Workshop Summary Report

APEC Workshop on Promoting Digital Transformation for Energy Efficiency

APEC Energy Working Group

January 2025

Asia-Pacific
Economic Cooperation

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I. Introduction

On June 2024, the *"**APEC Workshop on Promoting Digital Transformation for Energy Efficiency**"* was held in Hanoi, Viet Nam. The project was led by Viet Nam and co-sponsored China; Japan; Chinese Taipei; and the USA. Speakers and participants came from the private sector, business associations, international organizations, research institutions, and APEC economies' relevant Ministries and government agencies.

The objective of the "APEC Workshop on Promoting Digital Transformation for Energy Efficiency" is to provide capacity building to APEC member economies' governments, especially developing ones through sharing information, experiences in addressing challenges, implementing digital transformation in energy sector, in the interest of energy efficiency.

II. Background

According to the International Energy Agency (IEA), digital transformation is increasingly having a great impact on energy demand and supply – household, transport and industry. It is estimated that more than 1 billion households and 11 billion smart appliances could participate in interconnected electricity systems by 2040, which would contribute to reducing energy use by 10% by using real-time data to improve operational efficiency, avoiding USD 270 billion of investment in new electricity infrastructure.[1] In supply, digital transformation

[1] https://www.iea.org/news/digitalization-set-to-transform-global-energy-system-with-profound-implications-for-all-energy-actors

significantly affect how energy is produced – "from smart oil fields to interconnected grids, and increasingly, renewable power. Digital technologies could help integrate higher shares of variable renewables into the grid by better matching energy demand to solar and wind supplies. Energy supply sectors also stand to gain from greater productivity and efficiency, as well as improved safety for workers". On the other hand, digital transformation also triggers challenges such as new security and privacy risks, disrupting markets, businesses and employment. [2] Besides, there remain difficulties in implementing digital transformation in the interest of energy efficiency since it might bear associated costs of aggregating all of the potential energy savings from across the economy, which would make investment in energy in general, energy efficiency challenging.[3]

While digital transformation in energy is of increasing importance, governments should play a more active role in enabling a favorable environment in terms of policy promulgation and implementation to ensure that the transformation produces positive impacts and avoids negatives ones in the long term. It is up to the governments' awareness, capacity and resources to pursue the long-term goals. The project would focus on raising the awareness as well as sharing information and experiences for APEC member economies' governments especially developing ones to address challenges in implementing digital transformation for energy efficiently in the interest of stability, sustainability and security.

The project is in line with the 2015 APEC Energy Ministerial Meeting's Declaration that "APEC continues to be a platform for the exchange of experiences, and information related to technology development, demonstration and deployment. The ultimate goal is the adoption of cost effective, relevant and

[2] https://www.iea.org/news/digitalization-set-to-transform-global-energy-system-with-profound-implications-for-all-energy-actors
[3] https://www.iea.org/articles/better-energy-efficiency-policy-with-digital-tools

applicable cutting edge energy technologies that would sustain the development of each Member Economy and the region as a whole". Digital transformation in energy is one of holistic approaches of uptake of technologies and digital tools to promote energy efficiency in the long term.

The EWG Strategic Plan 2019 – 2023 stressed the objective of pursuing energy efficiency through supporting the development and commercialization of energy efficient technologies in the areas of power generation and distribution, industry, transport, buildings and appliances. The implementation of digital transformation would definitely contribute to the energy efficiency in the long-term and sustainable manner.

This project supports APEC's capacity building goal since it significantly contributes to providing capacity building to governments' officials in realizing digital transformation for energy efficiency, attaining sustainable growth and equitable development in the Asia-Pacific region

III. Key Issues

1. Overview of digital transformation for energy efficiency

Mr Ly Manh Ha, Chairman of Directors, Green Power Engineering Consultant JSC, Viet Nam: Definitions of energy efficiency can be understood from various perspectives such as from angles of engineering, environment, economics, etc. Generally, energy efficiency is commonly understood as the use of less energy to perform the same task or produce the same result. According to the International Energy Agency (IEA), energy efficiency can be defined as "a way of managing and restraining the growth in energy consumption".

While the demand of energy is steadily increasing day by day, especially in the context that emerging and developing markets are experiencing urbanization and industrialization, which leads to a dramatic increase in energy consumption, energy efficiency is widely regarded as the most efficient means of supplying additional energy to meet the rising demand. Renewable energy and energy

efficiency contribute over 90% of the mitigation measures needed to reducing energy-related emissions, which play an important role in addressing climate change. It is of significance in the context that over the past decade, global CO2 emissions have increased by an average of 1% annually, making the impacts of climate change more increasingly noticeable. In that sense, energy efficiency is believed to play an increasing vital role in sustainable energy transformation and must be scaled up rapidly and substantially.

The energy efficiency market is expected to experience strong growth in the coming years, driven by various factors. In practice, economies around the world are enacting strict regulations and offering incentives to encourage energy-efficient practices, giving a significant boost to the market. Technological advancements have spurred innovation in energy efficiency solutions. The integration of artificial intelligence (AI) and Internet of Things (IoT) in energy management not only optimizes energy usage but also enhances cost-efficiency. In that way, awareness and understanding of corporate social responsibility (CSR) are also enhanced and corporates have made more investment in energy efficiency technologies to reduce carbon footprint and reduce energy cost. Digital transformation can contribute to promoting energy efficiency thanks to a variety of technologies, which help to profoundly impact both energy demand and supply. Digital technologies have been utilized extensively across all energy end-use sectors, including residential and commercial buildings, manufacturing, heavy industry, transportation, mining, agriculture, and services, etc. These applications deliver benefits to end-users and reduce energy consumption per unit of activity.

Besides, digitalisation increases the share of renewable energy in the energy system. Digital technologies offer effective solutions for advancing distributed renewables, thereby enabling new opportunities for digital transformation and promoting clean, sustainable development in the energy sector.

In the APEC region, the energy efficiency transition is occurring at different pace across sectors. In developed economies, they have adopted digital application standards in energy use and supply for years, along with robust digital technology infrastructure, which has greatly enhanced the effectiveness of energy use through digital transformation. Developing and emerging economies have significant potential for applying digitalization to enhance energy efficiency.

However, the digital transformation process is still slow and ineffective due to various reasons, such as limited technological infrastructure, financial capacity, and energy consumption behaviors. According to the APEC Expert Group on Energy Efficiency and Conservation (EGEEC) report, "APEC is progressing towards meeting its energy intensity and renewable energy targets." However, the distribution of efforts among economies remains uneven, potentially leading to certain economies not meeting global commitments on carbon emissions and energy intensity. Additionally, the intricate and time-consuming process involved in implementing energy-efficient solutions can deter adoption. This includes the necessity for specialized technical knowledge, extensive planning, and substantial operational adjustments that may disrupt normal business operations. The absence of standardized regulations and policies across different regions presents another challenge. Inconsistent regulations can create uncertainty and complexity for businesses operating across multiple markets, potentially hindering the uptake of energy-efficient solutions.

On the other hand, APEC presents opportunities in promoting energy efficiency for sustainability, which include strong commitments from all member economies to enhance energy efficiency, aim to low and zero energy emissions. Many APEC economies have advantages for renewable energy due to favorable natural conditions. Many economies have widespread adoption of information technology and high levels of digitalization, with smartphone usage rates among the population ranging from 60-75%. The widespread social approval presents an exceptional chance for digital transformation.

Energy efficiency also presents huge potential for further adoption. For example, in residential sector, increased household awareness of energy efficiency and cost savings has surged with the advent of smart home technologies, solar rooftop systems, and energy-efficient smart appliances. Government policies and programs, including tax credits and rebates for energy-efficient equipment installation in residential buildings have been in place, contributing to driving market growth in this sector. In industrial sector, energy efficiency improvements present positive impacts on energy consumption. The adoption of Energy Management Systems (EMS) has proven effective in monitoring, controlling, and optimizing energy usage, resulting in lower operational costs and environmental impact reduction. A growing trend involves in retrofitting older industrial plants with energy-efficient equipment, which not only decreases energy consumption but also enhances machinery lifespan and performance.

Mr Joachim Monkelbaan, Global Trade and Sustainable Development Advisor:

Digital transformation significantly contributes to enabling and benefiting energy efficiency such as improved monitoring and management of energy consumption, enhanced predictive maintenance and asset optimization, increased operational efficiency and cost savings, and reduced carbon footprint and environmental impacts.

Based on digitalization, data can be gathered through sensors, meters, interfaces and being analyzed through algorithm, AI, digital simulations, which will contribute to producing action (automation, controls, 3D printing, interfaces). Other key technologies can enable energy efficiency, too. For example, IoT for real-time data collection; big data analytics for insights and decision-making; AI for predictive maintenance and energy optimization; blockchain for secure energy transactions.

Digitalization can provide multiple benefits to end-use efficiency such as improving energy system cost saving, enabling variable renewable integration, as

well as promoting energy consumer empowerment.

The readiness for energy efficiency through digitalization will require the promotion of technology and business model innovation; minimization of negative environmental impacts; increase in digital skills and plan for job market transformation; equitable access to digitalization; adequate protection from cyber security and data privacy risks; trust in digital technologies; etc. It is inevitable that emerging technologies will dramatically contribute to shaping the future of energy efficiency. In addition, potential impact of automation, machine learning, AI, and smart grids will be in place and produce huge impacts on energy efficiency and the way our world operates.

In this context, it is recommended that public awareness and education should be strengthened such as raising public awareness about the benefits of a low-carbon economy; educating the public about the impact of their energy consumption; promoting sustainable lifestyle choices; promoting wider understanding of benefits, and so on. Besides, APEC can consolidate international collaboration among APEC member economies through collaborating with other economies and organizations to share knowledge and best practices; working together to develop global solutions to climate change; supporting international agreements and initiatives; promoting trade and investment, and so on.

2. Technologies and innovation to promote digital transformation for energy efficiency

Mr Liu Yang-guang, Division Director, Industrial Technology Research Institute (ITRI), Chinese Taipei: ITRI was founded in 1973, and pioneered in developing and nurturing new tech ventures and delivering its R&D results to industries, leveraging technological innovations to inspire new lifestyles, engineer market-driven solutions toward a better future. ITRI has launched its 2035 Technology Strategy & Roadmap, which aims to enable technologies with a focus on four application domains, namely smart living, quality health, sustainable

environment, and resilient society. To head forwards to the net-zero emissions in 2050, it outlines four strategies (energy transition, industrial transition, lifestyle transition, and social transition), based on two foundations, namely technology R&D (net-zero technology, negative emission technology, etc.,), and climate legislation (carbon pricing, green finance, etc.,).

The speaker shared the case of deep energy-savings in high-efficient equipment, Alo T - EMS (Energy Management System) for food retail stores in particular. Food retail stores are among those require energy intensive, in which freezers can consume up to 60% of retail store energy use, and face energy inefficiency (cool air leakage, frosting, etc.,). Through the Alo T- EMS, power in stores can be saved from 5 to 10%. Based on the demand response prediction algorithm, they can collect information and data, and hence, through a process, provide precise load shedding to achieve agreed-upon reduction levels, achieving a 5% reduction from contracted capacity for 1 hour. In case of energy-saving in new buildings, they develop "comprehensive strategy simulation", and "design optimization" based on sensing and measurement technology (IOT/EMS) and simulation analysis (building energy-saving configuration and design) to produce energy-saving improvements.

Mr Atchariya Jangchay, Engineer, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand: Thailand pursues 4.0 based on promotion and adoption of digitalization and innovation, and place priority in areas such as (i) food, agriculture and bio-tech; (ii) health, wellness and bio-medicine; (iii) smart device, robotics and metrachonics; (iv) digital, IoT, artificial intelligence and embedded technology; and (v) creative culture and high value services.

They identify 10 targeted S-curved industries, namely: agriculture and biotechnology; smart electronics; affluent medical and wellness tourism; next-

generation automotive; food for the future; biofuels and biochemical; digital economy; medical hub; automation and robotics; and aviation and logistics.

Thailand has experienced the last over 20 years to promote digitalization with specific targets for every single period. While in the first phase, they just focused on developing a digital foundation, in the 2nd and 3rd phase, they were more active and proactive in promoting inclusion to ensure everyone to reap the benefits of digitalization; and adopting full transformation to drive the economy with digital technology and innovation. In the last 10 years, Thailand has been more deeply involved in promoting global digital leadership, which aims to leverage Thailand a developed economy.

Thailand's Ministry of Digital Economy and Society (MDES) has also updated their strategic and operation five-year plan to rearrange the move towards digital transformation with the development of the RECODES 2023 – 2027. (R – resilience; E – engagement/empower; C – collaboration; O – organizational assets; D – data driven decision; E – eco system enhancement).

The Ministry of Energy has developed their 2024 Energy Plan, which specifies on increasing share of electricity generation from renewable energy to over 50%; increasing the use of electric vehicles (EV); promoting energy efficiency; and energy transition. Under the pillar of energy transition, they promote the 4D1E Policy (4D – digitalization; decarbonization; decentralization; de-regulation; 1E – electrification), aiming to support the energy transformation toward carbon neutrality. Under the Energy Efficiency Plan (EEP), Thailand has been more ambitious to revise their 2024 target of reducing energy intensity (FEC/GDP) by 36% by 2037 instead of 30% as in the 2018 EEP (base year of 2010 (8.54 -> 5.47 ktoe/MBaht).

Ms Yulia Kostevich, Co-founder and Managing Partner, Smart Business Trips (SBT) and Lingvista LLC, Russia: It is important to involve various innovative ecosystem stakeholders such as government, business, academia, etc., to promote

the adoption of digitalization in energy sector. As a technology and innovation solution company, SBT emphasizes the importance of partnering with innovative ecosystem players in different economies and help to scout techs and innovative solutions for enterprises in various industries. Collaboration is also particularly encouraged through MTS Startup Hub, involving relevant startups, incubators, digital labs, funds, co-working spaces, etc., which help enable to update trends and innovation, create effective infrastructure to pilot new technology and solutions, as well as adapt the best tailored solutions to specific demands.

3. Energy efficiency policy and policy tools

Mr Vu Quang Dang, Energy Independent Consultant, Viet Nam: Energy Service Companies (ESCOs) play an important role in energy market in Viet Nam. Currently, Viet Nam has approximately 200 domestic energy service companies (ESCOs) with main services on energy audit without financing for the assets. Some ESCOs are providing energy performance contracts (EPCs) for thermal steam in the South. Viet Nam Electricity (EVN) piloted some EPCs for solar water heaters and rooftop solar PV with actual energy saving of 65%.

The Viet Nam's Government is planning to revise the Energy Efficiency Law (EE Law) with new ESCO regulations in 2025. In 2023 – 2024, the Asian Development Bank (ADB) supported the Department of Energy Efficiency and Sustainable Development (under the Ministry of Industry and Trade, Viet Nam) in a study on proposing ESCO regulations with reference from China; India; Korea; Thailand; and the USA. The study deliverables are expected to provide reference inputs for ESCO regulations in the EE Law revision in 2025.

In practice, ESCOs encounter a number of challenges. ESCO energy efficiency activities are not yet defined in Viet Nam's system of economic sectors. Energy efficiency project costs and expenses are not classified as deductible expenses causing issues for providers and clients. The demand or use of ESCOs services is not regarded as energy efficiency solutions for mandated energy users under the

EE Law or its guiding documents. Regarding asset transfer, public entities are restricted from transferring/receiving assets to/from private entities on the conclusion of shared saving EPCs (auction requirements). With relations to EPC and dispute resolution, ESCOs are exposed to finance and recovery risk for assets developed/financed by ESCOs but located on the premises of clients. They do not have protective mechanism as well as no specialized agency to resolve disputes arising from the ESCO model.

With On-bill financing (OBF), power utilities are currently not permitted to receive payments from energy efficiency projects via electricity bills. Payment of electricity bills is required to be compliant with regulatory electricity tariffs.

Incentives and supportive mechanism are of low efficiency due to limited financial support to demand response (DR) programs under the Circular 23/2017/TT-BCT, as well as no legal framework to support ESCOs and energy efficiency activities. Besides, there is no standard energy efficiency measurement system in place. Energy supply contracting (ESC) is not recognized as an EPC in the energy efficiency context, and classified as electricity generation under the laws on electricity. There is no association for ESCOs to promote network cooperation and the ESCO market, either.

Dr He Yuan, Research Assistant, China Institute of Standardization: Chinese President Xi Jinping made an important speech at the General Debate of the 75th Session of the United Nations General Assembly in 2020, in which he pointed out that China pursues the vision of a community with a shared future for mankind, and aims to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060". In the 14th *Five-Year Plan for Domestic Economic and Social Development and Long-Range Objectives for 2035* released in 2021, China aims to reduce energy consumption per unit of GDP and the CO_2 emissions per unit of GDP by 13.5% and 18% respectively.

Under the plan, China would aim to accelerate the development of digital and intelligent energy to promote energy efficiency, through promoting the digitalization of energy infrastructure (including but not limited to carrying out the intelligent upgrading of equipment, facilities and processes in power plants, power grids, oil and gas fields, oil and gas pipeline networks, oil and gas reserves, coal mines, terminal energy use and others); building smart energy platforms and data centers (e.g.: improving the data property rights protection system, strengthening the open sharing of energy data resources, etc.,); implementing smart energy demonstration projects such as multi-energy complementary clean energy bases, source-grid, charge-storage integration projects, integrated energy services, intelligent microgrids, and virtual power plants, demonstration of smart energy system technologies).

Since minimum energy performance standards (MEPS) are globally seen as one of most cost-effective tools tackling the climate change challenges, China has regulated specific policies under the Notice on Further Strengthening the Upgrading and Application of Energy Conservation Standards, which include accelerating the development and revision of energy conservation standards in key fields; steadily improving requirements on energy consumption norm in key energy consumption industries; improving energy efficiency of key products and equipment; expanding the coverage of energy conservation standards. So far, there are almost 380 domestic standards on energy conservation. Among them, nearly half of them are MEPs including over 70 mandatory energy efficiency standards for energy consuming equipment and over 110 mandatory standards on energy consumption norm, and the other half of these standards includes the supporting standards on energy management, monitoring, energy savings assessment, energy efficient operation, etc.

Ịn practice, China has developed standards for digital transformation for energy efficiency based on both energy supply and energy demand. Under energy supply,

the standards for smart integrated energy system are developed for concept, system planning, interconnection to distributed renewable energy network, micro grid and energy storage, etc. Under energy demand, so as to facilitate the digital energy operation and management in industrial sectors, standards are developed for the construction of energy management, control center for industrial enterprises as well as smart home (household appliances), including but not limited to design, manufacturing, control, security, test methods of smart home, so that all appliances could be interconnected through internet, IOT.

Since 2016, QR code was introduced to China Energy Label, which provides stakeholders such as market supervisors and inspectors, regular consumers, test labs with digital access to plenty of information, including product performance, energy efficiency, configuration, key components, etc. Database of energy-using products, energy efficiency labeling website and file information system contribute to providing product energy efficiency, green and low-carbon performance, green and low-carbon certification, quality supervision and other information. The synergy of China energy labelling and energy efficiency standards brought about accumulative electricity savings of 33,00 billion kWh, which means annual electricity savings of 180 kWh in China.

Ms Ealeen Lee, Advance Operations Coordinator, Offshore APAC Siemens Gamesa Renewable Energy Offshore Wind Limited, Chinese Taipei: Siemens Gamesa is a provider in the windpower industry as they make and install wind turbines. Since 2017, they have established a strong foothold in Chinese Taipei based on secured orders, gradually enabling a potential for a competitive localized industry and aimed to make Chinese Taipei a regional hub in Asia Pacific. They focus on digitalizing wind services such as providing application maps (monitoring and control; application suite; mobile application; customer data mart); or providing digital services (24/7-365 monitoring and control; advanced

model based and vibration diagnostics; wind and energy forecasting; cyber security).

From their 24/7 remote centers (4 operational control centers, and 2 monitoring rooms), they can provide support to their operation around the world, monitoring 4,000,000 sensor signals from 31,000 turbines and take action whenever an issue occurs that may cause the turbines to stop. Alarms are first handled by a robot which can restart a turbine automatically, if the issue falls within certain parameters. They also employ the human-cyber-physical system (HCPS) comprising an AI (red loop) that directly controls the operation of the wind turbines in quasi real time, making predictions that aid the decision-making process.

Besides, they employ a digital twin of a wind turbine blade. The digital twin follows the entire life cycle of a wind turbine blade from manufacturing to operation and maintenance. With sensors deployed over the blade, in-service damages are monitored, allowing the model to be continuously updated. The structural integrity can be assessed using the digital twin. Different scenarios can be simulated using virtual testing incorporated with damages, which facilitates reliable and accurate decision making for operation and maintenance. The physical blade and its digital twin are connected using Industry 4.0 technologies such as the Internet of Things, cloud computing, big data, etc., forming an integrated cyber-physical system.

Mr Chen Yenhaw, Director of Research Division 1, Institute of Economic Research, Chinese Taipei: Chinese Taipei develops the 2050 Net-Zero Pathway, outlining specific milestones to pursue such as: no new coal-fired power plants by 2025; 40GW of wind and solar power capacity by 2023; installation of Carbon Capture, Utilisation, and Storage (CCUS) in coal and gas-fired power plants by 2040; renewable electricity accounts more than 60% and installation of smart substations reaches 100% by 2050. They make focused efforts in areas such as

building (improving in exterior design, energy efficiency and appliance energy efficiency standards); transportation (changing in travel behavior, reducing demand for transportation, and electro-mobility); industry (improving in energy efficiency, fuel switching, circular economy, and innovative technologies); electricity (scaling up renewable energy, developing new energy technologies, energy storage, and power grid upgrade); negative emissions technologies (demonstration by 2030, at scale by 2050).

Apart from formulating policies, they also apply digital tools to promote energy efficiency. With the vision to promote the adoption of smart city, they aim to promoting the diversification, localization, and cleanliness of power supply, encouraging the establishment of smart energy-saving and green power generation equipment as well as integrating renewable energy, smart grid, big data and IoT for their first city-level virtual power plant. AloT intergraded motor energy saving is also applied to reduce energy waste since motor-driven system such as pumps, fans can account up to 53% of the world's total electricity consumption. Motor technology is important to industrial sector efficiency with the electrification of industrial sector. As the end-use energy sector moves toward electrification, electric motors will replace part of the industrial power originally provided by internal combustion engines (such as some air compressors, water pumps, and lifting equipment).

The awareness of low-carbon results in the promotion of electric vehicles and the decarbonization of electricity, which are expected to reduce carbon emission by 30,300,000 tons in 2050. They also deploy Mobility as a Service (MaaS) to support sustainable and green transportation towards net-zero emission. Green MaaS Tracking System records the relevant attribute information of each point-to-point voyage, such as the green mobility provider/user, vehicle type, energy resource, origin, destination, travel distances, and the contract. Green MaaS Tracking System can help people to understand their commute behavior to increase the green transportation awareness.

4. Raising awareness, building capacity and developing approaches to promote digital transformation for energy efficiency

Mr Atchariya Jangchay, Engineer, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand: Under the Energy Efficiency Plan, to raise awareness and promote adoption of digital transformation for energy efficiency, Thailand considers developing key measures in industrial and commercial sectors for implementation, which include both compulsory and voluntary measures. For example, it might be mandatory to develop energy management standards; enforce energy codes in designated factories and buildings; develop energy efficiency measures for land transport (excise tax – eco stickers, energy efficiency standards and labelling for tires); enforce energy performance standards to improve energy efficiency for residence; develop farming energy code to enforce minimum energy performance standards in agriculture, and so on.

Meanwhile, it might be voluntary to promote energy efficiency standards, labelling for equipment as well as financial incentives (direct subsidies; soft loan, ESCO fund; tax incentives; credit guarantee; etc.,). It might be voluntary to promote and adopt innovation (IoT, smart factory, smart building, big data); and adopt energy efficiency resource standards (EERS) in equipment utilizing renewable energy (biomass boiler, biomass furnace, generator, solar heat, etc.). They also develop voluntary energy efficiency measures for land transport (logistics and transportation management, subsidy up to 30%, financial support for energy service companies); for water transport (freight and public transport); for rail transport (double-railed transport, electric mass transport, sub-urban transport, and high-speed train). In residential buildings, it might be voluntary to promote energy efficiency residence design and construction in accordance with high energy performance standards.

To facilitate the discussion and implementation, Thailand also develops an energy efficiency platform, which collect, analyze data of export energy consumption and energy savings to fulfill the database system of related agencies; facilitate, simplify and standardize energy efficiency projects to enable to access and raise fund through any appropriated finance or investment platform; facilitate, simplify and standardize energy savings results to support incentive schemes that might be initiated in the future to increase motivation on energy efficiency projects.

Mr Ly Manh Ha, Chairman of Directors, Green Power Engineering Consultant JSC, Viet Nam: It is stressed that the awareness can be significantly raised when real benefits are visible and able to be reaped. In that way, policies can be pathway to promote digital transformation for energy efficiency. In practice, in many developing and emerging economies, policies are not keeping up with the development of technology, which hinders and discourages investors and businesses in the energy markets. While sound policies can contribute to promoting the transfer of technology among economies, robust policy development and stronger international cooperation are needed to effectively disseminate progress to all regions, especially in emerging market and developing economies.

On the other hand, finance is considered a sufficient leverage in scaling up the digital transformation market for energy efficiency. Financial tools will become effective when fiscal policies and funding programs create the momentum to mobilize all societal resources to participate in the digital disruption process.

5. Multi-stakeholders and access to finance to promote digital transformation for energy efficiency

Mr Liu Yang-guang, Division Director, Industrial Technology Research Institute, Chinese Taipei: Chinese Taipei develops the Energy Saving Performance Contract (ESPC) Incentive (Demonstration Subsidy Program), which aims to cultivate Energy Service Company (ESCO) industry to conduct the

Energy-saving Performance Contract (ESPC) projects to achieve wider energy savings. The Energy Saving Performance Contract (ESPC) financing plays an important part in promoting ESCO industry through providing credit guarantee funds and financing opportunities for ESPC projects. Juridical entities (corporations), governments, public services, medical institutions, and schools are among those identified eligible for the ESPC incentive. Under the program, governance and technology promotion are factors highlighted. When the Energy Management System (EMS) is introduced into a building (or factory), it can provide real-time monitoring of power usage status, energy consumption analysis, etc., and provide energy management effectiveness reports. The EMS can be selectively introduced into power systems, air conditioning systems, lighting systems, compressed air systems and other public systems, etc., and hence, provide energy performance indicator report after one year. The achievements in energy saving practices can be described through the EMS, too.

Mr Dang Manh Cuong, Director, Forever Green Engineering Ltd Co., Viet Nam: The speaker focused on the roles of multistakeholders and importance of promoting collaboration and engagement of stakeholders to address challenges from various perspectives and promote energy efficiency with more robust and innovative approaches. The engagement of various stakeholders will contribute to promoting wider commitments, facilitating smooth and sustainable implementation, improve transparency as well as enable a comprehensive approach to address complicated issues related to energy efficiency and digital transformation, which require a holistic approach since it is involved with economic, social and environmental factors.

Governments play a key role in driving the digital transformation to achieve energy efficiency through a multi-faceted approach, including policy and regulation, as well as funding and incentives. Governments have responsibilities to establish a strong regulatory framework that sets clear energy efficiency standards and target, including developing and enforcing energy codes and

standards for buildings, equipment and industrial processes, ensuring that they meet stringent energy performance criteria. By implementing policies such as mandatory energy audits, energy performance labelling and minimum energy performance standards (MEPS), governments can promote the adoption of energy-saving technologies and practices across a range of sectors.

In addition to regulatory measures, governments also play an important role in providing funding and incentives to promote digital transformation in the energy efficiency sector. This can include direct financial support through grants, subsidies, and low-interest loans to reduce the upfront costs of deploying advanced energy-saving technologies. Governments can also provide tax incentives, such as tax credits or deductions, to businesses and households that invest in energy efficiency improvements. Furthermore, governments can establish public-private partnerships and green finance mechanisms to attract private sector investment and leverage additional resources. By supporting research and development initiatives, pilot projects, and demonstration programs, governments can foster innovation and accelerate the deployment of advanced digital solutions to improve energy efficiency. Finally, proactive engagement by governments in both the regulatory and financial sectors is essential to create an enabling environment that encourages widespread adoption of digital transformation initiatives to improve energy efficiency.

Viet Nam’s Prime Minister Pham Minh Chinh, Chairman of the National Committee on Digital Transformation, signed the Decision 58/QD-UBQGCDS promulgating the 2024 Action Plan. The extended goal of this plan is to promote digital transformation in an effective and practical manner, thereby contributing significantly to the economy's socio-economic development. This initiative aims to achieve the Government's socio-economic development goals by 2024 and the 2021-2025 period. To realize these goals, the Committee has set out specific implementation tasks, including:

- Inspection and supervision: Developing a plan to inspect and supervise the implementation of digital transformation tasks among ministries, branches and localities.
- Developing the semiconductor industry: Developing and submitting for promulgation of the Strategy for developing the semiconductor industry until 2030, with a vision to 2035.
- Business integration: Promoting, connecting and facilitating digital technology enterprises to participate in the digital transformation process in industrial parks and export processing zones.
- Prioritize Vietnamese solutions: Prioritizing the use of digital technology solutions developed by Vietnamese enterprises to promote local industries.
- Develop local enterprises: Promoting the development of local digital technology enterprises to strengthen the domestic digital ecosystem.
- Electronic invoice solution: Deploying electronic invoice solutions initiated from cash registers to prevent tax evasion and budget loss.

These strategic actions are designed to ensure that digital transformation efforts are both impactful and aligned with Viet Nam's broader socio-economic goals.

Non-governmental organizations (NGOs) and communities play a key role in driving the digital transformation to achieve energy efficiency through advocacy, awareness raising, and grassroots initiatives. Advocacy and awareness raising are crucial as NGOs leverage their platforms to educate the public and policymakers about the benefits of energy efficiency and the importance of digital transformation. They organize campaigns, workshops, and seminars to disseminate information on how digital tools can optimize energy use and reduce carbon emissions. By highlighting successful case studies and best practices, NGOs inspire action and promote an energy-conscious culture among various stakeholders.

Finance plays a key role in the energy efficiency sector, acting as the backbone for the deployment and sustainability of innovative solutions. Adequate funding is needed to cover the upfront investment required for innovative energy-saving technologies, retrofit existing infrastructure, and support research and development. Access to finance enables stakeholders, from small businesses to large enterprises, to undertake energy efficiency projects that can deliver significant cost savings and environmental benefits over time.

The digital transformation for energy efficiency relies on a variety of funding sources, including public funding, private investment, and international funding. Public funding typically comes from government grants and subsidies that promote sustainable practices. Private investment is driven by companies and venture capitalists seeking to capitalize on innovative energy solutions. International funding includes contributions from global institutions and development banks that support large-scale cross-border energy projects. Together, these types of funding create a robust financial ecosystem to drive energy efficiency initiatives.

6. Sharing further experiences from APEC economies

Dr He Yuan, Research Assistant, China Institute of Standardization: China has made great efforts during the past 40 years to develop a comprehensive energy efficiency standards systems through establishing domestic steering strategy, developing comprehensive policy portfolio, attracting the most engagement from various stakeholders, encouraging research and the development of emerging technologies and market, continuously conducting capacity building and actively participating the related international collaboration.

China has put energy efficiency and digitalization as the top priority in the must-do list for domestic sustainable development. In another words, digital transformation for energy efficiency is one of the domestic priorities, and therefore, all the key stakeholders are encouraged to pay the most attention and

efforts to the digital transformation for energy efficiency, which ensure sufficient resources inputs to facilitate the transformation effectively and rapidly.

So as to facilitate the transformation to enhance energy efficiency, comprehensive policy framework, engagement of stakeholders, enhanced R&D, capacity building and international collaboration are among important factors highlighted. Digital transformation for energy efficiency is a challenging mission for all the economies because it is a cross-sector and interdisciplinary task, which means at the top level, and need to build up synergy from the related ministries/governing bodies by making the related policies from the different perspectives, so that all the resources and stakeholders can be attracted and play their most due roles. For example, in March 2023, the "Several Opinions on Accelerating the Development of Digital and Intelligent Energy" issued by the National Energy Administration mentioned to promote the actual integration of digital and intelligent technology application. Regarding promotion of R&D, China also focuses on developing database for research and development of energy efficiency by conducting market surveys and field/desk investigation. Based on the database, they propose the development of MEPs. Once it is approved by the government, China will focus on drafting the MEPs. Under this stage, key stakeholders (industries, research institutes, universities, testing labs, etc.,) will be convened to join in the drafting team. Capacity building is highlighted to promote the adoption of digital transformation for energy efficiency through focusing on personnel training and buildup of database, which is the foundation for policy making, R&D, standards development, etc. In addition, both collaboration within and beyond APEC are emphasized, which plays an important role in facilitating the information communication, knowledge dissemination and practices sharing, and so on.

Ms Yulia Kostevich, Co-founder and Managing Partner, Smart Business Trips (SBT) and Lingvista LLC, Russia: The speaker focused on sharing practical cases of uptake of digital transformation for energy efficiency to address environmental issue including global warming, climate change, etc. For example, in practice, to

reduce global warming and electricity consumption, PAC Corporation develop innovative water PAC energy, which utilizes the heat generated by an air conditioner to produce hot water by extracting energy from the air conditioner' compressors before it is released into the atmosphere. The system is capable of producing hot water up to 70^{o} C without the need for electricity. Another case is SEDMAX, who offers an integrated platform designed to streamline and enhance the management of energy systems in industrial enterprises, which consolidates data from various sources into a unified interface, providing real-time monitoring, data analysis, and comprehensive control over energy resources. With relations to improving cyber security, CodeScoring offers the development of secure and efficient software by providing advanced tools to analyze both open sources and proprietary code components. With the comprehensive analysis, it helps to identify vulnerabilities, ensure license compliance and optimize code quality. These software can be deployed in essential facilities such as electrical networks, which safeguards against threats, ensuring reliable and trouble-free operation.

IV. Discussion, Recommendations and Conclusions

Through the active sharing of information and experiences at the Workshop, speakers and participants exchanged views on how to promote digital transformation for energy efficiency. Recommendations are summarized as below:

1. Recommendations for business

- Business should take an active approach and strategies to pursue energy efficiency through digital transformation such as making strong commitments to transformation; transforming the commitments into workflow in practice; taking bite-sized actions; and applying relevant digital technologies; etc.

2. Recommendations for APEC member economies/governments

- It is important to raise public awareness of importance and/or benefits of digital transformation and figuring out a practical approach to adopt digital

transformation for energy efficiency in the interest of stability, sustainability and security, for example, through offering incentives to encourage energy efficiency practices, etc.

- The transformation might require a strong and efficient governance based on the four important pillars, named “the Sustainable Energy Transitions Diamond” that include technology (innovation), resources, human, and economics (finance, markets, trade).

- Governments should champion efforts for transformation. For example, promote connectivity and interoperability, increase coordinated investment, empower customers, promote greater efficiency, and so on. Governments’ policies should also reflect rapid developments in practice and act as a pathway to promote energy efficiency.

- Roles of multi-stakeholders can be consolidated through promoting collaboration and cooperation; creating frequent and adequate mechanisms or networks to support the transformation in practice. By leveraging the diverse expertise and perspectives of various stakeholders as well as securing access to the right financial resources, we can enable the transformation for a sustainable energy future.

- The development and adoption of smart Heating, Ventilation, and Air Conditioning (HVAC), EMS, smart grid and/or electric vehicles infrastructure, smart grid integrating renewable energy, extended energy storage solutions, promotion of automation in residential buildings and factories should be practically encouraged to improve energy efficiency.

3. Recommendations for APEC

- APEC should lead a more active role in leading energy efficiency through promoting digital transformation in energy sector, through sharing knowledge, experiences, best practices, or training programs.

- APEC continues to implement the APEC Internet and Digital Economy Roadmap (AIDER); promote innovative, inclusive, and sustainable growth; facilitate e-commerce and digital trade; promote renewable energy integration and energy efficiency, etc.

- APEC can also champion to promote stronger international cooperation and robust policy development to promote energy efficiency in the region in general, through digital transformation in particular.

Hereinabove are some recommendations from the workshop's participants and speakers that require further thoughts and discussions at the upcoming EWG meetings to transform into more concrete and practical activities.