's carbon dioxide emissions by around 1.4 million tonnes a year.

"With the rise of electric vehicles, we will convert petroleum refineries into facilities for producing chemicals," Ma said.

The investment rush comes as China aims to peak CO_2 emissions by 2030 and achieve net-zero emissions by 2060. Crude oil consumption in the country is expected to peak at nearly 800 million tonnes in 2030 before falling to around 200 million tonnes in 2060.

Meanwhile, wind and solar are expected to account for 28% of China's electricity production by 2030 and 81% by 2060, up from 13% in 2022, according to a state-backed research institution. China's oil giants are under pressure to reshape their businesses to continue growing.

China National Offshore Oil Co. (CNOOC) focuses on offshore wind, using its expertise to drill oil under the ocean floor. It finished building the Haiyou Guanlan deep-sea floating wind power platform last month. It is slated to start operations in June over 100 kilometers from the shore of Hainan province, where the water is deeper than 100 meters.

The project, which CNOOC Chairman Wang Dongjin called the first of its kind in China as well as the world, is expected to generate 22 million kilowatt-hours a year on average.

CNOOC plans to make around 100 billion yuan in investments annually through 2025. CEO Zhou Xinhuai said around 5% to 10% -- the equivalent of 15 billion yuan to 30 billion yuan over three years -- would go toward new energy sources.

PetroChina invested 7.6 billion yuan in 2022 in solar power and other renewable energy sources, including in the Xinjiang region. The company said it added six times as much capacity that year than its total capacity as of 2021.

The refiner also established a research hub for new energy sources in Shenzhen. It is expected to invest over 10 billion yuan a year in the field through 2025.

China's National Energy Administration issued an action plan to promote the integration of oil and gas with new energy sources., It said it would prioritise permits for new energy projects by the three state oil companies. Still, such efforts could face headwinds as China grapples with an electricity shortage and surging inflation.

https://asia.nikkei.com/

INDIA

Revised position in trademark filing

India is now at the fifth position in trademark filing and seventh in patents filed annually on a global level, Department of Promotion of Industry and Internal Trade Special Secretary Sumita Dawra said.

CSIR's former Director General Mashelkar highlighted the importance of recognising the IPR-driven industry, which leads to growth in GDP. He mentioned that the European study suggests that the IPR-driven industry in Europe generated around 30 per cent of jobs during 2014-16 and contributed around 44.8 per cent to GDP.

Masanori Katsura, Deputy Commissioner, Japan Patent Office, mentioned that the 8th International Conference on IPR is an opportunity for the participants to strengthen the global partnerships further.

He also highlighted that India and Japan have deepened their cooperation in IP through Indian – Japan Patent Prosecution Highway (PPH). Further, he shared that the WIPO has been extending & implementing IP financing support to SMEs and working towards green technology and AI-related technologies with a focus on global IP partnerships addressing emerging issues.

https://theprint.in/

250GW of renewable capacity by 2028

The Indian government will issue tenders for the installation of 250GW of renewable energy capacity by March 2028, as part of plans to cut emissions.

According to a government memo, India's government will install 250GW of renewable energy capacity by March 2028.

The announcement comes as part of a wider plan to boost non-fossil fuel energy capacity, including solar and wind energy and nuclear and hydro power. The country plans to bring its generation to 500GW by 2030 to help cut its carbon emissions by 45% from 2005 levels.

However, India narrowly missed a target to install 175GW of renewable capacity by 2022, having instead installed 172.72GW, according to the Ministry of New and Renewable Energy's end-of-year review. As of 28 February, non-fossil capacity has exceeded 175GW.

India's government will issue tenders to install 15GW of renewable energy capacity in each of the first two quarters of this fiscal year, ending in March 2024. This will be followed by bids for 10GW of capacity in the following two quarters, according to the memo.

Out of the planned 50GW of renewable tenders each year, 10GW will be allocated to the installation of wind turbines. Solar currently makes up over half of India's renewables capacity, with wind accounting for almost one-third.

India hopes to boost the share of non-fossil capacity to 50% in 2050 from 42.6%. Its rate of additional renewables remains second only to China among major nations in the Asia-Pacific.

Despite this, India currently stands as the world's third largest emitter of greenhouse gas emissions, after China and the US. It still depends heavily on coal to meet more than half of its energy demand. Its Ministry of Coal states that "coal will continue to occupy centre-stage of India's energy scenario", potentially for the "next century and beyond".

The government has previously cited lower per capita emissions compared with other richer nations as justification for its continued use of coal.

https://www.power-technology.com/

INDONESIA

New regulation in Indonesia on IP financing

The Government of Indonesia recently issued an implementing regulation for the Creative Economy Law that seeks to support business actors in the creative economy, including through IP financing.

Government Regulation No. 24 of 2022 regarding the Implementation of Law No. 24 of 2019 regarding the Creative Economy ("GR 24/2022") was promulgated on July 12, 2022, and is scheduled to come into force on July 12, 2023. With GR 24/2022, the government has moved to support those in the creative economy with their intellectual property ("IP")-related business.

One of the key points of the new regulation is IP financing. This article provides a

general overview of IP financing as regulated in GR 24/2022. It looks at some of the things business actors, and the government must do to attain or provide IP financing.

GR 24/2022 is not the first regulation in Indonesia to allow IP, or at least certain types of IP, to be used as collateral. Law No. 28 of 2014 regarding Copyright ("Copyright Law") and Law No. 13 of 2016 regarding Patents ("Patent Law") regulate that copyrights and patents can be encumbered with fiduciary securities. These two laws, however, merely stipulate that copyrights and patents can be subjected to fiduciary securities. Further provisions on the fiduciary securities over these IP rights were to be regulated in implementing regulations. However, no implementing regulation for the Copyright Law or the Patent Law was issued to address this topic, so in a way, GR 24/2022 can serve that purpose.

Article 1(1) of GR 24/2022 defines the creative economy as an embodiment of added value from IP originating from human creativity based on cultural heritage, science, and/or technology. And Article 1(2) of GR 24/2022 defines creative economy actors as individuals or groups of Indonesian citizens or business entities in the form of legal entities or non-legal entities established under the laws of the Republic of Indonesia.

Trade secrets do not require registration as protection is given perpetually to information in the technology or business fields for as long as the economic value of such information persists and the confidentiality of the same is maintained. However, the recordation of trade secrets is not necessitated by the DGIP, and only the licensing or assignment of trade secrets requires recordation.

In contrast, registration requirements apply to those IP rights that arise from registration, such as trademarks, patents, industrial designs, layout designs of integrated circuits, and plant variety protection. The DGIP will issue certificates of registration for each of the rights if it deems the applied IP registrable according to each law and regulation for each type of IP. Further, Article 10 of GR 24/2022 elucidates that managed IP means that the owner or other party has commercialised such IP based on the agreement. Therefore, having lawful proof of ownership over such IP would not suffice for the creative economy actor to obtain IP financing. They would also have to commercialise such IP rights that they own.

Article 11 of GR 24/2022 further stipulates that the MOLHR shall provide financial institutions access to data on IP used as collateral. To date, the DGIP has provided a publicly accessible database of IP for trademarks, patents, industrial designs, and copyrights called *Pangkalan Data Kekayaan Intelektual*. However, the information incorporated in the database is limited. To accommodate the provisions of Article 11 of GR 24/2022, the DGIP will have to provide more comprehensive information, including information regarding the assignment and license of IP rights used as collateral, that can be accessed by financial institutions.

Aside from the recordation and registration of IP used as collateral, as applicable, creative economy actors should also record the IP-based financing granted by financial institutions in the creative economy financing system maintained by the Ministry of Tourism and Creative Economy ("MOTCE").

https://www.mondaq.com/

Metaverse collaboration initiative to boost metaverse industry

Indonesia has made a significant move towards becoming a major player in the global metaverse industry with the launch of its Indonesia Metaverse Collaboration Initiative on 1 March 2023, in conjunction with the Mobile World Congress 2023 in Barcelona.

This initiative is a national-level collaboration that is significant for both national interests and stakeholders involved, Telkom University said in a statement.

According to the statement, the metaverse has the potential to boost economic growth, advance education, foster innovation, and promote Indonesian national identity in the digital world.

It said CSPs could collaborate with the community as co-creators, while researchers and academics can take on roles in innovation. For policymakers, it said this could help guide policy strategies. For the private sector, it said the metaverse could enhance customer outreach and business development. And for users, it said it could help shape the direction of technology adoption and promote inclusive metaverse development.

According to the statement, the Metaverse Indonesia Collaborative Initiative will be carried out in the form of a program called the Metaverse Research and Experience Center (MREC), a public-private partnership that aims to promote collaboration, research, innovation and development in the field of metaverse technology.

It will be a multi-year program with four workstreams; Network Baselining, Network Optimization and Innovation, Use Cases, and Ecosystem Support.

The statement said the Metaverse Research and Experience Centre (MREC) is expected to drive innovation and support the growth of the metaverse industry in Indonesia.

This aligns with the national vision of President Jokowi to promote the digital economy as a crucial pillar to help Indonesia reach the top 10 global economies by 2030.

Through this collaboration among industry leaders and the public sector, investment plans in Indonesia in the field of metaverse are expected to be facilitated, positioning the country as a leading hub for innovation in the digital economy.

The launch of the Indonesia Metaverse Collaboration Initiative also marks an important step in lifting Indonesia from being just a consumer to a producer in the metaverse industry and represents a significant milestone in the country's technological evolution.

This initiative is parallel with National vision from President Jokowi to promote the digital economy as a crucial pillar to help Indonesia reach the top ten global economies by 2030.

Franky O. Widjaja, Executive Chairman of Smartfren, said the first Indonesia metaverse with collaboration between the telco and small and medium-sized enterprises benefit from this metaverse. "This initiative is an important step forward in positioning Indonesia as a leading hub for innovation in the digital economy," he added.

Rizal Akbar, Vice President of Network, IT Strategy, Technology and Architecture of Telkom Indonesia, said the metaverse is a transformational technology with the potential to change the way people live, work and play.

"The Metaverse Research and Experience Center is an important step in realizing this potential and we are very keen to wait and join the all initiative of this Metaverse," he added.

https://technode.global/

JAPAN

Council to discuss trademarks, designs

Japan's government will soon consider how laws can be made to protect intellectual property rights in virtual spaces or the metaverse. The government of Japan set up a council where experts from the private sector, universities and other organisations can discuss IP issues. The metaverse is a virtual space on the internet that users can use to communicate and interact with others using alter egos. As it is expanding into gaming and business in general, the ambiguous handling of IP in this space has become important. Virtual spaces can feature the trade of goods that are branded or designed like in the real world. The question is how trademarks and design rights are applied in such a situation.

For trademarks, it is currently not clear if their power to protect a brand image can be exercised in a metaverse. So far, there have been cases where companies filed for their trademark as a program existing in a virtual space to assert their rights even there.

For designs, issues exist, too, as the present law in Japan covers articles and architectural structures, which are tangible objects. While matters like a selection screen of a cell phone, which is less physical in nature, can be protected, not everything in a virtual space seems to be covered.

Yet there is a concern that expanding the scope of rights into the virtual space may put break creative activities by the users of a metaverse. The question is, then, to what extent there should be free reign for creative activities and to what extent protection should be expanded. The newspaper expects that a sub-committee will be set up under the council to discuss separate issues. Additionally, matters like portrait rights for avatars, problems with sexual harassment, as well as slander and libel are set to be discussed. More information can be found here. https://www.nikkei.com/article/DGXZQOUA180FB0Y2A111C2000000/

https://www.lexology.com/

MALAYSIA

Pilot programme on intellectual property

To further its mission of fostering innovation and growth worldwide, the United States Patent and Trademark Office (USPTO) will commence a Patent Prosecution Highway (PPH) pilot program with the Intellectual Property Corporation of Malaysia (MyIPO).

Malaysia is one of the major economies in the Association of Southeast Asian Nations region, and this pilot program will facilitate patenting by U.S. interests in that country.

"The new PPH pilot program with the Intellectual Property Corporation of Malaysia is a further step in building a close and mutually beneficial partnership between the MyIPO and the USPTO," said Kathi Vidal, Under Secretary of Commerce for Intellectual Property and Director of the USPTO. "As we discussed in our trip to Malaysia at the end of the summer, I have no doubt our deeper collaboration will lead to a stronger and more productive relationship that will benefit our respective inventors and innovators."

The PPH program is a work-sharing arrangement between two or more patent offices that enables an applicant who receives a positive ruling on patent claims from one participating office to request accelerated prosecution of corresponding claims in another participating office. Therefore, the PPH program allows the applicant to obtain an expedited patentability decision in the second office.

https://www.uspto.gov/

PHILIPPINES

Renewable energy opened to full foreign ownership

The Philippines has fully opened its renewable energy sector to foreign ownership, representing a significant shift to the country's energy policies.

With the change, foreign investors can now hold 100 percent equity in the exploration, development, and utilization of solar, wind, hydro, and ocean or tidal energy resources. The policy change comes as the Philippines seeks to attract foreign investment to boost its renewable energy sector and meet its long-term climate targets.

The DOE issued the policy on November 15, 2022, and it came into effect on December 8, 2022.

Foreign ownership is fully permitted

The circular amends the implementing rules and regulations of the *Renewable Energy Act* of 2008, formally called the *Republic Act No. 9512*, to allow full foreign ownership of renewable energy projects. The Renewable Energy Act is a piece of legislation providing a framework for developing, transmitting, and utilizing renewable energy in the Philippines.

Namely, the circular amends Section 19 of the implementing rules and regulations

by removing the requirement that the exploration, development, and utilization of solar, wind, hydro, and ocean or tidal energy sources can only be undertaken by Filipino citizens or entities that are at least 60 percent Filipino-owned. That requirement meant foreign investors could only own up to 40 percent equity in such projects.

With foreign investors now able to own 100 percent equity in these projects, those currently operating in a joint venture with a Filipino partner may also take a controlling stake in such ventures.

Incentivizing foreign investments in renewables

The Philippine government hopes that allowing foreign ownership of renewable energy projects will increase the speed of the Philippines' transition to renewable energy sources.

According to the Philippines' *National Renewable Energy Program (NREP) 2020-2040*, the country aims for renewables to comprise 35 percent of power generation by 2030 and 50 percent by 2040. The government also seeks to lower the costs of renewable energy projects and make renewables more accessible to the public.

Despite these goals, the Philippines' transition to renewable energy sources is seeing a downward trend. In 2008, renewable energy made up 34 percent of power generation, but in 2021 it made up just 21 percent.

To encourage the development and use of renewable energy, the Philippine government has released an array of incentives and supportive policies.

Further, the government recently released new incentives for renewable energy companies and other green businesses in its 2022 Strategic Investment Priority Plan. These include corporate income tax holidays, enhanced deductions, and preferential tax rates for industries such as electric vehicle (EV) assembly, manufacture of EV parts, renewable energy, energy storage, recycling, and other green economy industries.

Accordingly, foreign investors entering the Philippines' newly open market for renewable energy can enjoy a variety of incentives. Together, these factors add momentum to the Philippines' renewable energy transition and pursuit of its climate goals.

The Philippines' untapped renewable energy potential

The Philippines has an estimated 246,000 megawatts (MW) of untapped renewable energy. It has the world's third-largest geothermal capacity at 1,900 MW, with Indonesia in second and the US on top.

The country's current mix of renewable energy consists of 4.3 gigawatts (GW) of hydropower, 896 MW from solar energy, and 427 MW of wind. The Philippines adopted an ambitious plan to increase the share of renewable energy in the power generation mix to 35 percent by 2030 and 50 percent by 2040.

This involves increasing geothermal capacity by 75 percent, expanding hydropower capacity by 160 percent, increasing wind power capacity to 2,345 MW, and adding an additional 277 MW of biomass power. The Department of Energy estimates the country needs US$120 billion by 2040, presenting ample opportunities for foreign investors.

https://www.aseanbriefing.com/

REPUBLIC OF KOREA

Investment of 160 tln won in key tech sectors by 2027

The Republic of Korea will funnel 160 trillion won (US$122 billion) into research and development to foster research capabilities in the three key technology sectors of semiconductors, displays and next-generation batteries by 2027, the science ministry said.

Under the road map submitted to a government meeting, the funding jointly created by the government and private sector will be used to help local companies and research centers secure cutting-edge technologies and create new markets in the three tech sectors, according to the Ministry of Science and ICT.

A total of 100 specified technologies, including semiconductor devices, free-form displays and hydrogen fuel cells, will be given priority for government funding.

As a first step, the government will set up a private-public consultative body later this year to map out plans to launch government-funded R&D projects and share their results with the industry.

The government's R&D scheme also includes programs to encourage well-educated students and experts to get jobs in related industries on time and to create social infrastructure for effective R&D.

"Semiconductors, displays and next-generation batteries are the sectors that have supported the Republic of Korean economy on the back of competitiveness of our private sector," Science Minister Lee Jong-ho said in a statement. "The government will join hands with the private sector to expand R&D investment to lead the world in the key technology sectors."

The Republic of Korea has been strengthening financial and administrative support for the country's key economic-driving sectors, like semiconductors, to regain growth momentum for Asia's fourth-largest economy.

https://en.yna.co.kr/

Semiconductor investment tax credit could be increased

The government announced that the tax credit on semiconductor investments might be increased from 8 percent to 15 percent for big companies.

For small and medium-sized enterprises (SMEs), the maximum tax credit could be raised to 25 percent from 16 percent.

If the National Assembly approves the increases, tax collections will likely fall by 3.6 trillion won ($2.8 billion) in 2024 and around 1.3 trillion won in 2025 and 2026.

"Semiconductors are a central industry in our economy as they accounted for

18.9 percent of exports in 2022 and 17.7 percent of facility investment," said Finance Minister Choo Kyung-ho Tuesday. "It is a strategic asset that is directly connected with our future competitiveness, national security and very existence."

Under the plan, an additional 10 percent tax credit will be granted for on-year increases in investment from this year.

"If so, companies will be able to get a maximum tax credit of 25 percent including the on-year increased investment and 35 percent maximum, for SMEs," Choo said.

If the 30 to 50 percent tax credit on R&D spending is included, the tax credit will be the highest globally, the finance minister stressed.

The proposal for more aggressive tax benefits comes less than a month after the National Assembly voted to raise tax credits by 2 percentage points from the previous 6 percent.

According to the presidential office, President Yoon Suk Yeol ordered the Finance Ministry to develop a more aggressive plan while expressing his disappointment in what he considers weak support for the Republic of Korea's semiconductor industry.

"National strategic technologies like semiconductors are our national security asset as well as our industry's core technology," Yoon said on Dec. 30. "We need to come up with a rational but aggressive policy."

While the two largest political parties wanted more aggressive tax credits for semiconductor investments — the People Power Party proposing 20 percent and the Democratic Party 10 percent — the finance minister wanted to limit the tax benefit to 8 percent as he worried about shrinking tax collections, according to local press reports.

The Finance Ministry estimates that if the 20 percent tax incentive is implemented, 2.7 trillion won less in taxes will be generated.

There have been particular concerns about Korea's relatively weak policy support compared to other leading competitors, such as the U.S. and Taiwan province of China

The United States, under its Chips Act, provides a 25 percent investment tax credit for spending on semiconductor production lines and related equipment.

The Taiwan province of China government approved a bill in November that offers a 25 percent tax credit on semiconductor R&D.

China plans to invest 187 trillion won by 2025 in its own semiconductor development.

https://koreajoongangdaily.joins.com/

$185 million for renewables rebates in 2023

The Republic of Korea's Ministry of Trade, Industry and Energy (MOTIE) has allocated KRW 244.7 billion ($185.5 million) for its rebate scheme for rooftop PV systems and other small renewable energy systems. The ministry started to accept applications from homeowners and businesses.

The MOTIE said its rebates for BIPV systems have been raised from 13.4% to 15%. However, it has reduced its rebates for conventional rooftop PV systems from 50% to 47%.

About KRW 48.9 billion of the total budget will be earmarked for detached and multi-unit houses, while KRW 61.1 billion will be assigned to commercial buildings. Another KRW 140.0 billion will be allocated for projects that combine two different renewable energy technologies.

News Directory3, a Republic of Korean news outlet, has reported that the MOTIE allocated a total budget of KRW 319.2 billion for the program in 2022. The Republic of Korea plans to install 30.8 GW of solar by 2030. According to the latest figures from the International Renewable Energy Agency (IRENA), it reached 20.9 GW of cumulative installed PV capacity at the end of 2022.

https://www.pv-magazine.com/

THAILAND

New agreement to boost procurement from women-led SMEs

A new agreement between UN Women and Thailand's Office of SMEs Promotion (OSMEP) aims to make public and private procurement more gender-responsive, particularly regarding women-led small and medium-sized enterprises (SMEs).

The memorandum of understanding (MoU) was signed on 27 March by OSMEP Director General Veerapong Malai and Sarah Knibbs, regional director a.i. of the UN Women Regional Office for Asia and the Pacific.

"Gender equality and women's economic empowerment are highly valued by the OSMEP," Veerapong said. "We are pleased to collaborate with UN Women under this MoU."

SMEs are an essential component of Thailand's economy. As the country strives to keep pace with its ASEAN counterparts and global markets, empowering SMEs and closing gender gaps in the business sector, have become critical imperatives.

Under this new agreement, which arrived in the month of International Women's Day (8 March), OSMEP has joined forces with UN Women to spearhead research initiatives, improve SMEs databases, and foster connections between SMEs and buyers from both public and private sectors.

"Today's agreement is a milestone towards promoting fair trade, stimulating economic growth and fostering innovation," said Knibbs. "This will not only narrow the economic gap but also paves the way for more effective measures to end gender inequality."

The cooperation framework consists of three distinct goals. The framework includes joint research studies or policy reviews aimed to supportsupplier diversity and more gender-responsive procurement. Secondly, efforts will be made to enhance the database and clearly define"women-owned business" in

Thailand, categorized by business type. This systematic data collection and analysis will support future economic policies. Finally, the framework aspires to create market opportunities by connecting buyers from the private and public sectors with women entrepreneurs and gender-responsive enterprises.

This collaboration is under the umbrella of UN Women's WE RISE Together programme, which seeks to empower underrepresented groups of entrepreneurs, particularly women in SMEs, and create equal market opportunities by advancing supplier diversity through gender-responsive procurement in Thailand and Viet Nam. As only 1 per cent of total procurement spending goes to women-owned businesses, fair policies and guidelines for public and private procurement are more crucial than ever for economic growth and gender equity.

https://asiapacific.unwomen.org/

New power plan will support renewables

Energy authorities expect to launch a new national power development plan (PDP) to promote and support greater use of renewable energy. The new PDP is meant to span 2023 to 2037, replacing the current one that took effect in 2018 and went through many revisions to align with changes in energy policy. Efforts to introduce the new PDP were earlier delayed by the Covid-19 pandemic, a surge in global energy prices and Thailand's new commitment to cutting carbon dioxide emissions.

The government announced in 2021 Thailand would take more serious action to achieve carbon neutrality, a balance between carbon dioxide emissions and absorption, by 2050.

The policy means the country needs to redesign its energy management to be less dependent on fossil fuels.

Drafting of the 2023 PDP is nearly finished and should be concluded around the middle of this year, said Veerapat Kiatfuengfoo, deputy director-general of the Energy Policy and Planning Office (Eppo).

A public hearing on the new PDP must be scheduled, with the plan approved by the National Energy Policy Council and the cabinet.

Under the new plan, the loss of load expectation (LOLE) method will be used to manage power supply to allay concerns over surplus power generation capacity in reserve, which is blamed for driving up power bills. The current power generation capacity in reserve is at 30% of the total capacity.

LOLE will estimate how many hours of electricity supply cannot meet actual demand in a year.

This method corresponds with Thailand's shift towards more use of renewable sources, such as clean energy, but raises concerns over intermittent electricity output.

LOLE for Thailand should be 0.7 days a year, said Wattanapong Kurovat, director-general of Eppo. In other words, load loss or generation deficiency should not exceed 17 hours in one year. He said that LOLE is suitable for higher use of renewable resources such as solar and wind to generate electricity as their power supply is monitored every hour. Thailand aims to have renewable energy makeup 50% of total fuels used for electricity generation by 2036. In 2021, the proportion of renewable energy tallied 11%. The new PDP will also pave the way for the development of alternative energy such as nuclear energy, said Mr Veerapat.

https://www.bangkokpost.com/

VIET NAM

Renewables deployment with US$15.5 billion deal

The G7 initiative Just Energy Transition Partnership (JETP) has agreed to support Vietnam's green energy transition and mobilise an initial US$15.5 billion of public and private finance over the next three to five years.

The partnership will work towards a series of targets, including acceleratingrenewable energy so that it reaches 47% of Vietnam's electricity generation by 2030, instead of 36% currently planned, as well as reducing the peak coal capacity from the 37GW planned towards 30.2GW.

Over the next 12 months, partner countries will work with Viet Nam to develop and adopt a JETP Resource Mobilisation Plan that will enable the implementation of the funding.

This mechanism could potentially help the country resolve issues it has had with solar power in recent years after a boom between 2018-2020 that was abruptly stopped, partly due to its grid capacity issues.

The financing includes US$7.75 billion of public pledges from the International Partners Group together with the Asian Development Bank and the International Finance Corporation. In contrast, private sector financing will be coordinated by the world's largest coalition of financial institutions, the Glasgow Financial Alliance for Net Zero (GFANZ).

GFANZ has established a working group with several financing entities – including Bank of America, Citi and HSBC, among others – to identify barriers to sourcing private investments and advocating for the necessary reforms to solve these barriers.

This is the third of such pledges from the JETP. South Africa received US$8.5 billion of support in 2021 at the COP26 in Glasgow and Indonesia secured a US$20 billion deal, announced during COP27 in Egypt to support its coal phase-out.

Ursula von der Leyen, president of the European Commission, said: "With investments from international partners, Vietnam can boost renewable energies and enhance its energy security and autonomy. We will help Vietnam to start reducing its greenhouse gas emissions five years earlier than planned, and dramatically reduce its coal power use."

Moreover, during an EU-ASEAN summit, the EU announced the mobilisation of €10 billion (US$10.6 billion) to accelerate

infrastructure investments in Southeast Asia, with a focus on green transition and sustainable connectivity.

Within that package, two initiatives were launched – the Sustainable Connectivity Initiative and the Green Team Europe Initiative – with the first one aimed at supporting the Association of Southeast Asian Nations' (ASEAN) electric grid interconnections to improve access to renewable energy and the investment in digitalisation, which includes connectivity via submarine cables for which it will have a funding of €1 billion.

"The Indo-Pacific region is becoming the new global centre of gravity. The Indo-Pacific generates 40% of global GDP and represents 60% of the world's population," said Josep Borrell, vice-president of the European Commission.

https://www.pv-tech.org/

ASIA-PACIFIC

AUSTRALIA

Scientists retrofit diesel engines to use hydrogen as fuel

Engineers at the University of New South Wales (UNSW) have successfully retrofitted a diesel engine to use hydrogen as a fuel in order to reduce carbon emissions. The team spent 18 months developing the dual-fuel injection system, which uses 90 percent hydrogen as fuel but is confident that future retrofits could be completed in a matter of months.

Electrified transport has been getting a greater push in recent months, with states and countries banning the sale of internal combustion engine-powered vehicles over the next decade. While this is a positive beginning, there is still a need to rapidly advance technologies that can replace the larger and long-haul vehicles that do the heavy lifting across industries.

Retrofitting existing vehicles

Retrofitting existing diesel engines would be a fast way to transition to a cleaner fuel-burning system to get the job done.

Hydrogen can be far more environmentally friendly when created using renewable energy rather than by burning fossil fuels like diesel. The research effort led by Shawn Kook, a professor at the School of Mechanical and Manufacturing Engineering, has demonstrated to have reduced carbon dioxide emissions to 90 g/ kWh, which is about 86 percent lower than that produced by a diesel-powered engine.

How does the dual fuel system work?

The team has retained the engine's original diesel injection and directly added a hydrogen fuel injection to the cylinder. Interestingly, the team's efforts also found a way to avoid the high nitrogen oxide (NOx) emissions associated with hydrogen engines.

Instead of putting hydrogen into the engine and letting it mix well, the researchers found that its stratified addition significantly reduces NOx emissions. This means that the hydrogen presence is more in certain parts of the engine while being less in other parts. Overall, the nitrogen oxide emissions, causative of acid rain and air pollution, were reduced in the dual-fuel engine.

More importantly, unlike hydrogen fuel cell systems, the dual fuel system developed by the UNSW researchers does not require high-purity hydrogen as fuel. Since producing high-purity hydrogen is expensive, the new system could be deployed at lower costs for the end users.

An added benefit is the increase in energy efficiency over existing diesel engines, which the researchers reported to have improved by as much as 26 percent. This was achieved by independently controlling the injection timings of both fuels.

The research team is confident of commercializing the technology within the next two years and plans to first deploy it in industrial locations, such as mining sites, where piped hydrogen lines already exist. Following this, the team will look to make its technology more mobile, which will necessitate the installation of a hydrogen storage system.

https://interestingengineering.com/

INDIA

New approach to using solar energy for EV charging

Researchers from the Indian Institute of Technology Guwahati have developed optimized control schemes for active power distribution networks, allowing for the coordinated operation of photovoltaic (PV) power generation and electric vehicle (EV) charging stations.

Dr. Sanjib Ganguly, Associate Professor, Department of Electronics and Electrical Engineering (EEE), IIT Guwahati, along with his research scholar Arunima Dutta and colleague Dr. Chandan Kumar, have recently published their research in the Journal of Sustainable Energy, Grids and Networks.

Electric vehicles are being increasingly explored as a solution to the transportation sector's carbon emissions. The sustainability of EVs can be enhanced if the power used to charge these vehicles is also based on renewable energy sources such as solar energy. However, solar energy is intermittent, which leads to voltage fluctuation problems in the power distribution networks. Furthermore, EV charging is uncoordinated at present, which may lead to under-voltage of the distribution networks, and associated efficiency loss, according to an IIT Guwahati press statement.

Voltage control approach

A coordinated control approach for power distribution systems is required to derive maximum benefits from renewable power generation and electric vehicle power sourcing. PV and EV inverters need to work in coordination with other Voltage Regulating Devices (VRD) to regulate the system voltages.

Highlighting his research, Ganguly said, "We have developed an optimization-based coordinated voltage control approach of power distribution networks, to mitigate the overvoltage and under-voltage problems due to high PV generation and high EV charging, respectively."

The research team has developed a three-stage model predictive control (MPC) approach to scheduling the charging of EVs and other devices. The three stages comprise coordination of the volt-var devices in two different time scales; reception of the reactive power set points by the local controller, and EV charge scheduling in accordance with the balance between the operating cost and customer satisfaction, as per the release.

https://www.thehindubusinessline.com/

Cheaper EV batteries

Given the abundance of zinc in India, researchers at IIT-Madras are developing mechanically-rechargeable zinc-air batteries as an alternative to Lithium-ion batteries which are used in electric vehicles.

In a significant development for electric mobility and the larger stationary battery

storage ecosystem in India, researchers at the Indian Institute of Technology, Madras, are developing mechanically-rechargeable zinc-air batteries as an alternative to lithium-ion (Li-ion) batteries.

After filing for patents, the researchers from IIT-Madras' Department of Chemical Engineering, led by Dr. Aravind Kumar Chandiran, are collaborating with major industries, to develop zinc-air batteries. Compared to existing Li-ion batteries, the researchers at IIT-Madras claim that their zinc air counterparts have a longer shelf life, are cheaper, safer, and can be used in two or three-wheeler electric vehicles (EVs).

"In our laboratory at IIT-Madras, we invented low-cost, safe metal-air battery systems based on zinc. These metal-air batteries are nearly three times cheaper. Moreover, the technology has been developed in-house. The country has abundant amounts of zinc, making it unique. This creates possibilities for India to own the technology and have the safest technology for its next-generation energy storage systems. These batteries can potentially be used in EVs for low-powered applications like two-wheelers and three-wheelers and stationary energy storage systems," says Dr Chandiran.

"Speaking of stationary energy storage, solar energy is available during the daytime, and that energy peaks around midday and weans off towards the end of the day. We use batteries to store that excess energy available at midday. So far, we have options based on lead-acid or lithium-ion battery technologies. But India does not own any of these technologies, so we will have to move to our in-house technologies with resources available domestically. Zinc is found abundantly in India and we are also one of its largest producers," he added.

Powering Zinc-Air batteries

Akin to petrol stations for IC-engine vehicles, the researchers are mooting separate 'Zinc Recharge Stations.' Using 'Battery-Swapping' technology, EV users can swap used 'zinc cassettes' of the battery for fully-charged 'zinc cassettes' at these 'Zinc recharge stations.'

Elaborating on this aspect, Dr. Chandiran says, "This is a major advantage of the zinc-air batteries as currently the only option available with the lithium-ion batteries is that the entire used battery pack must be removed and swapped with a complete lithium-ion battery pack. This results in double the capital investment in the case of lithium-ion batteries."

In other words, unlike Li-ion batteries, zinc-air batteries require only anode swapping rather than the entire battery.

Advantages of Zinc-Air batteries

Zinc is cheaper than Li-ion batteries. Researchers note that while Li-ion batteries cost USD 200 to 250 a KWh, zinc-air batteries cost around USD 150 KWh. With wider usage, the price is expected to fall below USD 100 KWh. They add that these batteries are water-based, and have a longer shelf life and high turnaround efficiency.

"Zinc-air batteries can offer better range. We are still testing their cycle life, but expect them to serve for a couple of thousand cycles. They do not require a dry atmosphere to fabricate batteries like Li-ion batteries. Zinc-air batteries can also be fabricated in ambient conditions, so there is less investment in CAPEX. They are yet to be tested on the road," explains Dr Chandiran.

Besides zinc-air batteries, there are other alternatives that are being considered for the Indian EV market. For example, there is sodium-ion, which experts believe is "cheaper than lithium-ion cells by about 30-40%". Besides cheaper costs, there are other advantages associated with sodium-ion like its availability in India, battery capacity, and environmental impact.

In developing zinc-air batteries, researchers at IIT-Madras have offered India another option for self-sufficiency in fulfilling its electric mobility and stationary battery storage requirements.

https://www.manufacturingtodayindia.com/

MALAYSIA

Powered by RISE develops in-house technology and expertise to produce EV chargers

With the government's focus on vehicle electrification as one approach to achieve carbon neutrality by 2050, the private sector has many opportunities to engage and contribute to the development of various areas ranging from the sale of zero emissions vehicles to being energy providers. Supporting areas, such as the network of charging points, need to be developed quickly to accelerate adoption of electric vehicles (EVs).

Local tech start-up Powered by RISE is one of the many new companies that is engaged with their new product called ONE RISE. It is said to be one of Malaysia's first EV charging stations that is fully equipped with its own payment system.

Powered by RISE not only installs charging stations but also develops its own chargers and applications utilizing IT expertise. This enabled the company to build in-house knowledge of the technologies and tailor its products to meet the requirements of its customers more closely. Not relying on other companies to supply products and technology also means that Powered by RISE can have more control over the quality and performance of its chargers.

ONE RISE has a comprehensive range of advanced features including an integrated payment system that supports e-wallet payment methods, a user-friendly interface, and safety features like automatic shut-off mechanisms that prevent overcharging and overheating. It also features an AI camera as a security measure to detect numberplates and motion tracking. This added layer of security ensures the car's and the user's safety.

It also incorporates built-in safeguards that protect against electrical faults and other safety issues, which is critical given the presence of high voltages.

Additionally, ONE RISE is the world's first charging station to implement flooding and fire detection and prevention systems.

"Our charging station is powered by sustainable energy sources, reflecting our commitment to environmental sustainability, and facilitating the transition to a clean energy ecosystem. Through our efforts, we aim not only to promote the use of renewable energy but also to encourage the adoption of eco-friendly practices and pave the way for a more sustainable future in Malaysia," said Kray Chong, Founder and Director of Powered by RISE.

"To accelerate the global transition towards sustainable transportation, it is crucial to provide electric vehicle users with convenient and hassle-free charging experiences. With our 'Powered by RISE' solutions, EV users can easily initiate charging sessions by downloading our All-in-One app from Google Play Store or Apple Apps Store. The app is simple and offers real-time monitoring of energy transfer, remaining charging time, and session cost, all accessible from their smartphone, which further enhances user convenience. This innovative solution represents a significant milestone in promoting the widespread adoption of EVs and a greener future," he said.

To date, Powered by RISE has installed more than 14 EV charging ports, with an additional 130 units nationwide in the pipeline. This will contribute to the government's expectation of 10,000 charging points being available nationwide by 2025.

https://www.thesundaily.my/gear-up/

REPUBLIC OF KOREA

New electrode production technique for high-capacity EV batteries

A joint team of researchers developed a new type of electrode using carbon fiber paper to increase the durability of high-capacity lithium metal secondary batteries commonly used in electric vehicles. The new paper-type batteries have the potential to prevent battery combustions, that could trigger catastrophic accidents.

Lithium-ion batteries' anode material plays a crucial role in the operation of the power bank by storing ions from the cathode inside the battery and discharging them to generate electric current. Theoretically, lithium metal anode materials can greatly improve the capacity of batteries by up to 1,000 percent.

However, the lithium-based electrodes can form lithium dendrites, an uneven deposition of lithium crystals, which can damage the separator membrane and trigger combustions. It is virtually impossible to extinguish lithium-ion battery fires, and the best way is to wait until all lithium is burnt off.

The Korea Institute of Science and Technology (KIST) said that its researchers collaborated with other researchers from the Gwangju Institute of Science and Technology (GIST) to develop the carbon fiber-based paper electrode. The anode consists of thin carbon fiber paper film containing lithium metal. To prevent lithium dendrites from forming, the film was coated with sodium carbonate and amorphous carbon nanoparticles.

Through tests, a conventional lithium anode wrapped in a thin copper film was short-circuited after about 100 charge-discharge cycle tests but the new carbon fiber paper anode was stable after more than 300 test cycles. The energy density was increased from the conventional lithium-ion battery's 240 watt-hours per kilogram to 428 watt-hours per kilogram.

"The anode material developed by the joint research team is a great achievement that can accelerate the commercialization of durable and lightweight lithium metal batteries, considering that the density of carbon is about five times less than that of copper and its price is also cheaper,".

https://www.ajudaily.com/

Revolutionary Lithium-ion battery technology

POSTECH-Sogang University joint research team develops layering-charged, polymer-based stable high-capacity anode material.

The electric vehicle market has been experiencing explosive growth, with global sales surpassing $1 trillion (approximately 1,283 trillion Korean Won/KRW) in 2022 and domestic sales exceeding 108,000 units. Inevitably, demand is growing for high-capacity batteries that can extend EV driving range. Recently, a joint team of researchers from POSTECH and Sogang University developed a functional polymeric binder for stable, high-capacity anode material that could increase the current EV range by at least tenfold.

A research team led by POSTECH professors Soojin Park (Department of Chemistry) and Youn Soo Kim (Department of Materials Science and Engineering) and Professor Jaegeon Ryu (Department of Chemical and Biomolecular Engineering) of Sogang University developed charged polymeric binder for a high-capacity anode material that is both stable and reliable, offering a capacity that is 10 times or higher than that of conventional graphite anodes. This breakthrough was achieved by replacing graphite with Si anode combined with layering-charged polymers while maintaining stability and reliability.

High-capacity anode materials such as silicon are essential for creating high-energy density lithium-ion batteries; they can offer at least 10 times the capacity of graphite or other anode materials now available. The challenge here is that the volume expansion of high-capacity anode materials during the reaction with lithium poses a threat to battery performance and stability. To address this issue, researchers have been looking towards polymer binders that may successfully restrict the volumetric expansion.

However, research to date has focused solely on chemical crosslinking and

hydrogen bonding. Chemical crosslinking involves covalent bonding between binder molecules, which solidifies them, but it has a fatal flaw: once broken, the bonds cannot be restored. On the other hand, hydrogen bonding is a reversible secondary bonding between molecules based on electronegativity differences, but its strength (10-65 kJ/mol) is relatively weak.

The new polymer developed by the research team not only utilizes hydrogen bonding but also takes advantage of Coulombic forces (attraction between positive and negative charges). These forces have a strength of 250 kJ/mol, much higher than that for hydrogen bonding, but they are reversible, making it easy to control volumetric expansion. To effectively bind with the anode, the layering-charged polymers are arrayed alternately with positive and negative charges, and the surface of high-capacity anode materials is mostly negatively charged. Furthermore, the team introduced polyethylene glycol to regulate the physical properties and facilitate Li-ion diffusion, resulting in a thick high-capacity electrode and the maximum energy density found in Li-ion batteries.

https://scitechdaily.com/

KINGDOM OF SAUDI ARABIA

AI to speed up development of greener fuels

Computers can be taught to generate mixtures from a set of target properties using an inverse mixture-design approach based on machine learning. KAUST-developed technology could be used to identify high-performance transportation fuels with minimal atmospheric carbon dioxide (CO_2) emissions.

Most of the increase in global temperatures can be attributed to greenhouse gas emissions. The combustion of hydrocarbon fuels, such as gasoline, which power most automotive engines, is a major source of CO_2 emissions.

Engineering transportation fuels with higher efficiency and reduced carbon emissions is a viable answer to these environmental problems.

Numerous methods for fuel screening have been developed; however, they are typically only proven on smaller blends or call for additional preprocessing, making these combinations unsuitable for inverse fuel design.

Kuzhagaliyeva, Mani Sarathy, and colleagues built a deep learning model that consists of numerous smaller networks dedicated to certain tasks in order to effectively screen fuels.

"*This problem was a good fit for deep learning that allows capturing nonlinear interactions between species*," stated Kuzhagaliyeva.

The researchers used the inverse-design method to identify possible fuels by first defining combustion-related characteristics, such as fuel ignition quality and sooting propensity.

Few experimental data are available to the general public. To train the model, the researchers created a large database utilizing experimental measures from the literature. The database included all kinds of pure compounds, substitute fuel blends, and complex mixtures, like gasoline.

The researchers had to incorporate vector representations into the model as no model could be modified for inverse fuel design, according to Kuzhagaliyeva. They created a mixing operator that directly connects hidden representations of pure compounds and mixes through linear combinations.

This mixing operator was inspired by text processing methods that use hidden vectors to connect words to phrases. They also included search algorithms to find fuel mixes within a chemical space that match the predefined parameters.

The model correctly predicted the fuel ignition quality and the sooting propensity of different molecules and mixes. Additionally, it found several gasoline blends that met the predetermined standards.

The team is now improving model accuracy by adding new properties to the property database, like volatility, viscosity, and pollutant generation. The technique is being improved to create synthetic aviation fuels and e-fuels for gasoline.

https://www.azorobotics.com/

SINGAPORE

5G projects in EV manufacturing, river cleaning

Singapore will see three new applications of 5G technology this year, including two firsts in electric vehicle manufacturing and river cleaning.

Singapore's first two 5G standalone networks have reached 95 per cent nationwide outdoor coverage, ahead of a 2025 target for nationwide coverage.

In one project, more than a hundred 5G-enabled robots are being deployed to transport materials to vehicle manufacturing cells on the factory floor of the Hyundai Motor Group Innovation Centre in Singapore.

The 5G technology will allow for real-time data transmission between the automated control system and the robots. It will reduce labor-intensive activity, enhance workers' safety and allow them to take on higher-value roles.

River Cleaning Vessels

In another new project, IMDA and Weston Robot will collaborate to use 5G-enabled electric unmanned surface vessels for river cleaning and inspection.

Currently, river cleaning is done manually from petrol-fueled boats. Each boat emits up to 20 tons of carbon per year and costs S$6,000 to S$12,000 a year to maintain.

The electric vessels can run autonomously and use video analytics to detect and clear trash outside of the pre-programmed paths. They will also reduce carbon emissions by 80 percent compared to the gasoline boats.

https://www.channelnewsasia.com/

EUROPE

FRANCE

Low-cost method of generating green hydrogen

Green hydrogen is needed as a fuel for the decarbonization of transportation as well as for the energy sector and the chemical industry, particularly fertilizer production. However, the hydrogen production cost currently limits its use on a large scale.

Researchers from Swansea University and Grenoble Alpes University (Université Grenoble Alpes) have joined forces to develop a practical way to produce green hydrogen using sustainable catalysts. This could be a major step towards making green hydrogen production simpler, more affordable, and scalable, according to researchers.

In their work, the team used natural enzymes – hydrogenases – to generate green hydrogen, using sunlight. Hydrogenases are biological catalysts that can reversibly convert protons and electrons into hydrogen at low overpotentials without the use of precious metals.

Unlike synthetic catalysts based on precious metals like platinum, hydrogenases contain only earth-abundant elements such as iron and nickel. However, researchers say these enzymes are very sensitive and quickly deactivate when exposed to air, making their practical use nearly impossible.

Now, the team has developed engineered solvents that enable hydrogenases to function in the air. Simply placing hydrogenases in these solvents, instead of water, makes them more active and stable so that they can be practically used to generate hydrogen.

"We integrated synthetic nanoparticles with natural enzymes into so-called hybrid materials, which combine the best of both worlds to achieve new, superior functionality. TiO2 nanoparticles are excellent at using sunlight to generate charges, and hydrogenases are extremely efficient in using these charges to generate green hydrogen," said Dr. Christine Cavazza, senior scientist at CEA Grenoble. "*Combining the two, therefore, allows for the efficient generation of green hydrogen from sunlight, something none of the separate components are capable of.*"

The research brought together Swansea University's expertise in photocatalysis, solvent design, and its focus on delivering practical solutions to complex problems and combined this with knowledge of extracting natural enzymes and utilizing them for renewable energy conversion at the Alternative Energies and Atomic Energy Commission (CEA) and Université Grenoble Alpes (UGA).

Using sustainable catalysts such as hydrogenases instead of expensive platinum can lower the cost of electrolyzers and fuel cells, making green hydrogen more affordable to produce and use. It also lowers dependence on imports, which can be disrupted by external factors.

https://www.inceptivemind.com/

GERMANY

Ammonia-based systems for mobile energy

Researchers at the Fraunhofer Institute for Microengineering and Microsystems IMM are developing ammonia-based systems for a mobile, decentralized energy supply in the infrastructure, transportation and industry sectors.

An alternative to fossil fuels is power-to-X fuels, which are synthesized from electrolysis-based hydrogen.

To date, ammonia has primarily been known as a source material for agricultural fertilizers. However, it is also a high-quality energy carrier, notably as a storage medium for hydrogen.

The conversion of hydrogen into ammonia is a viable option for using it as an energy source both on-site for industrial processes on a large scale as well as on a decentralized basis in the logistics sector.

As part of the Spaltgas project, researchers at Fraunhofer IMM and their project partners are developing a combustion technology for this gas mixture that will be used in the brick firing process. Ammonia produced from hydrogen via electrolysis can thus be used to make the entire brick manufacturing process chain carbon dioxide-free. The Spaltgas project is funded by the German Federal Ministry of Education and Research (BMBF) as part of the "Klim-Pro-Industrie" program.

Ammonia can also be used for supplying hydrogen to land vehicles. It can be converted into hydrogen right at the filling station using decentralized plants. This eliminates the need to transport compressed and liquefied hydrogen—a costly and complex process.

To this end, Fraunhofer IMM is developing a cracking reactor based on innovative catalyst technology and microstructure reactor technology. In this reactor, pure hydrogen is produced from ammonia through cracking and subsequent purification, which is then injected into PEM fuel cells. Hydrogen for use in fuel cell vehicles can therefore be produced sustainably from ammonia right at the filling station.

The AMMONPAKTOR reactor from Fraunhofer IMM, which was financed by the State of Rhineland-Palatinate using ERDF (European Regional Development Fund) funds, is also the most efficient reactor on an international scale. Even in its first generation, the cracking reactor achieved the second-highest specific hydrogen production rate ever published, owing to Fraunhofer IMM 's unique technology.

The second-generation cracking reactor, which is currently in the manufacturing process and has a throughput of 25 kg/hour of ammonia, produces 70 kilos of purified hydrogen per day. It was exhibited at the Hannover Messe 2023.

In addition to supplying hydrogen to land vehicles, ammonia is also of interest for maritime propulsion systems because conventional fuels have failed to achieve the CO2 reduction goals in this sector, and there are numerous applications where compressed or liquefied hydrogen cannot be used as an alternative. Partially cracked ammonia can be combusted in (ship) engines, in the same way that Spaltgas reactors can.

Furthermore, as part of the ShipFC project, Fraunhofer IMM is collaborating with 13 European consortium partners to develop the world's first ammonia-based fuel cell system for maritime applications.

https://www.greencarcongress.com/

USA

Hydrogen-powered train engine

As the United States shifts away from fossil-fuel-burning cars and trucks, scientists at the U.S. Department of Energy's Oak Ridge and Argonne national laboratories are exploring options for another form of transportation: trains. The research focuses on zero-carbon hydrogen and other low-carbon fuels as viable alternatives to diesel, for the rail industry.

Researchers from the multidisciplinary team kicked off the project and celebrated the installation of rail technology company Wabtec's single-cylinder dual-fuel locomotive engine in the National Transportation Research Center, a DOE-designated user facility located at ORNL.

Both laboratories have entered into cooperative research and development agreements with Wabtec, described in an ORNL news release, as a leading manufacturer of freight locomotives. The Argonne and Wabtec agreement also includes Convergent Science Inc., a software developer. The project will run for four years.

Hydrogen as a fuel has many advantages, but locomotive engines must be modified to ensure safe, efficient, and clean operation. The team will develop hardware and control strategies for the engine, which will run on hydrogen and diesel fuel to demonstrate the viability of using alternative fuels.

"We are excited to be a part of this collaboration because it addresses the need to decarbonize the rail industry by advancing hydrogen engine technology for both current and future locomotives," said Josh Pihl, an ORNL distinguished researcher and group leader for applied catalysis and emissions research. "It is also a perfect example of how a DOE-funded collaboration between industry and national laboratories can accelerate the development and commercialization of technologies to help reduce carbon emissions from transportation."

Pihl said the project aligns with the goals of DOE's Vehicle Technologies Office to use low-carbon fuels in hard-to-electrify transportation sectors. While electrifying vehicles is an effective strategy in reducing carbon emissions from some parts of the transportation sector, railways are seen as more problematic due to the high cost of constructing a single coordinated electrified rail system across North America. Each year, the North American rail fleet emits approximately 87.6 billion pounds of carbon dioxide, a major driver of climate change.

Researchers are exploring the potential of hydrogen combustion engine technology in the rail industry, said Muhsin Ameen, Argonne senior research scientist. Hydrogen is an energy carrier that can be produced from clean energy sources such as solar and wind power. Scientists have been researching hydrogen-powered vehicles for decades.

"To reduce carbon dioxide emissions to net zero by 2050, we must make dramatic improvements in energy efficiency and emissions in the overall transportation system, including railways," Ameen stated in the release. "Hydrogen has been used in light-duty combustion engines. However, hydrogen is a newer area of research in railway applications."

The research team is developing combustion technology to power the next generation of trains with up to 100% hydrogen and other low-carbon fuels. The team's goal is to design train engines that will deliver the same power, range, and cost-effectiveness as the current diesel technology.

In the project's first phase, the ORNL team will work on hardware changes for retrofitting locomotives. Their goal is to reduce carbon dioxide emissions from the roughly 25,000 locomotives in use in North America. Locomotives have a service life of more than 30 years, so replacing the entire fleet would take decades.

During the second phase of the project, ORNL and Wabtec will continue to alter the engine hardware to increase the amount of hydrogen that can be used. The team aims to completely replace diesel with hydrogen or low-carbon fuels in new locomotives.

At the same time, Argonne will leverage more than a decade of experience in modeling hydrogen injection and combustion to create a modeling framework to study combustion and emission control technologies used in hydrogen combustion engines. The project will be overseen by experts in fuel injection, kinetics and combustion modeling, design optimization, high-performance computing, and machine learning.

Scientists are using Argonne's high-performance computers to develop simulation software. This tool will help predict the behavior of combustion engines as operating conditions change and hardware is modified. Simulations help researchers understand the combustion process, which drives engine efficiency and reduces emissions.

Each diesel-powered locomotive that is converted to a zero or low-carbon energy source is anticipated to save up to 5.6 million pounds of carbon dioxide per year.

https://www.oakridger.com/

Method for making net-zero aviation fuel

New Sustainable Aviation Fuel Would Significantly Reduce Long-haul Flight Emissions

An interdisciplinary team of researchers at Worcester Polytechnic Institute (WPI) has developed a potential breakthrough in green aviation: a recipe for a net-zero fuel for planes that will pull carbon dioxide (CO_2) out of the air.

Aviation accounts for approximately 2.5% of all global greenhouse emissions, according to the International Council

on Clean Transportation (ICCT), and that number is only expected to increase.

Through modeling and computation analysis, the team developed a formula for a fuel that consists of magnesium, a mineral that is found all over the globe, most abundantly in the world's oceans. A slurry of magnesium hydride, a chemical compound made up of magnesium and hydrogen, mixed with hydrocarbon fuel would burn to produce CO_2, water vapor and magnesium oxide (MgO) nanoparticles. The magnesium hydride fuel would also give planes the range for long-haul flights, such as those from Boston to Tokyo, which has proven difficult for other sustainable aviation fuels to provide. That longer range is achieved, in part, due to the chemical properties of the slurry, a lower volume of it is needed for combustion than a typical aviation fuel.

The Department of Energy describes sustainable aviation fuel as a "biofuel used to power aircraft that has similar properties to conventional jet fuel but with a smaller carbon footprint." These biofuels have been made from resources including corn grain, algae, forestry, and agricultural residues, among others. Using biofuel as the hydrocarbon in this slurry with magnesium hydride could potentially lead to net negative emissions.

https://www.wpi.edu/

Hydrogen from plastic waste

A team of university and U.S. Army researchers has developed a way to extract hydrogen from plastic waste, that can be used as fuel for transportation and to produce electricity in fuel cells.

Hydrogen is a clean-burning fuel, generating energy while leaving only water as a byproduct. It is currently produced mainly by reforming natural gas or by splitting water into hydrogen and oxygen through electrolysis.

According to the U.S. Energy Information Administration, global energy demand is projected to increase by 56% by 2040, driven by population growth and industrialization, particularly in developing countries. At the same time, more than 400 million tons of plastics are produced globally each year, which, combined with low recycling rates, has led to a dramatic increase in plastic waste, polluting the environment and interfering with ecosystems.

The team is using plasma technology to address both challenges simultaneously, by breaking down plastic waste – in this case, low-density polyethylene (LDPE) – into its chemical components. Hydrogen is then produced efficiently in the process, while minimizing carbon dioxide emissions, according to Trelles.

In 2019, the United States produced an estimated 3.5 million metric tons of LDPE, which is commonly used in single-use plastic bags and packaging, as well as in containers, bottles, trays, tubing, and molded parts for many consumer products. Unlike other plastics, LDPE breaks down when exposed continuously to sunlight, releasing significant amounts of greenhouse gases like methane and ethylene.

The researchers say their strategy could help address the challenge of disposing plastic waste, which is often incinerated or dumped in landfills, thereby cutting down greenhouse gas emissions while simultaneously providing a source of hydrogen.

The team's reactor differs from thermal plasma reactors, which have temperatures that typically exceed 12,000 degrees Celsius (more than 21,000 degrees Fahrenheit) and are employed in waste treatment plants around the world.

With their current system, the researchers estimate that from 1 metric ton of LDPE, they can produce up to 6 kilograms of hydrogen.

In addition to LDPE, the team's plasma technology can potentially be applied to convert other plastic wastes, as well as biomass waste from agriculture, food industry and cellulose from sawmill dust, into high-value chemicals and additives.

https://www.uml.edu/

New type of fuel cell

Researchers found an ultrafast alternative to the slow oxide ion transfers of conventional fuel cells, increasing efficiency and performance by using hydrocarbon fuel directly. The commercial applications are promising.

Like batteries, fuel cells produce energy through an electrochemical process. Unlike batteries, they do not run down or require recharging. However, the potential advantages of fuel cells are offset by challenges that include cost, performance, and durability.

Michigan Technological University researcher Yun Hang Hu and two graduate students, Hanrui Su and Wei Zhang, took on those challenges, changing the conventional path of a fuel cell by creating an interface between the electrolyte and melted carbonate as an ultrafast conduit for oxygen ion transfer.

"This allowed us to invent an entirely new type of fuel cell, a carbonate-superstructure solid fuel cell (CSSFC)," said Hu.

Like other fuel cells, CSSFCs have a wide array of potential uses, from providing energy to operate fuel cell vehicles and household power generation to powering whole power plants. Because CSSFCs are fuel flexible, they offer higher durability and energy conversion efficiency at lower operating temperatures than other types of fuel cells.

Most fuel cells are powered by hydrogen, typically produced from hydrogen-containing compounds, most often methane, through an expensive process called reforming. But the CSSFC developed in Hu's lab can directly use methane or other hydrocarbon fuels.

Hu said fuel flexibility is of particular interest for commercial applications. Furthermore, the new fuel cell's electrochemical performance at lower operating temperatures offers several other advantages. "The operating temperature of a conventional solid oxide fuel cell is usually 800 degrees Celsius or higher, because ion transfer in a solid electrolyte is very slow at a lower temperature," Hu said. "In contrast, the CSSFC's

superstructure electrolyte can provide a fast ion transfer at 550 degrees Celsius or lower, even as low as 470 degrees Celsius."

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The relatively low operating temperature offers high theoretical efficiency and lower cell fabrication costs. Hu said it is also potentially safer to operate than other solid fuel cells.

Tests on the CSSFC also showed an unprecedentedly high open circuit voltage (OCV), indicating negligible current leakage and high energy conversion efficiency.

Hu estimates that CSSFC fuel efficiency could reach 60%. By comparison, the average fuel efficiency of a combustion engine ranges between 35% and 30%. The CSSFC's higher fuel efficiency could lead to lower carbon dioxide emissions in vehicles.

https://www.mtu.edu/

New battery with 4 times energy density of lithium-ion

Scientists and engineers at US-based technology research center Argonne claim to have developed a new battery which, according to them, has four times the energy density of lithium-ion batteries.

The researchers from the Illinois Institute of Technology (IIT) and U.S. Department of Energy's (DOE) Argonne National Laboratory say that the new battery could power an EV for more than a thousand miles (1600 km) and could also someday be used to power domestic planes and long-haul trucks.

"The main new component in this lithium-air battery is a solid electrolyte instead of the usual liquid variety,"

"The battery chemistry with the solid electrolyte can potentially boost the energy density by as much as four times above lithium-ion batteries, which translates into longer driving range."

More electrons stored means higher energy density. Lithium-air battery has the highest projected energy density of any battery technology being considered for the next generation of batteries beyond lithium-ion.

"The chemical reaction for lithium superoxide or peroxide only involves one or two electrons stored per oxygen molecule, whereas that for lithium oxide involves four electrons," said Argonne chemist Rachid Amine.

Argonne says the new lithium-air design is the first lithium-air battery that has achieved a four-electron reaction at room temperature. It also operates with oxygen supplied by air from the surrounding environment.

The capability to run with air eliminates the requirement for oxygen tanks, which Argonne says was a problem with earlier designs.

"With further development, we expect our new design for the lithium-air battery to also reach a record energy density of 1200 watt-hours per kilogram," said Curtiss. "That is nearly four times better than lithium-ion batteries."

For comparison Tesla's new 4680 cells have an energy density of 272-296 Wh/kg and which is considered very high by current standards. At four times the density, the new cells would open up all sorts of possibilities, including aircraft capable of flying well over 1000 km on a single charge.

https://thedriven.io/

New battery technology

The tech, which was developed by researchers at Penn State and EC Power, could reduce battery size significantly.

Researchers at Penn State may have found a way to make EVs even more appealing.

The university has just unveiled a new battery technology that has the potential to cut charging times in half for EVs. The technology could also reduce the size of the batteries, which could certainly improve their performance in other ways, including range.

The new technology, which was developed in collaboration with university-backed startup EC Power, is an internal thermal modulation system for EV batteries. An ultra-thin nickel foil is added to the structure of the battery that helps regulate temperature, keeping it "hot, but not too hot," without the need for bulky heating and cooling systems, according to the school. Not only would this allow for 10-minute charge times, but it could also reduce battery size by up to two-thirds. A smaller battery would store energy more efficiently and cost less.

"Our fast-charging technology works for most energy-dense batteries and will open a new possibility to downsize electric vehicle batteries from 150 to 50 kWh without causing drivers to feel range anxiety," Chao-Yang Wang, the university's William E. Diefenderfer Professor of Mechanical Engineering and lead author of the study, said in a statement. "The smaller, faster-charging batteries will dramatically cut down battery cost and usage of critical raw materials such as cobalt, graphite and lithium, enabling mass adoption of affordable electric cars."

Long charging times are currently viewed as one of the main drawbacks of EVs.

EC Power is currently trying to manufacture and commercialize the new battery, according to Penn State. The timing could not be better, as EVs seemed to have hit a tipping point over the last couple of years. While they currently only represent five percent of the new vehicles sold, and one

percent of those on the road, adoption is quickly increasing. On top of this, the last few months have seen both the EU and the state of California announce plans to ban the sale of new gas-powered vehicles by the middle of the next decade.

https://robbreport.com/

Zero-emissions, ammonia-fueled tractor demonstrated

Amogy, Inc., a Brooklyn, New York-based startup, demonstrated a zero-emissions, ammonia-fueled tractor. For the demonstration, Amogy blended its ammonia-to-power technology into a standard mid-size John Deere tractor, giving it a 100-kW capacity. The technology uses ammonia cracking modules with a hybrid fuel cell system combined with a liquid storage tank. During the demonstration, the ammonia-fueled tractor was operated for several periods and refueled. The demonstration took place at Stony Brook University in New York. (In 2021, the startup demonstrated an ammonia-powered, zero-emissions 1 kW drone.) Amogy was founded in 2020 and has received funding from AP Ventures and Amazon's Climate Change Fund.

Ammonia is attracting increasing attention as an enabler of emissions reductions in hard-to-abate transportation sectors like long haul trucking, locomotives, aviation, and shipping. Produced by combining hydrogen with atmospheric nitrogen, ammonia has been used by various industries for more than a century, primarily as a chemical precursor to nitrogen fertilizers. However, ammonia also possesses a relatively high volumetric energy density compared with hydrogen and existing battery chemistries, which makes it an attractive energy carrier.

Technological advances in recent years have presented new opportunities for using ammonia within the transportation sector. These include more efficient methods of cracking ammonia to generate hydrogen for use in fuel cells or combustion engines; propulsion systems optimized for the direct use of ammonia; or combined approaches that can include blending ammonia or hydrogen with conventional fuels.

At Amogy, we have developed a compact, high efficiency reactor that cracks ammonia and uses hydrogen to generate power through a fuel cell. The design leverages superior physical characteristics of liquid ammonia to carry the performance advantages of hydrogen far from the supply source and does so at lower operating temperatures and higher efficiency levels than alternative designs.

Ammonia is not a flammable or explosive chemical, but it is a toxic substance.

Because of its toxicity, ammonia is not viable for consumer vehicles, which is why Amogy is targeting commercial vehicles only.

What is the ammonia source and cost? Is it cost-competitive with gasoline and diesel fuel?

Per dollar-per-energy basis, ammonia presents about 2x larger cost compared to conventional fuels (e.g., gasoline or diesel). However, this cost is substantially cheaper than other potential alternative fuels, e.g., hydrogen. Ammonia is produced today from natural gas, and there is a large pipeline of "blue" & "green" ammonia projects that have been announced to develop ammonia in a more sustainable way, as technology advances and demand increases from adoption of zero-emissions technologies such as Amogy's.

We expect that the cost of "green" ammonia will be in parity with diesel by 2035, or potentially sooner, if carbon taxes are enacted by then.

https://cleantechnica.com/

Technology to convert methanol to SAF

ExxonMobil has unveiled its new process technology to produce sustainable aviation fuel (SAF) from renewable methanol.

ExxonMobil converts methanol derived from the gasification of biomass and waste, captured carbon dioxide or lower-carbon hydrogen into SAF, using its methanol to jet proprietary process technology and catalysts.

ExxonMobil lower-emission fuels venture executive Russ Green said: "SAF produced from renewable methanol can play an important role in helping the aviation industry achieve the transition to a net-zero future.

"Reaching that goal by 2050 will require a multi-faceted approach, including advancements in aircraft-related technology, changes to infrastructure and operations, and a dramatic increase in SAF supply. Our process technology can be an important step in this direction."

With its new technology and infrastructure, ExxonMobil aims to grow its lower-emission fuel business.

The new solution also enhances ExxonMobil technologies that are engineered to manufacture SAF from bio feeds, such as used cooking oils, animal fats and vegetable oil.

The company is also in the process of identifying opportunities to deploy these technology solutions to help with decarbonization in the aviation industry.

ExxonMobil catalysts and licensing president James Ritchie said: "Methanol to jet technology is scalable and suitable for the conversion of methanol produced from today's world-scale plants. The work necessary to qualify the resulting renewable jet fuel pathway has already started."

ExxonMobil agreed to supply the green fuel to Changi Airport using an existing fuel hydrant system.

https://www.airport-technology.com/

EV batteries charge in just 10 mins

Researchers have developed a novel EV battery tech that can charge an EV battery in just ten minutes, paving the way for the mass adoption of much more affordable electric vehicles.

The technology has been developed by researchers from Penn State and it is

based on internal thermal modulation, an active method of temperature control to pull the best performance possible from the battery.

Researchers explain that batteries operate most efficiently when they are hot, but not too hot. Keeping the temperature consistent at the perfect sweet spot has been a challenging endeavor for battery engineers.

Researchers in the past have relied on external, large heating and cooling systems for battery temperature management, which does not really work as promptly and ends up wasting energy along the way.

Researchers from Penn State, however, decided to try a different approach, and regulate the temperature from inside the battery. For this, they created a new battery structure with an ultrathin nickel foil as the fourth component alongside anode, cathode, and electrolyte.

Nickel, acting like a stimulus, self-regulated the battery's temperature and reactivity that allowed for 10-minute fast charging on any EV battery type.

Chao-Yang Wang, the William E. Diefenderfer Professor of Mechanical Engineering at Penn State and lead author on the study, explained, "The need for smaller, faster-charging batteries is greater than ever. There are simply not enough batteries and critical raw materials, especially those produced domestically, to meet anticipated demand."

Wang added, "Our fast-charging technology works for most energy-dense batteries and will open a new possibility to downsize electric vehicle batteries from 150 to 50 kWh without causing drivers to feel range anxiety. The smaller, faster-charging batteries will dramatically cut down battery cost and usage of critical raw materials such as cobalt, graphite and lithium, enabling mass adoption of affordable electric cars."

Researchers in the study conclude stating that true fast-charging batteries could have an immediate impact, as there are not enough raw materials for every internal combustion engine car to be replaced by a 150kWh-equipped EV, fast charging is imperative for EVs to become mainstream.

https://www.indiatimes.com/

Impact of Zero Emission Vehicle Adoption on the Fuel Cycle and the Vehicle Cycle

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Abstract

The adoption of electric cars is considered a necessary step in the transition towards achieving net zero CO_2 emissions in the energy system. In this article, the shift to electric cars in road transport is discussed, focusing on the impact of Zero Emission Vehicle (ZEV) adoption on the fuel and vehicle cycles. Adopting ZEVs will shift fuel consumption in road transport from gasoline to hydrogen and electricity, affecting parts and services required for fuel production, transportation, and storage. Additionally, adopting ZEVs will shift the demand for services and part manufacturing from those required by internal combustion engines to those required by batteries, motors/generators, controllers/inverters, and fuel cells. Furthermore, if car mass reduction is targeted, material consumption for lightweight materials such as carbon fiber-reinforced polymers and glass fiber-reinforced polymers will increase, affecting services and parts required for manufacturing, maintaining, disposing, and recycling cars.

Introduction

Combustion of fossil fuels constitutes the main source of greenhouse gases (GHG), such as CO_2, CH_4, and N_2O. The transport sector relies heavily on fossil fuels and contributes significantly to global GHG emissions. According to the International Energy Agency (IEA) (IEA/OECD, 2021), the transport sector accounted for 24% of the 33,622 Mt-CO_2 emitted in the world from fossil fuel combustion in 2021, with the road transport sector representing around three-quarters of the transport sector CO_2 emissions. In particular, cars represent a significant share of energy consumption and CO_2 emissions from the transport sector. For instance, cars consume 52% of the energy and emit 41% of the CO_2 emissions from the transport sector in the world (WEC, 2011). In the future, the situation tends to be more critical as the number of cars worldwide increases. For instance, the Global Fuel Economy Initiative (GFEI) (GFEI, 2016) predicts the number of cars in the world to increase from 850 million in 2013 to more than 2 Billion vehicles by 2050.

The contribution of cars to global CO_2 emissions is explained by the widespread use of gasoline- and diesel-fueled internal combustion engine cars (ICEVs). For instance, more than 99% of the approximately 1.1 billion road vehicles (including cars, trucks, and buses) in the world in 2015 corresponded to ICEVs (IEA/OECD, 2017). Replacing the internal combustion engine with electric powertrains and shifting from fossil fuels to alternative fuels such as hydrogen or electricity can contribute to achieving net zero CO_2 emissions in the road transport sector. With the shift to electric powertrains, cars are experiencing a shift towards connectedness, automation, and sharing. These changes constitute a once-in-a-century revolution, and future cars are expected to be Connected Autonomous, Shared, and Electric (CASE). Despite the simultaneity of these changes, this article focuses only on the shift to electric powertrains, known as powertrain electrification.

Cars using electric powertrains include Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), Battery Electric Vehicles (BEVs), and Fuel Cell Electric Vehicles (FCEVs). The latter two types of cars, BEVs and FCEVs, have zero tailpipe CO_2 emissions. For that reason, they are often called Zero-Emission Vehicles (ZEVs). ZEVs are fundamental in achieving zero CO_2 emissions in the road transport sector. Despite ICEVs dominating the global car fleet, the number of electric cars in the world has been increasing steadily, reaching 16.5 Million cars in 2021 (IEA/OECD and EVI, 2022). Furthermore, with more ambitious goals for CO_2 emissions reductions related to achieving net zero CO_2 emissions in the energy system, global ZEV sales are expected to increase in the future, affecting the fuels, materials, parts, and services consumed by cars in the world. In this article, the shift to electric cars in road transport is discussed, focusing on the impact of ZEV adoption on the fuel and vehicle cycles.

Adoption of electric cars in the car fleet

A shift to electric cars is necessary to achieve zero CO_2 emissions in the road transport sector. However, the potential of electric cars to reduce CO_2 emissions in road transport depends not only on the CO_2 emissions reductions achievable

by each powertrain but is also affected by the share of electric cars in the car fleet. For example, there are approximately 62 Million cars in Japan (AIRIA, 2022); if few BEVs enter the car fleet, the impact on road transport CO_2 emissions will be negligible despite BEVs having zero CO_2 emissions. The more BEVs enter the car fleet, the larger the CO2 emissions reductions. Eventually, if all the approximately 62 million cars in the Japanese fleet become BEVs, then zero CO_2 emissions in the car fleet will be possible.

However, the adoption of electric cars in the car fleet is a process that takes time, as the time lag effect of the car service life influences it. The service life of a car is in the order of decades. For example, in the case of Japan, the average service life of a car is 13 years for compact and normal cars and 15 years for mini-sized cars (Nishimura, 2011). In the case of developing countries, the average service life of the car is longer; such is the case of 26 years for cars in Colombia (González Palencia et al., 2012). When a car is manufactured, it enters the car fleet as a new car when the vehicle is purchased. The owner uses the car for several years and then sells it. Then other owner buys the car, uses the car for several years and sells the car. The process is repeated until the car is disposed of at the end of the car service life of. Therefore, it takes several years from when a new car enters the fleet until the car is disposed of at the end of the service life. This aspect must be considered when setting targets for CO_2 emissions reduction in the road transport sector. For instance, in the European Union (EU), gasoline car sales will be banned starting from 2035, considering that the average service life of a car in the EU is 15 years, and it is aimed to have zero CO_2 emissions by 2050 (Kottasová, 2023). In that sense, by 2050, the average gasoline car sold in 2035 will no longer be used.

The number of cars in a given country for a given year is determined by the number of cars in the previous years, the new car sales during that year, and the number of cars disposed of during that year. The resulting behavior shows that a country's number of cars is driven mainly by income. As income increases, people can afford a car causing the number of cars to increase until reaching a saturation value that varies from country to country depending on circumstances such as existing infrastructure and consumer preferences. New car sales can be classified into two types: new purchases and replacement purchases. New purchases correspond to cars purchased by people who did not own a car, while replacement purchases correspond to cars purchased by people who previously owned a car.

In developed countries, replacement purchases account for the majority of new car sales, causing the number of cars in the future to experience few variations. In the case of developing countries, it is expected that new purchases will account for the vast majority of new vehicle sales. As the number of cars in the world keeps growing, the majority of the increase in the number of new cars is expected to occur in developing countries, where new purchases account for the majority of new car sales.

The adoption of new technology in any sector of the energy system usually takes place in an incremental manner. For example, in the case of telecommunications, telephones were adopted first, which were replaced by cellphones, which were replaced by smartphones. In the same way, an incremental way for the adoption of electric cars will be the shift from ICEVs to HEVs, later to PHEVs, to shift to BEVs or FCEVs finally. Based on data for the adoption of other technologies in the automotive sector, it has been estimated that it takes around 24 years for new technology to increase its market share from 10 to 90% (Hollinshead et al., 2005) (Grübler, 2003). In developed countries, the incremental pattern for the adopting electric cars is observed, with the number of HEVs, PHEVs, and BEVs gradually increasing. In the case of developing countries, the adoption of electric cars is at a very early stage, with new car sales for HEVs at very low levels and sales for PHEVs, BEVs, and FCEVs almost inexistent.

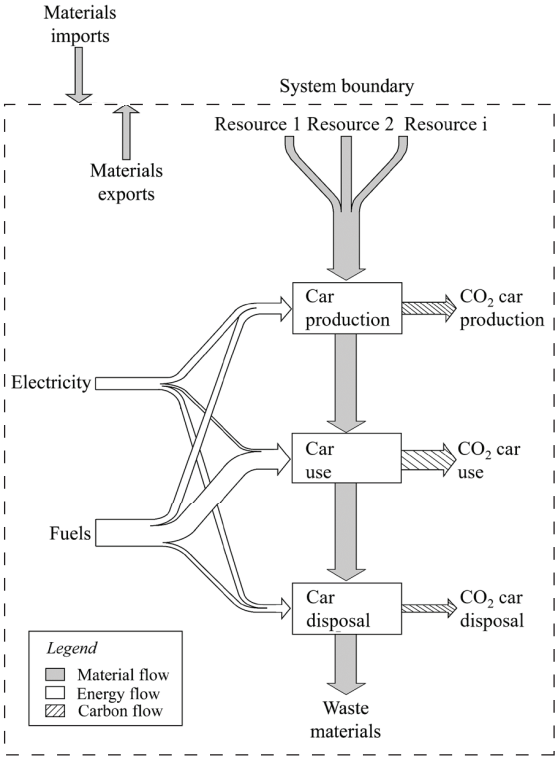

Figure 1. Energy and material flows associated with cars. Built using data from (González Palencia et al., 2012).

Similar to the adoption of cellphones and smartphones in developing countries where people went from not having a fixed telephone to having a cellphone or a smartphone without a fixed telephone, people can go from not having a car to purchasing a BEV or a FCEV directly. This leap-frogging approach can be very effective in adopting ZEVs and curbing the increase of CO_2 emissions from road transport. However, several economic barriers prevent the adoption of ZEVs. For instance, ZEVs have higher capital costs than ICEVs. Additionally, infrastructure development is required to charge BEVs and refuel FCEVs with hydrogen. The development of infrastructure to use electricity and hydrogen in road transport requires large investments. Since developing countries have lower incomes than developed countries, the primary option for consumers when purchasing a car will be the cheapest one, which is usually the gasoline-fueled ICEV. In that sense, leap-frogging to ZEVs in developing countries requires international cooperation to subsidize the cost differences between gasoline-fueled ICEVs and ZEVs using electricity and hydrogen.

The energy flows and material flows associated with cars used in road transport are shown in Figure 1. Shift from gasoline-fueled ICEVs to ZEVs will affect the demand for fuels in road transport, shifting from gasoline to electricity and hydrogen. Simultaneously, it will also affect the demand for materials and parts for car manufacturing. The impact of the adoption of electric cars on the fuel cycle and the vehicle cycle is discussed in the next sections.

Impact of the adoption of electric cars on the fuel cycle

ICEVs use fossil fuels such as gasoline, diesel, natural gas, and liquified petroleum gas as energy sources. Fossil fuels enter the engine mixed with air and are ignited to produce heat through combustion, emitting CO_2. Gasoline is the main fossil fuel used in cars. The main motivation for shifting to ZEVs is to replace gasoline with another fuel that does not produce CO_2 emissions during car use. However, replacing gasoline with electricity or hydrogen in road transport has significant implications for the fuel cycle.

To use gasoline in a car, oil is extracted from an oil well and transported to an oil refinery. Oil is processed at the oil refinery, obtaining gasoline and other products such as diesel and kerosene. Gasoline is then transported to the gas stations, where it is fueled into the tank of ICEVs. As shown in Figure 2, the fuel cycles for gasoline, electricity, and hydrogen used as fuels in road transport are very different.

In the case of electricity, energy resources are transported to the power plant, where electricity is generated. After that, electricity is transmitted and distributed using transmission and distribution lines. BEVs are charged using an electrical outlet. Electricity generation may produce CO_2 emissions depending on the energy resource used. Fossil fuels such as coal and natural gas are the main energy resources used in electricity production, and their combustion emits CO_2. In the case of renewable energy sources such as solar, wind, and hydro, electricity is produced with zero CO_2 emissions. Achieving net zero CO_2 emissions in the energy system requires a drastic reduction of CO_2 emissions across all sectors. If gasoline-fueled ICEVs are replaced with BEVs and electricity is produced using fossil fuels, CO_2 emissions will be shifted from road transport to electricity generation. In that sense, to boost the benefits of ZEV adoption in road transport, it is necessary to simultaneously promote the use of renewable energy resources for electricity generation.

In the case of hydrogen, there are several technologies for hydrogen production. 96% of the hydrogen in the world is produced from fossil fuels using technologies such as steam methane reforming (SMR), oil/NAFTA reforming, and coal gasification (Weger et al., 2017). SMR is probably the most common technology to produce hydrogen. Hydrogen production using SMR uses methane and water as feedstock and methane and electricity as energy resources. Hydrogen production using SMR emits 9 to 10 kg-CO_2/kg-H_2 during the process (Parkinson et al., 2018). Electrolysis using water as feedstock has been considered an option to produce hydrogen without emitting CO_2. In the case of electrolysis, electricity separates hydrogen and oxygen from the water molecule. CO_2 is not emitted directly from the electrolysis process. However, as mentioned above, electricity generation emits CO_2 if fossil fuels are used; and when assessed on a cradle-to-gate basis, electrolysis using electricity produced using fossil fuels emits more CO_2 than hydrogen production using SMR. For instance, using data from (González Palencia et al., 2022), it is estimated that hydrogen production using SMR emits 15.1 kg-CO_2/kg-H_2 on a cradle-to-gate basis, which is lower than CO_2 emissions for hydrogen production using electrolysis with electricity from the grid in Japan that emits 27.7 kg-CO_2/kg-H_2. In that sense, similar to BEVs, it is necessary to promote hydrogen production using electricity generated using renewable energy resources to boost the potential of ZEVs to reduce CO_2 emissions in the energy system.

Renewable energy use for electricity generation offers the advantage of zero CO_2 emissions. However, it has high variability and low availability, requiring large installed capacities to satisfy the demand. For example, Japan's solar photovoltaic electricity generation capacity factor is 0.12 (METI, 2014). This means that electricity can only be generated during 1,051 hours of the 8,760 hours in one year. In addition, electricity generation requires large capital investments and time to build power plants. For this reason, retrofitting current thermal power plants that use fossil fuels to prevent them from emitting CO_2 into the atmosphere is an attractive option for achieving carbon neutrality. This can be achieved using carbon capture and sequestration (CCS). In this case, CO_2 is separated from the exhaust gases after combustion, compressed, and stored in former oil or natural gas wells or other geological formations. Additionally, captured CO_2 can be used to cultivate microalgae that can be processed to produce biodiesel. In this case, CO_2 is used after capture, and the process is

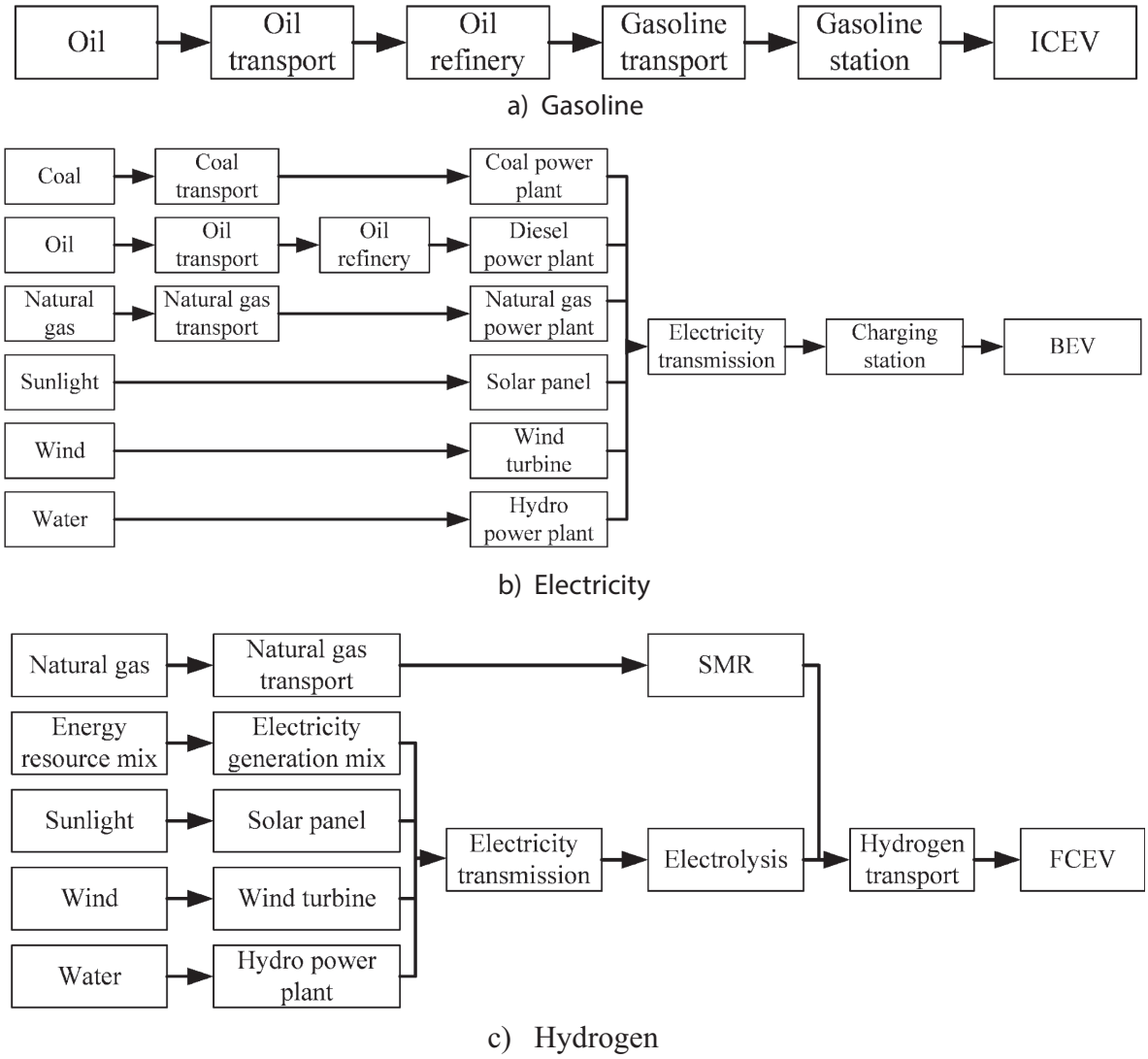

Figure 2. Fuel cycle for a) gasoline, b) electricity, and c) hydrogen

named carbon capture use and sequestration (CCUS). CO_2 can be used in different industrial processes and is not limited to fuel production.

Gasoline, electricity, and hydrogen production are processes intensive in the capital. For that reason, they are controlled mainly by large-scale enterprises. In contrast, small and medium-scale enterprises (SMEs) are part of the supply chain for fuel production for the transport sector as suppliers of services and parts for the technologies used in the energy conversion processes. In order to achieve net zero CO_2 emissions in the energy system, replacing gasoline with electricity and hydrogen will require a shift from oil refining to electricity generation using renewable energy and electrolysis. Services and parts for technologies required for fuel production will shift from those related to oil refining to those related to electricity generation using energy conversion technologies such as solar panels, wind turbines, and hydraulic turbines. Additionally, services and parts related to electrolysis will be required for using hydrogen in the road transport sector. In the case of CCS and CCUS adoption, there will be a demand for services and parts associated with the capture, use, and sequestration of CO_2.

Impact of the adoption of electric cars on the vehicle cycle

Fuel storage and energy conversion processes in cars vary significantly depending on the type of powertrain used. For this reason, the components and materials utilized also vary depending on the powertrain and the fuel used. The schematics of the main components of the powertrains for ICEVs, HEVs, BEVs, and FCEVs are shown in Figure 3.

In the case of gasoline-fueled ICEVs, gasoline is stored in the fuel tank and then injected into the engine cylinder using a fuel injector. Gasoline mixes with air,

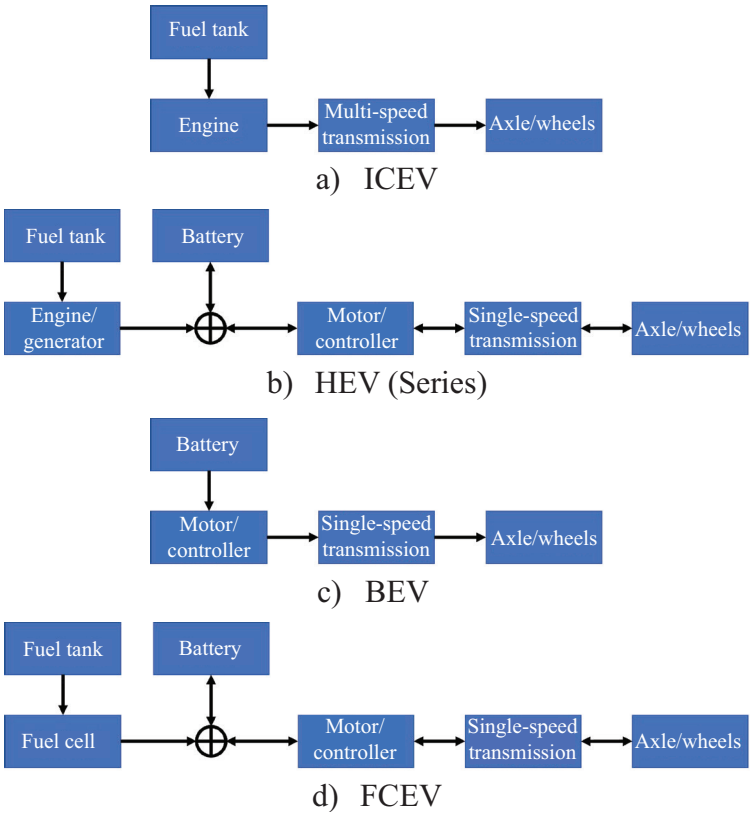

Figure 3. Schematic of the main components of the powertrain for a) ICEVs; b) HEVs (series configuration); c) BEVs; d) FCEVs. Based on data from (Simpson, 2005)

and it is ignited using a spark plug. The gasoline-air premix burns, generating heat that is transformed into work by the internal combustion engine, making the crankshaft rotate. Crankshaft movement is transmitted to the transmission, and it is connected to the axle that makes the tires rotate. In the case of HEVs, kinetic energy is regenerated during braking using a generator that produces electricity. Electricity is stored onboard using a battery, and converted to work in a motor. The motor shaft rotates, and movement is transmitted to the axle using a transmission, making the tires rotate.

In the case of BEVs, electricity is stored onboard using a battery. The electricity is converted to work in a motor, causing the shaft to rotate. Shaft movement is transmitted to the transmission connected to the axle, making the tires rotate. Similar to HEVs, kinetic energy is used to generate electricity using a generator, and electricity is stored in the battery during braking. Regarding FCEVs, hydrogen is stored at high pressure in a hydrogen tank onboard. Hydrogen is used to generate electricity in the fuel cell. Electricity is converted to work in a motor, causing the shaft to rotate. Shaft movement is transmitted to the transmission connected to the axle, making the tires rotate. Like HEVs and BEVs, in FCEVs, kinetic energy is used to generate electricity during braking using a generator, and electricity is stored in the battery.

Components and materials used in car manufacturing vary depending on the powertrain utilized. The main components of cars using different types of powertrains are presented in Table 1. At the same time, materials used in car manufacturing also change according to the powertrain used. Furthermore, to reduce vehicle mass, the use of lightweight materials has been gaining attention in recent years. Conventionally, steel is used for manufacturing the vehicle glider. Vehicle mass can be reduced by replacing steel with lightweight materials such as high-strength steel, carbon fiber reinforced polymers, and glass fiber reinforced polymers. The same strategy can be applied to other components in the car. As a result, the material breakdown of cars tends to change in the future, as shown in Figure 4.

Additional to lightweight materials used, car mass reduction can be achieved by reducing the size of the car. The main motivation behind car mass reduction is to reduce energy consumption. For instance, for gasoline-fueled ICEVs, every 100 kg mass reduction improves energy consumption by 7% (Cheah, 2010). In the case of electric cars, reducing car mass also

	ICEV	HEV	BEV	FCEV
Glider	✓	✓	✓	✓
Internal combustion engine	✓	✓		
Fuel cell stack				✓
Fuel tank	✓	✓		
Emission control electronics	✓	✓		
Transmission multi-speed	✓	✓		
Transmission single speed			✓	✓
Motor/generator		✓	✓	✓
Controller/inverter		✓	✓	✓
Fuel cell auxiliaries (including hydrogen storage)				✓
Li-ion battery		✓	✓	✓
Charger			✓	

Table 1. Main components for cars using different powertrains.

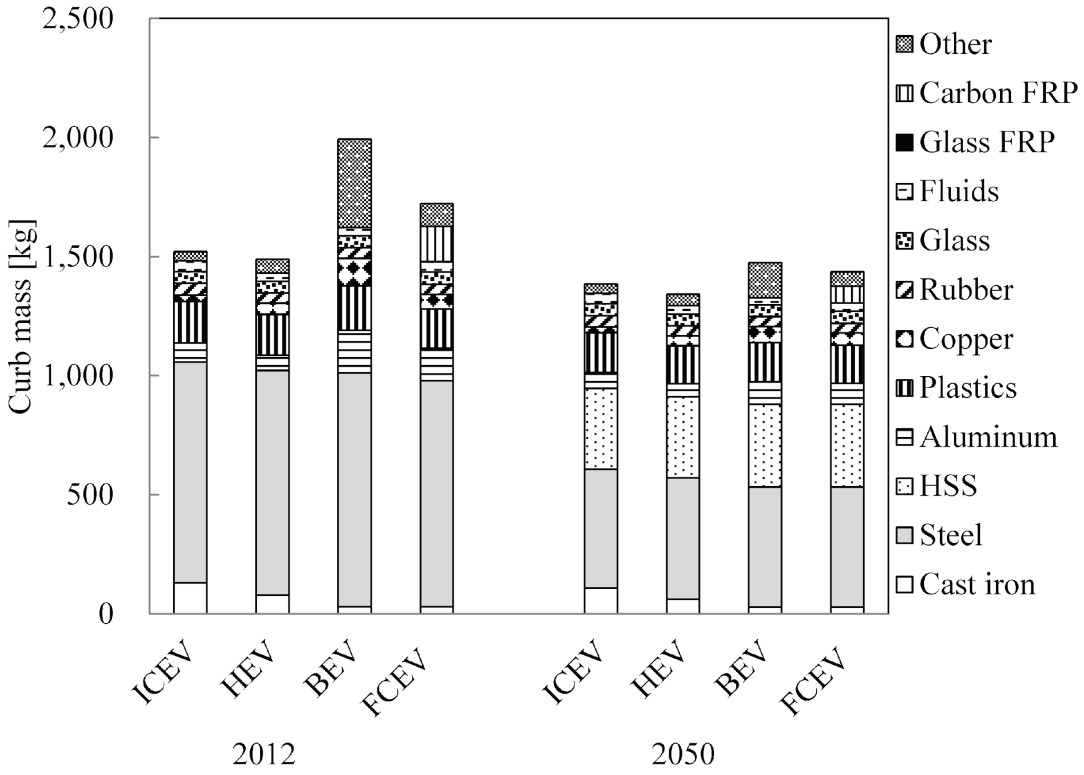

Figure 4. Change in material composition for normal cars in Japan between 2012 and 2050. Using data from (González Palencia et al., 2016)

contributes to reducing energy consumption. However, the impact of car mass on energy consumption is lower for electric cars than for ICEVs due to the increase in the energy conversion efficiency of the powertrain (Pagerit et al., 2006). Nevertheless, energy consumption reduction due to car mass reduction lowers the demand for electricity and hydrogen in road transport, requiring less infrastructure for adopting ZEVs.

SMEs are an important part of the car supply chain. SMEs engage in a large range of activities such as supplying parts and services for car manufacturing, supplying parts and services for material manufacturing, maintenance service during the car service life, recycling, and final disposal of parts and materials at the end of the car service life. Switching from gasoline-fueled ICEVs to electric cars will significantly impact the services and products that SMEs supply to the automotive sector. For example, in the case of the powertrain, demand for services and parts will shift from those required by internal combustion engines to those required by batteries, motors/generators, controllers/inverters, and fuel cells. In the case of lightweight materials used, shifting from steel to composite materials such as carbon fiber-reinforced polymers and glass fiber-reinforced polymers will change the process for material manufacturing and the process for parts manufacturing. Furthermore, the process for recycling and final disposal of parts made using lightweight materials will likely differ from the process for parts made of steel.

Conclusions

Replacing gasoline-fueled ICEVs with electric cars is considered a necessary step in achieving net zero CO_2 emissions in the energy system. In this article, the shift to electric cars in road transport is discussed, focusing on the impact of ZEV adoption on the fuel cycle and vehicle cycles. The main conclusions are as follows:

1. The adoption of electric cars in the car fleet is a process that takes time, as the time lag effect of the car service life influences it. Based on historical data for the adoption of other technologies in the automotive sector, it takes about 24 years for the market share of a new technology to increase from 10 to 90%. The share of electric cars in the car fleet affects the CO_2 emissions reduction potential.
2. Adoption of ZEVs will shift fuel consumption in road transport from gasoline to hydrogen and electricity. To boost the benefits of ZEV adoption for CO_2 emissions reduction, it is likely the simultaneous adoption of electricity using renewable energy and electrolysis. This will affect the parts and services required for fuel production, transportation, and storage.
3. Adopting ZEVs will shift the demand for services and parts manufacturing from those required by internal combustion engines to those required by batteries, motors/generators, controller/inverters, and fuel cells.

Furthermore, if vehicle mass reduction is targeted, material consumption for lightweight materials such as carbon fiber-reinforced polymers and glass fiber-reinforced polymers will increase, affecting services and parts required for manufacturing, maintaining, and disposing of cars.

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Riding the Electric Wave

Policy landscape and opportunities in the growing electric two-wheeler market of India, Indonesia, and Viet Nam

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Abstract

The electrification of vehicles continues to gain traction worldwide, with governments taking strategic actions to decarbonize the transport sector. In Asia, this transition prominently features electric two-wheelers (E2Ws). Two-wheelers have predominantly been used for daily commutes, as shared mobility, i.e., bike-rental and bike-taxi services, as well as urban deliveries. In this growing and competitive electric mobility market, traditional automotive original equipment manufacturers (OEMs) and start-ups, including small and medium enterprises (SMEs), will find potential opportunities to capture value during the transition towards electric mobility.

The objective of this article is to present the policy landscape supporting the E2W transition across three emerging electric vehicle (EV) markets in Asia – India, Indonesia, and Viet Nam. The article begins by highlighting the evolution and challenges of the two-wheeler population in these markets. Following, we explain the necessity for the transition to E2Ws and provide an overview of the current status of E2W adoption. Next, a summary of the regulatory and policy actions to promote E2Ws in the three countries is presented. Finally, policy recommendations to encourage the growth of the entire electric vehicle ecosystem are described.

Introduction

The transport sector is a key contributor to the emission of greenhouse gases (GHGs), with estimates suggesting it will account for over 30% of total emissions in the future (United Nations Environment Programme). In Viet Nam, the transportation industry is accountable for 18% of the total national GHG emissions (Oh, et al., 2019). The sector is also a leading cause of air pollution and short-lived climate pollutants. Therefore, incorporating electric mobility solutions into modern transport systems in Asian countries presents an opportunity to achieve more sustainable mobility by promoting well-connected cities, improved mass transit, and active mobility.

While electric vehicles (EVs) alone cannot solve all transport-related issues, their implementation can align with larger development goals. Adopting EVs is crucial to meeting the objectives of the Paris Climate Agreement and reducing air pollution. Therefore, low and middle-income countries must adopt zero-emissions electric mobility to achieve these objectives.

Transition to electric two-wheelers

Two-wheelers (2Ws) have become a popular mode of transportation in Asian countries due to their socioeconomic advantages, including lower costs for purchase and operation compared to cars. These vehicles are particularly practical in cities that are expanding, lack public transportation, and suffer from traffic congestion.

Electrification of two-wheelers offers the potential to reduce emissions and noise pollution, as electric versions produce zero tailpipe emissions and emit minimal noise levels. Adopting electric two-wheelers (E2Ws) is a crucial strategy for reducing GHG emissions, mitigating climate change effects, and achieving a more sustainable transport system. In addition, E2Ws offer many potential applications, including last-mile delivery of goods and cost-effective mobility solutions in remote areas.

The rise of E2Ws has also led to the growth of service industries and created employment opportunities for drivers. Since the onset of the COVID-19 pandemic, E2Ws have experienced a surge in demand primarily due to individuals opting to avoid public transportation. Thus, the development of shared mobility and micro-mobility solutions has boosted E2W sales in Southeast Asia and India. For instance, electric bike sales skyrocketed in India in 2020, and manufacturers faced difficulty keeping pace with the demand (Khan, 2023).

Purpose of this article

The market for E2Ws presents a variety of opportunities for players across the value chain, in addition to established automotive original equipment manufacturers (OEMs). Small and medium enterprises (SMEs), start-ups, and other industry participants can capture value in this dynamic and competitive market. For instance, original equipment suppliers and new entrants can explore various opportunities, including electric power trains, retrofits for ICE-to-electric conversions, cell and battery technologies, and user platforms, among others.

For the electric mobility industry to thrive, it is important to have a combination of regulations that encourage demand and sale models that attract consumers. The article examines current policies, regulations, and standards

related to E2Ws in India, Indonesia, and Viet Nam, identifies areas where progress on two-wheeler electrification may be impeded, and offers suggestions to address these issues. The article aims to provide insights and guidance for industry participants looking to capitalize on the growing E2W market.

Popularity of two-wheelers in Asia

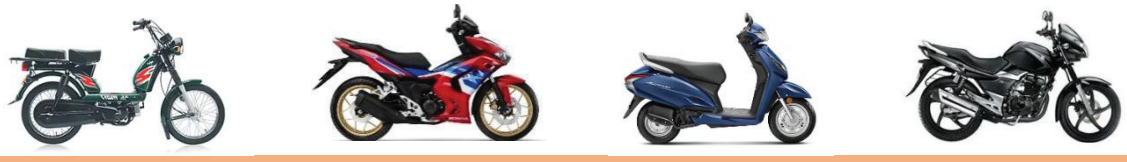
Urban transportation systems, particularly in Asia, are undergoing significant changes due to rapid urbanization and increasedvehicle ownership. Developing markets have the largest portion of the micro-mobility market, with two-wheelers being the dominant mode of transportation.

There exist variations in the definitions and classifications of two-wheelers across various countries. In order to maintain consistency, the definitions of 2Ws (based on body type) have been sourced from MotorCycles Data and are presented in Figure 1.

India, Indonesia, and Viet Nam are significant markets for two-wheelers in Asia and are among the largest markets in the world after China. In Viet Nam, over 65 million registered two-wheelers served around 80% of the country's travel demand in 2020 (Le & Yang, 2022). Figure 2 shows the annual sale of 2Ws from 2016 to 2022 in the three markets. The sales of 2Ws experienced a notable decline in 2020 and 2021 due to the COVID-19 pandemic. Nonetheless, the 2W market in Indonesia is recuperating gradually, with a growth rate of 3.2%; however, the pace of recovery is not as rapid as that observed in India and Viet Nam, where the growth rate has been approximately 20%.

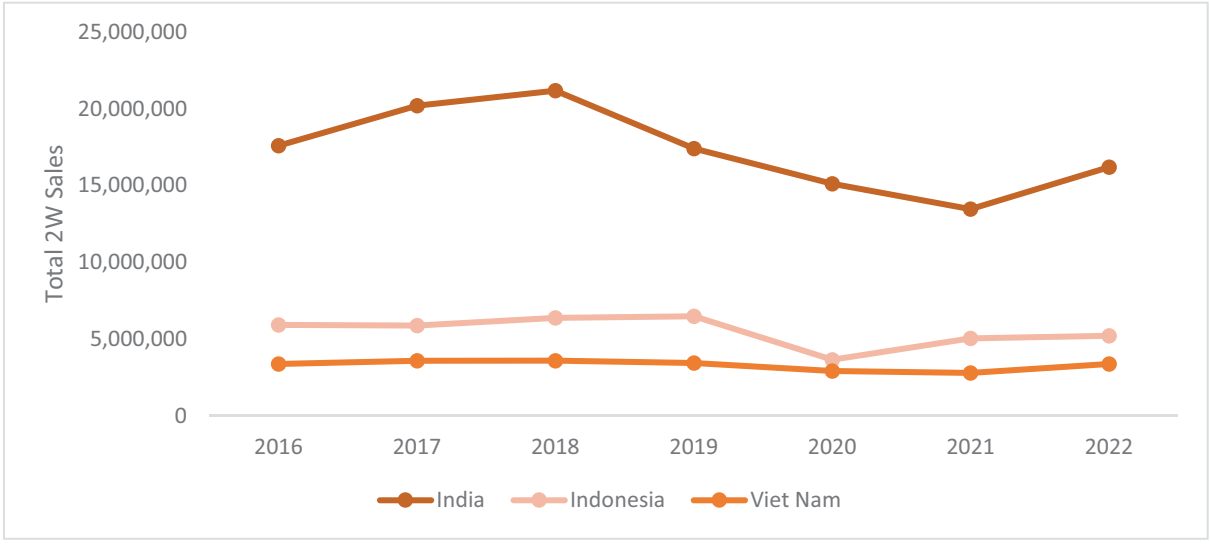
Decarbonizing the transport sector through electric two-wheelers

Asian nations are confronting numerous environmental challenges. Among the top 100 most polluted cities worldwide, 93 are located in Asia, and of the ten countries with the highest vulnerability to climate risks, six are in Asia (Farmer, et al., 2022). The transportation sector is one of the principal contributors to these challenges. Despite existing commitments to decarbonize the sector, global traffic



Moped	Underbone	Scooter	Motorcycle
Mopeds have an engine under the seat with a maximum speed of under 30 km/h.	Underbones have a fuel tank under the seat and a single tube frame.	Scooters have enclosed engines, storage under the seat, and varying engine capacities.	Motorcycles come in various models and have front fuel tanks.

Figure 1. Types of two-wheelers, based on body type



Data sources: Society of Indian Automobile Manufacturers, Association of Indonesia Motorcycle Industry, International Council on Clean Transportation (ICCT), Motorcycles Data.

Figure 2. Annual sale of two-wheelers

emissions are expected to increase by 16% by 2050 compared to the levels in 2015 (Kloth, 2021).

This increasing use of motor vehicles leads to negative consequences such as increased GHG emissions, severe traffic congestion, hazardous levels of air pollution, and a growing number of traffic accidents. For instance, in India, two-wheelers constitute over 70% of the 200 million plus registered vehicles, resulting in roughly 20% of the total carbon dioxide (CO_2) emissions and nearly 30% of particulate emissions (Gulia & Thayillam, 2020).

The transportation sector's advancement is crucial in achieving the climate objectives in Asia since robust policies can significantly reduce in transport emissions. Electrifying the vehicle fleet holds the potential to lower CO_2 emissions, exhaust emissions, fuel consumption, and vehicular noise. Governments worldwide have established ambitious targets for electrifying all vehicle segments to take advantage of this decarbonization prospect. Figure 3 shows the selected three countries' commitment to the electrification of vehicle fleets, especially electric two-wheelers.

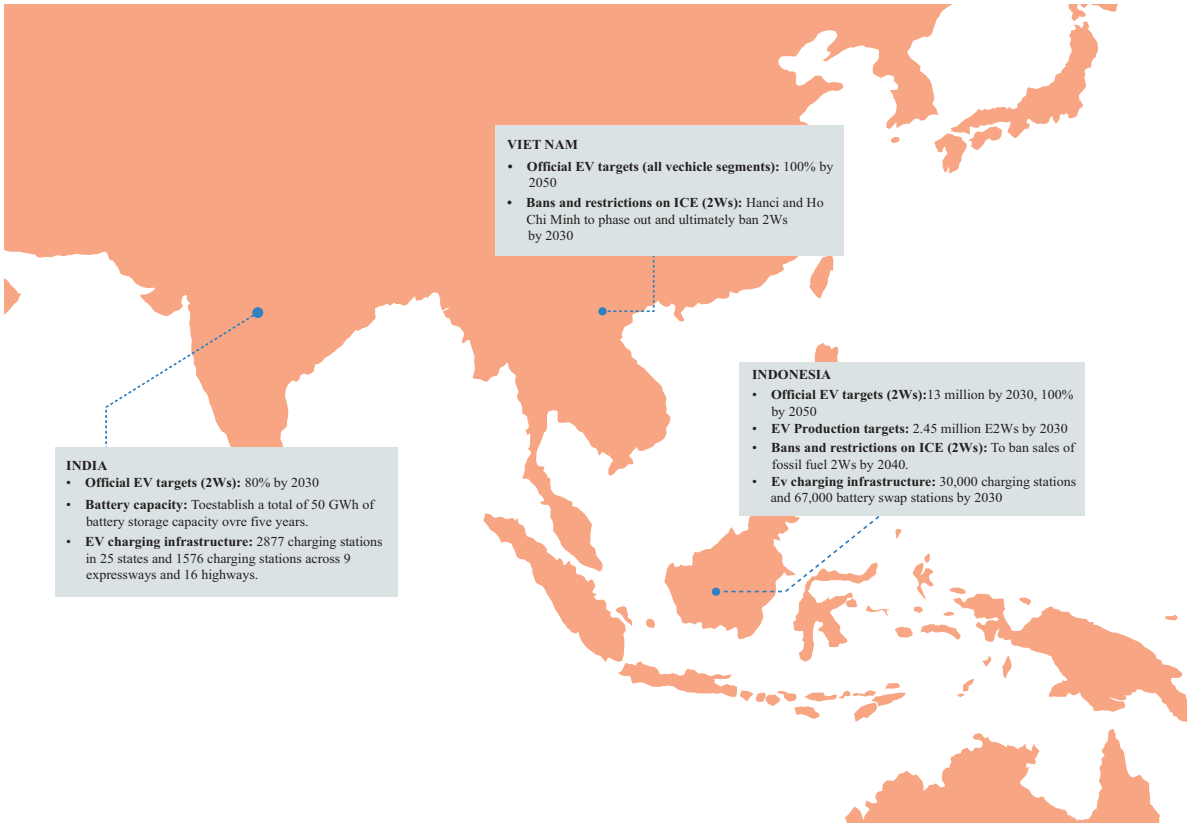
Electric two-wheelers are gaining popularity as a means of transportation worldwide, particularly in densely populated urban areas of Asia where air pollution and traffic congestion are major concerns. In Indonesia, for example, the replacement of 12.5 million internal combustion engine (ICE) vehicles with E2Ws by 2030 could lead to a reduction of 6.1 million tons of CO_2 emissions, which is equivalent to 4% of the country's total transport emissions (Meyer, et al., 2022).

The batteries used in e-bikes and E2Ws are usually low-voltage, with a capacity ranging from 0.3 to 3.3 kWh, as illustrated in Figure 4. It is common for EV owners to charge their vehicles at home, and in India, for example, low-powered AC chargers rated at 3kW are often used to charge E2Ws. Some E2W models also offer the option of a portable battery, which can be charged using a 5-amp socket. E2Ws also use battery swapping, wherein a discharged battery is replaced with a fully charged one at dedicated service stations.

Advantages and disadvantages of electric two-wheelers

Aside from the significant potential for mitigating GHG emissions when paired with low-carbon electricity generation, electric vehicles, including E2Ws, offer advantages such as no exhaust emissions and higher energy efficiency than traditional fossil fuel-based vehicles.

While E2Ws have benefits in promoting clean and affordable transport systems, certain challenges still need to be addressed. While EVs are typically labeled as clean modes of transport during their usage (tank-to-wheel), the production



Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Data source: NITI Aayog, Press Information Bureau – Government of India, ICCT, International Energy Agency. Boundary shapefile source: Opendatasoft.

Figure 3. Electrification targets for two-wheelers

E-bikes	Electric two-wheelers
E-bikes are low-power, low-speed, low-performance two-wheelers with a maximum speed of 25 km/h and do not require a license to operate. Battery capacity: 0.3 to 1.9 kWh Range: 55 to 100 km	Electric two-wheelers have a maximum speed of 25 to 45 kmph and can be powered by either lead-acid or lithium-ion batteries. Battery capacity: 1 to 3.3 kWh Range: 50 to 150 km

Data source: ICCT, market research of available models.

Figure 4. Defining electric two-wheelers

and disposal of EV battery packs may create significant environmental challenges. Being plugged into the local electricity grid, EVs may still rely on fossil fuels depending on a particular country's prevailing electricity generation mix.

E2Ws are also confronted with safety challenges concerning potential battery fires. In India, there have been several instances of E2Ws catching fire, which is attributed to the inadequate thermal management of lithium-ion batteries, and high temperatures and faulty packaging of cells. Singapore addressed this issue by implementing a ban on e-scooters that fail to comply with the UL2272 fire safety standard in 2019 (Asokan, 2019). This safety standard pertains to the electrical drive train system, which encompasses the battery system, of personal mobility devices.

Electric two-wheeler sales and market share by region

The adoption of electric vehicles differs among Asian countries, with emerging markets like India and ASEAN falling behind compared to countries such as China and Japan. In 2021, the market share of EVs in

Advantages of electric two-wheelers

Reduction in GHG emissions

EVs, including electric bikes and cars, reduce GHGs significantly, and this can be further reduced by integrating clean or renewable sources for electricity generation. For example, Ampersand, an electric two-wheeler taxi fleet company in Rwanda, has the potential to reduce carbon dioxide equivalent (CO_2e) emissions by 450,000 tonnes over the course of the next ten years (Scheerooren, et al., 2021).

Lower tailpipe emissions

E2Ws achieve zero tailpipe emissions due to their electric motors, which do not produce any pollutants while operating. This is unlike ICE two-wheelers, which discharge hazardous pollutants such as carbon monoxide and particulate matter (PM10) through their tailpipes while in use (Dai, et al., 2005).

Mitigation of traffic noise pollution

EVs can potentially reduce road traffic noise owing to their propulsion systems emitting considerably less noise than ICE vehicles. Specifically, for E2Ws, their usual operation is at lower speeds, below 45 km/h. This results in minimal rolling noise from the tire-road contact, contributing further to noise pollution mitigation(Huang, et al., 2022).

Economically viable

EVs may have a higher initial cost but significantly lower maintenance and operating costs, making them more cost-effective in the long run. When considering the total cost of ownership (TCO), EVs are particularly well-suited for high daily utilization applications, such as last-mile delivery and ride-hailing fleets. Adopting E2Ws can reduce operational costs for fleet operators, a business opportunity for commercial operations.

Thailand, India, Malaysia, and Indonesia was less than 1% (Farmer, et al., 2022). Despite this, India and Indonesia are predicted to become the second and third biggest markets for E2Ws by 2030, respectively, trailing behind China. The growth rate for these markets is projected to be over 60% per year (Farmer, et al., 2022).

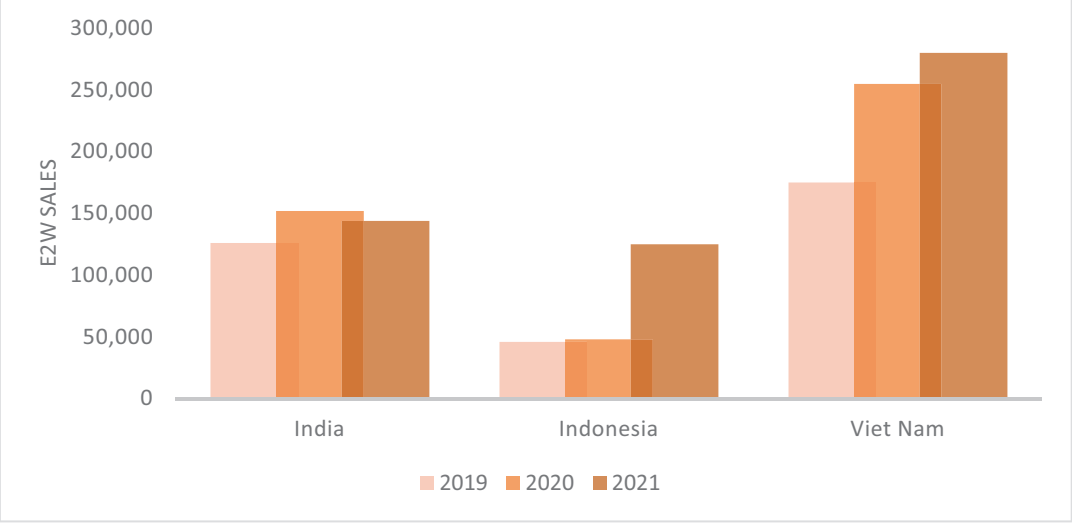
Figures 5 and 6 illustrate the sales and market share of E2Ws in India, Indonesia, and Viet Nam. Viet Nam emerged as the leading market for E2Ws among the three countries, with sales of over 280,000 units in 2021, indicating a 10% increase compared to the previous year. In contrast, the market share of E2Ws in India and Indonesia remained relatively low in 2021, constituting less than 3% of all two-wheelers sold. In contrast, the corresponding figure for Viet Nam was approximately 10%.

Policy landscape to promote electric two-wheeler adoption

In emerging Asian countries, developing a robust electric vehicle ecosystem is crucial to promote consumer adoption and achieve climate objectives. The development of such an ecosystem requires the establishment of a complete EV value chain, which involves promoting both the supply and demand aspects. It requires significant policy and technical efforts, thus making government intervention critical.

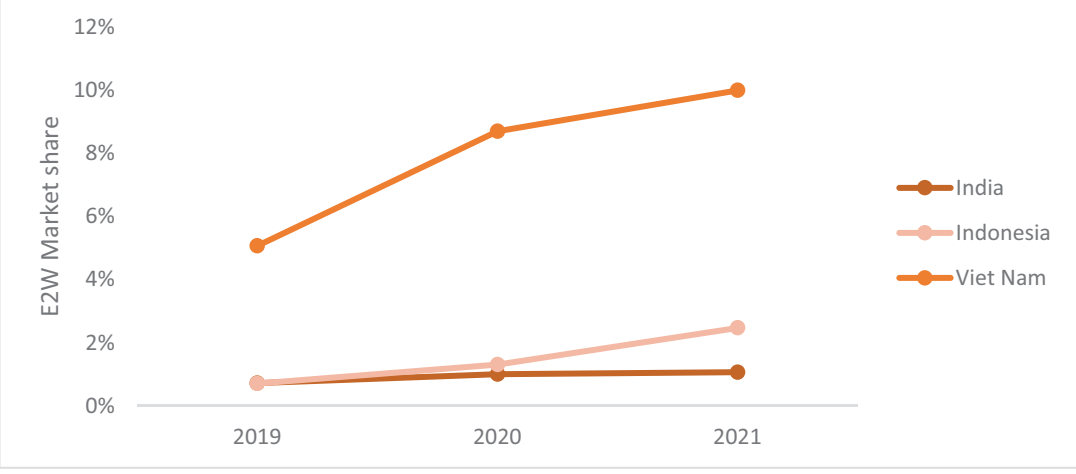
This section outlines the policies implemented in India, Indonesia, and Viet Nam to facilitate the adoption of E2Ws. It summarizes the national policies, highlights local policies and industry activities, and presents global best practices undertaken to promote the uptake of EVs.

In established EV markets, policies are classified into three main themes:



Data source: Society of Manufacturers of Electric Vehicles, ICCT, Deloitte.

Figure 5. Sale of electric two-wheelers



Data source: Estimated based on 2W and E2W sales.

Figure 6. Market share of electric two-wheelers

demand-side incentives, supply-side incentives, and support for charging infrastructure. Thus, the policy interventions discussed in this section are grouped based on these three categories.

Demand-side policies

Given the growing significance of the EV market on both a global and Asian level, providing incentives to consumers is an essential component for stimulating the initial market growth. Such incentives may be in the form of either purchase or operational incentives.

Governments offer purchase incentives for EVs to make them more competitive with traditional ICE vehicles. These incentives aim to surmount obstacles to adoption and promote the nascent development of the EV market. For example, in Taiwan, a province of China, purchase incentives have been extended until 2026. These subsidies range from NT$5,100 to NT$7,000 (approx. USD 170 to USD 320) for the purchase of mini E2Ws and heavy or lightweight E2Ws (Wang et al., 2022). Furthermore, an additional scrapping incentive of NT$1,000 (about USD 33) is provided to those who decommission their old scooters (Wang, et al., 2022).

Complementary policies to discourage ICE vehicles' use by implementing regulations restricting their sales or users can also hasten the transition. An example of this is the ban on the sale of ICE scooters in China, which was implemented in 2011, and this has been a contributing factor to the widespread adoption of E2Ws in the country (Hertzke, et al., 2020).

Table 1 compares the demand-side policy measures adopted by the three countries in focus. Examples of these measures include:

- The government of Indonesia has announced an incentive of Rp 7 million (approx. USD 460) for E2Ws, which will be implemented in March 2023. In contrast, India already has a purchase incentive of INR 15,000/kWh (equivalent to USD 240/kWh), which is based on the battery size.
- In Viet Nam, Hanoi and Ho Chi Minh City are currently strategizing to phase out and ultimately ban ICE motorbikes by 2030.

Supply-side policies: Industry incentives

Industry incentives are designed to promoteg the production of EVs and components within the EV value chain by OEMs, battery manufacturers, and other associated entities. These incentives can be in the form of tax exemptions, subsidies, and support for infrastructural development. In Indonesia, for instance, a 25% reduction in import taxes on EVs is estimated to increase EV penetration up to 24% by 2035. If local manufacturing is also supported, this could go up to 63% (Farmer et al., 2022).

Additional measures to encourage the production of EVs include setting targets or credits for EV manufacturers. One example is the California Zero-Emission Vehicle (ZEV) regulation that mandates manufacturers of intermediate and large volume vehicles to ensure a certain percentage of their sales in California consist of zero-emission vehicles or plug-in hybrid electric vehicles. Additionally, a business-friendly environment with streamlined regulatory processes can encourage companies to establish EV-related businesses easily.

Moreover, battery recycling initiatives are crucial to extract critical minerals from used batteries, reduce the demand for new mines, and mitigate harmful environmental and health effects. This is especially beneficial in countries like Indonesia and Viet Nam, which have abundant nickel and lithium mineral reserves. The

Electric two-wheeler ambitions

Numerous OEMs, start-ups, shared mobility, and last-mile delivery companies have unveiled plans to shift to electric. Examples include:

Ride-hailing companies - Grab and Gojek have pledged to transition entirely to an EV fleet. Gojek has collaborated with more than one million drivers and aims to exclusively deploy EVs by 2030.

VinFast, an EV manufacturer based in Viet Nam, has set a goal to manufacture 500,000 cars and one million E2Ws per year by 2025.

Hero Electric, an EV manufacturer in India, aims to sell more than five million E2Ws within the next three years.

Data source: Reuters, ICCT, Business India

Country	Purchase incentives	Tax incentives	Access to financing	Scrapping & Retrofit	Preferential access
India					
Indonesia					
Viet Nam					

Level of promotion	Not addressed	Low	Medium	High

Table 1. Policy measures to encourage demand for electric two-wheelers

Note: The indicated level of promotion is assessed based on the official announcement of the policy, its implementation, and the presence of any accompanying local-level (state or city) measures.

- Low - The policy has not been officially announced yet, but there are intentions to implement it in the future.
- Medium - The policy has been announced, but it is only implemented locally (in certain cities).
- High - The policy is implemented across the country and at the local level.

EU regulation, for example, mandates OEMs to collect over 70% of EV batteries (Tschödrich, et al., 2022).

In addition, various measures are required to support the growth and advancement of EV technology, including skills development and training programs, research and development initiatives for innovations, and collaborative efforts between public and private stakeholders. One such collaborative effort is the plug-and-play EV Park in Telangana, India, established in partnership with manufacturer MG Motors (PTI, 2022). This facility offers EV manufacturing infrastructure and a startup incubation center. These interventions can facilitate knowledge sharing and resource pooling among innovators, contributing to the development of the EV industry ecosystem.

Table 2 compares the supply-side policy measures implemented by the three countries to foster the development of the EV industry. Examples of measures implemented in these countries include:

- In India, the Bureau of Indian Standards (BIS) has implemented new performance standards for EV batteries in India, which include updated safety standards. These standards require additional safety measures for various aspects of EV battery design and operation, including battery cells, battery management systems, battery pack design, thermal propagation, and onboard charger.
- The Indonesian government allows duty-free import of electric vehicle components, which are assembled domestically.
- The Viet Nam government offers exemptions on import taxes for raw materials and components utilized in the manufacturing and assembly processes that are not produced within the country. In addition, industry zones have also provided tailored incentives (including income tax and land rental reductions) to attract investments from automobile companies.

The rise of electric mobility startups in India

Electric mobility startups are paving the way in the future of urban transportation systems. In India, for instance, over 550 startups have been established in the electric mobility sector as of 2022, with 63% focused on electric vehicle manufacturing. Of these enterprises, more than half are dedicated to the development of electric two- and three-wheelers, including companies such as Ola and Ather Energy.

Data source: WRI India

Charging infrastructure development

A comprehensive network of EV charging points can increase owners' confidence in charger availability and alleviate range anxiety. Governments have a role in developing charging infrastructure by providing financial incentives, such as equipment subsidies, installation grants, and land provision at concessional rates.

Furthermore, EV-ready building codes that mandate the integration of charging infrastructure in buildings for existing and newly constructed structures can be implemented. Additional measures involve offering concessional EV tariffs on charging stations accessible to the public or individual EV owners and integrating the administration of the public charging

Global policy measures to support EV charging infrastructure deployment

Singapore plans to deploy EV chargers in public car parks and introduced the EV Common Charger Grant to subsidize installation costs in private residential buildings.

Guangzhou (China) has mandated new buildings to allocate 18% of their parking spaces to be equipped with EV charging or made EV-ready for future installation.

The State of California intends to deploy solar-powered EV chargers to charge its zero-emissions state fleets.

Data source: Land Transport Authority Singapore, IEA, CleanTechnica

Country	Manufacturer incentives	Performance standards for EVs	Battery recycling	Skill development	R&D support
India					
Indonesia					
Viet Nam					

Level of promotion	Not addressed	Low	Medium	High

Table 2. Policy measures to foster the development of EV industry

Note: The indicated level of promotion is assessed based on the official announcement of the policy, its implementation, and the presence of any accompanying local-level (state or city) measures.

- Low - The policy has not been officially announced yet, but there are intentions to implement it in the future.
- Medium - The policy has been announced, but it is only implemented locally (in certain cities).
- High - The policy is implemented across the country and at the local level.

network to disseminate data on the accessibility of charging amenities and allow electronic payment methods.

EV charging infrastructure can either be public or private. EV owners, especially individual E2W owners, prefer to charge their vehicles at home or their destination and may not need battery swapping services unless they are traveling long distances. However, commercial E2W fleet owners tend to rely more on public charging points, such as bike rental, bike taxis, and last-mile delivery services.

Commercial users prefer battery swapping due to its time-saving advantage and lower downtime, as they tend to cover more daily mileage. However, to provide battery-swapping solutions, standards are needed to enable compatibility between EVs, batteries, and swap stations from different vendors. Moreover, it is essential to strategically place these swapping and public charging stations in locations with high volumes of E2W traffic to maximize access and usage and minimize additional infrastructure costs.

Table 3 presents a comparison of the policy measures undertaken by the three countries to facilitate the development of EV charging infrastructure. Examples of these measures include:

- The Indian government has dedicated INR 1000 cr (approx. USD 134 million) towards the expansion of EV charging under phaseII of the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) policy. This policy has authorized the deployment of 2,877 EV charging stations in 68 cities (PIB Delhi, 2022).
- The government of Indonesia is currently exploring the possibility of reducing electricity tariffs for charging station operators, with proposed rates of Rp 714/kWh for medium-voltage stations and Rp 1,650/kWh for low-voltage stations. It should be noted, however, that this measure is yet to be implemented.

Barriers to electric two-wheeler growth

In emerging markets that are transitioning to EVs, there are typically three main obstacles that hinder this: (1) the high initial cost of EVs, (2) limited access to charging infrastructure, and (3) concerns about range anxiety, as highlighted in multiple government reports and consumer surveys (Batra, et al., 2022).

In Viet Nam, for instance, safety concerns, travel distance, and vehicle cost were found to be the primary factors leading to the low adoption of EVs (Le, et al., 2022). Similarly, in Indonesia, the high upfront cost of EVs remains a primary concern, as the purchase price and down payment requirements for E2Ws continue to exceed those of ICE vehicles (Le, et al., 2022).

Based on the analysis of policy measures in India, Indonesia, and Viet Nam, it is evident that there are significant barriers that hinder the development and adoption of E2Ws in these countries. Figure 7 outlines the obstacles to the growth of the E2W industry in the selected countries.

Viet Nam has the potential to develop a strong EV sector through policy actions due to the need to reduce emissions in its densely populated cities. Deploying EVs in public transport and commercial fleets can be effective in shifting away from ICE vehicles. However, the lack of a charging station network and funding for infrastructure poses challenges. Viet Nam also has limited expertise and capacity in producing original equipment for EVs and a shortage of necessary research, experience, and technology to leverage its mineral reserves for EV production.

Indonesia's E2W industry is currently in its infancy, and there is potential for the market to grow. However, despite some policy measures in place, challenges still hinder the industry's growth. On the demand side, obstacles include the higher cost of EVs, inadequate vehicle specifications, and limitations in charging infrastructure. On the supply side, challenges include low demand and high capital expenditure requirements for vehicle manufacturing and infrastructure development.

Country	Charging equipment subsidies	Land provision for charging infrastructure	EV charging tariffs	EV-ready building codes
India				
Indonesia				
Viet Nam				

Level of promotion	Not addressed	Low	Medium	High

Table 3. Policy measures to support the development of EV charging infrastructure

Note: The indicated level of promotion is assessed based on the official announcement of the policy, its implementation, and the presence of any accompanying local-level (state or city) measures.

- Low - The policy has not been officially announced yet, but there are intentions to implement it in the future.
- Medium - The policy has been announced, but it is only implemented locally (in certain cities).
- High - The policy is implemented across the country and at the local level.

Consumer demand

- Limited purchase incentives: In Viet Nam, E2Ws are not granted purchase subsidies and are subject to equivalent taxes and fees as their ICE counterparts. In Indonesia, discussions are still ongoing regarding the implementation of purchase incentives for E2Ws.
- Limited financing options: In India, private domestic banks offer financing options for high-end personal E2Ws. Most domestic and international banks are not financing commercial fleets due to a limited understanding of the technology and associated risks.

Industry constraints

- Challenges in securing capital investments: In Indonesia, the development of a local EV production base has been hindered by the need for significant capital investments and limited domestic demand.
- Insufficient support for manufacturing: In Viet Nam, the dearth of supportive policies for EV manufacturers and their supply chains, and the lack of technical standards and regulations impedes the investment of ICE 2W manufacturers in EVs.
- Challenges in local manufacturing and sourcing of EV Components: In Viet Nam, the growth of local E2W industries has been shielded by the high cost of imported E2Ws compared to locally produced or assembled units. This, however, leads to a temporary price hike in components such as advanced batteries which are not produced locally. Meanwhile, Indonesia is experiencing a scarcity of local EV part suppliers, resulting in higher logistics costs and an increased tariff burden associated with importing parts.
- Lack of effective battery recycling initiatives: None of the three countries have extensively implemented effective battery recycling initiatives for E2Ws. In Viet Nam, where lead-acid batteries power the majority of E2Ws, these batteries are often disposed of without any recall or exchange by the manufacturing and trading enterprises. This is due to the absence of battery-recall stations/points in most industrial facilities, leading to significant challenges in the sustainable management of batteries in the region.

Charging infrastructure access

- Insufficient regulatory framework to promote residential charging: In India, the absence of regulations has created challenges for E2W owners seeking to charge their vehicles at residential complexes, as opposition from homeowners or Residential Welfare Associations (RWAs) often arises.
- Lack of government-led business models: In Indonesia and Viet Nam, there is a dearth of effective business or partnership models from the government for establishing EV charging infrastructure.
- Inadequate integration of EV charging and renewable energy: Across three countries, there appears to be a significant disconnect between the integration of EV charging and renewable energy sources.
- Lack of technical standards and regulatory framework: In Indonesia and Viet Nam, the lack of framework for public E2W charging infrastructure and battery swapping systems impedes progress in this area. As a result, most users are still charging their vehicles at home.

Figure 7. Policy gaps hindering the E2W transition

The analysis of India's booming EV market can provide valuable insights for emerging markets, such as Indonesia and Viet Nam, that are currently in the early stages of their electric vehicle journeys. Key lessons learned from India's experience include:

Achieve total cost of ownership parity between EV and ICE vehicles	Focus on domestic production	Investments in EV charging infrastructure
The FAME-II scheme's subsidy expansion in 2019 significantly boosted the EV industry, especially in the 2W and 3W segments. In addition, the launch of EV policies by 26 states aimed at achieving EV penetration, attracting investments, and creating employment opportunities, has further accelerated EV market growth.	The country has shifted its focus towards domestic production, with tax reductions for EV batteries and production-linked incentives.	Government and private sector investments in charging infrastructure have been critical for supporting the targeted number of EVs on the road. These investments were made at a large scale, with the aim of making EV charging convenient and accessible to a growing number of EV owners.

Policy recommendations

Different markets can contemplate additional policy backing to attain electrification objectives and address current challenges. Major opportunities for developing the E2W industry are highlighted below:

Consumer demand measures

- **Incentivize EVs and disincentivize polluting vehicles:** Financial incentives are crucial in creating demand for EVs, particularly in the absence of purchase subsidies. Tax exemptions can also complement these incentives. Additionally, implementing disincentives for ICE vehicles, such as fuel taxes, carbon taxes, and emission charges, can help to reduce pollution. Governments can also provide purchase subsidies for those who scrap their fossil fuel-based vehicles. Non-financial incentives, such as EV parking areas and access to low-emission zones, are also important for promoting EV adoption.
- **Aggregate demand through EV deployment in public and private fleets:** Fleet conversion mandates can be instrumental in encouraging EV uptake within the commercial sector. It is important to involve commercial fleet operators in spearheading this transition. Moreover, expediting the electrification of government fleets utilizing mandates and incentives can furnish the essential impetus for the extensive adoption of EVs.
- **Increase availability of EV financing:** Government intervention plays a significant role in enhancing the availability of debt financing for EVs at lower interest rates than ICE models.
- **Focus on consumer awareness:** As EVs gain competitiveness with ICE vehicles in terms of cost and performance, the primary obstacle to their widespread adoption remains the insufficient knowledge of EV technology among consumers. To address this issue promptly, raising consumer awareness about EVs and incentives through campaigns such as test drive events and exhibitions and establishing a knowledge-sharing platform is crucial.

Industry measures

- **Support the E2W industry and its supply chains:** To support OEMs in ramping up EV production, governments can provide preferential loans and reduce company income taxes. Regulations such as fuel economy or CO_2 emission standards on 2Ws could incentivize manufacturers to invest in EV manufacturing and components. Mandating EV production could also encourage ICE vehicle manufacturers to shift investment and production to EVs. This will particularly help in Viet Nam, as ICE manufacturers are not keen on investing in EVs. Indonesia, with its large nickel reserves, holds the potential to appeal to manufacturers seeking to cater to the growing demand for EVs within the country and the wider region. The development of the domestic EV industry can be bolstered through collaborations with international producers,s investment incentives, and export tax subsidies.
- **Promote E2Ws equipped with lithium-ion batteries:** E2Ws utilizing lead-acid batteries have unfavorable environmental impacts as they require frequent battery replacements and have lower durability. Regulatory measures could promote the adoption of lithium-ion batteries, which offer greater energy density and range. This could enhance Viet Nam's competitiveness as an E2W exporter, given its lead-acid E2W market. Furthermore, India can develop import policies to enhance access to battery raw materials such as lithium.
- **Address sustainability concerns in the EV battery supply chain:** As mining and manufacturing of EV batteries contribute significantly to GHG emissions, recycling and reusing EV battery packs can be more environmentally sustainable. Policy measures should focus on ensuring a sustainable supply chain and mitigating risks related to labor, health and safety, and the environment.
- **Ensure vehicle safety through stringent standards:** As the market for EVs continues to develop, it is crucial to address concerns regarding vehicle safety by implementing rigorous standards. In addition, manufacturers of EVs can demonstrate their commit-

ment to safety by sharing information about the measures they are taking to ensure the safe operation of their vehicles and by making data about their safety records publicly available. These actions can help to increase consumer confidence in EVs and encourage investment.

- **Support R&D and innovations in EV and battery technologies:** Prioritizing the development of training and certification programs focused on battery manufacturing and EV infrastructure could empower the industry and drive growth. Secondly, allocating R&D funds throughout the EV value chain, with a particular emphasis on battery technology as a critical component, has the potential to stimulate significant progress.
- **Support industry workers' skill upgradation:** Developing new skills is crucial for industries, particularly those undergoing a transformation like the EV industry. A comprehensive system for upskilling and reskilling can create more job opportunities. It should include training in areas of EV driving and maintenance, product design, battery and vehicle assembly, and charger installation. Collaboration among academia, industry, and the government is crucial to upskill the EV workforce.

Charging infrastructure measures

- **Support investments in the rollout of public charging infrastructure:** Government funding is anticipated to be an essential factor in facilitating extensive infrastructure deployment. The deployment of charging infrastructure is a crucial domain where oil marketing corporations and utility companies have the potential to offer vital support through patient capital.
- **Enable framework for scaling up EV charging network:** It is essential to collaborate with private sector companies, such as charging point operators, to enhance the availability of EV charging infrastructure and battery swapping. Public-private partnerships can be established through government tenders to install charging infrastructure at public locations. This approach is particularly relevant in Viet Nam, where a private enterprise, VinFast, is taking the lead by partnering with entities to install chargers on their premises.
- **Establish operational framework for battery swapping facilities:** Regulations should specify the operational standards to ensure the smooth operation of battery-swapping facilities. Specifically, manual swapping stations for E2Ws require battery pack designs that are lightweight, compact, and ergonomically designed for easy swapping. Additionally, it is important to develop guidelines on battery swapping facility safety and reliability, as well as standardize batteries.
- **Support integration of EV charging points in residential complexes:** It is recommended that regulations be established mandating that 100% of parking spaces in existing buildings have EV charging installed to facilitate EV charging. Housing societies should be encouraged to cooperate by providing no-objection certificates for EV owners to install and charge their vehicles. Moreover, emphasis should be placed on formulating building regulations that mandate the inclusion of requisite electrical infrastructure during the construction of new buildings, which would not only facilitate EV charging but also minimize retrofit expenses.
- **Support integration of renewable energy sources in power generation:** Renewable energy sources play a vital role in achieving decarbonization in transportation, as EVs have the potential to considerably reduce transport emissions alongside the expansion of renewable energy generation. For example, charging point operators can consider utilizing clean sources such as solar photovoltaic (PV) systems for

India

- Implement measures to support EV financing: Develop policies to support EV financing for commercial operators in India. A limited understanding of technology and associated risks is preventing financing options for commercial fleets.
- Focus on developing policies for battery raw materials and battery recycling: India can strengthen its battery industry by developing import policies for lithium and other raw materials. Additionally, policy measures should prioritize battery recycling to promote a sustainable and circular economy.
- Enable private charging and integrate clean energy for power generation: India can overcome challenges faced by E2W owners seeking to charge their vehicles in residential complexes by implementing policy measures such as No-objection certificates or mandates to install private chargers. Integrating clean energy sources for power generation can also reduce carbon footprint while supporting EV charging demand.

Indonesia

- Implement financial and non-financial incentives to facilitate E2W market growth: Indonesia can encourage the growth of its E2W market by implementing a range of measures, including financial and non-financial incentives. Ongoing discussions in the country regarding purchase incentives for E2Ws can pave the way for their implementation.
- Collaborate with international producers to develop the domestic EV industry: The development of the local EV production base in Indonesia has been hindered by the need for significant capital investments, limited domestic demand, and scarcity of local EV part suppliers. Therefore, collaboration with international producers can help to develop the domestic EV industry. Investment incentives and export tax subsidies can further support this growth.
- Deploy a public charging network, including battery swapping: In Indonesia, the lack of a framework for public E2W charging infrastructure and battery swapping systems impedes progress in this area. Deployment of a public charging network, including battery swapping, is essential to support the increasing demand for EVs.

Viet Nam

- Implement financial and non-financial incentives for early market uptake: In Viet Nam, E2Ws are not granted purchase subsidies and are subject to equivalent taxes and fees as their ICE counterparts. Therefore, Viet Nam needs to implement measures including financial and non-financial incentives for early market uptake.
- Mandate EV production and promote lithium-ion batteries: Viet Nam can encourage investment and production in EVs by mandating their production and promoting the adoption of lithium-ion batteries over lead-acid batteries. This will require the implementation of supportive policies for EV manufacturers and their supply chains, as well as technical standards and regulations. Battery recycling initiatives can also be implemented to support sustainability efforts.
- Establish public charging and battery swapping network through collaborations with private sector companies: In Viet Nam, there is a dearth of effective business or partnership models from the government for establishing EV charging infrastructure. Therefore, the deployment of a public charging network, including battery swapping through collaborations with private sector companies, is essential.

Figure 8. Country-specific policy recommendations to promote electric two-wheelers

captive electricity generation to enable EV charging. Furthermore, EV and battery manufacturers can also utilize renewable energy sources to power their plants instead of relying on coal.

Conclusion

The promotion of electric vehicles is considered an important strategy to mitigate environmental issues associated with transportation in many countries, including India, Indonesia, and Viet Nam. This article highlights how these countries have taken concrete steps toward electrifying their transportation sector. Various incentives and measures are recommended to overcome obstacles and promote the development of electric two-wheelers in the future.

India's flourishing E2W market provides a strong foundation for implementing effective national and local-level actions toward electric mobility. Indonesia and Viet Nam still have room to establish comprehensive policies to promote the growth of E2Ws, with good potential to become leading producers of EVs and batteries by leveraging their mineral reserves and local manufacturing capacity. With the

deliberate effort to promote both EV adoption and EV industry, the transition towards electric two-wheelers can be realized much sooner.

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Tech Events

2023

June 06–07 Singapore
Cleantech Forum Asia
Contact: Cleantech Group Europe Ltd
5 New Street Square
London EC4A 3TW, United Kingdom
Tel: +44 (0) 203 743 8615
Email: europe@cleantech.com
https://www.cleantech.com/event/cleantech-forum-asia/

June 13–16 Manila, Philippines
Asia Clean Energy Forum (ACEF) 2023
Contact: *Asia Clean Energy Forum*
ADB Headquarters, 6 ADB Avenue,
Mandaluyong City
Metro Manila 1550, Philippines
Tel: +63 2 632 4444
Fax: +63 2 636 2444
E-mail: acef@adb.org
https://asiacleanenergyforum.adb.org/

June 26–28 Kuala Lumpur, Malaysia
Energy Asia
Contact: Intan Baizura
Email: bhaizura@icep.com.my
https://www.officialenergyasia.com/

Jun 29–01 Jul Gwangju, Republic of Korea
2023 International Green Car Exhibition
Contact:
Tel: 062-611-2211, 2260, 2263
Email: auto@kdjcenter.or.kr
http://www.greencarkorea.com/

July 07–09 Zhejiang, China
IEEE 6th International Conference on Big Data and Artificial Intelligence (BDAI 2023)
Contact: *Ms. Ashley Liu*
Email: bdai2018@vip.163.com
http://www.bdai.net/

July 07–09 Xi'an, China
2023 the 8th Asia-Pacific Conference on Intelligent Robot Systems (ACIRS 2023)
Contact: Ms. Iris QIN
Conference Secretary
Email: acirs_contact@163.com
http://www.acirs.org/

July 11–12 Singapore
Energy Storage Summit Asia
Contact: Solar Media Limited, 123 Buckingham Palace Road, London, SW1W 9SR, United Kingdom
Tel: +44 (0) 207 871 0122
Email: energystorage@solarmedia.co.uk
https://storageasia.solarenergyevents.com/

July 14–16 Tianjin, China
5th International Artificial Intelligence Technology Conference (AITC 2023)
Contact: Ms. Willow Wong
Conference Secretary
Tel: +86-021-59561560
E-mail: aitc@acm-sg.org
http://aitc.org/

July 21–23 Qingdao, China
2023 Asia Conference on Smart Grids and Sustainable Energy Systems (SGSES 2023)
Contact: Ms. Grace Lee
Conference Secretary
Tel: (+852) 6359 2147
Email: sgses@applied-computing.net
http://www.sgses.net/

Aug 17–18 Bangkok, Thailand
Sustainable Energy and Technology Asia 2023
Contact: Ms. Lili Geng
Project Manager-International
Mobile: +86 1662 046 3220
Email: lili@gat.co.th
https://setaasia.com/

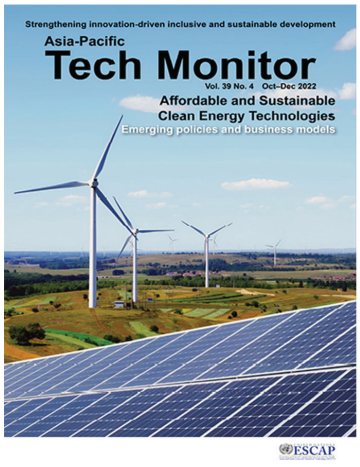
Oct 17–18 Okayama, Japan
The 9th International Conference on Low Carbon Asia
Contact: UTM Low Carbon Asia Research Centre, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia
Email: secretariat@iclcaconf.com
https://iclcaconf.com/

Oct 19–21 Ahmedabad, India
13th Asia-Pacific Innovation Conference (APIC 2023)
Contact:
Conference Secretariat
Email: apic2023@ctier.org
https://ahduni.edu.in/all-events/asia-pacific-innovation-conference-apic-2023/

Oct 27–29 Beijing, China
2023 4th Asia IoT Technologies Conference (AIOTT 2023)
Contact: Teri Zhang
Email: aiott_conf@yeah.net
http://www.aiott.net/

Oct 30–31 HCMC, Viet Nam
ASEAN Wind Energy 2023
Contact: Kathy Xi
Programme & Speakers Enquiries
Tel: +86 151 2112 8297
Email: Kathy@leader-associates.com
https://www.aseanwindenergy.com/

Nov 21–22 Manila, Philippines
ASEAN Clean Energy Week
Contact: Cheryl Yu
Tel: +86 137 9522 9971
Email: Cheryl@leader-associates.com
https://www.aseancleanenergyweek.com/



Oct-Dec 2022

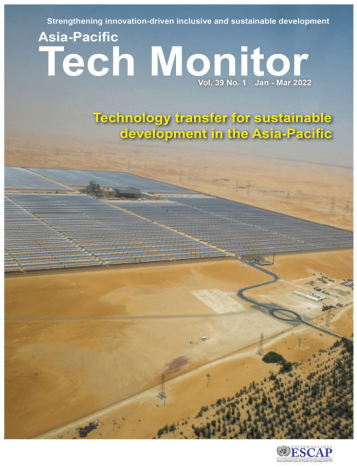
Affordable and Sustainable Clean Energy Technologies

Jul-Sep 2022

Regional cooperation for innovation and technology transfer

Apr-Jun 2022

Innovative technologies for air pollution control



Jan-Mar 2022

Technology transfer for sustainable development in the Asia-Pacific

The *Asia-Pacific Tech Monitor* has been the flagship periodical of APCTT since 1993. It is an online quarterly periodical featuring theme-based articles that provide trends in technology transfer and development, innovation and technology policies, market, data and analysis with respect to relevant issues, case studies, good practices and innovative technologies. Each issue of *Tech Monitor* focuses on a special theme and the articles are written by authors/experts of national and international repute. The periodical aims to enhance the technology intelligence of relevant stakeholders from member States of ESCAP to meet the challenges of today's dynamic business and technological setting.

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