

TECH-BASED ENTREPRENEURSHIP: DRIVING THE GREEN TRANSFORMATION IN ASEAN

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Abstract

The Association of Southeast Asian Nations (ASEAN) is at a critical juncture in its development: one of the most pressing issues is the imperative for a comprehensive and sustainable green transformation. An essential driving force behind the advancement of the circular economy and the green transformation in ASEAN is technological innovation, through the creations of green-tech startups and new ventures that create and operate environmentally sustainable business models and whose contribution combines social and economic development. Several promising examples are emerging across ASEAN. While creating opportunity for new green businesses is important, it is also necessary to enhance the building blocks of vibrant innovation and tech ecosystems for the green transformation, especially skills development and the removal of barriers to entry for under-represented groups, such as women green entrepreneurs, who lack equal access to STEM and technology jobs.

1. Why the Green Transformation Matters for ASEAN

The Association of Southeast Asian Nations (ASEAN) is at a critical juncture in its development, facing a unique set of challenges and opportunities in the 21st century. One of the most pressing issues that this diverse and dynamic region confronts is the imperative for a comprehensive and sustainable green transformation. ASEAN spans an area of immense ecological diversity and significance, comprising tropical rainforests, vital marine ecosystems, and abundant natural resources. These natural assets have not only shaped the region's unique biodiversity but also provided the foundation for its economic development. Agriculture, fisheries, and forestry are critical sectors, providing livelihoods for millions.

In recent decades, the region has experienced remarkable economic growth, lifting millions out of poverty and positioning itself as a global economic powerhouse (ASEAN Secretariat, 2021a; Kimura et al., 2019; Tonby, Choi, et al, 2019). Yet, this growth has come at a cost to the environment. Dependence on resource-intensive industries such as agriculture, mining, and manufacturing has put pressure on natural resources and ecosystems. ASEAN's rapid industrialization, urbanization, and increasing consumption have strained its ecosystems, heightened pollution levels, and exacerbated climate change impacts. If climate change is not addressed, it could result in a decrease of regional GDP by 11% by the year 2100, as well as the potential displacement of 87 million individuals residing in flood-prone areas in Indonesia, Malaysia, Myanmar, Thailand, and Vietnam (ASEAN Secretariat, 2019). In addition,

some of the major cities of ASEAN need to improve their environmental performance: for example, Jakarta, has topped the list as the world's most polluted city in August 2023, having consistently ranked among the 10 most polluted cities globally since May 2023, according to data by Swiss air quality technology company, IQAir. With a population of over 10 million, Jakarta's consistently high pollution levels pose a significant public health risk and highlight the urgent need for comprehensive measures to address air quality issues, as well as initiatives like the Nusantara Project to create a more sustainable and healthier urban environment for its citizens (Xu and Nadiman, 2022).

Regional Efforts towards a greener ASEAN and its challenges

Recognizing the urgency of these challenges, ASEAN has been steadily evolving its green policies and sustainability initiatives, striving to harmonize economic development with environmental preservation. In the past years, ASEAN has made progress to address challenges of climate change, for example via the development of an ASEAN Circular Economy Framework in 2021 (ASEAN Secretariat, 2021b). This strategy delineates five interconnected focal areas, which encompass the harmonization of standards and the mutual recognition of circular products and services, the facilitation of open trade for circular goods and services, the enhancement of green innovation, a focus on sustainable finance and investments guided by ESG (environmental, social, and governance) criteria, and the optimization of energy utilization. This strategy also explicitly acknowledges the role of technological innovation as a key driver of the green transformation, in particular through its strategic priority No 3 "Enhanced Role of Innovation, Digitalization and Emerging Technologies".

Many regional examples of these technological innovations are currently being developed. Developments in biodegradable materials, renewable energy sources and waste management solutions are simplifying the transition for businesses towards eco-friendly practices (Anbumozhi, Ramanathan et al., 2020). Some examples include the creation of biodegradable plastics using advanced biotechnology and materials science to transition from plastic to bioplastics and the use of Artificial Intelligence (AI) to automate waste sorting processes, increasing efficiency and reducing contamination in recycling streams. The rise of electric vehicles (EVs) is also gradually gaining momentum, with the ASEAN region poised to become a hub for both EV manufacturing and a significant consumer market (Schröder, Fusanori, et al., 2021). Technological advancements have enabled the production of more affordable and efficient EVs. For instance, in 2020, Thailand produced over 2,000 electric vehicles, a significant increase from previous years, and the number of EVs sold in the country has been steadily growing. To support the adoption of EVs, Thailand has invested in expanding its EV charging infrastructure. As of 2021, there were over 1,300 EV charging stations across the country, making it easier for EV owners to charge their vehicles conveniently (Thananusak et al., 2020).

Nevertheless, ASEAN still confronts a multitude of challenges to accelerate the green transformation. For instance, the region experiences high costs for renewable energy technology and needs up to US\$ 987 billion to achieve the short-term energy transition target in 2030 to achieve a net zero scenario in 2050 (IRENA & ACE, 2022). These high costs can be an important barrier to adoption, therefore innovations to accelerate investments in renewable power and upgrade e infrastructure, such as electricity networks and battery storage, is critical.

Other challenges towards green innovation and entrepreneurship are related to uneven access and connectivity. While urban areas often enjoy robust

connectivity, rural regions may lack adequate infrastructure. This digital divide hinders access to online education, market information, and networking opportunities for aspiring green entrepreneurs (Ajmane Marsan, 2022). ASEAN must continue to expand its investments in skills development, with a particular focus on rural and peripheral areas where skills are most lacking. Creating incubation and mentorship programs is essential for nurturing green entrepreneurship, which can be led by universities and government agencies and enterprises.

During the recent ASEAN Summit in September 2023, ASEAN leaders recognized the urgent need to strike a balance between economic growth and sustainable use of natural resources and protection of the environment. Making the most of this balance, in particular by making sure that the digital and green transformation reinforce and complement one another, is the challenge that ASEAN is confronted with. Especially as the digital economy of the region is growing at a very fast pace (according to some estimates, the digital economy could even account for 1 trillion USD by 2030 (Google et al 2021) and is progressing towards more integration in the digital space, for example through the initial negotiations of ASEAN Digital Economy Framework Agreement (DEFA) (Sefrina, 2023). In the journey towards this double transition, not only ASEAN governments but also ASEAN businesses have a major role to play.

2. The Importance of ASEAN Tech based entrepreneurs and consumers for the Green Transformation

The green transformation requires collective efforts by governments, citizens, and the business sector alike. Within business sector actors, tech-based green entrepreneurs have a pivotal role to play. Tech based green entrepreneurs are entrepreneurs who develop tech-based business models to develop greener products and services for ASEAN consumers (Ajmane

Marsan, Sabrina & Ooi, 2021). They create and operate environmentally sustainable businesses whose contribution combines social and economic development. By creating jobs and promoting sustainable practices, green entrepreneurs allow a long-term impact for both local society and economic growth (Ajmane Marsan and Singh, 2023).

One important (but often overlooked) driver of the shift toward sustainability in ASEAN arises from the increasing awareness of environmental concerns among both consumers and enterprises. Millennials and Generation Z are emerging as increasingly significant consumer demographics within the ASEAN region and are projected to account for roughly 75% of the total consumers by 2030 (WEF, 2023). These younger and tech-savvy demographics are starting to acknowledge the enduring economic advantages associated with embracing sustainable practices, while at the same time being comfortable with digital technologies, and therefore driving the growing demand for products that are sourced and manufactured sustainably.

3. Investment opportunities are growing for ASEAN green tech startups

According to the ASEAN Investment Report 2022, the number of start-ups in ASEAN that have raised more than \$1 million in funding almost tripled between 2015 and 2021. Three ASEAN Member States combined (Singapore, Indonesia and Malaysia) account for 83 per cent of start-ups that have raised more than \$1 million in funding in the region. However, other ASEAN Member States are also witnessing fast growth (Viet Nam, Philippines and Thailand especially).

Investors have started to recognize opportunities emerging in the green tech space, with more than \$1 billion in capital invested in green technology companies by 2020 (ASEAN Investment Report, 2022). Investments in the renewable energy sector witnessed the largest increase in

investments. This sector together with the construction industry accounted for 75% of international project finance activities in 2021. EV is another area that witnessed one of the fastest growth in investments.

Despite this growth, there is still significant room for more investments in green tech startups across ASEAN, with sectors like forest conservation still relatively under-invested but growing especially in Indonesia and Malaysia (Bain and Temasek 2022). Another example of the remaining growth potential of investments in green tech startups is given by the fact that of the 100 most funded startups in ASEAN, only 3% were active in the clean energy sector for example (ASEAN Investment Report 2022).

Moreover, according to a recent report by the Asian Development Bank (ADB 2022), a capital investment of 172 billion USD in the green transformation in Southeast Asia, could generate up to 30 million jobs and significantly contribute to achieve SDGs targets. In particular, the study identifies five areas that are particularly promising: i) clean energy transition; ii) circular economy models; iii) healthy and productive oceans; iv) sustainable urban development and transport models and v) productive and regenerative agriculture.

Another sector that is particularly promising is smart farming and agrotech, which is seen as an effective way to raise production and increase efficiencies in less developed rural areas (Statistica, 2022; Litania and Singh, 2022). For instance, in Vietnam, the startup known as Mimosatek has harnessed the power of technology to address crucial agricultural challenges. Through the implementation of a cloud-enabled device equipped with sensors, this innovative startup has provided farmers with a transformative tool to monitor the growth of their crops and receive real-time alerts about drought conditions. Following a successful pilot program, Mimosatek's technology is now poised for broader implementation throughout the Mekong Delta, a region of significant agricultural importance in Vietnam. This expansion promises to empower more

farmers, enhance agricultural productivity, and mitigate the risks associated with drought, ultimately contributing to food security and economic stability (ASEAN Investment Report, 2023).

4. Interesting tech-startups solutions are emerging in ASEAN

Thanks to the enabling factors described above (from favorable demographic trends to investment flows), numerous promising tech startups are emerging to address a wide range of challenges in climate change and green tech. These startups are not only driving economic growth but also contributing to the region's green transformation, social progress, and digital revolution and contributing to the transition towards an ASEAN knowledge economy. The next sub-section present examples of tech-based green startups from different ASEAN countries, operating across the spectrum of green technology fields: from renewable energies to electric vehicles, smart grid, agri-food tech, and digital tech & plastic-free logistics.

4.1 Innovative Renewable Energy Solutions

One of the foremost areas where technology is catalyzing the green transformation in ASEAN is the energy sector. Startups and entrepreneurs are harnessing cutting-edge technologies to accelerate the adoption of renewable energy sources (G20 Digital Innovation Network, 2022). Solar, wind, and hydropower technologies are being deployed with greater efficiency and cost-effectiveness, significantly reducing the region's reliance on fossil fuels. Advancements in solar panel efficiency, energy storage solutions such as Carbon Capture Utilization and Storage (CCUS), and grid integration technologies are making energy sources more reliable and accessible (Afifi, F., Venkatachalam, et. al., 2023). As a result, ASEAN countries are experiencing a notable shift towards sustainable power generation, a critical step in reducing greenhouse gas emissions and mitigating climate change.

Xurya Daya (Indonesia)

This Indonesian renewable energy startup is pioneering the method of switching to solar through design, installations, operations and maintenance of rooftop solar power plants with a lease scheme ("zero-down method") that offers more flexibility and affordability for a company looking to move to renewable energy option. It has installed more than 133 solar roof projects in diversified industries in multiple areas of Indonesia.

Source: <https://xurya.com/en/>



4.2 EV adoption

With a growing urban population, the role of these startups in shaping the future of transportation becomes increasingly vital for fostering livable and sustainable cities in ASEAN. In 2023, ASEAN leaders issued a declaration aimed at cultivating a regional EV ecosystem, showcasing their political commitment to developing the region's EV supply chain and positioning it as a global EV manufacturing hub. However, there are several challenges that are still need to be address including higher costs compared to conventional vehicles and charging infrastructure readiness (Nugroho, 2023).

Etran (Thailand)

Start-up developer of clean energy electric vehicle provides products including EV motorcycle that for food delivery and power stations across Bangkok, providing more than 1000 motorcycles for rent and ownership since 2021. The company also innovates Thailand's first EV motorcycle design for food delivery.

Source: <https://www.etrangroup.com/en/>



4.3 Digital Platforms for Sustainability

Digital platforms and e-commerce are pivotal in promoting sustainable consumer choices. Tech-based entrepreneurship in ASEAN has given rise to online marketplaces and apps that facilitate the discovery and purchase of eco-friendly products. These platforms provide consumers with information about product origins, certifications, and sustainability ratings, empowering them to make green choices. Additionally, influencers and content creators on social media are leveraging their digital presence to advocate for sustainability, further amplifying the impact of tech-based initiatives in promoting eco-conscious consumer behavior (ASEAN Consumer, 2022).

Grocerdel (Cambodia)

Cambodia online supermarket that connects local, small farmers for the consumers, and promotes the sustainable agriculture products. Grocerdel offers multiple options of the high-quality agriculture products with delivery service to the costumers. Founded 2019, Grocerdel offers more than 2,000 products through its website and app. The company has made farm-to-fork possible by working with more than 300 farmers across Cambodia and leveraging technology to improve the service offerings as the company grows.

Source: <https://grocerdel.asia/>



4.4 Agriculture and Food Technology

In the agricultural sector, technology is driving entrepreneurship focused on sustainable farming practices. Precision agriculture, IoT-enabled farming, and data-driven decision-making are enhancing crop yields while minimizing resource use. Startups are developing innovative agricultural technologies that reduce water consumption, minimize chemical inputs, and promote soil health (Litania and Singh, 2022). Moreover, food technology has been growing in recent years, with ASEAN countries especially Singapore, leading the innovation, research, and development for alternative food consumption and products (Hui, 2022). In 2019, US\$423 million was invested in Southeast Asia's agri-food tech (Ellis, 2020).

Urban Tiller (Singapore)

The world's first and only B2B leaf protein company from Singapore, with a mission to accelerate the adoption of plant-based foods by supplying novel ingredient Rubisco (one of the most abundant and sustainable form of protein available in green leaves). By leveraging alternative protein products, Urban Tiller continues to bring innovation and technology to create new sources of value for its partner farms.

Source: <https://urbantiller.sg/home>



4.5 Smart Grids and Energy Efficiency

Tech-driven innovation extends to the development of smart grids and energy-efficient solutions. Some of the solutions include smart meters, sensors, and data analytics to optimize energy distribution, reduce transmission losses, and

empower consumers to make informed decisions about their energy consumption. These innovations not only enhance the reliability of the energy supply but also contribute to a more efficient utilization of resources. Smart buildings and eco-friendly urban planning are becoming prevalent, promoting energy conservation and sustainability in rapidly urbanizing ASEAN cities and often are aimed at the rural communities (Kimura et al., 2022)

Smart Grid (Indonesia)

Smart Grid technology has been installed in Java-Bali from 2020 (targeting 25 smart grid system by 2024) to increase energy efficiency and better utilization of renewable energy to reduce CO2 emission. The main features of the smart grid include innovative design of floating solar photovoltaic (PV) power plans, combined with the existing hydropower plant.

Source: <https://opengovasia.com/smart-grid-systems-to-power-indonesia/>



5. The Way Forward towards Green Tech Entrepreneurship in ASEAN

ASEAN is still at the beginning of its journey towards the green transformation and the transition into a knowledge economy. ASEAN tech-based green startups can provide a major contribution. While promising developments are happening, for entrepreneurs and startups to flourish, grow and scale-up, it is necessary to further develop innovation ecosystems across the region. In particular, two building blocks of green-tech entrepreneurship need particular attention: skills development and inclusive innovation.

Nurturing Skills and Tech Talent for Green Entrepreneurship

Globally, there is an increasing demand for skills related to the green economy. According to LinkedIn Green Skills Report 2022, the number of green talents in the workforce has increased by more than 38% since 2015, with entrepreneurs driving green skills globally (for instance, every 2 out of 100 entrepreneurs in India are categorized as “highly skilled in green”) (LinkedIn Economic Graph, 2022). Green entrepreneurship combined with technology therefore has emerged as a powerful avenue to support this positive change. However, nurturing, upskilling and re-skilling talents for green entrepreneurship comes with its unique set of challenges and imperatives in ASEAN.

Education and skills development, especially with a focus on creating a talent pool, that is equipped to excel in technology and creativity-driven industries, remain a challenge. The enrolment rate in higher education across the ASEAN region is lower, on average, compared to other countries in the Asia Pacific, and so is the quality of universities and higher education institutions (aside from Singapore) (Ajmone Marsan, 2022). Countries such as Malaysia and Vietnam, have begun to boost their investment in education and are giving significant priority to technology and innovation within higher education. However, worries about graduate employment and skill mismatch, particularly the shortage of STEM graduates, continue to persist (ASEAN Secretariat-SHARE, 2023).

To advance both green entrepreneurship and tech talents, it is essential to ensure access to relevant education and training. Green entrepreneurs need to acquire expertise and proficiencies in sustainable methodologies and technologies, and this can be achieved through specialized educational initiatives or mainstreaming green skills in Technical and Vocational Education Training (TVET). Including green skill components in all training programs and offering specialized green technology courses in addition to the traditional ones,

would enhance graduates’ work opportunities (ASEAN Secretariat-ILO, 2021). For example, these strategies are currently being developed or implemented in Cambodia (through the National Technical Vocational Education and Training Policy 2017-2025) and the Philippines (through the Green Jobs Act 2016). Moreover, under the coordination of ASEAN Ministries of Labor, coordination mechanisms exist to support green jobs development at regional level.¹

Inclusive Transition in Green Transformation

The transition to a green economy is not just a technological shift; it is a societal transformation that must be underpinned by inclusivity and equality. Without inclusive strategies, there is a risk of encountering resistance, particularly from groups that fear job loss and worsening economic conditions. Such resistance could place significant pressure on governments to slow down or halt green initiatives altogether (Ajmone Marsan, 2022).

Some groups of individuals face substantial disparities and challenges.

Women, in particular, continue to face barriers to access (Ajmone Marsan and Sey 2021). Firstly, when it comes to entrepreneurship opportunities, women often encounter barriers that limit their entry into the world of business ownership, including those in the green sector. Across ASEAN, according to the Global Entrepreneurship Monitor (GEM) data, in the six countries covered (Philippines, Indonesia, Viet Nam, Thailand, Malaysia and Singapore), women are less likely to have an established business and when going into entrepreneurship are more driven by necessity rather than opportunity when compared to men. The situation remains similar when looking specifically at sectors related to energy and the green transition. For instance, women’s representation on energy company boards in Southeast Asia is below 50%, ranging from 10.7% in Thailand to 29.7% in Vietnam (Han et al., 2022). Access to capital remains a barrier for

women entrepreneurs in ASEAN. According to the latest World Economic Forum ASEAN Survey (WEF 2022)², only 22% of women (compared to 28% of men) receive credit from commercial banks when in need of loans.

Additionally, women have traditionally been underrepresented in STEM fields (Science, Technology, Engineering, and Mathematics), which are pivotal in driving green tech entrepreneurship (Ajmone Marsan and Singh, 2023). This gender gap in STEM skills further exacerbates the challenges women face in pursuing careers in environmentally-focused industries.

Furthermore, women’s access to leadership positions remains limited across the ASEAN region, with men predominantly occupying these roles. This lack of representation not only perpetuates gender disparities but also hinders the diverse perspectives and innovative ideas that women can bring to the green economy (Ajmone Marsan and Sey, 2021).

On the business demographic front, micro, small, and medium-sized enterprises (MSMEs) represent a significant portion of the ASEAN economy. However, these smaller enterprises tend to invest in and adopt digital technology at a considerably lower rate compared to their larger counterparts. This digital divide within the business community can be a significant impediment to women’s participation in the green economy transition (Ajmone Marsan and Ruddy, 2020).

Promoting gender equality within the realm of green entrepreneurship is not just a matter of social justice; it is a strategic imperative. Research consistently indicates that women entrepreneurs often prioritize social and environmental outcomes in their businesses (Ajmone Marsan, Sabrina & Ooi, 2021). Harnessing this orientation toward sustainability can greatly contribute to the success and impact of green ventures. Moreover, governments should actively engage in efforts to dismantle barriers and biases that hinder the

¹ Final-Adopted-ASEAN-Labour-Ministers-Joint-Statement-on-Green-Initiative....pdf

² New ASEAN Survey: Digitalization Advances Financial Inclusion for Women and Micro Business Owners but More Is Needed > Press releases | World Economic Forum (weforum.org)

participation of women and other marginalized groups in the green economy. This includes implementing gender-sensitive policies, providing funding and support for women-owned businesses, and actively promoting the representation of women and underrepresented groups in leadership roles within the green sector (Ajmone Marsan and Singh, 2023).

Inclusivity within the green economy must also extend to other underrepresented groups, including ethnic minorities and individuals with disabilities. These groups often face unique challenges in accessing green jobs and entrepreneurial opportunities, and policy measures should be devised to address these disparities. Such policies should create an enabling environment that not only encourages the growth of green jobs and enterprises but also actively promotes inclusivity for underrepresented groups.

6. Conclusion

In conclusion, the ASEAN region stands at a pivotal juncture in its pursuit of a comprehensive and sustainable green transformation. This transformation is propelled by the dynamic synergy of technology-driven entrepreneurship, serving as a beacon of hope in addressing the pressing environmental challenges of the 21st century. The adoption of innovative green technologies by startups and entrepreneurs has emerged as a potent catalyst for change, reshaping the economic landscape while promoting sustainable practices. These green entrepreneurs are not only generating jobs but also driving societal and economic development, to place ASEAN on a sustainable path.

As technology-driven startups and entrepreneurs continue to lead the charge towards a greener future, they are forging a transformative alliance with sustainability. Their endeavors are aligning economic growth with environmental preservation, driving progress in areas like renewable energy, circular economy practices, and sustainable agriculture. In this dynamic landscape, education, skills development, and women inclusion remain pivotal imperatives, ensuring that

the benefits of the green transformation are accessible to all segments of society.

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