Asia-Pacific
Economic Cooperation

APEC Digital Innovation to Facilitate SMEs' Green Transformation Feature Report

APEC Small and Medium Enterprises Working Group

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Introduction

Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) set the 2050 net-zero target in 2021. Since then, many economies have incorporated net-zero emissions targets into their energy policies, industrial development. and MSMEs' twin transformation (digital/green) objectives. International organizations such as APEC actively emphasize inclusivity in green transformation to ensure that no one is left behind. Further, APEC promotes the green transformation agenda in its initiatives and has voiced consistent support during its annual leaders' meetings.

The G7 Hiroshima Leaders' Communiqué in 2023 highlighted the reduction of primary resource usage through enhancing resource efficiency and circularity along value chains.[1] OECD's "Arrangement on Officially Supported Export Credits" focused on generous and flexible financing terms for climate-friendly projects, in the hope of increasing the influence of trade and financial sectors in the fulfillment of environmental goals.[2] Additionally, APEC promotes the Putrajaya Vision 2040 and has begun implementing the Aotearoa Plan of Action with the goal of balancing sustainability and inclusive growth. APEC began the adoption of the Bangkok Goals in developing a bio-circular-green (BCG) economy model in 2022, which further helps MSMEs both build capabilities in sustainability practices and integrate with the global green supply chain.

In light of the global trend, Chinese Taipei has proposed its own series of initiatives towards SMEs' green transition. The first stage is "APEC Digital Innovation to Accelerate SMEs' Green Transition." Chinese Taipei has organized

1."G7 Hiroshima Leaders' Communiqué," G7, May 20, 2023. https://www.g7hiroshima.go.jp/en/documents/

2."Agreement to expand export credit support for climate-friendly and green projects," OECD, April 3, 2023. https://www.oecd.org/newsroom/agreement-to-expand-export-credit-support-for-climate-friendly-and-green-projects.htm

various forums, best practice competitions, participatory exhibitions, and best practice compilations to enhance MSMEs' green transformation awareness and encourage businesses to reduce carbon emissions through digital innovation. Chinese Taipei's new series of initiatives will highlight capacity building and knowledge dissemination, enhancing MSMEs' green competitiveness in APEC economies and helping them keep pace with global supply chain zero-emission trends. The initiatives also echo the goals addressed in Chair's statement of the 2023 APEC SME Ministerial Meeting: to strengthen MSMEs' green transitions, and to foster green jobs of the future.

This report analyzes three best practice cases from Singapore; Chinese Taipei; Thailand. Each case study begins with the featured business' pain point or opportunity for green transition. Each study then elaborates on the specific implementation of a digital solution for green transition, or how the highlighted business, via collaboration between a large and small enterprise or corporate startup engagement (CSE), has optimized green supply chain management and expanded their green business model.

From these case studies and their analysis, we have synthesized three key suggestions: first, to continue to promote innovation via public-private-partnership; second, to deepen collaboration between large and small enterprises, and third, to provide assistance to SMEs in areas such as finance and technology.

This report provides green transition case studies and pathways for the reference of SMEs, start-ups, the public sector, and other stakeholders in the APEC region. We hope this report can disseminate useful experiences and help MSMEs establish green transition awareness, grow green capacity, and jointly build a resilient and sustainable future.

Chacper 2
Case Study

Case 1: Evercomm (Singapore)

Pain Point and Opportunity for Businesses: Supply Chain Goes Low-Carbon

As sustainable development has become a pressing worldwide trend, "net-zero" has become a core objective driving global green transitions. Green international trends have prompted MSMEs on the global value chain to contemplate their response.

The EU's Carbon Border Adjustment Mechanism (CBAM) is a useful example of green global shift. CBAM requires EU-registered importers to submit carbon emissions-related numbers, which means that non-EU producers working with these importers must monitor and calculate their actual emissions and submit the data to importers in EU.

A second example is that of Thailand, considered a gateway to the Southeast Asian market. The economy has set a goal to reduce greenhouse gas emissions by 20% by 2030, reach carbon neutrality by 2050, and implement their net-zero emissions targets by 2065. Outside exporters to Thailand will be required to comply with these carbon reduction requirements.

Such global trends and supply chain demands require businesses to confront multiple challenges in response. Evercomm, a carbon ser vice provider, has estimated that at least 190,000 SMEs of Chinese Taipei will likely to be required to comply with their supply chain's carbon inventory requirements or to conduct carbon inventory before exporting products to the EU, representing a burden for these companies.

In addition, businesses also face challenges in participating in the carbon market. Due to the lack of a universal carbon market standard, it is difficult for different regions and economies to connect and trade among carbon markets. Chinese Taipei was a late entry to the global carbon market and as a result, many businesses operate with a substantial knowledge gap. Moreover, carbon inventory is both time-consuming and costly, as the process of inventory is mostly manual.

Solution: Online Carbon Inventory and Simulation Program

To help SMEs face these challenges, Evercomm launched a series of solutions incorporating the carbon service experiences of companies worldwide. They include NXMap, a carbon footprint verification (CFV) program, which is the first in the Southeast Asia region to receive Bureau Veritas' ISO14064-1 and ISO14064-2 certification. NXMap is also the key foundation of Evercomm's solution.

NXMap works as a carbon accounting platform to accurately track, monitor, and analyze the recycling performance of energy, water, and waste and then convert the data to a carbon emission number following the ISO 14064-1 standard. Evercomm has also combined digitalization and automation technologies to analyze carbon accounting numbers in depth, to track the unit carbon emissions of batches, individual products, office space, and even a company as a whole. This information can then be compiled into a carbon accounting report that provides valuable operational insights. To ensure the completeness of the carbon accounting report, all data on NXMap is verified by a third party to strengthen a business' carbon disclosure against scrutiny.

Evercomm has also worked with Industrial Technology Research Institute (ITRI) to localize NXMap, helping businesses in Chinese Taipei to produce their carbon inventory reports. The program provides enterprise clients the option of working with a verification body to help conduct carbon inventory. NXMap's online verification feature greatly reduces the verification cost for both businesses

and the verifying parties, and accelerates the verification speed. When a business completes its carbon inventory, it will understand its carbon emission structures and how to improve them.

Once a business confirms a direction for carbon emission improvement, it needs to introduce verified carbon reduction technologies. However, these technologies, once integrated with the system, need to be tested and calibrated. Evercomm uses its NXPlan program to simulate net-zero emissions to optimize their clients' solutions.

Lastly, Evercomm helps businesses connect with global carbon markets to trade carbon credits and work toward total green transition. Evercomm also works actively with banks, connecting green financial services to support businesses in achieving green transition.

Success Story: Thailand Sugar Plant's Carbon Inventory

Kaset Thai International Sugar Corporation (KTIS, Thailand's third largest sugar company) generates byproducts such as molasses and bagasse in the sugar manufacturing process. As the result, the company is involved not only in sugar manufacturing and delivery, but also in bleaching and turning bagasse into paper pulp, ethanol production and distribution, turning bagasse into biofuel for power generation, and recycling biogas and ethanol from the sugar manufacturing process to turn into soil ameliorants.

Evercomm complied with the ISO 14064-1 standard and the guidance of the NXMap system, entered related data, and uploaded necessary proof documents to help KTIS conduct its carbon inventory. The carbon inventory result indicated that KTIS mistakenly considered the burning of agricultural waste for power generation

to be green energy. Not only did this practice fail to increase green energy, but on the contrary, it generated a large amount of carbon dioxide. Evercomm partnered with ITRI to understand the client's issue and, based on the client's needs, introduced the NXPlan system for net-zero simulation, providing the company a solution for biogas power generation.

1 Biomass Cycle

ITRI has developed innovative ionic solution hydrolysis technology which converts varied lignocellulosic feedstock into sugars under mild conditions. The cellulosic sugar not only competes with molasses on quality and price, but also provides further supply to downstream applications. ITRI's process can reduce energy consumption and CO_2 emissions by nearly 50% compared to enzymatic hydrolysis process and 31% of sugar production cost.

In addition, Evercomm used low-carbon wastewater anaerobic treatment, combined with biological desulfurization and chemical desulfurization "two-stage renewable desulfurization technology," and reduced the concentration of hydrogen sulfide in biogas from 5,000 ppm to under 10 ppm.

2 Water Cycle

Compared with the traditional operation, BioNET technology can more than double the operating load, and hydraulic retention time can be shortened to reduce the operation volume and save more than 50% of the operation costs. The BioNET has assisted domestic high-tech factories, water plants, and water resource centers, contributing to carbon emissions reduction by about 120,000 tons of CO_2 per year.

Fluidized bed crystallization (FBC) for water and wastewater treatment can effectively remove inorganic ions from wastewater and reduce sludge production by 75%, lowering disposal costs. This method of recovering valuable resources in crystalline form can leverage environmental mandate compliance to generate profit from residue treatment.

3 Carbon Cycle

Calcium-looping CO_2 capture technology can be used to capture CO_2 from industrial emissions for microalgae carbon sequestration. The KTIS's sugar plant is the world's largest calcium loop capture CO_2 pilot plant. It uses the captured CO_2 to breed Haematococcus pluvialis algae to achieve zero emissions from the factory.

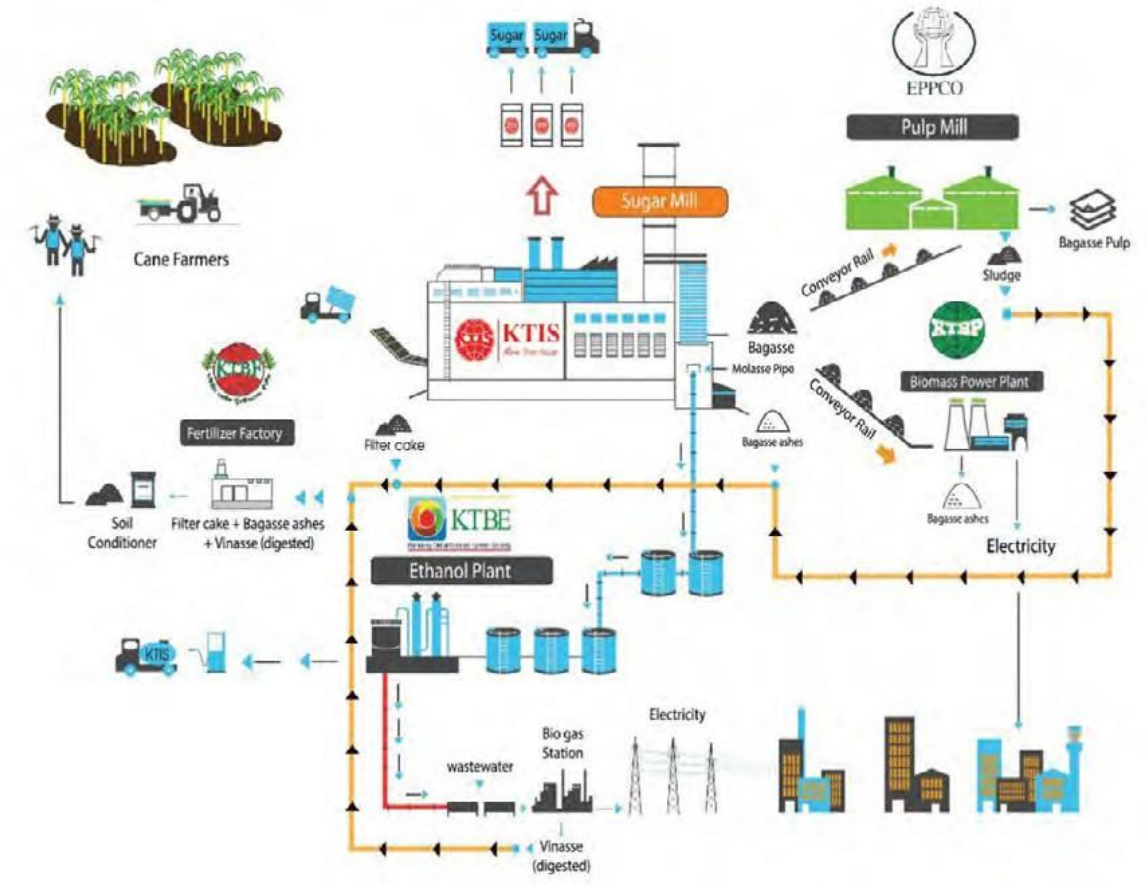

Diagram 1. Thailand Sugar Company KTIS Operation Illustration

4 Agricultural Cycle

ITRI uses a direct-thermal anoxic combustion system with an intelligent control interface. The Energy Saving Fast Biochar Expert System can set up parameters for different materials and apply carbonization heat without requiring additional fuel.

ITRI can simultaneously produce biochar and natural vinegar while recycling energy to be used for the purpose of heating. With different moisture content of raw materials, the carbon yield is 25-30% and vinegar yield is 30-35%. These output products can enhance soil optimization, pest control, and crop growth promotion to reduce the use of agricultural fertilizers, while thermal energy can provide hot water or be used to dry crops.

Vision: Achieve Net-Zero Together

Joint effort worldwide is required to achieve net-zero. Businesses require feasible solutions to handle the complicated carbon market as well as to face the challenges of carbon emissions management. Evercomm's vision is to help businesses achieve green transition while meeting their sustainability goals, reducing carbon emissions, and playing an active role in the global green economy.

Green transition is the inevitable future, and Evercomm's solutions aim to help businesses overcome difficulties in the carbon market and in carbon emissions management while sharing quality technologies and best practices across the international market.

Case 2: Charoen Pokphand Foods (Thailand)

This section was based on the interview with and further information provided by the Thailand Development Research Institute (TDRI). TDRI, a private research institute, provides studies and analysis of various economic and social development policies from government institutions. In addition to creating SME policies, TDRI has directed its attention to climate change-related policies in recent years, including business carbon reduction and green growth.

Background

In 2022, although the agricultural sector's output accounted for 8.82% of the GDP, it encompassed nearly one-third (31.6%) of the total employment. Additionally, among Thailand's total businesses, 71.6% operates in agriculture. These numbers highlight the importance of agriculture to both employment and economic development in Thailand.

However, due to the aging of agricultural workers and social shifts, since the 1980s Thailand has increasingly adopted mechanized agriculture. Since mechanization requires greater capital investment, many small agricultural businesses have gradually merged vertically into medium and large-sized enterprises, combining their capital and resources. Today, the result is often that a single group is responsible for growing, harvesting, processing, packaging, and delivering agricultural products as well as for sales, distribution, and marketing. This shift has offered Thailand's agricultural sector opportunities to introduce new technologies and management models. Similar changes have occurred outside

the agricultural sector; for example, the market structure for poultry and livestock husbandry has also shifted towards large-scale and vertical business integration.

The Charoen Pokphand Group (CPG) is an agricultural and food company and serves as a success case for agricultural industrialization and mechanization in Thailand. CPG comprises four business lines and ten companies, and has a comprehensive supply chain, with multiple suppliers covering ever ything from poultry and livestock raising to food processing. In response to the net-zero emissions trend, CPG has begun tracking GHG emissions from poultry and livestock farming and from the growing of feeds for these animals. This case study focuses on CPF (Charoen Pokphand Foods), which operates poultry and livestock husbandry and fish/shrimp farming.

Contract farming resulted from the process of agricultural industrialization in Thailand, with CPG as the main locomotive behind its promotion. Contract farming refers to the practice of signing a farming contract between food companies and local farmers in which procurement standards, prices, and other production requirements are stipulated. With contract farming, a food company can control the technologies used in the production process, register the place of origin of produce, and enhance food safety by monitoring the feeds and fertilizers used in manufacturing. This article discusses CPG's green management model of its supply chain and how the company, facing pain points in its operation, promoted and introduced digital tools to its supply chain, and thus achieved its desired objectives.

Pain Points/Opportunities

1. Agricultural industrialization in Thailand has accelerated the industry's shift from labor-intensive to technology- and knowledge-intensive manufacturing. As various types of agrifood move towards providing high-added value, high quality, and diversity, consumers are increasingly attentive to food safety, prompting agricultural businesses to introduce technologies to enhance their value chain's traceability.

2 The main component of CPG is agribusinesses, the majority of which are small and medium-sized enterprises with limited capital and resources. Insufficient capital discourages agribusinesses from adopting digital and green technologies; this reality has slowed CPG's progress in carbon reduction promotion.

3 In response to the trend of net-zero by 2050, the value chain for agricultural products should introduce low-carbon technologies to or reduce carbon emissions in the manufacturing process as soon as possible. For example, many Thai farmers, after harvesting corn or other crops, still burn their farmland to increase soil nutrients and reduce pests, a process which emits excessive CO_2. Failure by large food corporations to control carbon emissions in the value chain will hinder the achievement of net-zero.

4 Although EU's Carbon Border Adjustment Mechanism (CBAM) does not yet include food, it may eventually expand to include imported agricultural, animal, and food products. Australia; Canada; United States could also establish border control measures against the carbon footprints of agricultural and food products, which would impact exporters.

Solutions

To effectively reduce carbon emissions, CPF has introduced the following digital solutions to help track manufacturing methods and carbon emissions in the upstream of its value chain.

1 Growing feed crops

Feed crops, the foundation for livestock products, are grown by companies at the uppermost stream of the value chain. Raising livestock and poultry requires feed crops (such as corn). As noted, Thai farmers often burn their cornfields after a harvest, emitting a massive amount of CO_2. In light of this, CPF utilized blockchain technology integrated with satellite data to track whether the company's corn

feed comes from farms that conduct post-harvest burning, farms that utilize low-carbon farming, or farms that have implemented friendly and zero-residue farming. The satellite images can pinpoint hot spot farmlands which do not utilize low-carbon farming.

CPF has also developed a reporting application for smart phones, allowing farmers to report the location and time of any farm burning. The app serves as a bridge between CPF and farmers, allowing farmers to help the company monitor farm burning.

❷ Feed manufacturing and food processing

Feed manufacturers are in the midstream of the CPF supply chain. Materials are shipped from their place of origin to processing facilities before being weighed and having their water content and nutrient content analyzed. Next, they are mixed based on their formula, packaged, and then delivered to various farms. Food processors are at the lower stream of the supply chain. After poultry and livestock are delivered to the food processing facilities, the meat undergoes testing for safe chemical levels before being cut, packaged, frozen, and delivered.

CPF has connected the aforementioned processes to the IOT system for data compilation, analysis, and remote control. The factories have further incorporated AI technology; based on the data collected from the manufacturing process, AI adjusts production machines intelligently to reduce energy consumption and greenhouse gas generation.

Results

According to CPF statistics, implementing AI, IOT, automation, and other technologies in agricultural and food production has helped the company reduce its emissions by the equivalent of 70,000 tons of CO_2. CPG expects this number to continue to decrease.

Secondly, CPG's meat processing factories have increased their renewable energy usage, comprising biogas and solar power, which is estimated to have cut previous emissions by the equivalent of 630,000 tons of CO_2.

Case 3: Turing Certs (Chinese Taipei)

Pain Point and Opportunity: Challenges Facing Traditional Certificates

In the trend of green digital transformation, businesses commonly direct their attention to technological innovation, compliance, market competition, and sustainability reputation, but often ignore a seemingly minute detail: paper certificates.

Paper certificates, at first glance, do not seem worthy of much attention. However, the processes to obtain the necessar y raw materials and then to transform them into paper certificates is both expensive and complicated. This cost includes harvesting trees, manufacturing paper, buying printing equipment, designing and generating certificates, mailing replacements for any inaccuracies in printing or quality defects, and document preservation and management. The manufacturing and distribution of paper certificates and the warehouse management costs over time can become burdensome both to the certificate creators financially and to the environment.

In addition to the high production and supply chain costs, paper certificates can be easily dampened, discolored, damaged, or lost. Paper documents are nearly impossible to preserve or restore in the case of natural disaster, constituting potential

risks to a company's business and operations. Additionally, paper certificates can be easily tampered with or counterfeited, creating risk and liability. Further, there is the issue of information security when certificates are digitized and stored online. Bad actors must be stopped from accessing these certificates for illegitimate purposes, as this has consequences for an individual or a business' reputation.

A certificate owner may be required to wait for delivery or visit a venue personally when reviewing or providing a paper certificate; such activity is time-consuming and impacts the immediacy of a company's operations and decision-making, generating a large carbon footprint in the process. Further, if a certificate is misprinted or the certificate owner changes his or her name, the certificate must be revoked or replaced, requiring repetition of the tedious process above.

Paper usage reduction is crucial for ESG performance and the green-oriented energy transition. The demand for certificates each year surpasses 1.3 billion units, a market of nearly USD1.95 billion. However, the market still primarily relies on paper certificates, an arrangement which is highly risky. In the modern digital era, sustainability and convenience are the top priorities. As organizations at all levels consider how to adapt to the digitalization trend, they should seek solutions that are modern, environment-friendly, highly efficient, and safe.

Solution: Turing Certs

Turing Certs utilizes blockchain technology (anti-counterfeiting, real-time and paperless validation, and complete data source tracking), and e-signature technology to achieve the international digital identity standard set by the World Wide Web Consortium's Decentralized Identifiers. Important certifications are digitalized and stored on a chain. The certifications are then permanently stored on an international digital certification management platform, providing both certificate creator and owner a solution that combines data tracking, cross-origin sharing, inspection, preservation, and high privacy design.

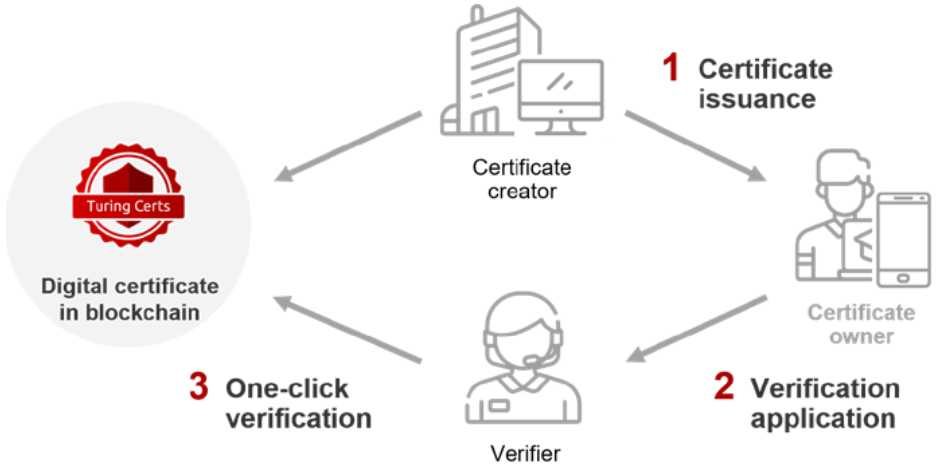

Diagram 2. How Turing Certs Works

Turing Certs serves the three parties involved in certificate issuance:

1 Certificate Creator:

The organization that needs to produce, manage, and issue certificates. Turing Certs covers the production, management, and supervision of all certificates' issuance, as well as revocation and acceptance, without the creator's responsibility to deal with physical certificates.

2 Certificate Owner:

Any party that receives a certificate from a certificate creator. With Turing Certs, a certificate owner can receive his or her certificate with just one click, regardless of the geographical distance or time zone differential. A certificate owner can also manage their personal certificates and even link them to social media.

3 Verifier:

An organization that verifies a certificate's effectiveness and authenticity and tracks its origins with just a click of a button. Any expired certificate that needs replacement is identified during the verification process.

Diagram 3. Turing Certs Benefits

As of September 2023, Turing Certs has served more than 300 international organizations and academic institutions across nine economies and regions, including WHO, APEC, Erasmus+ in Italy, Dun & Bradstreet, Harvard College in Asia Program, Berkeley University Law School, and Technological University of the Philippines. Turing Certs users in Japan include the Ministry of Internal Affairs and Communications, Camp Hack, Cert Pro, and Code for Japan. Turing Certs users in Chinese Taipei include the Ministry of Digital Affairs, Industry Technology Research Institute, Institute for Information Industry, Taipei City Government, and Tungs' Taichung Metroharbor Hospital.

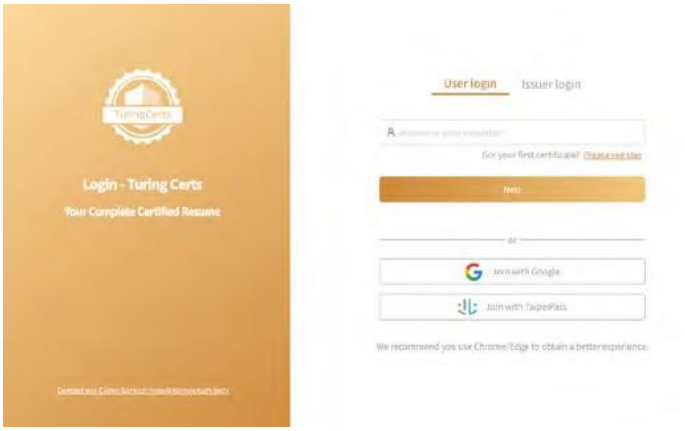

Diagram 4. Login page for Turing Certs

Real-Life Applications and Success Stories

1 WHO Goes Paperless with Turing Certs amid the Sustainability Trend

WHO's Partnership for Maternal, Newborn and Child Health (PMNCH) held Global Forum for Adolescent in Geneva, Switzerland in October 2023. More than 20,000 youths from over one hundred economies participated in this forum to discuss issues related to women and the youth.

In compliance with the environmental trends, WHO worked with Turing Certs to issue paperless International Youth Travel Cards (IYTC) for the event's participants. As a digital certificate that is universal, available in multiple languages, convenient and private, IYTC encouraged the youths to engage in international issues more. By issuing paperless IYTC, the event reduced its carbon emission by the equivalent of the CO_2 absorbed in one year by 148 full-grown trees.

2 Dun & Bradstreet, to enhance the level of trust in its sustainability report, worked with Turing Certs to publish its ESG report that can be verified across borders.

Started in 2022, the Financial Supervisory Commission has required listed companies with a market value over USD62 million to publish their corporate sustainability and net-zero reports, showcasing their commitment to the environment and circular economy in addition to their economic contribution.

In 2022, Dun & Bradstreet's "DUNS Number" became a unique identification number for international enterprises. The DUNS number integrates with a company's trade, credit assessment, and other information, and has thereby become a symbol of a business' reliability. Dun & Bradstreet works with Turing Certs to help businesses go paperless with their sustainability reports and to produce full-digital ESG reports with single-point data validation, interactivity, and data source tracing.

Diagram 5. Certificate issued by Dun & Bradstreet with Turing Certs solution

LINE, Audi, and Ministry of Digital Affairs are all Turing Certs Adopters

Turing Certs makes certificate issuance, management, and privacy protection convenient. Digital certificates can reduce carbon emissions, eliminate paper use, and are recognized globally. In 2021, LINE, an instant messaging app, adopted Turing Certs for the certificates issued to start-up and accelerator participants in its LINE Protostar event, effectively preventing certificate counterfeiting and misuse, and ensuring authenticity with e-signature. In 2023, automaker Audi adopted Turing Certs in its Audi Innovation Award, wherein winners were able to receive, manage, and share their certificates instantaneously with their mobile devices, conserving paper resources and ensured the permanent preservation of these certificates.

In 2022, Chinese Taipei established its Ministry of Digital Affairs, which works with Turing Certs to digitalize its certificates. Turing Certs has been adopted for various projects, including the T Ambassador project, a program that build

capacity of digital youth, various university information and communication technology competitions, the Ministry of Economic Affairs' "Technological Service Organization Registry," cybersecurity competitions, and the forthcoming "Business Carbon Footprint History Platform" and "Renewable Energy Certificate Center," showcasing the public sector's digital tools deployment towards paperless era.

Chacper 3
Analysis & Findings

Analysis & Findings

The three best practice cases in this report can help businesses optimize online carbon inventory and carbon reduction simulation systems for their manufacturing processes. These case studies also show how supply chains, from upstream to downstream, utilize the blockchain, IoT, and AI technologies to reduce carbon emissions. In addition to examining the manufacturing process optimization, this report also discusses how to use digital technologies to produce certificates and other certificates to help reduce carbon emissions. The following section explores how the company in each case study has successfully reduced emissions.

Evercomm – Digital Technologies with Circular Economy

One of Evercomm's advantages is that it provides businesses with services beyond just carbon inventory. After utilizing digital tools to help a Thai sugar company produce its carbon accounting report, Evercomm also helped the company conduct a digital simulation of net-zero emissions to seek the most suitable interdisciplinary emission reduction solution, such as ITRI's lignocellulose fractionation technology, BioNET, calcium-looping CO_2 capture technology and value-added applications, and Energy-Saving Fast Biochar Expert System. These technologies not only reduce emissions during the sugar manufacturing process, they can also create even more value by recycling the processing residue. For example, captured CO_2 can be used to breed Haematococcus pluvialis algae, instead of emitted, to achieve zero emissions from the factory. Begasse from sugar production is used for biogas power generation and also turned into pulp, which can increase resource utilization efficiency, reduce waste, achieve material circularity, enhance renewable energy technology, and fully take advantage of the circular economy with renewable energy.

The case demonstrates that Net-Zero emissions and regional sustainable development can be achieved through cross-border cooperation between a startup and a research institute that offered solutions to combine carbon-reduction technologies and carbon footprint verification software.

CPF - Collaboration Between Large and Small Enterprises to Enhance Supply Chain Resilience

In response to the net-zero trend worldwide, CPF (Charoen Pokphand Foods) has set a reduction goal for its group. Since CPF has its own agricultural and animal husbandry supply chain, leading its small and medium-sized suppliers to introduce low-carbon technologies and reduce emissions from the manufacturing process are the keys to CPF's carbon reduction.

CPF has implemented different digital technologies for the upstream, midstream, and downstream of its supply chain to track and control the GHG emissions throughout the supply chain. First, small and medium-sized partners use blockchain technology along with satellite images to monitor if farms are implementing low-carbon farming; a reporting application also has been developed allowing farmers to monitor farms, which has helped CPF to keep track of the implementation of low-carbon farming in the upstream farms. Second, the majority of primary crop processers and food manufacturers are SMEs, who have introduced IoT and AI systems to effectively collect and analyze the power consumption data of their factories. Overall, CPF conducts green management from the perspective of the supply chain's resilience. Not only has the corporation reduced its own emission, it has also led its SME partners to transition to low-carbon production. In 2022, CPF has removed approximately 70,000 tons of GHS emissions from the air.

In light of the net-zero goals worldwide, large enterprises have incorporated ESG into their business and supply chain management. Large conglomerates often have greater resources and exert greater pressure on upstream, midstream, and

downstream suppliers. Therefore, large conglomerates leading SMEs in supply chain carbon reduction may be the future. On the path to achieve green transition, SMEs can utilize innovative digital tools or digital platforms to effectively manage their energy consumption to reduce carbon emissions. They can also partner with large corporations to ensure SMEs' steady income while reducing their barriers to obtaining technology and capital. For example, large corporations can provide joint guarantees to help SMEs obtain favorable bank loans to develop more ideal green business models.

Turing Certs – Public-Private Partnership to Promote Innovation

Turing Certs found success using blockchain technology to certify paperless certificates and reduce carbon emission, through discovering the often-ignored carbon footprint in paper certificates. The company also actively works to encourage public organizations to adopt its digital certificate module. As the result, digital certificates by Turing Certs are widely adopted in the public and private sectors' training, competitions, business carbon tracking platform, and other venues in Chinese Taipei, indicating that both the public and private sector are gradually leaning towards the concept of digital trust.

Knowledge deficits, sparse awareness, and limited manpower and resources are the most common hurdles for the green transition of SMEs. Therefore, in addition to large enterprises partnering with small-sized enterprises on the supply chain in carbon reduction, public-private-collaboration is also key to SMEs' green transition. The value of public-private collaboration lies in the public sector executing its policy, budget and resources, through the government's promotion or procurement, to broaden the market opportunities for SMEs.

Chinese Taipei, to connect resources within the innovation ecosystem, has been actively promoting corporate startup engagement (CSE). In order to assist startups with developing green technologies, Chinese Taipei holds a competition

with the theme of green technology and the net-zero emissions. In the competition, large businesses present their challenges of green transformation and startups propose their solutions. The public sector provides financial incentives for the cooperation between large corporates and startups.

Startups enjoy the advantage of proactive entrepreneurship and technological development capabilities, but often still need a proper venue to accelerate technological adoption. Established businesses, on the other hand, require a proper venue, sufficient capital, market channels and other resources as well as innovative technologies and talents for proper upgrade and transformation. The CSE model allows startups to complete a field validation of their carbon reduction and monitoring technologies while businesses can utilize innovation in their new technologies or products. Large businesses can boost their competitiveness in the global market with innovations from startups, while startups can expand their market presence both domestically and abroad. Large enterprises partner with small startups to achieve both digital innovation and green transition, which helps the green business model of digital innovation to spread quickly.

Chacper 4
Conclusion

Conclusion

Currently, the digital solution for carbon reduction is no longer limited to just carbon inventory. Instead, it has expanded to provide carbon reduction measure simulation and tool suggestions. The most effective digital solutions even assist with carbon credit trading and work with banks to provide green financing services. For example, Evercomm helped a Thai sugar company conduct carbon inventory and uncover pain points, and then introduced a green solution to help the company reduce emissions in their operations and manufacturing processes. The technologies introduced helped the sugar company control its GHG emissions and had applications to agriculture and bio-cycles. Evercomm's example shows that circular economy can play a crucial role in energy conservation and carbon reduction.

Green supply chain management is not the responsibility of one single business. If large corporations who have more information, technology, and capital can actively work towards the net-zero goal, countless SMEs on the supply chain will be prompted to approach the challenge seriously and begin green transition. Other than the cooperation between large companies and startups, regional and cross-border collaboration is also one of key approaches to achieve sustainable growth. Therefore, carbon inventory should go from carbon accounting at a single point to the tracking of the supply chain's carbon footprint with suitable digital solutions introduced. For example, from monitoring of the farms on the upstream to the food processors at the downstream of the supply chain, CPF of Thailand introduced digital technologies and successfully conserved energy and reduced carbon emissions.

According to World Economic Forum (WEF)'s estimation, by using digital technology solutions such as 5G, the cloud, IoT and big data, more than 15% of the global carbon emissions can be reduced by 2030. Research literature and this study both indicate that digital technology innovation and technological adoption can help businesses engage in green transition and achieve net-zero. Some examples include: IoT monitoring a factory's pollutants, waste, and carbon emissions in real-time; big data and AI analysis to boost a company's automation and operational efficiency to help it achieve carbon reduction goals; and cloud computing and storage virtualization to reduce energy consumption and carbon emissions of traditional data centers. However, despite the massive benefits of digital innovation to green transition, SMEs' limited awareness, knowledge, and resources will hinder them from adopting digital innovations to connect to the global green value chain. As indicated by this report, collaboration between large and small enterprises and public-private-collaboration are the keys to SMEs' digital transformation and green transition.

This report was inspired by the APEC Digital Innovation to Facilitate SMEs' Green Transformation Initiative, with the goal of encouraging SMEs to develop digital innovations to achieve best practices in green transition and green supply chain participation. Our various forums and this report itself have showcased the practice of green transition in ESG.

APEC Digital Innovation to Facilitate SMEs' Green Transformation Initiative and the content of this report both echo the pillars of innovation, digitalization, and sustainability, which will help achieve the Bangkok Goals on Bio-Circular-Green (BCG) Economy. In addition, this report also manifests the Chair's Statement of the 29th APEC Small and Medium Enterprises Ministerial Meeting, which focused on the MSMEs' entry to the global value chain and how to use digital innovation and green transition to boost MSMEs' global competitiveness.

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