ASIA HOUSE **RESEARCH**

ASIA'S DOUBLE ACT:
MANAGING ENERGY TRANSITION AND DIGITAL INNOVATION

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CONTENTS

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EXECUTIVE SUMMARY

Battling climate change constitutes a serious dilemma for policy makers, who face the challenge of mitigating its long-term consequences while still supporting economic growth in the short and medium term. This is felt more acutely in emerging economies, hard hit by the COVID-19 pandemic. Crucially, digital technologies have the potential to reduce global emissions by about two-thirds, according to the IPCC.

Digitalisation facilitates both climate change mitigation (reducing GHG and CO2 emissions) and climate change adaptation. In Asia in particular, the advent of the fourth industrial revolution has seen the increased application of digitalisation in agriculture and finance, which has notably increased climate resilience and domestic energy transitions.

Challenges remain in several of Asia's economies, including around food and water security, improving power infrastructure, and mobilising adequate finance to facilitate energy transition. This paper examines some of the key digital pathways on a country-by-country basis to overcome climate challenges and to optimise the opportunities offered by digitalisation in support of climate change adaptation.

KEY TAKEAWAYS

- Digital technologies have the potential to reduce global emissions significantly and to facilitate underlying resilience to climate change shocks.
- Asia's technological opportunities and challenges around the fourth industrial revolution are crucial for effective early warning and emergency response systems.
- The financial, agricultural and energy sectors constitute key pathways through which digital innovation will impact Asia's energy transitions.
- As economies recover from the COVID-19 pandemic, a policy emphasis on sustainability and innovation will drive stronger inward investment to build greater climate resilience.
- China's data-driven innovation will be essential; Indonesia has advanced in Agritech and FinTech, Vietnam has fostered catalytic investments and India's coal-dependence carries risks for its transition.
- There remains huge potential, particularly in Asia, to scale up existing technologies through business model innovation.
- Mobilising larger-scale funding and FinTech for climate-resilient infrastructural development remains one of developing Asia's biggest obstacles.

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1. INTRODUCTION

DIGITAL TRANSFORMATION AS A CATALYST FOR ENERGY TRANSITION

The scientific community continues to warn of a climate emergency (Ripple et al., 2020; Ripple et al 2017). Climate change has been closely linked to excessive consumption in both advanced and developing economies. This constitutes a challenging trade-off for policy makers, who are tasked with mitigating the consequences of climate change and supporting economic growth. Some estimates, such as that of the Intergovernmental Panel on Climate Change (IPCC) P4 pathway, show that digital technologies have the potential to reduce global emissions by about two-thirds (de Coninck et. al., 2018).

Digitalisation is crucial in that it can facilitate an operation which is data driven, intelligent, secure, inter-connected, automated and cost-effective. It encompasses the use of data science/analytics and other digital technologies (Greenstein, 2020). Sector-specific digital transformation is offering new decentralised pathways for unlocking innovation, providing new opportunities to workers, decarbonising and producing more economic output at lower cost. Digital technologies have the potential to enable a 20 per cent reduction of global CO2 emissions by 2030 (DigitalEurope 2020).

Digitalisation facilitates both climate change mitigation (reducing emissions) and climate change adaptation (UNFCCC, 2020). Digitalisation is a key enabler of sustainable development of cities' socio-economic dynamics with the potential to foster climate-friendly urban and rural environments. The advent of the fourth industrial revolution has seen the increased application of digitalisation in several sectors. High-tech digital devices, platforms and ecosystems are increasingly being deployed to enhance productivity, efficiency and sustainability, and improve overall well-being of urban dwellers (Balogun et al., 2020).

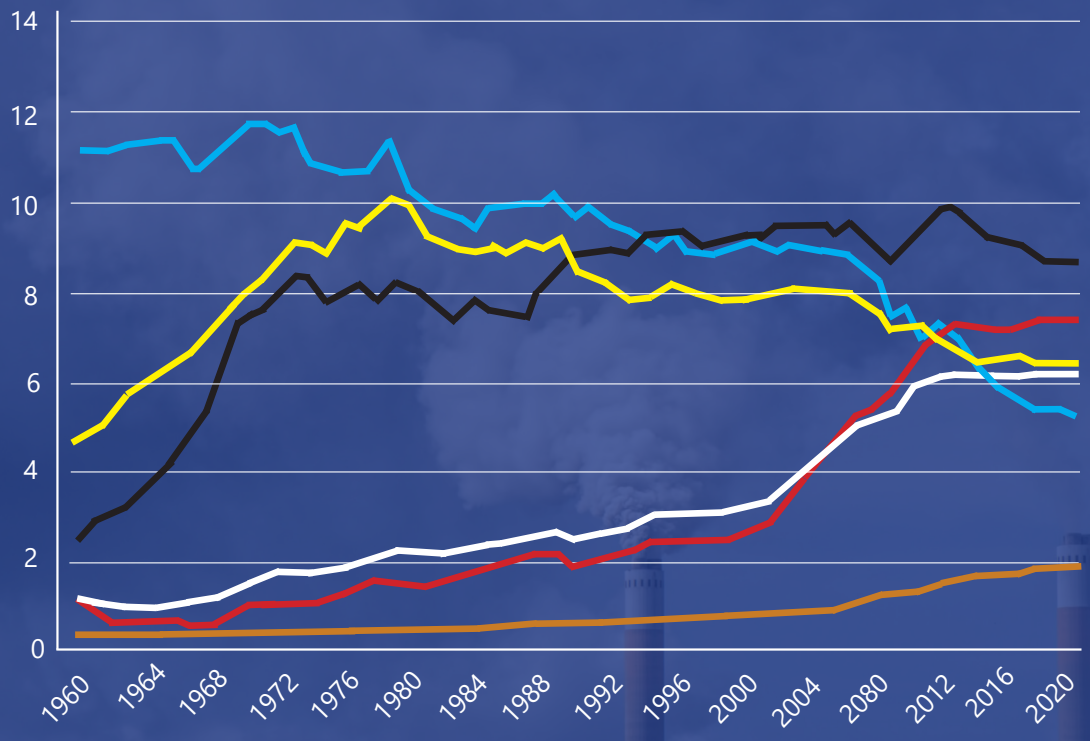
Digitalisation can provide more effective early warning and emergency response systems, enhancing food and water security, improving power infrastructure performance, enabling citizen engagement and participatory adaptation measures and minimizing the impacts of climate hazards. This paper examines some of the key digital pathways to overcome present climate risks and challenges in order to optimise the opportunities offered by digitalisation in support of climate change commitments.

1.1 THE IMPORTANCE OF DIGITAL TRANSFORMATION IN ASIA

Asia has seen a significant increase in per-capita emissions of CO2 (Figure 1). Digital transformation for Asia's climate commitments is twofold: first, their growth models have been resource and carbon intensive (Anwar et al., 2020); second, Asia's economies are more vulnerable to climate risk (Dabla-Norris et al., 2021, Prakash 2018). Although the carbon intensity of economic output has declined substantially in most developing Asian economies over the last decades, Thailand and Vietnam are notable exceptions. And regional carbon intensity is higher than in advanced economies outside of the region, according to World Bank data. Myanmar, the Philippines, Bangladesh, Vietnam and Thailand have been particularly affected by climate change.

ASEAN faces increases in temperatures and rising greenhouse gas (GHG) emissions. Since the 1960s, ASEAN has experienced a cumulative temperature increase of between 0.3 – 1.1 degrees Celsius (Anwar et al., 2020). Geographical and demographic factors, as well as dependence on the agricultural sector, natural resources and forestry for growth, account for ASEAN's acute vulnerability to extreme weather events. It experienced 217 storms and cyclones, and 236 cases of severe flooding, between 2014 and 2017, according to United Nations data. If climate change continues unmitigated, it could cost between US$2.8 trillion and US$4.7 trillion of Asia's annual GDP by 2050, according to the McKinsey Global Institute. The costs could be significantly higher with international spill-over effects.

Figure 1: **Asia's carbon emissions have accelerated**



Source: World Bank and Asia House Research. Emissions are in metric tonnes per capita. Data for 2020 are Asia House estimates.

ASIA HOUSE **RESEARCH**

1.2. KEY PATHWAYS BETWEEN DIGITALISATION AND CLIMATE CHANGE

There are multiple economic and financial pathways through which climate change, and the need for climate resilience, is felt. They include:

- **The widening investment gap in climate-resilient infrastructure.** The gap in developing Asia has been estimated at US$26.2 trillion between 2016 and 2030 or US$1.7 trillion annually (Ra and Li, 2018). Of the US$26.2 trillion that needs to be invested by the Asian Development Bank's (ADB) 45 developing member countries, US$3.6 trillion is specifically required for climate change mitigation and adaption costs (ibid). For South East Asia, an annual US$110 billion will be needed for infrastructure investment in power, transport, ICT, and water and sanitation through 2025, according to ASEAN.
- **Global warming reduces productivity and potential growth.** Climate change can be viewed as a series of real autocorrelated negative supply shocks (Economides and Xepapadeas, 2018). Each of these supply shocks will likely lead to a contraction in each economy's productive capacity, generating higher prices and diminishing growth rates. The more persistent these shocks are, the higher the chances that they will lead to a permanent reduction of potential output. Productivity miscalculations could inadvertently lead to misguided policy (Batten et al., 2019).

- **Transition risks can materialise through multiple economic pathways.** Carbon pricing may lead to permanently higher prices for carbon-intensive goods and lower output, depending in part on how revenue and profits from carbon taxes are used (McKibbin et al., 2017); the impact of the pricing also depends on the time horizon and the strategy employed to move to a low carbon economy (ibid). Transition risks also affect the financial sector and central bank balance sheets given exposure to stranded assets (Caldecott et al., 2016).

- **Physical risks** from climate change could cause underlying and long-lasting distortions in asset prices. These distortions arise from the direct impact of weather events such as floods to properties, infrastructure damage and crop failures. They materialise into liability risks for compensation claims and litigation, leading to financial costs. Global asset managers, with a multi decade time horizon, are focused on understanding how companies are planning to adapt to the physical risks of climate change.

- **Income shocks** from climate change are increasingly prevalent for households and businesses; this has a knock-on impact on financial institutions and banks through rising loan delinquencies, which then reduces credit availability for SMEs. Rising credit risk may also result in tightening credit conditions as financial institutions protect their balance sheets from bad loans. Access to liquidity from the money market may also be constrained as some banks may be perceived to have higher counterparty risks due to climate change (BIS, 2021).

Digital transformation and innovative technologies can circumvent the resource-intensive processes and support energy transition. Examples of this include:

- **Digital technology can help close the infrastructural investment gap** for climate resilience and sustainability. Digital platforms can facilitate a higher level of investment to fuel energy transition and build climate resilience (UN Environment, 2019). This would transform risk and liquidity through the pooling of investments and create efficient settlement technology, through creating digital financial assets built on distributed financial technologies (Schulz and Feist, 2021). This would help close the gap for climate-resilient infrastructure.

- **Digitalisation can safeguard and improve productivity,** enhancing climate resilient production methods and improving capacity to act. Automating and maximizing the efficiency of processes in agriculture, industry and manufacturing could make a large contribution to this effort. For example, increased automation and connectivity (such as AT&T optimising Emerson's industrial food grinders to convert commercial food waste into electricity, heat and fertilizer) has helped not only to reduce GHG emissions, but to produce low carbon energy.[1]

- **Digital technology can help protect against transition risks.** The Paris Agreement's objective effectively requires that more than 80 per cent of all proven fossil fuel reserves become stranded resources, and investments in such resources may become stranded assets particularly in industrialised and developing countries (Bos and Gupta, 2019). The concept of stranded assets has moved from the electricity sector to multiple energy sectors; digitally enabling divestment will mitigate the risk and magnitude of stranded assets (OECD 2015).

- **Digital technology can help minimise physical risks.** AI has the potential to help reduce global GHG emissions by four per cent in 2030 (PWC, 2019). Within the AI for Earth scheme, Microsoft is providing organisations working on climate change their suite of AI and cloud tools: Terrafuse has partnered with Microsoft to create sophisticated models (built on Microsoft's cloud computing service Azure, historical fire data, and real-time satellite observations at a local level) to mitigate climate-induced wildfires. It combines satellite imagery with machine learning to assess forests more precisely. Data collected can help conservationists and landowners improve species habitats and promote sustainable harvesting (UNDP, 2014).

- **Digitalisation can boost income resilience in the face of climate change loss.** Digitalisation shows promise in addressing climate challenges, and the associated economic shocks and long-term impacts, in the agriculture and food sectors. Climate-related shocks and income loss in the agricultural and food sectors have close and long-established links (Arora, 2019). Improvements in primary production, supply chain and logistics performance, and digitally optimised use of scarce natural resources (notably water) could be significant with new technologies. Adoption of digital agriculture is at an early stage, generally led by high-value agricultural production. (Bahn et al., 2021).

2. TAKING STOCK OF ASIA'S PROGRESS

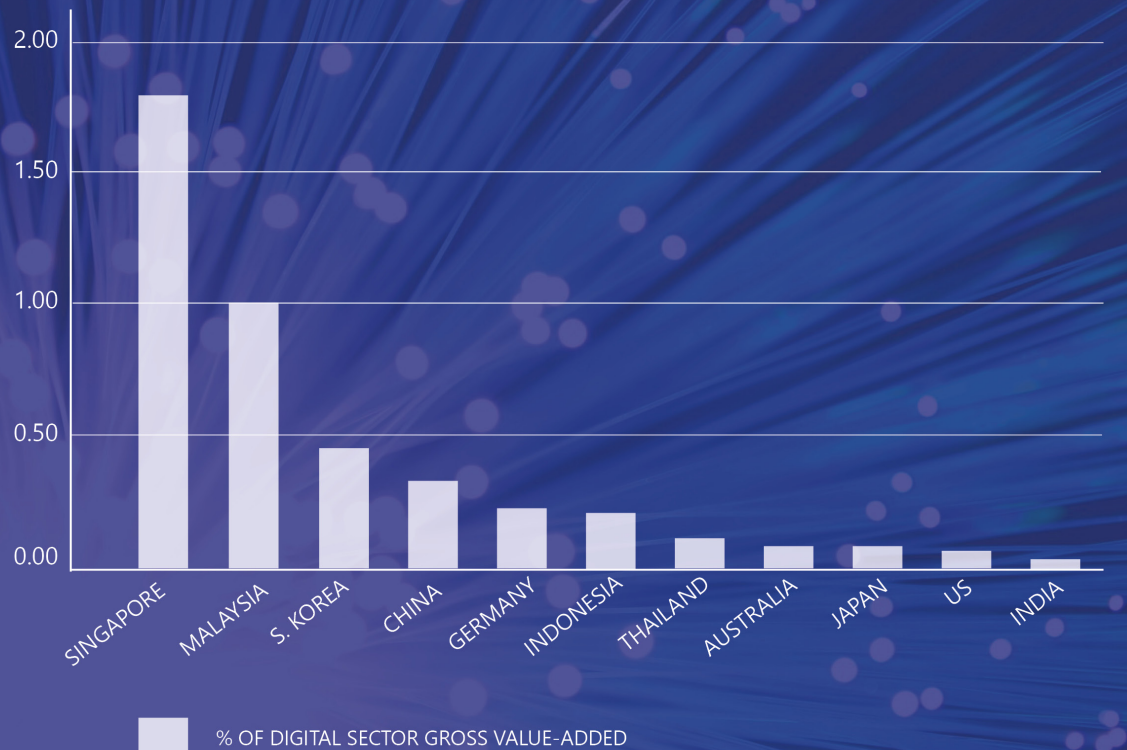
Digital innovation, and sector-specific digitalisation, are crucial to transforming Asia's energy systems in order to meet carbon reduction targets and to achieving sustainable and resilient economic growth in the longer-term. Digital technology in its various forms – digital assets, data algorithms and AI – help the private sector and government build new products and services that will spur energy transition.

2.1. DIGITALISATION IN ASIA'S FINANCIAL, ENERGY AND AGRICULTURAL SECTORS

Finance is pivotal for energy transition (Pathania and Bose, 2014). Green finance [2] is driven by investment and lending decisions taken that are based on environmental screening, sustainability standards, and insurance services that cover climate risk. Funds for green finance will need to come from both the private and public sectors, both domestically and from cross-border sources. For instance, digital imports remain comparatively low as a share of Asia's economies (Figure 2). Digital blended finance facilities will be instrumental in de-risking and facilitating finance towards climate change initiatives; this will facilitate the financing of sustainable infrastructure. Crucially, new financial instruments that are decentralised and adapted to local climate circumstances are emerging. Green bonds and green quantitative easing (QE)[3] are key at a macroeconomic level.

The digitalisation of energy systems is essential: the complexity and scale of integrating multiple technologies and solutions to reach net zero emissions is predicted on the digitalisation of the energy system (IEA, 2017). In particular, better data,

Figure 2: **Imports of digital sectors (2019)**



Source: ADB (2021a)

ASIA HOUSE **RESEARCH**

open data sharing, effective system planning and increased distributed technology are needed at both national and regional levels. Better data helps inform consumer decisions at an individual level through personal energy consumption choices; it also facilitates planning investments in generation assets and in network upgrades (Davis and Metcalf, 2016). Data [4] is key to optimising outcomes entailing lowest emissions, and best cost to both producers and consumers.

Within the energy market, blockchain (and distributed ledger technology (DLT) more broadly) has been beneficial. DLT offers disintermediation, transparency and tamper-proof transactions. Crucially, it can offer innovative solutions for empowering consumers and small renewable generators to play a more active role in the energy market, and to monetise their renewable assets (Andoni et al., 2017). DLT has, for example, enabled sharing economy applications in the energy sector, prompting novel market models of energy democratisation (Gourisetti, 2017). Blockchain technologies and broader blockchain ecosystems allow scalability, decentralisation and security while also enabling energy companies to be disruptive in creating new solutions for a variety of climate challenges.

Within the agriculture sector, ICT can provide a wide range of benefits for small-scale farmers. In the Asia-Pacific region, the use of ICT and digital technology has been increasing steadily; this has also been the case across rural areas for the past two decades (Brett and Kherallah, 2021). The benefits include an increase in yields, the adoption of locally suited seeds and fertilizers, electronic trade mechanisms that ensure sale of produce at the best possible price and increased food security through timely data.

Additionally, weather monitoring, the use of AI for improved pest control, as well as tools allowing optimised management of natural resources and early warning of food-security threats stemming from climate change are instrumental. And yet, access to these technologies remains one of the biggest challenges to widespread adoption, giving rise, in part, to a global divide in data-driven farming (Mehrabi et. al., 2021).

2.2. CHINA: DATA-DRIVEN INNOVATIONS WILL DRIVE 2060 COMMITMENTS

China's per capita carbon dioxide emissions have exceeded both the US and the EU combined for some time. Digital innovation continues to be critically important in delivering on the government's aim to reduce carbon intensity. In his speech to the UN General Assembly on September 22, 2020, President Xi Jinping stated that China will scale up its Nationally Determined Contribution for tackling climate change, and that China would adopt more vigorous economic and regulatory policies to reduce carbon dioxide emissions and to reach carbon neutrality by 2060.

China's key adaptation technologies have included forecast and pre-warning technology for extreme weather events, drought-ridden region water resource exploration, high-efficiency water utilization, drought-resistant and high-temperature-resistant plant selection and cultivation, and pest-prevention technology (Liu et. al., 2018). Additionally, climate-sensitive ecosystem protection, remediation technology, climate change impact and risk assessment technology are integral to China's agricultural infrastructure. Coastal land adaptation technology and city lifeline engineering ensure that there is a technological safety net in response to extreme weather events (ibid).

One example of China's decentralised FinTech is evident in the initiatives taken by Ant Financial, the mobile payment company. It is using digital finance innovatively to help tackle climate change by allowing the platform's 520 million users to record their daily carbon emissions (calculating, for example, whether they walk or drive to a destination, or pay a bill online instead of travelling to an office to do so). The saved energy is turned into a virtual tree, which grows as carbon is saved. When the tree reaches a certain size, Ant's partners plant real trees in the desert. [5]

Alibaba Cloud[6] uses technology to monitor real-time traffic patterns which helps save fuel by ensuring that cars do not remain idle. In Beijing, a low-cost sensor network has been installed to obtain microlevel data on air pollution – an area of collaboration between the US and China. Blockchain technology, used by a number of China's digital firms, can also facilitate the usage of smart contracts to enable increased transparency. For example, new data sources on blockchain technology can now be sourced from the sharing of geographic information or positioning data, which can shed light on deforestation or air pollutant emissions (Stock and Guesgen, 2016).

2.3. JAPAN: NEXT GENERATION SOLAR TECHNOLOGY A DRIVING FORCE

Japan has announced its commitment to a 46 per cent reduction in GHG emissions by 2030 from 2013 levels and has also pledged that it will be carbon neutral by 2050.[7] Japan's Global Zero Emission Research Center (GZR), established by the National Institute of Advanced Industrial Science and Technology in January 2020, plays a core role and drives accelerated research in zero-emission technology.

Japan's long-term climate commitments are predicated on its ability to utilise FinTech to deliver greater green finance and transition finance. Japan's commitment to green bonds has made it the second largest issuer in the Asian Pacific region (following China) and the 10th largest in the world. The Japanese Ministry of the Environment subsidises companies and local municipalities that require support in raising green finance (Green Digital Finance Alliance, 2020). Although green bonds finance Japan's green start-up projects, it needs more in the way of transition bonds to help decarbonise 'brown' businesses and to finance carbon capture-and-storage (ibid).

Japan's digitalisation has sparked a new economic paradigm for its businesses using renewable energy, including through cloud technology and AI (Bank of Japan, 2021). Japan leads in the field of next-generation solar cells; it has facilitated the production of ultra-lightweight solar panels. The GZR has also built multi-junction solar cells consisting of layered materials, which enable more power generation in smaller spaces. This innovation has been able to facilitate installation in locations where conventional solar cells are not feasible. The innovation is expected to have an even wider range of usage, including its installation in vehicles and stand-alone sensors.

Under the Panasonic Environment Vision 2050, the firm is working to create factories with zero CO2 emissions and to develop energy-saving products during production. Its strategy is underpinned by the development of photovoltaic power generation, storage batteries, and the use of hydrogen energy.[8] In addition to this, has seen significant infrastructural innovations which has been spearheaded by both the public and private sectors: the construction of the world's first hydrogen supply chain from Brunei Darussalam to Japan (Kawasaki's coastal region) is a ground-breaking step towards zero-emissions (Kumagai, 2020).

The Japanese government wants to use data visualization strategically to accelerate decarbonisation. Part of this strategy involves positioning itself as a leader in climate-related financial disclosure; and here, data visualisation is has been pinpointed as a key tool. Japan has developed the world's first platform to enable side-by-side comparison of different companies' climate-related information.[9] Data visualisation is effectively employed to attract and channel inward investment into sustainable companies.

2.4. INDIA: TRANSITION AND PHYSICAL RISKS ELEVATED BY COAL DEPENDENCE

Under the Paris Agreement, India has committed to cut the GHG emissions intensity of its gross domestic product to 35 per cent by 2030 and to increase non-fossil fuel power capacity to 40 per cent, from 28 per cent in 2015 (Sharma, 2021). Prime Minister Modi has stated that India-US cooperation on financing innovation, to expedite the deployment of green technologies, is crucial to its climate goals.

India's economy is highly dependent on coal and its government has, as a consequence, aimed to target the power sector: coal powers over 70 per cent of India's electricity demand. With the easing of COVID-19 lockdown restrictions leading to higher demand, India's government has encouraged further coal production; it has also urged the import of coal as a stop-gap measure to meet demand (Varadhan, 2021) – a policy that stands in contrast to its longer-term green recovery. The government's strategy of partnering with General Electric to raise mine productivity and efficiency (The Hindu, 2021), including through the use of data science and digital sensors, is aimed at its net zero commitments but is likely to be insufficient in isolation.[10]

India's green finance sector is dominated by debt (project and corporate finance) and accounts for 54 per cent of the country's total green finance (Sinha, 2020). More than 85 per cent of its debt is linked to the power sector, with solar power comprising an approximate 50 per cent share (ibid). India's government must look to boost digitalisation further; and in particular, to find new and unconventional financing mechanisms for its energy transition, particularly through scaling up investments. India's blended finance market has been growing (Merchant, 2021). With increasing policy recognition that collaboration between public, private, and philanthropic capital is critical, digital platforms to foster forms of blended finance will be essential to meet climate commitments.

India's other basic industries have seen ground-breaking innovation. The water industry has been underserved by digital technology. Increasingly, the private sector is instituting and providing cloud-based machine learning technology to streamline desalination and wastewater treatment plants. AI algorithms can guide energy savings in network operations using optimisation; AI techniques can do this by identifying the most cost-efficient investment in a given system for energy savings (for example in pump replacement systems, increased storage capacity, or change of energy contracts) (Jenny et. al., 2020).

2.5. INDONESIA: ACCELERATING AGRITECH AND FINTECH WILL BOOST CLIMATE RESILIENCE

Indonesia Indonesia has committed to climate adaptation and resilience; its emissions targets include a 41 per cent GHG emissions reduction contingent on sufficient international financial support. Indonesia's government has also stated its ambition to reach net-zero GHG emissions by 2060 or sooner, according to the World Resources Institute.

Significant efforts to close the digital divide (particularly with the implementation of the Palapa Ring project) have aimed to expand the national fibre-optic infrastructure to Indonesia's outer eastern islands. Despite this, almost half of the population, even in regions with relatively better infrastructure, remain without internet access (World Bank, 2021). In Indonesia, for example, internet penetration is 50 per cent, or 132.7 million people, and as long as it continues to increase more people will be able to access FinTech services. In Indonesia, the penetration of ICT is lower than in other ASEAN member states (McKinsey, 2016). Investments in digital infrastructure may be needed to close any ICT infrastructure gaps and ensure the full exploitation of new technologies.

Sustainable finance is still developing; the development of The SRI KEHATI Index is ASEAN's first green index. For the most part, banks lack the necessary tools to assess environmental credit risk. Indonesia's Minister of Agriculture Syahrul Yasin Limpo has underscored Indonesia commitment to transform Indonesia's agrifood systems through the expansion of technology and finance, particularly through AI (FAO, 2021). Indonesia's digital economy is projected to be worth US$133 billion by 2025 and hosts one of the most vibrant e-commerce markets in ASEAN. It hosts several unicorns valued at above US$1 billion (ADB 2020).

Developments at the intersection of agriculture, technology and finance have been of note. TaniHub is an example of data-driven and digitalised agriculture in Indonesia. An Indonesian agritech startup, it is comprised of TaniHub (e-commerce platform), TaniFund (peer-to-peer lending platform), and TaniSupply (supply chain management). It offers integrated services and by doing so, it has disrupted Indonesia's multi-layered agricultural supply chain, which creates market price distortions. Crucially, TaniHub Group provides farmers with access to funding through its decentralised peer-to-peer lending platform, TaniFund, which has built resilience during economic and climate-related shocks (World Bank, 2020a).

2.6. VIETNAM: BUILDING RESILIENCE THROUGH CATALYTIC INVESTMENT INITIATIVES

Vietnam ranks in the top quarter of SDG performance across the Southeast Asian region for several SDG sub-indicators. In November 2020, the government passed the revised law on Environmental Protection legalising an emission trading scheme, to take effect on 1 January 2022. The policy is aligned with Vietnam's stated commitment to reduce GHG emissions under the Paris Agreement on climate change.

Foreign direct investment into agricultural technology, biotechnology, automation, and information technology is fundamental in supporting Vietnam's green economy. Its three most prominent areas relating to this sector are Hau Giang, Phu Yen, and Bac Lieu provinces. Vietnam's domestic developments in green bond certification will also augur well for raising finance for enterprises in the AgriTech sector. Finance and investments that promote the spatial re-patterning of the economy in non-coastal areas will help build climate resilience.
Vietnam's coal-fired power plants provide about 50 per cent of electricity—up from 17 per cent in 2010. As a result, Vietnam's energy sector accounts for 65 per cent of its overall GHG emissions (IFC, 2021). Vietnam has a significant offshore wind resource (World Bank, 2021a) that could help meet Vietnam's rapidly growing electricity demand; it has the potential to supply 12 per cent of Vietnam's electricity by 2035. By replacing coal-fired power generation, this could help to avoid over 200 million metric tons of CO2 emissions (ibid). There has been a gap between how the offshore wind industry operates, and its potential with greater usage of data and digital technology. The development of mobile offshore wind units and Vietnam contracting Siemens Energy for digitally enhanced transmission equipment is encouraging. (Offshore Engineer, 2021; Siemens, 2020; Durakovic, 2019).

Vietnam's strong economic performance has helped reduce poverty over the past decades; however, its industrialisation since the late 1980s was predicated on unsustainable exploitation of forests, fisheries, and other renewable and non-renewable natural resources. Agriculture and industry have contributed significantly to degradation of natural capital. Given this, disaster risk financing and insurance is key to managing the costs and economic impacts of Vietnam's natural disasters. Globally, there is evidence to suggest that the flood risk is underinsured (OECD, 2016) The onus is on Vietnam to institute investment

facilities, including blended finance, that include the public and private sectors, to improve disaster preparedness.

2.7 MALAYSIA: TACKLING RENEWABLE ENERGY INVESTMENTS AND FINTECH IS KEY

The government of Malaysia has committed to a 45 per cent reduction in GHG emissions[11] (compared to 2005) by 2030. The government's objectives are ambitious in light of the fact that Malaysia's economy is largely driven by and dependent on fossil fuels; Malaysia has the second highest demand for energy per capita in the region (Gouldson et. al., 2014).

Malaysia's leveraging of the internet, smartphones, big data, the internet of things, AI, and other technologies, has helped in building resilience. Digital technologies have enabled existing firms and entrepreneurs to serve markets that are currently underserved, have lowered costs and allowed new, sustainable and climate-friendly business models to emerge (World Bank 2021b).This, in turn, has already led to a reduction in fossil fuel dependence in Malaysia, preceding the Paris Climate Change Agreement. In its COVID-19 economic relief package, government funds (US$2.9 billion) have been earmarked for the installation of new grids, LED streetlights and rooftop solar panels (Vaka et. al., 2020). The Green Technology Financing Scheme is aimed to boost green technology (ibid).

A lack of international funding and multiple barriers to investment in renewable energy have hindered the impact of digital innovation on Malaysia's energy transition (Susskind et. al., 2020). The Malaysia Digital Economy Corporation (MDEC), has put forward the country's digital strategy (Digital Investments Future5 (DIF5) Strategy) for the period between 2021 to 2025, to secure high-quality digital investments. The five targeted sectors (AgriTech, HealthTech, Islamic Digital Economy and FinTech, CleanTech and EduTech) are linked to strategic national industries for digitalisation and are mapped to the national priority sectors (CIO TECH ASIA, 2021). The digitalisation strategy is aimed at catalysing inward investment and international partnerships with local companies for technology and knowledge transfer.

Analytics and cloud computing have significantly enabled Malaysia's small and medium-sized farmers to both reduce costs and increase sustainable practices. Farmers are also using the smart Internet of Things (IoT) devices connected to a central Network Operations Centre (Savita et. al., 2018). Mobile apps, smart sensors, drones and cloud computing makes precision agriculture possible for cooperatives and small family farms. Low-cost sensors and smartphones facilitate low-cost entry points for new sustainable practices. Other digital innovations to mitigate these climate risks include information technology, telematics, GPS systems, robotics, automated hardware, agriculture drones, and variable rate technology (ibid).

2.8. THAILAND: A REGIONAL EMERGING LEADER FOR SMART CITIES

The government of Thailand has committed to reducing its GHG emissions by 20 per cent by 2030. Over the past seven years, Thailand's policymakers have drafted several plans and programs which underpin this goal: the Climate Change Master Plan (CCMP), the Power Development Plan (PDP), the Alternative Energy Development Plan (AEDP) and the Energy Efficiency Plan (EEP).

Thailand is the first country in Southeast Asia to offer incentives to electric vehicle (EV) manufacturers: it is imagining itself as an electric vehicle hub. Thailand's EV production comprises less than 10,000 units out of the estimated five million globally (IEA, 2020). The Electric Vehicle Association of Thailand projects 1.2 million battery electric vehicles will be registered by 2036. Thailand's growing battery storage capacity coupled with a stronger move to clean energy, such as solar, will then facilitate its energy transition to net zero carbon emissions. Linking increased electricity demand to increasingly affordable renewable energy production will drastically cut the air, climate, and noise pollution caused by its transport sector.

Smart Cities have also been a focus for Thailand's new economic model. They are catalytic in their ability to foster transformation with state-of-the-art technology, renewable energy, energy-efficient infrastructure and sustainable environment management. Ban Chang, the first smart city in Thailand to run on a 5G network (based on Open RAN), delivers live traffic diagnostics, digital signage and sensitive environmental conditions applications. Ban Chan is connected to a motorway linking the cities of Pattaya and Bangkok, making it well-placed to take advantage of 5G use cases in several areas including industrial robots and telemedicine (SmartCitiesWorld, 2021).

Sector-specific digitalisation will play an integral role in all of this, from mechanising manufacturing processes to enabling more efficient production and services through data. Precision farming in controlled environments will reduce variability in

crop yields for Thailand's farmers, (Bongiovanni and Lowenberg-Deboer, 2004). Automated government processes will enable small farmers to easily provide relevant sustainability certifications, according to the central bank. As Thailand has recalibrated their economic focus to digitalisation, the agriculture industry opened up to the adoption of agricultural technology (AgriTech), comprised of tech-driven farming frameworks linked to robotics, automation and data-analytics to increase the yield and quality of agricultural products to build resilience against shocks.

2.9. PHILIPPINES: AMBITIOUS CLIMATE TARGETS REQUIRE MORE DIGITAL FINANCE

The Philippines has revised its GHG emissions target to a 75 per cent reduction by 2030 under its commitment to the Paris Agreement on Climate Change, up from 70 per cent. A large proportion of the target (72.29 per cent) is conditional on international provision of green finance, technology transfer and capacity development (Reuters, 2021).

In light of the Philippines' ambitious targets, the use and broader deployment of digital technologies – such as digital payments, e-commerce, telemedicine, and online education – have taken on increased importance. The number of internet users has more than tripled to 73 million in 2020, from 23 million in 2010.[12] The use of digital technologies is still below its potential (World Bank 2020b), The relatively poor performance in digital adoption can be traced to a multitude of factors including the high cost and uneven quality of internet, limited adoption of digital payments, expensive logistics, and a business environment with low levels of competition (ibid).
Support for digital banking is growing; the challenge for the new banks will be to build trust and convince customers in a country with a low level of financialisation and a preference for face-to-face interaction. The Philippines central bank (Bangko Sentral ng Pilipinas) in November 2020 approved a new license category for digital banks (Sanglap, 2021). Through combining the decentralisation of blockchain with solar cells, energy storage and other hardware, the Philippines hopes to accelerate power generation in off-grid areas and devote itself towards making clean electricity more accessible in remote areas in the near future (UNCTAD 2021, Smart Energy International 2018).

The adoption of digital and precision farming practices in the Philippines has been shown to improve crop resiliency and boost productivity and incomes. This is particularly the case for small-scale farmers are often more vulnerable to climatic shocks. With increasing support from international aid agencies, as well as the public and private sectors, precision farming will help the Philippines maintain production through the use of mobile apps, automation, and precision farming techniques and projects. The usage of precision farming and AI for rice crops in the Philippines is also particularly relevant in building food security resilience to climate shocks, according to the Food and Agriculture Organization (FAO).

2.10. CAMBODIA: UNEVEN DIGITALISATION A KEY RISK FOR ENERGY TRANSITION

Cambodia's government has committed to achieving a 40 per cent reduction in GHG emissions by 2030. Nearly half of Cambodia's total emissions are from the forestry sector, with deforestation and forest degradation comprising almost all GHG emissions. Agriculture has been Cambodia's second highest emitter, followed by energy and industrial processes (Ge et. al., 2020). Cambodia's government aims to make the economy an ICT-driven upper middle-income country by 2030. And yet its digital strategy faces challenges, including gaps in infrastructure, the capacity to implement policy, prohibitively high electricity prices and insufficient internet access.

Agriculture is not only is the most vulnerable sector to climate change, but supports the most vulnerable groups, including women and the rural poor.[13] Digitalisation could be a key opportunity for its young AgriTech entrepreneurs. During Cambodia's rainy season (from May to October) storms have become increasingly frequent and severe, exacerbating flooding in the Mekong River, damaging canals and blocking access to drinking and irrigation water from the reservoirs. The ADB has been assisting and supporting Cambodia to combat climate change through a US$588 million Strategic Program for Climate Resilience, an investment plan approved by the government and funded by the Climate Investment Funds' Pilot Program for Climate Resilience.

Cambodia's business and financial sectors have successfully implemented digital apps; however, its agriculture sector, which is more vulnerable to and accountable for climate risk, is catching up more slowly through blockchain or precision agriculture (SET, 2020). Under the ADB investment program, a key innovative technology includes laser land leveling; laser land leveling equipment flattens land with a deviation of 3-6 centimeters. That means the same amount of water, fertilizer, and agricultural pollutants can be applied homogenously in the field, reducing input costs, increasing rice yields, and crucially cutting down on the use of gasoline. The ADB's program has helped boost crop yields by 25 per cent by giving farmers easier access to quality seeds and improving food resilience against climate change while reducing emissions (ADB 2021b).

3. LOOKING AHEAD

As Asia's economies recover from the COVID-19 pandemic, a heightened policy emphasis on sustainability and innovation will drive stronger inward investment to building greater climate resilience. In Asia, for example, during post-crises periods, policies that had a beggar-thy-neighbour element will no longer have the same effectiveness. The focus now must be on sustainability as a core element of policy. In Asia, the economies that were success stories are those that have attracted long-term inward investment, promoted resilience and engaged in economic and energy transformation.

In the world of finance-led globalisation, with greater transparency and information availability, it will be important for the private sectors in Asia's economies to be clear about their sustainability policies on supply chain management and trade. With the growth of an active civil society, and the increased presence of decentralised finance, policies, practices and business models associated with sound sourcing, equitable trade and fair business practices will provide companies with a new, differentiated strategy based on ethical standards. Digital companies and digital innovation is likely to be at the forefront of this dynamic in both Asia and globally.

Governments and private sector stakeholders need to increase their efforts to both diversify away from and transform the sectors that generate GHG emissions and re-constitute their economic models towards becoming providers of solutions for climate change. The success stories have effectively combined digital innovations to tackle sector-specific climate risks; this is evident in developments in the AgriTech and FinTech sectors in a number of Asian economies. It's also important to recognise that they don't necessarily need new technology to innovate.

Technology is critical to generate new opportunities and yet there remains huge potential, particularly in Asia, to scale up existing technologies through business model innovation. The broader challenge of mobilising larger-scale funding and FinTech for climate-resilient infrastructural development remains one of developing Asia's biggest obstacles.

NOTES

1. https://about.att.com/newsroom/2018/food_waste_into_clean_energy.html

3. Green finance is defined here as all forms of investment or lending that take environmental effects into consideration and enhance environmental sustainability (Volz 2018).

4. Green QE is defined here as a policy that changes the central bank's balance sheet toward green bonds (issued by firms in non-polluting sectors). It is an effective tool in mitigating detrimental emissions, though it has limited effects in reducing the stock of pollution (Ferrari and Landi, 2020).

5. The future energy system will require many types of data from multiple sources to be gathered, combined, analysed, and shared in new ways (Chang et. al., 2021).

6. https://unfccc.int/climate-action/momentum-for-change/planetary-health/alipay-ant-forest

7. https://www.alibabacloud.com/about

8. https://www.meti.go.jp/english/policy/energy_environment/global_warming/roadmap/report/20201111.html

9. https://www.panasonic.com/au/corporate/sustainability/eco.html

10.https://www.ge.com/news/press-releases/ge-introduces-digital-power-plant-steam-enhance-efficiency-and-reduce-emissions-coal

11. This objective is per unit of Malaysia's GDP.

12. We are Social, 2020. "Digital 2020: Global Digital Overview," Accessible Online: https://wearesocial.com/digital-2020, February 8, 2020.

13. https://www.un.org/en/chronicle/article/womenin-shadow-climate-change.

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