APPENDIX B

Asia-Pacific
Economic Cooperation

APEC Workshop on Energy Intensity Reduction in the APEC Regions' Urbanised Cities

WORKSHOP SUMMARY REPORT

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APEC Energy Working Group

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1 Background

Asia-Pacific Economic Cooperation (APEC) Workshop on Energy Intensity Reduction (EIR) in the APEC Regions' Urbanised Cities was held on 23 March 2021 in Hong Kong, China. The workshop targeted to analyse the energy intensity reduction performance in developed APEC member economies' urbanised cities, and then identified key drivers for accelerating aggregated energy intensity reduction for new and existing buildings, in addition to regulations. By disseminating the policies and experiences from urbanised cities of the developed economies and emerging Energy Efficiency and Conservation (EE&C) technology application opportunities, the outcomes of this project enabled the policymakers to have a guidance of urbanising their city to a low aggregated energy intensity in one sitting.

2 Objective

The workshop was a full-day event conducted via a virtual platform and physical attendance in Hong Kong, China. The workshop supported collaboration and capacity building which enabled member economies, particularly the developing economies, to obtain, share, strengthen, maintain and develop knowledge, abilities, skills and technical know-how to improve their EE&C policies and regulations in the building sector. Furthermore, the experience shared by regulators, experts, international organisations, designers and operators during the workshop provided a platform for dialogue between APEC member economies with a view to mapping out guidelines for the implementation of building EE&C measures and achieving the APEC goal of energy intensity reduction. The EIR workshop agenda is attached in Appendix A.

There were sixteen (16) speakers and eighty-eight (88) participants from twelve (12) APEC member economies, and seven (7) international organisations, including Asia Pacific Energy Research Centre (APERC) and APEC Sustainable Energy Centre (APSEC), attending this online workshop. The attendees were from Australia, China, Hong Kong, China, Japan, the Republic of Korea, Malaysia, Mexico, the Philippines, Singapore, Chinese Taipei, Thailand, and the United States.

3 Workshop Summary

3.1 Opening Remarks

Presenter: Mr WONG Kam-sing, GBS, JP, Secretary for the Environment, the Government of the Hong Kong Special Administrative Region, Hong Kong, China

APEC's Energy Intensity Reduction Goal is to reduce APEC's aggregate energy intensity by 45% by 2035, against the 2005 level. Hong Kong, China (HKC) has set a more ambitious target to reduce energy intensity by 40%.

On a more strategic level, the reduction in energy intensity helps to mitigate climate change. HKC's targeted to reduce its carbon intensity by 65 per cent to 70 per cent by 2030 compared with the 2005 level. Mr WONG reported that HKC's carbon emission peaked in 2014, and the carbon intensity in 2018 was about 36% lower than the 2005 level. As for the long-term decarbonisation strategy, HKC strives to achieve carbon neutrality before 2050.

Besides focusing on fuel for electricity generation and adopting more zero-carbon energy. The HKC Government has also been taking the lead in developing renewable energy and facilitating the private sector to do the same. The Government explores different types of zero-carbon energy and decarbonisation technology, enhances the energy efficiency of both new and existing buildings, introduces more stringent energy efficiency standards, promotes green mobility, and develops large-scale waste-to-energy/resources facilities, etc. In addition, green finance has been introduced to boost investments conducive to reducing carbon emissions, build a low-carbon economy which is more resilient to climate change, and enhance public education and publicity.

Mr WONG concluded that building a greener future requires the concerted efforts of every sector of society and every economy in the region.

3.2 Welcoming Speech

Presenter: Mr VY Ek Chin, EGEEC Chair

APEC member economies consume approximately 60% of the global energy. With the region urbanising progressively and the population shifting from rural to urban areas, energy consumption will be increased to support the region's urbanisation in the coming decades.

To support APEC Leaders' goal to reduce aggregate energy intensity by at least 45% by 2035, Mr VY reported that the APEC EGEE&C has been encouraging member economies to promote energy efficiency and conservation in supporting the development of energy-smart, low-carbon communities. Member economies recognised the importance of sustainable energy development and incorporated various EE&C strategies and initiatives into their economic development plans. Meanwhile, member economies are actively participating in conducting APEC Projects to translate the policy directions into actions and create tangible benefits for people in the Asia-Pacific region.

In 2019, Hong Kong, China secured the APEC Project Funding to study the energy intensity reduction performance in APEC's urbanised cities to share the most effective pathways to reach the energy intensity reduction goal and promote the development of sustainable communities across the region. Mr VY hoped that the policymakers had a burning ambition to achieve the energy intensity reduction goal. All member economies were encouraged to continue playing vital roles in the APEC region and join hands to promote EE&C in combating the climate challenges.

3.3 Introduction of the Project and Findings

Presenter: Ir Gigi KAM, Research leader of the project, Associate Director from Arup Hong Kong

There were two stages in this study. The first stage was the Conceptual Study to shortlist seven cities with outstanding energy performance according to the urbanisation level, leading performance in energy intensity reduction, the weighting of building energy consumption and availability of GDP and energy data. It would be a good development direction to collect data at the city level for long-term energy data analysis. In the second stage of the study, the historical events, policies, GDP and energy end-use data of the shortlisted cities were reviewed. Key drivers for successful building energy reduction were identified. The final study outcome will be on the best practice of policies, key drivers, innovation and technology implementation in the building sector.

The seven shortlisted cities for this study were the City of Sydney, Australia; Beijing, China; Hong Kong, China; Tokyo, Japan; Seoul, the Republic of Korea; Singapore and New York City, the United States.

Ir KAM reported the interim findings of each shortlisted city as below.

1. The City of Sydney:

The National Construction Code (NCC) is a performance-based code containing all Performance Requirements for the construction buildings and setting out minimum building energy performance requirements. Energy efficiency is a core focus of the Australian Building Codes Board and forms part of the Australian, state, and territory governments' strategies to improve energy productivity.

National Australian Built Environment Rating System (NABERS) is a domestic initiative managed by the NSW Department of Planning, Industry and Environment. The energy ratings are based on actual energy data and compared to buildings' environmental performance. The rating tools can be applied to various types of buildings, including office buildings and

tenancies, shopping centres, apartment buildings, hospitals, hotels, and data centres. Green Star and Building Sustainability Index are commonly used in Sydney in rating building sustainability performance.

Collaboration between the Government and private sector is emphasised in Sydney. The Better Buildings Partnership aims to achieve a 70% greenhouse gas emission reduction target according to the "Sustainable Sydney 2030". Leading property owners and industry influencers work together to develop collaborative solutions to reduce energy use in existing service buildings.

Energy Saving Scheme was launched in 2009 by the New South Wales Government. The scheme provides financial incentives in terms of Energy Savings Certificates. Details of the scheme are revised annually to incorporate feedback from stakeholders and new technologies.

2. Beijing

Aiming for sustainable economic growth, the China Central Government continuously developed the Five-Year Plan to set domestic targets. The Beijing Government further developed its roadmap to set out a solid target and methodology to reduce building energy use. Implementation and monitoring of the energy reduction achievement fall to the district government's work. Apart from code and technical guidelines, the Beijing Government provides funding, feasibility assessment and technical support to the building owners to motivate the city to achieve the energy reduction target.

3. Hong Kong, China

The HKC Government enacted the Buildings Energy Efficiency Ordinance into full operation in 2012. The ordinance regulates the energy efficiency of the building services systems and requires the building owner to perform an energy audit for the existing buildings.

BEAM Plus Green Building Certification covers both passive and active system design and emphasises the building energy end-use. GFA concession isis linked to the BEAM Plus certification scheme to reward new buildings in achieving the basic requirements of energy saving and sustainable design.

The mandatory and voluntary Energy Efficiency Labelling Schemes have been implemented in HKC to encourage the wide use of energy-efficient household and office appliances.

4. Tokyo

In 2005, the Tokyo Metropolitan Government launched various policies and measures in addressing climate change and improving energy efficiency in the building sector. Mandatory CO2 Emissions Reduction Programme and Tokyo Cap-and-Trade Programme are successful drivers in achieving the energy consumption reduction target. Numerous labelling schemes are

adopted to promote sustainable building design and operation, such as Comprehensive Assessment System for Built Environment Efficiency (CASBEE), Building-Housing Energy-efficiency Labelling System, Energy Performance Certificate, Green Labelling for Residential Buildings and Zero Energy Building labelling scheme.

In governing the energy efficiency standards for energy-intensive products, for example, home appliances and motor vehicles, the "Top Runner Program" is implemented to regulate the energy efficiency requirements to drive companies to make a more efficient model for competing for the award. Compliance with the standard will be rewarded, while non-compliance with the standard will result in a penalty.

5. Seoul

The mandatory design code and guidelines for energy-efficient buildings are launched in Seoul. The guidelines are developed based on the domestic building energy labelling programme and green building certification programme.

G-Seed certifies eco-friendly buildings that have saved energy and reduced environmental pollution throughout their life-cycle. In contrast, Zero Energy Building Certification endorses the buildings with exceptionally high-efficiency achievement based on an Energy Independent Rate.

Energy efficiency product labelling is fully implemented in Seoul. The e-Standby Program mandatory was launched in 1999 to reduce the standby power of electronic appliances and office equipment. From 2003 to 2011, 45% less standby power was achieved, which demonstrated its success.

6. Singapore

In Singapore, the Green Mark Certification Scheme is closely related to the Code for Environmental Sustainability of Buildings. Buildings are required to achieve the minimum scores under Green Mark as a mandatory requirement.

Singapore offers conspicuous financial incentives to accelerate the energy reduction move. The Green Mark Incentive Schemes assist building owners to overcome the high initial cost of retrofitting existing buildings. The Green Mark GFA Incentive Scheme is a performance-related scheme to allow the building that achieved a higher Green Mark rating will be granted a higher percentage of GFA concession.

Singapore launched the Super Low Energy Building Smart Hub website as an online energy resource centre to introduce the latest energy-efficient technologies and solutions. It provides a centralised energy statistic database with an interactive dashboard.

7. The New York City

The Greener, Greater Building Plan (GGBP) involves a comprehensive set of building efficiency laws for all new residential and commercial buildings, as well as renovations and existing buildings in New York City (NYC).

The GGBP highlights the energy consumption in existing buildings. Nearly all existing buildings in NYC are required to be retrofitted for aligning the city's energy intensity reduction roadmap. Local Law mandated professional energy audit and retro-commissioning to large buildings, benchmarking and reporting of energy consumption data.

The Energy Star for products is a voluntary labelling scheme that certified appliances to meet strict energy efficiency standards. The Energy Star for buildings is a trend apart from the LEED Certification Scheme.

The interim findings showed that none of the key drivers of EE&C existed independently. Some policies form the basis of other programmes. For example, building energy codes and appliance energy labelling set the baseline for assessing the building energy performance under the green building certification scheme. Furthermore, data collected through energy audits and certification can be analysed for benchmarking purposes. The benchmarking of energy end-use can then be used to determine the long-term energy use reduction target and roadmap to motive energy efficiency improvement through comparative consumption and visualise super low energy building development.

The interim study reveals that a solid and holistic framework helps achieve the APEC's energy intensity reduction target. Building Energy Code shall be developed as the foundation of the mandatory policy infrastructure to cover both new and existing buildings. The codes and policies shall be upgraded regularly to drive energy efficiency improvement.

Data transparency is essential in helping people to green their buildings. The Government shall collect energy performance to assist the policymaker in setting the reduction target and assess the current policy's effectiveness. The Government shall lead by example, not just in creating an environment in which others can improve energy efficiency, but by putting in place new measures that allow Government departments to do the same. The Government can provide financial or non-financial incentives to support the building energy performance requirement and encourage the building owners to achieve more advanced reduction targets. For the appliances, a minimum energy performance requirement can regulate energy consumption. Additional labelling systems to govern the standby power can be introduced to encourage energy-saving products which consume low standby power. The regulated appliances shall extend from household to office appliances.

Ir KAM concluded that advanced innovative technology, such as the Internet of Things (IoT), machine learning and city-level digital twin will become a trend for energy optimisation in this digital era.

3.4 Section 1: Policy & Regulation

Sharing 1-1: U.S. Experiences in Urban Energy Intensity Reduction

Presenter: Dr Cary BLOYD, Senior Advisor from Pacific Northwest National Laboratory, the United States

New York City (NYC) is the most populous and densely populated city in the United States. Dr BLOYD shared the energy-efficient implementation of the Empire State Building and One World Trade Center as examples. Empire State Building was built in 1930 and retrofitted in 2010 by adopting several energy-efficient measures, including an automated window blind system, automatic interior LED lights, regenerative elevators, and shutting off unused power outlets during non-occupied periods. One World Trade Center, completed in 2014, incorporated energy-efficient measures into the building design, such as natural lighting through spiral building skins, variable voltage variable frequency elevators, regenerative elevators and a 4.8 MW Pure cell phosphoric acid fuel cell.

The Department of Citywide Administrative Services (DCAS), Division of Energy Management (DEM) is the hub to support public and private buildings towards emission reduction and energy objectives. DEM sets five goals, i.e. “80 × 50” targeted 80 % economy-wide reduction in overall New York City emissions by 2050; “40 × 25” and “50 × 30” targeted 40 % emissions reduction for City Government operations by 2025 and 50 % by 2030; “100MW × 25” required installing 100-megawatts of solar photovoltaic systems on city buildings by 2025; “100MWh × 20” required installing 100-megawatt hours of energy storage across private and public facilities by 2020; Executive Order 26 (“EO26”) committed the city to the principles of the Paris Climate Agreement. The city pledged to reduce energy usage from city buildings by a further 20 % by 2025 with the Fiscal Year 2016 baseline.

The DEM has a large online library providing major energy management reports and publications for city agencies. The Technical Working Group (TWG) issued the “One City Build to Last” with several suggestions, such as updating the existing buildings with energy efficiency and GHG emissions reduction, designing and constructing the new buildings concerning whole building energy performance, addressing tenant energy use, ensuring the readiness of the workforce to deliver high-performance buildings and assisting building owners investing on energy efficiency improvements.

Dr BLOYD recommended that the leader from the top is essential for making the city as efficient as possible. Also, the actions shall involve a broad range of city interest groups in the planning process. There shall be a commitment from human and financial resources to maximise building energy efficiency. The energy efficiency enhancement works should be an ongoing process by us.

Sharing 1-2: Australian breakthroughs on building energy efficiency

Presenter: Mr Carlos FLORES, Director from National Australian Built Environment Rating System, Australia

"National Australian Built Environment Rating System" (NABERS) is a performance-based domestic rating system initiated by the Australian Government for building sustainability measurement. NABERS measures and compares buildings based on 12 months of performance data with a six-star rating (six being the highest performance indicating the most efficient energy-saving performance compared to similar buildings in Australia).

Mr FLORES reported that NABERS mainly focused on service buildings with large energy consumption, including offices, shopping centres, hotels, etc. Energy consumption data from Australia Square demonstrated how the existing buildings enhance their energy efficiency through years of improvement and achieve the highest rating in NABERS. Energy efficiency measures should not only be implemented in new buildings, but also in existing buildings which can also have a significant amount of energy saving.

For existing buildings, apart from deep retrofits with large investments, the buildings shall seek every small opportunity for a gradual process of reducing energy consumption. Data from the office building sector shows that on average, a 33 % reduction has been achieved since the building achieved the first NABERS rating in the past decade, which is the fastest reduction of energy consumption in the office sector around the world.

There are two policies that Mr FLORES considered to be the most effective in driving energy efficiency in buildings in Sydney, they are Government leasing and commercial building data disclosure. The Government leasing policy states that the Government will only rent buildings which achieve minimum energy performance of a 4-star rating. This policy stimulates the building owners to certify for NABERS. The commercial building disclosure policy mandates the disclosure of energy performance. The owners shall disclose the NABERS rating on the website, on-site and in lease documents etc. This policy makes the energy consumption data transparent to the public and brings a lot of office buildings into NABERS every year. The policy not only increases the number of buildings certified under NABERS, but more importantly, it also brings a positive impact on the energy saving of commercial buildings. In

particular, 35% of energy was saved in office sectors in 9 years when the disclosure policy was introduced.

For building owners, NABERS benefits beyond energy efficiency, it also creates financial values for being greener. Market leaders tend to choose more sustainable buildings. Statistics showed that buildings with higher energy performance have longer leases, lower vacancy rates and more values.

The NABERS website discloses sustainability portfolio index rankings for most of the major property owners and their properties. The property owners can learn from other targets and work out a strategy on how to improve their rankings. There were many barriers, both in terms of financial and technical aspects, to promote energy efficiency in the building sector. NABERS helps to break down the information barrier. Transparent energy consumption data can help create a positive competitive environment for the market to implement energy-efficient measures in buildings.

Sharing 1-3: Building Energy Efficiency Policy in the Republic of Korea

Presenter: Dr Kihyun PARK and Mr Minkyu KIM, representatives from Korea Energy Economics Institute, the Republic of Korea

In the Republic of Korea, the Basic Plan for Energy Use Rationalization is established and implemented every five years. The Basic Plan presents goals, visions, and implementation tasks for rational energy use from the demand side. The plan includes high-level mid to long-term implementation strategies. It covers energy demand management, energy efficiency improvement and system improvement.

In the 5th plan (2013-2017), the final energy consumption reduction target for the building sector in 2017 was achieved. During the 5th plan, the Government promoted energy efficiency improvement through regulations such as replacing LEDs in public institutions and mandatory certification of zero energy in public buildings.
In the 6th plan (2020-2024), the final energy consumption reduction target in the building sector is 7.5% as compared with the forecast consumption in 2024. Mr KIM summarised several tasks that were carried out for reaching the target, such as providing Investment Support for public buildings to implement energy-saving strategies, creating an investment market by expanding the coverage of mandatory Zero Energy Certification to more new buildings and existing buildings, developing an energy consumption information database and carrying out strategic R&D of data utilisation in building operation and energy management.

The policy “Green New Deal” was launched in July 2020, aiming to accelerate the transition to a green economy, such as eco-friendly and low-carbon, toward carbon neutrality (Net-Zero). The New Deal plans to invest about US$4.8 billion and create 124,000 jobs by 2025.

To achieve the target energy saving target, various building energy efficiency policies are implemented, as summarised below.

	Policy
Existing Building	Building GHG and energy target management system
	Efficiency of energy use in public institutions
New Building	Zero Energy Building Certification
	Building Energy Saving Plan
	Environment-friendly Housing Performance Evaluation System
	Activation of Supply of Building Energy Management System(BEMS)
Existing Building and New Building	Building Energy Efficiency Rating Certification System
	Building Energy Evaluator

Green Remodelling will be one of the major focus areas under the building sector of the Green Deal. The Green Remodeling Activation Plan targets to engage private participation and links with the Eastern Evaluation Research Society (EERS). The plan includes financial support, such as interest-free loans, subsidies and repayment as well as promoting business links with EERS. It is expected that various socioeconomic effects of Green Remodelling will combat the double crises of the environment and economy by reducing the GHG emission in response to climate change, creating job opportunities and even lowering housing costs.

3.5 Section 2: Incentives

Sharing 2-1: Presentation by Singapore

Presenter: Ms Regina LEE, Analyst International Relations Branch External Relations Department from Energy Market Authority

In February 2021, Singapore launched Green Plan 2030. The plan consists of five pillars: City and Nature, Sustainable Living, Energy Reset, Green Economy and Resilient Future. Under each of these pillars, Singapore set up ambitious plans which will target over the next 10 years. The four plans identified are natural gas, solar, regional power grid and low-carbon alternatives,

which will guide and transfer Singapore's energy landscape over the next 50 years.

The building sector plays a critical role in energy efficiency. For the building and construction sectors, the incentive is driven by the Building and Construction Authority (BCA). Singapore's green journey started in 2005 by launching the BCA Green Mark scheme, with the following key milestone: 2006 -1st green building masterplan, 2008 - environmental sustainability legislation for new buildings, 2009- 2nd green building masterplan, 2012 - environmental sustainability legislation for existing buildings, 2014- 3rd green building masterplan, 2018- SLE buildings roadmap. Singapore targets to achieve 80% building GFA to be recognized as 'green' by 2030.

The Green Mark scheme launched by BCA in 2005 is an internationally recognized green building rating system tailored for the tropical climate in Singapore. It provides a comprehensive framework for assessing the overall environmental performance of new and existing buildings to promote sustainable design.

BCA launched the Super Low Energy (SLE) Programme in 2018 to encourage cost-effective and energy-efficient building designs tailor-made to Singapore's climate and urban environment. The program includes a technology roadmap, Green Mark, an artificial intelligence-enabled smart calculation system. The SLE technology is grouped into four categories: Passive, Active, Smart Energy Management and Renewable Energy. Green Mark has set up criteria for SLE buildings to achieve 60% to 80% energy reduction as compared with the 2005 baseline. Lastly, the "National Research Foundation" has funded the SLE Building Smart Hub, which is a platform for building an energy technology database and assessing the SLE potential for building owners, professionals, researchers and policymakers.

The Green Buildings Innovation Cluster, launched in 2014, can accelerate to SLE. It catalyses technology development, funds innovation piloting for SLE buildings and shares the latest technology with the industry.

School of Environment Building 4 (SDE4) of the "National University of Singapore" has been shared as an example of a net-zero energy building. SDE4 was the first new net-zero energy building in South East Asia. It is designed to be climate responsive, energy efficient and environmentally friendly, and only consumes as much energy as it generates. The SDE4 features sustainable designs, such as solar roof installations, a hybrid cooling system, innovative ventilation systems and architectural structures.

Sharing 2-2: Can a building be running at zero carbon?

Presenter: Prof. Yi JIANG, Director of Building Energy Research Centre, Tsinghua University, China

Prof. JIANG has introduced the possible roadmap to achieve a low carbon development for China and how the buildings can be changed to a low carbon future.

Two problems are to be addressed in China, one is to reduce the fuel demand as much as possible and the other is to harness the uncontrollable wind and solar power. The building sector is necessary to develop a fully electricity-driven format. However, it could be a challenge to replace gas with electricity in China for cooking and gas boilers. Another challenge is to balance the supply and demand for unstable wind or solar power technology. Prof. JIANG suggested that electric vehicles (EVs) can play an important role to solve the problem.

Prof. JIANG introduced a new type of energy-flexible building "PSDFP means Solar PV on building external surface; S means electricity storages with distributed battery and the EV; D means direct current (DC) power supply inside buildings; F means flexible load to the grid. For a PSDF building, solar power would be the major energy source while the electricity will be transmitted through the buildings through a DC bus to serve the equipment and EVs. The PSDF building with EV as energy storage will act as a virtual power plant and balance the energy supply and demand. The additional benefits of the PSDF system include the reduction of the power access capacity, enhancement of the reliability of power supply, a better quality of electric energy, improved safety due to low voltage DC, and less energy loss compared with the AC system. The equipment loading in PSDF buildings shall be in DC voltage. Electrical appliances, such as lighting, motor, electronics and thermal devices, can be powered by DC. In terms of cost, AC and DC systems would be similar. The charger for an EV would be an investment, however, it can be shared with the EV carpark operator.

Prof. JIANG reported that China plans to have 100GW installations of solar and wind power annually before 2030, and around 150-200 GW annually after 2030. To coordinate with the renewable energy installation plan in China, about half of the new buildings shall be PSDF buildings (0.5 to 1 billion m2 floor area) and 1.5 to 2 billion m2 buildings should be retrofitted into PSDF annually after 2030, to realize the fully zero-carbon electricity by 2050.

Currently, Prof. JIANG reported that the pilot PSDF buildings were completed in Shenzhen and Zhuhai. DC building alliance has been established through the joint effort from research institutes, universities, and industries. Standards for design and operation are under development to provide technical and policy support. PSDF could be a possible strategy to achieve zero carbon. Not only are buildings the energy consumers, but they are also energy producers and energy storage. Great changes need to be made for achieving zero carbon building.

Sharing 2-3: Energy Efficiency for Livable Cities and Role of Asian Development Bank

Presenter: Dr Yongping ZHAI, Chief of Energy Sector Group, Sustainable Development and Climate Change Department, Asian Development Bank

Dr ZHAI reported that the energy intensity in Asia has decreased by 3.6%, which achieved the highest improvement compared to other regions. However, energy demand is increasing quickly due to the growing economy. Buildings make up 27% of the energy consumption in ASEAN, China and India. Energy intensity reduction in the building sector is not sufficient to offset the growing building floor area to achieve the IEA's sustainable development scenario (SDS). A lot of effort is required to get on track with SDS.

Asia is the key driver of the growth of global building stock, which accounts for 65% of new floor area to be constructed from now to 2050. There is an urgent need to avoid the existence of inefficient and carbon-intensive buildings (both new and existing) in Asia. The newly constructed buildings should be designed with a higher standard building energy code.

Policy, technology and financing shall form the three major pillars for achieving energy efficiency in new buildings, existing buildings, building operations and systems and appliances. Asian Development Bank's (ADB) energy sector's operation follows three guiding principles, Sustainable development goals 7 (SDG 7) – Universal Energy Access, United Nations – Global Climate Goals and ADB Strategy 2030. The energy sector accounts for 20% of ADB's lending between 2009 and 2020. Among these guiding principles, 45% are in renewable energy, energy efficiency as well as a cleaner fuel.

ADB works with Energy Efficiency Services Limited (EESL) to provide financial support to sub-borrowers including small businesses, industries and households. Through the ESCO business model, EESL helps to replace inefficient lighting and agricultural water pumps. The project has demonstrated that an energy efficiency business is financially viable with a high rate of return.

ADB works with Jinan Heating Group to carry out the three sub-projects related to clean heating, including waste heat utilisation to supply heat to the industrial park, retrofitting of residential buildings to improve energy efficiency as well as the adoption of heat pumps for space heating, and low-emission combined district heating and cooling.

ADB provided technical and financial support for energy-efficient solutions in the centralised air-conditioning systems to provide a clean and healthy indoor environment.

3.6 Section 3: Implementation

Sharing 3-1: Energy Efficiency Issues in APEC Low-Carbon Model Town (LCMT) Project

Presenter: Dr Kazutomo IRIE, President, Asia Pacific Energy Research Centre (APERC)

APERC has been pursuing energy efficiency issues in APEC Region's cities mainly through the APEC LCMT project, especially "The Concept of the Low-Carbon Town in the APEC Region (the Concept)" published in November 2016. This Concept included case studies and practical methodologies for town planning and design.

For buildings, low-carbon building is a critical action. In office and commercial buildings, a lot of electricity and heat energy is used for air conditioning, lighting, office automation equipment and hot-water supply. It is advisable to follow the three steps as they will lead to more efficient and cost-effective CO2 reduction. The first step is to reduce heat load in buildings through rooftop greenery and improve the heat insulation of windows, etc. The second step is to deploy passive energy design, such as natural lighting and natural ventilation. The last step is to improve energy efficiency in air conditioning, lighting equipment, etc.

Building-level energy management systems prevent unnecessary energy use by automatically adjusting the operation of equipment in a building. Depending on the type of the targeted buildings, there are different forms of building-level energy management systems: building energy management systems (BEMS), home energy management systems (HEMS) and factory energy management systems (FEMS).

Energy management systems at the regional or district level will prevent unnecessary energy use in the central heat-supply plants. These systems use surveillance and control systems and high-speed communication networks to monitor and control plant operations. This energy management system is called the Area Energy Management System (AEMS).

The other component is the smart grid system. The smart grid system is a new concept of electricity transmission/distribution network that controls and optimizes the flow of electricity from both the demand and supply sides. These systems require the installation of smart meters on the demand side. Smart grid systems have several benefits, such as a reduction in electricity consumption by improved management with smart meters, stability of electricity supply and prevention of blackouts will be improved, and controlling surplus renewable energy generated electricity by temporarily storing and discharging using batteries or other storage technologies connected to the grid (e.g. thermal storage, pumped hydro).

Sharing 3-2: Experience Sharing of Retro-commissioning in Hong Kong, China

Presenter: Mr KW KONG, Senior Engineer, Electrical and Mechanical Services Department, Hong Kong, China

Mr KONG introduced retro-commissioning. When a building has operated for a certain period, it often gets out of tune due to the changes induced by addition, alterations and improvement works, drift off control set points and drop in accuracy of sensors. All these factors would result in decreasing building energy efficiency which causes higher energy consumption and unsatisfactory system performance. (RCx) as a cost-effective and systematic process to check the energy performance periodically of the existing building. The process can identify operational improvements that effectively reduce energy consumption. The framework of retro-commissioning consists of four work stages, which are planning, implementation, verification and ongoing commissioning. Mr KONG explained the five keys to unlocking the benefits of retro-commissioning.

The first one is to lead by example. Besides the development of Technical Guidelines on Retro-commissioning with good practices and valuable experiences for sharing with the stakeholders, the implementation of retro-commissioning at government buildings will be an example for the industry to refer to. A seven-year retro-commissioning program is launched in 2019, targeting to cover over 200 government buildings.

The second key solution is to launch training schemes. To top up retro-commissioning skills for operation and facilities management staff, training schemes for RCx are provided. In 2019, Hong Kong Green Building Council (HKGBC) launched the “Retro-commissioning Training and Registration Scheme” (Scheme). This scheme aims to build greater capacity among retro-commissioning professionals and practitioners.

The third key is to encourage public participation. The targeted participants are property developers, property management companies, hotels, utility companies, professional organisations, large corporations and public bodies. The 4Ts framework is launched with 4T partners who have been encouraged to set their energy-saving targets and timelines, work together and share their energy-saving measures for achieving transparency. Moreover, a retro-commissioning competition was organised to encourage implementation and awareness.

The fourth key is the establishment of sharing platform. Technical support is vital for implementing a new policy, the online Retro-commissioning resources centre is a website launched in 2017 to share the latest technical guidelines, training and seminar information and successful cases.

The fifth key is to provide incentives. Power companies provided the Eco-Building Funds and the Smart Power Building Fund, under the Scheme of Control Agreements with the Government, to support the citizens to implement retro-commissioning.

Sharing 3-3: Tokyo's Actions for 2050 Carbon Neutral- Buildings Sector

Presenter: Dr Naoko DOI, Senior Economist, Manager, Energy Efficiency Group, Climate Change and Energy Efficiency Unit of the Institute of Energy Economics, Japan

Dr DOI reported that the latest Tokyo's 2050 Carbon Neutral Target aims at 38% of energy savings done by 2030, compared with the level in 2000. The CO2 emissions shall be reduced by 30% by 2030 compared to 2000.

Tokyo Cap-and-Trade Program is critical as a top-level certification system. There is a detailed checklist for assisting to reach energy savings or CO2 emissions reduction targets. Building owners need to have their buildings certified at the top level. Building owners have to fill two asserting lists on the checklist for energy savings. If the scores are more than 80%, the building would be certified as a top-level building. Aside from the contribution of CO2 emissions reduction, the checklist also serves as an emergency procedure after the great Osaka earthquake and the rolling blackout.

For Tokyo Cap-and-Trade Program, commercial buildings/factories with annual energy consumption above 1,500 kJ should comply with the target. The first compliance period was 2010-2014 and the second was 2015-2019. There are penalties in case the buildings fail to reach the target, e.g. commercial buildings/factories are requested to meet more emissions reduction than the original target (1.3 times higher). Besides, if a company fails to meet the target, it would be charged with a penalty while its name would be made public.

As a result of the introduction of the Cap-and-Trade Program, Tokyo has achieved a 27% of CO2 emissions reduction in 2018 compared with the base year. The trend indicates that the final consumption in business and industrial sectors decreases gradually and the CO2 emissions from facilities have decreased.

Innovative building technologies for energy savings are another measure of energy saving. Dr DOI shared two examples, i.e. Daikin and Taisei. Daikin introduced a real-time analysis system to make continuous efforts on operational energy efficiency. As a result, Daikin achieved 20% of energy savings after building commissioning. Also, Daikin established a committee for operational management to achieve additional energy savings. Taisei Corporation adopted two ways for energy saving, i.e. a passive design of lighting to introduce natural light from the outside and a sensor system that can control the temperature depending on the tenant's needs.

Sharing 3-4: Sustainable and Energy Efficient Buildings and Cities

Presenter: Ms Melanie SLADE, Senior Programme Officer, Energy Efficiency Division, International Energy Agency

Energy efficiency is crucial for achieving global climate goals. Ms SLADE reported that energy efficiency will contribute over 40% of the energy sector's GHG abatement up to 2040. A slowdown in improving energy efficiency today lessens the chance of meeting long-term climate goals. Efficiency progress is slower, and it faces setbacks from the pandemic. Investment is down and structural trends are putting pressure on energy efficiency. Scaling up efficiency action has the potential to create millions more jobs as well as ensure lower energy bills and lower emissions in the future. The Government actions on energy efficiency are uneven and opportunities to boost efficiency are not being seized.

Clean energy progress in buildings is still below the potential achievable level. Energy-related CO2 emissions from buildings have risen in recent years after flattening between 2013 and 2016. Direct and indirect emissions from electricity and commercial heat used in buildings rose to 10 GtCO2 in 2019, the highest level ever recorded. Several factors have contributed to this rise, including growing energy demand for heating and cooling, rising air-conditioner ownership and extreme weather events.

Ms SLAND reported that the Buildings and Construction Roadmaps from the International Energy Agency (IEA) help the stakeholders and Government work on energy savings. The GlobalABC Regional Roadmaps for Buildings and Construction provide views on some important elements including urban planning, new buildings and clean energy.

The vision of urban planning is that cities are developed with low-carbon spatial planning, buildings, and urban infrastructure using integrated approaches and policies. The city will be more sustainable, resource-efficient, compact, connected and liveable. New buildings are designed and constructed to enable higher levels of thermal comfort and energy efficiency, resulting in comfortable, affordable and low-carbon. In terms of clean energy, cities are powered by clean, integrated energy systems, which enable buildings, districts and communities to provide flexibility to local power systems.

Digitalisation is important for connecting city infrastructures and consumers to achieve carbon neutrality. Digitally enhanced planning and operating cities can help integrate end-use, supply, network and transportation infrastructure in a city, minimising urban energy use and increasing utilisation of resources. Digitalisation can unlock untapped efficiency and flexibility in urban buildings. Digital platforms enable system-wide planning and operation of cities. Cities with digitalisation can help with energy transitions.

3.7 Section 4: I&T and Women's contribution to Energy Intensity Reduction

Sharing 4-1: Efforts of APSEC to provide sustainable energy solutions for APEC Cities

Presenter: Prof. ZHU Li, President, APEC Sustainable Energy Center

Prof. ZHU reported that APSEC studied the Low-Carbon Energy System. Low-carbon Energy System is a proactive action. The system aims at energy efficiency, clean utilisation and large-scale renewable energy consumption as the background. The Low-carbon Energy System covers energy supply and energy demand parts. On the city energy supply side, it is recommended to integrate with clean new and renewable energy. On the city energy demand side, it is recommended to adopt energy-efficient buildings, smart communities, low-carbon transportation, energy storage and an area energy management system.

Prof. ZHU proposed three forms of the Low-carbon Energy System, i.e. the island cities, peninsula cities and inland cities. For island cities, renewable energy applications should expand from solar and wind to ocean energy. For peninsula cities, new energy and renewable energy shall be utilised. Also, adopting resource and energy endowment and promoting the multi-energy complementary system are recommended for peninsula cities. For inland cities, greater efforts should be made to develop smart grids and comprehensive energy services.

For energy-efficient buildings, the rapid development of cities has brought opportunities and challenges for energy-efficient residential and commercial buildings, including energy efficiency standards for new buildings and deep energy retrofits for existing buildings. For smart communities, it integrates the overall cooling, heating, and electrical loads of the building complex with energy-dynamic big data. Also, it will monitor the energy usage of each system at any time by combining the Internet of Things, mobile Internet, cloud computing, automatic control and other technologies. These are to realise the monitoring of energy nodes, remote control of electrical equipment and analysis of energy use.

In energy-efficient buildings, carbon emission reduction requires efficient measures at both the energy supply and the energy consumption stages, with priority given to load reduction, utilisation of natural and renewable energy and the adoption of efficient equipment and management systems.

Sharing 4-2: Advancing Net Zero in a high-rise high-density context

Presenter: Ms Ada FUNG, Former Director of WorldGBC, Member of Sustainable Development Committee of Hong Kong Green Building Council

Ms FUNG introduced that Advancing Net Zero is a global campaign to accelerate the uptake of Net Zero Carbon Buildings to 100% by 2050. The campaign aims to raise awareness and education on urgency and achievability, achieve consistency and commonality between methodologies and certification programs, and accelerate global market uptake by sharing market-leading examples.

Net zero embodied carbon is part of a whole lifecycle approach to carbon reduction that includes net zero operational carbon. The definition of net zero embodied carbon is a net zero embodied carbon building (new or renovated) or infrastructure asset that highly resource efficiently with upfront carbon minimised to the greatest extent possible and all remaining embodied carbon reduced or, as a last resort, offset to achieve net zero across the lifecycle. There are over 42,000 private buildings and more than 8,000 government-owned buildings in HKC. With the current rate of construction of between 300 and 500 new buildings per year, between 60% and 80% of the buildings that will be in existence in 2050 have already been built. So, addressing the carbon emissions of existing buildings is therefore critical in the process of decarbonising the building sector. There is an opportunity to reduce the operational carbon emission of existing buildings through retro-commissioning, renovation and retrofitting.

Ms FUNG highlighted that health is another element to be addressed. Better Places for People is a global project that links buildings to the people that occupy them. It accelerates a sustainable built environment by proving and supporting benefits for people, particularly related to health and wellbeing. There are several study reports from HKGBC which demonstrate that these trends of health and wellbeing co-benefits in green buildings are taking shape around the world and support a positive business case.

In the context of high-rise buildings, the challenges include:

1. Low dissipation of internal heat gains due to a low surface-area-to-volume ratio.
2. Limited roof areas for photovoltaic (PV) panels for on-site energy generation.
3. Difficulties in the implementation of mixed-mode ventilation systems due to temperamental wind conditions at height.
4. Mixed-mode ventilation systems provide comfort and lower carbon emissions.
5. Façade areas tend to be exposed and unshaded by the surrounding, leading to unwanted heat gain in perimeter zones.
6. High-rise buildings are also a source of significant embodied carbon reduction.
7. The embodied carbon impacts of structural materials are substantial and high-rise

buildings typically require the use of more structural elements (e.g. steel outriggers, high-strength concrete) which are more carbon-intensive.

Ms FUNG recommended that the building industry can move towards carbon neutrality by adopting and developing low/zero carbon design and technologies, stimulating innovative carbon reduction ideas and solutions, and continuously reviewing current regulations and codes of practices.

Sharing 4-3: Energy Conundrum in Africa

Presenter: Ms Yetunde HOLLOWAY, Chair, World Federation of Engineering Organisations Committee of Women in Engineering

Ms HOLLOWAY reported that Africa is the second most populous region, with a population of about 1.3 billion, and shall increase further over the next 15 years. Energy in Africa is a scarce commodity. Africa desperately needs clean, renewable energy. Electricity comes from thermal power plants, such as coal plants in Southern Africa and oil-fired generators in Nigeria and North Africa. There is a need for more renewable energy to usher in the fourth industrial revolution and develop economically sustainable and environmentally sustainable societies.

Among the 17 Sustainable Development Goals (SDGs) in the 2030 Agenda for Sustainable Development set by UN members, the speakers shared insights related to two goals - Gender Equality #5 and Energy Access #7. Addressing the different SDGs together can lead to exponential development gains. Goal 5 is to achieve gender equality and the empowerment of all women and girls; gender equality has a key role as a driver of development progress, and women's potential should be more realized due to persistent social, economic and political inequalities. Attention was drawn to the important role of women and the need for their full and equal participation and leadership in all areas of sustainable development. Another goal #7 is to ensure access to affordable, reliable, sustainable and modern energy for all. Efforts should be made to double the share of renewable energy in the global energy mix and to double the rate of improvement in global energy efficiency. By addressing these two SDGs together, we find that women have the potential to contribute to the scaling up of sustainable and renewable energy sources to address energy challenges.

3.8 Closing Remarks

Presenter: Ir Eric PANG Yiu Hung, JP is the Director of the Electrical and Mechanical Services Department, Hong Kong, China

The Energy Intensity Reduction workshop held is a part of Hong Kong, China's first-ever APEC Funded Project. APEC projects are vital activities of the APEC that help translate policy directions of APEC Economic Leaders and Ministers into actions, and create tangible benefits for people living in the Asia-Pacific region. Hong Kong, China conducted this APEC-funded project to identify key drivers in urbanised cities with outstanding energy performance for accelerating energy intensity reduction.

Amidst COVID-19 and climate change challenges, this workshop shared intelligence and insights into deliberate energy efficiency policies, incentives and implementation. Energy management and plans for energy use, the building energy efficiency policies and trends, as well as insight on low carbon cities and energy efficient building solutions, were shared during the workshop. On top of the capacity-building opportunity to appreciate and develop knowledge on energy efficiency and conservation, the importance of "I&T and Women in Energy Intensity Reduction" was also addressed.

HKC buttresses APEC's agenda to advance women's economic integration in the region by creating an environment for women to achieve their economic potential and contribute to pursuing energy intensity reduction in the APEC region.

The energy efficiency and conservation markets continue to flourish vibrantly among APEC member economies in response to climate change, notwithstanding the recent COVID-19 crisis. There are enormous opportunities for collaborating among APEC member economies and international organisations to take forward the APEC target to reduce energy intensity. On top of the drive of APEC member economies to share experience in reducing energy intensity and emerging technologies through APEC projects, there is still a long way to a greener future. HKC will continue to play an active role and join hands with all APEC members to promote energy-efficient technologies and progress towards a liveable and sustainable future.

4 Summary of Discussion

(i) Section 1: Policy and Regulation

Polling Question: *Policy and Regulation are driving the ways to reduce energy use for the building sector. What is the next 3-5 years' focus area for Building energy reduction?*
A. Existing building retro-commissioning (28%)
B. Strengthen incentives/penalties for both landlord and tenant (4%)
C. Strengthen performance requirements (12%)
D. Performance data disclose and benchmark (56%)

Panel Discussion

Q1. Several economies have conducted a lot of energy data analysis from city to building level. How is the data affecting policy making?

The speakers reported that most people do not know how badly the building is performing against the direct competitors in the same market. It is a fundamental barrier to action. Data transparency for building clients could be a powerful motivator for building owners or operators to solve the energy efficiency problem. Moreover, data should be read properly so that people can make decisions with it.

Taking New York City as an example, the city was continually updating the data, collecting different types of data, and using the data to assist policy implementation. It is also worth considering different types of building with a flexible framework. A flexible framework can take account of the different types of building in a large city.

In the Republic of Korea, about 20 to 21% of the total energy consumption was consumed in the building sector. The Republic of Korea has been collecting individual building data for the past 3-4 years. The work is almost done and the data are being used to analyse how to reduce each building's consumption. The ICT technology has been well adopted to collect data in the Republic of Korea, the Government has already made a policy on energy saving. The future work will be focused on all buildings' energy consumption.

Looking only at the U. S. experience in past years, the buildings' energy using and saving data should be linked with the financial data like who's paying for the upgrades. Because of any energy savings, the building might have benefits that accrued to a different agency. The agency is making an investment where the people in the building had no incentive to make the investments. So it is important in setting up initial data collection and includes energy in years, but also essentially follows the money and the finances of who is paying for it and then who is

benefiting from it.

Q2: Is there a need to increase the amounts of the incentives, for example, the tax or for the new project the buildable floor area so from the policy and the regulation perspectives that's it is a need to have an incentive to further speed up the adoption of the energy efficiency programs or systems in the industry?

The speakers agreed that incentive is important. More people are willing to take action on energy saving if there are more incentives. There are a lot of incentives to stimulate the market, like subsidies or grants.

According to the speaker's experience, sustainable buildings are easier for the Australian Government to procure. Many investors no longer invest in a company unless the company has a very high score on either the global real estate sustainability benchmark in Europe, the Dow Jones sustainability index in the US, or CDP/G. R. Investors may not invest in a company which is doing poor in sustainability. Shopping centres in Australia have reduced energy consumption by an average of 20% over the last seven years. It is almost exclusively because of international finance. Multiple incentives could hit the market and promote energy saving.

In the US, the revolving fund is mandated by an entity with technical expertise and can help identify and push the project forward. In establishing and utilizing the revolving fund, it was found the amount of energy savings to be obtained is related to the number of employees. The building owners will add employees every year to look after the efficiency of the buildings.

In the Republic of Korea, for first-grade high-efficiency appliances, like washing machines, TVs, and air conditioners, there is a 10% discount subsidy provided by the government. More incentives and low-interest rate loans will be given to improve energy efficiency in the building sector.

(ii) Section 2: Incentives

Polling Question: Zero energy building is the ultimate solution to tackle climate change. Regarding incentives from local government, which aspect do you think is the most important?
A. Building appliance (3%)
B. Building sub-meters and data visualisation (21%)
C. New building floor area exemption (14%)
D. Renewable energy and energy efficient building services (62%)

Panel Discussion

Q1. The development of Super Low Energy Buildings and Zero Energy Buildings in Singapore is a good reference for other economies. As a good reference, can you tell us the major challenges for these 2 schemes, in terms of development or implementation?

The speaker explained there were two aspects of challenges.

In the technical aspect, to achieve SLE or even zero energy, the building needs to generate enough energy for its consumption, however not all locations can install PV panels on rooftops. PV panels may compete for space on rooftops with green roofs. In the future, the role of buildings goes beyond an energy consumer but also a producer or even storage. But the challenge is how to get there, especially for high-rise buildings.

For the resource aspect, the cost of these high technologies and the lack of resources are examples. For building the capability of the stakeholders, a smart hub is initiated to facilitate information exchange and green building innovations to accelerate the deployment of emerging technologies. Financing is a critical challenge for many economies too.

Q2. In your city, what are the current views of developers and building owners on implementing zero-energy buildings or low-energy buildings?

The speakers reported that most of the developers welcome the government's mission towards net zero energy because they understand this is the future of the industry transformation. The Government consulted the stakeholders in developing a technology road map for super low energy. Also, the public sector in Singapore is leading the way in green procurement.

It is very difficult for a bank to reach individuals in building efficiency work. Building as a virtual power plant, which can consume, store and produce. If a central platform can be owned by anyone and consider all the building in this town or district has one power plant, then financiers can calculate the investment return. If a building can be packaged, then the financier would be able to finance it, to help people to fight the problems.

(iii) Section 3: Implementation

Polling Question: How do engage stakeholders like building owners, corporate, investors and technology providers, to devote their effort to energy efficiency and conservation?
A. Set up an energy reduction roadmap (17%)
B. Ease regulation on new technology adoption (17%)

C. Economic gain in operation (45%)
D. Recognition and certificate (21%)

Panel Discussion

Q1. How do effectively encourage the building owners to implement retro-commissioning in existing buildings? Particularly for residential housing in economies like Japan and Hong Kong, China.

The speaker reported that the average lifetime of an apartment building in Japan is 40 to 50 years, which is relatively short compared to other economies. So, the owner would prefer new buildings to refurbish the old ones, except for historical or design reasons. Residential building is a major energy consumption sector. For encouraging the implementation of retro-commissioning, information diffusion is important. Electric and gas companies play an important role to provide information to consumers. The company's website could provide the energy efficiency potential information and kinds of the scorecard compared with the neighbouring buildings. Also, incentives are needed to help residential buildings work on their energy-saving strategy such as building envelope upgrades. Moreover, the administrative departments provide an audit to identify any energy efficiency potential for building owners.

The speaker highlighted that the promotion and training provided to stakeholders are important. In HKC, building owners will engage with property management companies. Therefore, property management companies are the target audience of the training. Arranging more seminars and training for property managers can help them to raise their awareness. The power company offers funding to help the owners to carry out retro-commissioning. As a result, more building owners will participate in retro-commissioning.

Q2. In the scale of urban infrastructure and city-town energy reduction implementation, how can we conduct performance monitoring and energy use tracking? We may like to know the energy reduction performance as a whole including buildings, infrastructures, open spaces etc. and obtain insights for further improvement.

The speaker suggested that digital technology can help with performance monitoring by forming a database. A building management system and data access could help achieve energy reduction.

(iv) Section 4: I&T and Woman contribution in Energy Intensity Reduction

Polling Question: Innovation & Technology I&T is essential for us to strive for zero energy Building. Which I&T aspect is your priority?

A. Digital technology for data monitoring & benchmarking (22%)

B. Building system efficiency enhancement (37%)

C. Technology driving behaviour change (33%)

D. District energy, heating and cooling (7%)

Panel Discussion

Q1. Regarding I&T, we are looking for effective technical solutions to guide the building sector toward the energy reduction target. With the rapid development of digital & IoT technology, would digital twin be a trend for us to implement in all buildings and urban components?

The digital twin will be the trend for application to a building or city. The typical feature from the third industrial revolution to the fourth is the Internet of Things (IoT). This industrial revolution is based on distributed energy and using IoT.

In the public housing aspect, the common area EUI is around 22 kWh/sqm, which is already very low. The Government achieves this through approaches plus the application of innovation that includes all kinds of IT applications.

The speaker summarised the IT applications. From the planning to design stages, the Government introduced the use of geographical information system (GIS) and building information modelling (BIM) at the design stage, using lots of simulations, like computation fluid dynamic (CFD) to identify the wind, and positioning of buildings to allow the best penetration of wind and airflow. Also, sunlight was designed for all the areas that can reduce lighting energy.

The speaker advised that planning and designing smart technologies can help designers to find the best solutions that will help reduce energy consumption. A collective effort from governments, practitioners and academia is very important. More sharing of data could help all private sector businesses.

Q2. What do you see as the trend of I&T in the coming 3-5 years? Any particular I&T aspect would play an important role? Some people say IoT, building system efficiency, or something driving behaviour change, etc.

The speaker estimated that the energy system will be visualised in the next three to five years as the trend of I&T adoption in the energy industry. The IoT makes a breakthrough and the visualizing technology allows the whole plant to be seen, checked and monitored. Due to the different human habits of each person, the data collection method may be different for the same system and affect the system analysis. Automatic data collection based on IoT sensors can help to track the whole system and allow data analysis to be worked in the right way. IoT will make the energy transition quicker, and smoother and give people lots of impacts.

Behaviour plays an important role, especially the occupant's behaviour. People are different. If the monitoring feedback system is not based on information technology, it's impossible to have the smart system working in the right mode. The technology based on the smart system to track monitors makes the whole system work in the right way.

5 Conclusion

Representatives from APEC member economies and international organisations have joined the capacity-building workshop to share their successful experience in promoting energy efficiency policy and recommendation of innovation and technology for moving APEC cities toward the energy intensity reduction target. Detail discussion was carried out on the challenges faced, such as data disclosure, higher target for building energy consumption reduction, incentives for policy implementation, etc.

In the workshop, it has been identified that buildings account for around one-quarter of the total energy consumption in cities. Hence, energy intensity reduction in the building sector would play an important part in achieving the APEC Leader's goal of aggregate energy intensity reduction. Key drivers and policies identified include mandatory efficient building energy code, financial and non-financial incentives, data transparency, recommissioning and retrofit of existing buildings and government leadership.

With the rapidly increasing urbanisation rate, the building stock will increase dramatically by 2035. To avoid the lock-in inefficiency in buildings, a mandatory building energy code shall be established to lay down a higher standard of energy efficiency for new building design and construction as well as retrofit existing buildings.

Making energy consumption data open to the public helps to raise public awareness and stimulate a competitive environment within society. By collecting and analysing the correct data, the problems of inefficient energy consumption can be identified and support the policy makers for new policy-making and target setting. The data collection framework shall be flexible and specific to different building types and reviewed regularly. IoT technology can be

adopted to streamline an automatic data collection system to avoid human error and lower the barriers for public participants.

Incentives can motivate the industry and market to take action for EE&C. The energy efficiency projects shall be financially viable for building owners and investors. ESCO is a practicable business model to facilitate policy implementation on upgrading existing buildings. Government or financiers can provide low-interest rates, subsidies, tax concessions, and GFA concessions linked with green building certification. Apart from financial incentives, the Government and the tenant's procurements of a sustainable asset to consolidate their ESG portfolio can provide business incentives for building owners to take action and increase the supply of energy-efficient service buildings.

New technology at building levels and instruction levels shall be implemented in urban planning, building design and operations to help to achieve the energy intensity reduction target. A decentralised system such as microgrids and smart grids can help to redistribute and balance the energy demand and supply. Digital twins with energy consumption data will be helpful for planning and testing energy efficiency solutions.

In the post-pandemic era, there are trends of health and wellbeing co-benefits in green buildings around the global building market. The energy efficiency projects can create job opportunities in different roles in the building industry and support positive business cases for suppliers, designers, contractors and building owners.

In conclusion, it would be a collective effort by all the economies to achieve the APEC Leaders' goal. Most of the APEC member economies have planned the roadmap to achieve the APEC Leaders' goal. The experiences and technologies shared by the speakers of the workshop are informative and valuable for future policymakers for implementing effective drivers to reduce energy intensity in the building sector.

Appendix A - Workshop Agenda

Agenda	
Time (HKC time)	**Details**
08:30 - 09:00	**Registration**
09:00 - 09:10	**Opening Remarks** by Hong Kong, China
09:10 - 09:15	**Group Photo Taking**
09:15 - 09:20	**Welcoming** by EGEEC Chair
09:20 – 09:30	**Introduction of the Project and Findings** by Ir Gigi KAM from ARUP Hong Kong, Hong Kong, China
	Section 1: Policy & Regulation
09:30 – 09:50	Sharing from the United States by Dr Cary BLOYD (Senior Advisor, Pacific Northwest National Laboratory, the United States) -"U.S. Experiences in Urban Energy Intensity Reduction"
09:50 – 10:10	Sharing from Australia by Mr Carlos FLORES (Director, National Australian Built Environment Rating System, Australia) - "Australian breakthroughs on building energy efficiency"
10:10 – 10:30	Sharing from the Republic of Korea by Dr Kihyun PARK and Mr Minkyu KIM (Representatives from Korea Energy Economics Institute, the Republic of Korea) - "Building Energy Efficiency Policy in the Republic of Korea"
10:30 – 10:45	**Plenary Session & Discussion** by Mr MK LEUNG (Director and Chairman of Sustainable Development Committee, Hong Kong Green Building Council, Hong Kong, China)
	Section 2: Incentives
10:45 – 11:05	Sharing from Singapore by Ms Regina LEE (Analyst International Relations Branch External Relations Department from Energy Market Authority, Singapore)
11:05 – 11:25	Sharing from China by Prof. Yi JIANG (Director of Building Energy Research Centre, Tsinghua University) - "Can a building be running at zero carbon?"
11:25 – 11:45	Sharing from Asian Development Bank by Dr Yongping ZHAI (Chief of Energy Sector Group, Sustainable Development and Climate Change Department, Asian Development Bank) - "Energy Efficiency for Livable Cities and Role of Asian Development Bank"
11:45 – 12:00	**Plenary Session & Discussion** by Mr MK LEUNG (Director and Chairman of Sustainable Development Committee, Hong Kong Green Building Council, Hong Kong, China)
12:00 – 14:30	**Lunch Break**

Agenda	
Time (HKC time)	**Details**
14:30 - 15:00	**Registration**
	Section 3: Implementation
15:00 – 15:15	Sharing from Asia Pacific Energy Research Centre by Dr Kazutomo IRIE (President, Asia Pacific Energy Research Centre (APERC)) - "Energy Efficiency Issues in APEC Low-Carbon Model Town (LCMT) Project"
15:15 – 15:30	Sharing from Hong Kong, China by Mr KW KONG (Senior Engineer, Electrical and Mechanical Services Department, Hong Kong, China) - "Experience sharing of Retro-commissioning in Hong Kong, China"
15:30 – 15:45	Sharing from Japan by Dr Naoko DOI (Senior Economist, Manager, Energy Efficiency Group, Climate Change and Energy Efficiency Unit of The Institute of Energy Economics - "Tokyo's Actions for 2050 Carbon Neutral- Buildings Sector"
15:45 – 16:00	Sharing from International Energy Agency by Ms Melanie SLADE (Senior Programme Officer, Energy Efficiency Division of IEA - "Sustainable and Energy Efficient Buildings and Cities"
16:00 – 16:15	**Plenary Session & Discussion** by Prof. Christopher CHAO (Dean of Engineering and Chair Professor of Mechanical Engineering, The University of Hong Kong, Hong Kong, China)
	Section 4: I&T and Women's contribution to Energy Intensity Reduction
16:15 – 16:35	Sharing from APEC Sustainable Energy Center by Prof. ZHU Li (President, APEC Sustainable Energy Center) - "Efforts of APSEC to provide sustainable energy solutions for APEC Cities"
16:35 – 16:55	Sharing from Hong Kong Green Building Council's Sustainable Development Committee by Ms Ada FUNG (Former Director of WorldGBC and Member of Sustainable Development Committee of HKGBC) - "Advancing net zero in a high-rise high-density context"
16:55 – 17:15	Sharing from Women in Engineering Committee of the World Federation of Engineering Organisations by Ms Yetunde HOLLOWAY (Chair of WFEO-WiE) - "Energy Conundrum in Africa - Energy Intensity for Sustainable Development by African Women"
17:15 – 17:30	**Plenary Session & Discussion** by Prof. Christopher CHAO (Dean of Engineering and Chair Professor of Mechanical Engineering, The University of Hong Kong, Hong Kong, China)
17:30 – 17:35	**Group Photo Taking**
17:35 – 17:45	**Closing Remarks** by Hong Kong, China
17:45	**Close of Workshop**