



**Asia-Pacific  
Economic Cooperation**

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# **APEC Workshop on Strategies and Successful Case Studies on Solar Energy**

**APEC Energy Working Group**

July 2022



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Economic Cooperation**

# **APEC Workshop on Strategies and Successful Case Studies on Solar Energy**

**SUMMARY REPORT**

**24 – 25 March 2012**

**APEC Energy Working Group**

**July 2022**

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# **APEC WORKSHOP ON STRATEGIES AND SUCCESSFUL CASE STUDIES ON SOLAR ENERGY**

**24 – 25 March 2022**

**(Hybrid Event)**

## **Summary Report**

### **I. INTRODUCTION**

On 24 and 25 March 2022, the APEC Workshop on Strategies and Successful Case Studies on Solar Energy, initiated by Viet Nam and co-sponsored by Australia; Canada; Chile; Hong Kong, China; Japan; Singapore; Chinese Taipei; Thailand; USA was held in a hybrid mode. Speakers and participants came from energy-related international organizations and research institutions and APEC member economies' relevant Ministries and government's agencies, companies and business associations.

The Workshop aimed at the following objective:

- to bring together officials, representatives from the private and academic sectors and other stakeholders solar energy to share respective case studies and strategies in solar energy, learn from experiences to support all member economies of APEC to develop and implement policies on solar energy to provide energy needs in the midst of economic development and increasing consumption, draw more investments and address environmental issues.

### **II. BACKGROUND**

Solar energy is one of the fastest growing types of resources right now and it has so much more to offer. The world installed a record 98 gigawatts of new solar capacity, far more than the net additions of any other technology – other renewable, fossil fuel or nuclear.

Solar power also attracted far more investment, at \$160.8 billion, up 18 per cent, than any other technology. It made up 57 per cent of last year's total for all renewables

(excluding large hydro) of \$279.8 billion, and it towered above new investment in coal and gas generation capacity, at an estimated \$103 billion.<sup>1</sup>

The implications of such progress are huge, especially for the environment. As for the coal industry, including coal power plants, they are expected to experience a sharp decline somewhere between 2020 and 2050. The number ranges from 62 percent to 16 percent, which is significant either way<sup>2</sup>. Furthermore, the cost of renewable energy is now falling so fast that it should be a consistently cheaper source of electricity generation than traditional fossil fuels within just a few years, according to a new report from the International Renewable Energy Agency (IRENA)<sup>3</sup>.

APEC member economies have the biggest opportunities to facilitate solar energy thanks to the abundance of sunshine in the region. At the moment, according to Bloomberg Reports, China is the leading economy in terms of solar power, producing the most solar panels in the world compared to any other economy.

In the midst of economic development and growing demand of energy consumption in the region, the topic of renewable and clean energy, especially solar energy have become a very important topic in the APEC region, with APEC Leaders continuously reaffirming the APEC aspirational goal of doubling the share of renewables in the APEC energy mix from 2010 levels by 2030.

Realizing this opportunity and the need to take the next step in facilitating the development of solar energy in APEC member economies, Viet Nam proposed to organize an APEC Workshop on Strategies and Successful Case Studies on Solar Energy, which will bring officials, representatives from the private and academic sectors and other stakeholders in the renewable energy sector, particularly solar energy to draw from case studies, learn from experiences to support all member economies of APEC to develop and implement policies on solar energy to meet with energy needs.

### III. OPENING REMARKS

In the opening remarks, **Mr Nguyen Van Vy (Deputy Chairman, Viet Nam's Energy Association)** stressed that APEC's common goals in the energy sector are to reduce aggregate energy intensity by 45 percent by 2035 and double renewable energy in the regional energy mix by 2030 under the declaration of the Leaders at the APEC Summit. Accordingly, in recent years, APEC has been implementing many cooperation activities towards the goal of identifying and removing unnecessary trade

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<sup>1</sup><https://www.unenvironment.org/news-and-stories/press-release/banking-sunshine-world-added-far-more-solar-fossil-fuel-power>

<sup>2</sup><https://www.ecosolarusa.com/2018-and-the-future-belongs-to-solar-energy-heres-why/>

<sup>3</sup><https://www.forbes.com/sites/dominicdudley/2018/01/13/renewable-energy-cost-effective-fossil-fuels-2020/#7a7112d14ff2>

barriers, promoting open, transparent, and fair investment mechanisms to attract available resources from the private sector for solar energy development.

According to the International Energy Agency (IEA), the scalability and cost reduction of solar panels and solar thermal support the rapid growth of renewable energy in the future. The speaker observed that at least two-thirds of the APEC economy has more than 2,000 hours of sunlight per year; this abundant source of solar energy can be harnessed by installing rooftop solar systems. In the APEC Energy Outlook, the Asia-Pacific Energy Research Center (APEREC) calculated that rooftop solar installations have the potential to generate around 2,000 TWh of electricity from solar panels in 2016. This power output is equivalent to the total amount of electricity that the APEC region generates from hydroelectricity, which is currently the largest renewable energy source. However, in developing economies, including Viet Nam, solar energy is a fairly new field and accounts for a relatively modest proportion of the total energy supply of the economy. The culprit of this situation is that the majority of developing economies in the Asia-Pacific region, in addition to limited financial resources, share the common feature of capital limitations, incomplete legal framework, inadequate and weak infrastructure systems, and underdeveloped management science and technology etc. This fact has been posing many challenges for developing APEC members in the planning of solar energy development. Through sharing strategies and case studies on solar energy, Mr Nguyen expected that APEC members can learn from each other's experiences in formulating and implementing development policies and attracting investment in solar energy, contributing to solving energy and environmental problems in the context of increasing energy consumption demand.

In that sense, the Workshop is the contribution of Viet Nam to the joint efforts of the APEC region towards further promoting its advantages and potential in implementing policies to support and attract investment for solar energy development.

#### **IV. KEY ISSUES**

##### **1. STRATEGIES TO DEVELOP SOLAR ENERGY IN SOME ECONOMIES**

There were two speakers in Session 1 including: (1) Mr Takao Ikeda, Senior Economist, New and Renewable Energy and International Cooperation Unit, The Institute of Energy Economics, Japan; (2) Dr Xia Ting, Senior Engineer, China Renewable Energy Engineering Institute (REEI), China.

- Mr Takao Ikeda presented about Strategies to Develop Solar Energy in Japan. To begin the presentation, the speaker shared that Japan aimed to reduce its greenhouse gas emissions by 46 percent in the fiscal year 2030 from its fiscal year 2013 levels, and that Japan would continue strenuous efforts in its

challenge to meet the lofty goal of cutting its emissions by 50 percent in the fiscal year 2030. The Green Growth Strategy was launched in December, 2020, updated in June 2021 which covers Electricity, Industry, Transport, Service/household areas. Japan would leverage all of their policies and do their best to encourage companies to take on positive challenges toward innovation. About the 2050 Carbon-Neutral and new Strategic Energy Plan, the speaker said that The 6th Strategic Energy Plan was approved by the Cabinet on October 22, 2021. To promote technology development Japan focused on R&D and societal implementation of advanced solar photovoltaic mountable on the building walls and less resilient roofs. A 2 trillion yen Green Innovation Fund has been established to encourage companies to take on ambitious challenges.

- Dr Xia Ting's presentation included 2 main parts: Development History of Solar PV in China and Development Status of Solar PV in China. To begin, the speaker introduced about five major development stages of China's PV industry and the goals of "carbon peaking and carbon neutrality" drive the PV power generation into new stage. After that Dr Ting mentioned about some policies facilitation. The policies help to guide the healthy market development by a multi-layer and multi-dimension policy system, to improve major strategies and mechanisms for industry development and fully coordinating various industry development mechanisms, and to improve the business environment, reducing non-technical costs, to promote long-term mechanism establishment, and to developing innovative business models and expanding diversified applications. In the second part, the speaker presented about status quo of application market including a bigger role of the PV industry in social economy because of its scale development, continuous and rapid cost reduction, accelerated subsidy reduction, and innovative development and diverse utilization of PV projects.

## **2. CASE STUDIES FROM SUCCESSFUL SOLAR ENERGY PROJECTS ON BUILDINGS**

There were three speakers in Session 2: (1) Ms Ku-Hsiu Hsiung, Project Director, Photovoltaic Technology Division, Green Energy and Environment Research Laboratories, Industrial Technology Research Institute (ITRI), Chinese Taipei; (2) Mr Gukhan, Solar Business Developer, Canadian Solar Inc (CSIQ), Canada; (3) Mr Daniel Lee-Wai Ying, Project Specialist Engineer, Electrical and Mechanical Services Department, Hong Kong, China.

- Ms Ku-Hsiu Hsiung presented about "The Successful Deployment Experience of PV-ESCO Model in Chinese Taipei". Firstly, she talked about solar PV



distribution diagram including energy transition and Solar PV Policy. She shared that Tariff rates are set and applied for 20 years, for long-term contracts provide to accelerate investment and reduce management risk. The tariff rates for renewables are reviewed annually by an expert committee, and the tariff rate for each individual solar PV plant are determined by the date when generating equipment are interconnected to the power grid. The speaker also talked about 6 PV-ESCO Business Model and rooftop solar PV showcases. At the end of the presentation, the speaker concluded that the passage of Renewable Energy Development Act has paved the way for a sustainable long-term development of Chinese Taipei renewable energy development. Chinese Taipei's long-term target is to achieve 20GW of cumulated solar PV installed capacity by 2025, including 8GW of rooftop systems and 12 GW of ground-mounted systems. The economy will continue to utilize PV-ESCO model for future development and welcomes the international collaboration to foster the development of renewable energy in the global society.

- Mr Gukhan introduced about an 5.5 MWp Rooftop Case Study in Penang, Malaysia. Firstly, he talked about rooftop challenges that include available electrical load, rooftop condition and loading, regulatory requirement, client requirement, EPC's stabilities, PPA complexity. About project challenges, he mentioned about coordination at site, change request of client, safety, weather condition, project size extension at last minute, faulty equipment inverter, leak and damage, unexpected cost and system performance. At the end of the presentation, the speaker provided some recommendations such as: Incumbent distribution license should upgrade all substation to handle fault current; Requirements for scada system for solar installations beyond 1 MWAC should be relaxed or improved to reduce cost of implementation; Storage solution should be encouraged now with incentives from the government or distribution license; Comprehensive PV rooftop standard encompassing structural assessment, permits from local town council planning and building department, mandatory safety systems with the mandatory endorsement from relevant government bodies; Mandatory requirements for new buildings to have rooftop solar without any limitations from the distribution license; All inclusive tax exemption that also rewards the building owners under PPA model.
- Mr Daniel Lee-Wai Ying presented about policy, promotion and case sharing for solar energy projects in Hong Kong, China. Firstly, he talked about some policy directives including Climate Action Plan 2030+, Climate action Plan 2050 which would help Hong Kong, China to be a "Zero-carbon Emission •Livable •Sustainable Development" City. The economy aimed to reduce total carbon

emission by half as compared with 2005 level before 2035. He also mentioned about some challenges, physical constraints of Hong Kong, China, for example: hilly terrain, limited land, dense population. The speaker shared some information about incentives, facilitations and some case sharing such as: General Design Criteria, A Role Model Project – Dia Soleade III, Hong Kong Air Cargo Terminal Building, Hong Kong Disneyland Resort, Solar Harvest Project and The Hong Kong University of Science and Technology. To conclude the presentation, the speaker emphasize on 4 important factors including: Direct and Clear Policy; Good Promotion Schemes; Effective Communication; Attractive Tax Incentives.

### **3. CASE STUDIES FROM SUCCESSFUL SOLAR ENERGY PROJECTS ON ISLANDS**

There were four speakers in this Session: (1) Mrs. Andriah Feby Misna, S.T., M.T., M.Sc, Director of New Various Energy and Renewable Energy, Directorate General of New, Renewable Energy and Energy Conservation, Ministry of Energy And Mineral Resources, Indonesia; (2) Dr Marissa E. Morales-Rodriguez, Technology Manager, Systems Integration, Solar Energy Technologies Office, Contractor to U.S. Department of Energy, USA; (3) Mr Taeil Kang, CEO, One Energy Island Co., Ltd, Korea; (4) Ms Elena Villanueva, Senior Analyst for Electricity Access in the Energy Access and Social Development Division, Ministry of Energy, Chile.

- Mrs. Andriah Feby Misna introduced about “Solar Energy Development in Indonesia”. Firstly, she talked about Indonesia’s commitment to GHS’s reduction including mandate of the Energy Law and the Electricity Law, NRE supply and utilization to be improved. She then shared about solar energy potential map of Indonesia and Power Plant Development Plan in RUPTL 2021-2030. She said that solar energy is the most abundant NRE potential, its costs continue to decline, and rapid deployment makes solar power generation a priority. After presenting about best practices of solar energy, she talked about challenges of solar PV implementation in Indonesia. To conclude the presentation, she emphasized that Indonesia is committed to achieve of 23% Renewable Energy in Indonesia Energy Mix in year 2025 as part of to fulfill the Indonesia energy Policy target and Paris Agreement. Renewable Energy is being developed focus on fast installation and competitive prices (low cost production). In terms of Solar Power development in Indonesia, there are 3 trends that will be entering the electricity system, namely Rooftop Solar PV, Large Scale Solar PV (Solar Farm), and Floating Solar PV. The development of Solar PV in the islands not only increases the use of clean energy but also able to encourage the economy growth of the local community.

- Dr Marissa E. Morales-Rodriguez began her presentation by giving an overview on Solar Energy Technologies Office (SETO). The office accelerates the advancement and deployment of solar technology in support of an equitable transition to a decarbonized energy system by 2050, starting with a decarbonized power sector by 2035. She briefed about the Systems Integration (SI) subprogram that supports early-stage research, development, and demonstration (RD&D) of technologies and solutions – focusing on technical pillars data, analytics, control, and hardware - that advance the reliable, resilient, secure and affordable integration of solar energy onto the U.S. electric grid. She mentioned about challenges for Solar Grid Integration, maximum instantaneous and average annual level of inverter-based generation as a percentage of load by system size, island power grids challenges, integration of renewables into island power grids. The speaker talked about multi-timescale integrated dynamics and scheduling, multi-lab energy planning support for Puerto Rico, resilient operations of networked community micro-grids with high solar penetration. At the end of the presentation, Dr Marissia concluded that the systems integration program at SETO continues to dedicate research efforts on Islands Power Grids.
- Mr Taeil Kang started his presentation by sharing that Korea is the 8th largest energy user in the world, 94% of its energy consumption relying on imported energy sources, among economies with the highest energy-intensive industry. About Korea's Net Carbon Zero Goals, the economy plans to achieve net carbon zero by 2050. The speaker then talked about status of power supply in islands in Korea and the policy to replace fossil-fuels with renewable energy Sources. He shared some case studies including Solar PV and ESS Microgrid in Gasado Island including, Solar PV and ESS Microgrid in Jukdo Island. From lessons and knowledge to share from, he concluded that solar PV and battery ESS system were proven a reliable solution to replace polluting and costly diesel generators in power supply in island. System reliability of solar energy project on island can be achieved through redundancy of battery ESS and well-designed EMS (Energy Management System). However, the battery ESS redundancy comes with additional cost which makes solar energy projects on islands still expensive; 100% carbon free not commercially feasible yet. Falling ESS prices on the global market and enhanced knowledge of solar energy projects on islands will soon make solar PV and battery ESS a prevailing solution both technically and commercially in powering islands. Solar PV and battery ESS is a technically advanced system. On the contrary, environment in which the system is located is remote and challenging: therefore, it is critically

important to develop capacity of managers and operators who are responsible for operation of solar energy projects on islands.

- Ms Elena Villanueva introduced Chilean isolated micro/mini grids by saying that Chile has 111 isolated micro/mini-grids powering about 10.100 users (households, public services, small businesses). About 40% of the systems are in fact, islands. About renewable energies on islands, In the 2000s, a GEF project called “Removal of Barriers to Rural Electrification with Renewable Energy” allowed Chile to conduct studies about renewable energy potential. Results mostly led to the conclusion of introducing wind energy on the islands. The first project was carried out in Isla Tac, in Chiloe archipelago. The speaker also shared some information of other project such as Isla Chaullín, Isla Queullín. To conclude the presentation, she listed out some challenges for the future which include long term planning of the generation mix; criteria to decide on the public investment for the hybridization of power plants (solar, wind, storage, and new technologies such as hydrogen); incentives to bring new operators to the systems currently under the control of municipalities and the users; creating a sustainable mechanism for financing the operation (currently based on public subsidies which limit the kWh consumed every month by each user).

#### **4. DISCUSSIONS**

- Regarding carbon pricing, a speaker informed that in Japan the government regulated the pricing for fuel and taxes for crude oil for a long time since 1970, so tax revenue may improve Japanese PV development by encouraging technological innovation. Japan was one among the world leading PV manufactures until 2004 – 2005. Fuel tax collection was used for “sunshine program” or “moonlight program”, R&D of energy technologies. The carbon tax was increased from time to time to include coal for promoting carbon emissions reduction activities, later.
- In addition, the government of Japan put in place a FIT system for renewable energy to be paid by consumers.
- Relating to the strategy to foster young people’s involvement in green energy innovation, the answer was that in Japan the strategy was designed to promote university initiatives. It may include: (i) human resources development in university; and (ii) analysis methods and statistics related to carbon neutrality. Besides, the Youth Working Group was established at the request of the working-age population in 2015.

- A speaker explained how China could have reasonable costs of solar PV panels. She made clear that in the early stage the PV panels were very costly and needed subsidies to survive in China. However, various measures were taken until now to reduce the costs, including:
  - Making enabling policies for the manufacturers to reduce the price of modules and parts of solar PV components as well as providing policy incentives for cost reduction;
  - Operating a “top-runner” program, which was a FIT scheme for those solar PV projects located in one area. In addition, PERC, TOPCon, HJT, IBC, dual-sided, half-slice, MBB, imbrication and other advanced technologies were being continuously developed and applied, and cell modules and performances constantly improved. Therefore, the government asked manufacturers to use the latest technologies for manufacture and cost reduction.
- To encourage people to use more rooftop solar PV, China offered subsidies and policy incentives for rooftop solar PV installation to make it more popular.
- A speaker shared Japan’s experience on solutions and policies for expired panel disposal. The government developed a waste policy and a “recycle, reduce and reuse” strategy for specific wastes. Recycling and reuse of PV panels were considered to reduce environmental effects. At first, expired PV panels and other materials were considered for reuse. And then Japanese carbon and fuel tax revenue were used to fund R&D technologies for : (i) recycling of PV panels; and (b) the evaluation of reused PV panels.
- Similar to Japan, the government of China also applied the recycle and reuse strategy for expired solar PV panels. Recycle and reuse technologies for the PV panels offered an effective way to minimize damages to the environment.
- A speaker shared that in case of suffering from devastating natural disasters, it was important to help affected communities to recover by making efforts to determine damages and related research on technology, models, infrastructure and energy systems, including the solar PV data and installation to recover from power outages.
- Some speakers suggested the most important success factors for a solar PV project:
  - In Hong Kong (China), a speaker considered the incentive measure was one of the important factors because installation of solar PV panels required large capital expenditure. The government with the two power companies in Hong Kong, China set up a FIT scheme to encourage more private investment on renewable projects.
  - In Chinese Taipei, besides FIT, PV co-model was key because local buildings were relatively small, so the installation of PV panel was very costly and site owners did not often have sufficient experience and knowledge to install them. Therefore the PV company could set up a PV co-model to advance this work and make money from it.

- Another speaker recommended that combination of government and PV companies was key to the success of a solar energy project.
- In Indonesia, there were many programs in renewable energy and energy conservation, particularly in small islands. Due to possible requirement, the plan to replace diesel power plants with renewable energy was on progress. In addition, Indonesia had a big plan to develop the smart grid interconnection along the islands to advance the penetration of renewable energy in the system by improving infrastructure and connection.
- The impact of renewable energy projects on the poor should be given more consideration than costs. It was suggested to listen to the voice of the community and think in a multidisciplinary way to do things.
- In term of sharing on the renewable energy development, the following key factors should be considered:
  - The transmission grid to move electricity from renewable resources to load centers;
  - Long term energy storage in case of poor sun light;
  - Life-cycle analysis of solar cells;
  - Interconnection rules for dispute resolution, particularly for issues between utility and the developers;
  - Last, it was advisable to think about recycling batteries, such as lithium ion systems and related materials.

## V. RECOMMENDATIONS

During the final session, there were 3 panelists in this Session: (1) Professor Terrence Surles, Senior Advisor, Hawaii Natural Energy Institute, USA; (2) Dr Nguyen Hoai Nam, Viet Nam Academy of Science and Technology; (3) Associate Professor Dr Prapita Thanarak, Senior Lecturer, School of Renewable Energy and Smart Grid Technology, Naresuan University, Thailand.

- Professor Terrence Surles showed some diagrams on renewable consumption for electricity generation slightly greater than coal in 2020, utility-scale solar and wind dominated (~ 90%) new generation additions in 2021, (latest 2021 information), utility-scale solar is now at about 60GW in United States, significant growth for dPV with investment tax credit extended through 2025. He shared that Solar PPA prices are competitive with wind PPA prices and cost of burning fuel in existing gas-fired generators. However, costs are rising slightly, although not as fast as wind. Future solar curtailment problems in Hawaii are now happening on mainland. He concluded that changes continue for grid and solar, both utility-scale and distributed systems for residential and commercial sites. There are three main point to focus: State Regulators – subject to legislative mandates; Utility business models must change due to

changes in technology and government policy; Utilities should remain profitable, but consumer prices should be reasonable.

- Dr Nguyen Hoai Nam divided his presentation into 4 main part: Overview; Recent growths; Renewable energy and solar development and; Recommendations. In the first part, Dr Nam presented some diagram and figures to show Primary Supply and Demand in energy sector of Viet Nam, the proportion of mix energy and penetration of Renewable energy. He listed out some recent policies on solar power incentives and introduced about rooftop solar photovoltaic (RSPV) development of Viet Nam (EVN). The speaker summarize with some challenges and recommendation to the Government with focus on Grid codes and interconnection standards for RTS connections; Requirements for self-consumption and; Market-based instruments, e.g. carbon market introduction.
- The topic in the presentation of Professor Dr. Prapita Thanarak was “Solar Energy Perspectives for achieving Carbon Neutrality.” In the first part, the speaker provided an overview of the development of global energy in the past, present and predicted the future. She talked about global perspectives on the energy issues 2021, including the direction of car manufacturers related to the Global Carbon Neutrality Target, clean energy transition, smart energy landscape, energy sector disruptive trends, and green technology. The speaker also presented some tools for implementing deregulation and smart grid integration technology. He introduced The Thailand Energy Policy Framework with Smart Grid Development Action Plan: Medium Term ((2022 – 2031). The speaker concluded with some policies direction such as: (1) Increase the share of new electricity generation with an RE ratio of not less than 50%, in line with the trend of lower RE costs, considering the cost of ESS, and will not increase the long-term cost of electricity generation; (2) Change the use of transportation in the transport sector to green electricity through EV according to the policy; (3) Improve energy efficiency by more than 30%; (4) Restructuring the energy industry to support the energy transition trend (Energy Transition) according to the 4D1E guidelines.

Participants also shared overall views and recommendations on what APEC should do in term of policies and actions to support the solar energy development in APEC member economies as follows:

### **1. Recommendations to the government for the healthy development of solar energy in your economy**

- Continued and substantial interaction between governments and the private sector. The government can provide some funding, but the expertise and additional funding needs to come from the private sector. This is particularly true for transportation (electric and fuel cell vehicles) and industry (reduction of fossil fuels for industrial heat).
- More work needs to be done to determine how intermittent renewables such as solar and solar + storage fit into maintaining grid reliability and stability. As more and more electricity is required for transportation and industries, grid stability and reliability is increasingly important.
- New technologies are required for transmission to a grid primarily served by intermittent renewables. They include:
  - Long-term storage technologies, including hydrogen storage, new redox batteries, etc.;
  - Emerging use of “internet of things”, which is able to manage load remotely to enhance the effectiveness of demand response technologies;
  - Development of carbon capture/storage technologies (CCS) – continued use of fossil fuels may be required for firm power that allows for the maintenance of grid stability and reliability. CCS technologies will also be important for those industries (such as cement production) that require high temperatures and emit a lot of carbon dioxide during production;
  - Development and enhancement of new transmission lines – includes repowering to include high-voltage lines that can carry more power than traditional lines;
- It is advisable to listen to community leaders. While people may support overall renewable energy goals, some communities may not want to have large utility-scale projects nearby.
- As an economy moves to more and more renewable technologies, it should consider other topics, for example:
  - Standardization of interconnection rules. There can be conflicts between utilities and behind-the-meter (BTM) solar and solar plus storage installation companies;
  - Life-cycle analyses. Some renewable technologies, including solar and solar plus storage, can emit large amounts of carbon dioxide during mining and manufacturing steps;
  - Development of recycling technologies, particularly for batteries. There is a need to find ways to recycle critical materials, including nickel, cobalt, and rare earths;
- Implementation of FIT should be accelerated, which would encourage renewable energy producers to get committed to the scheme. It usually requires long term contracts that guarantee over-market-price properties.
- Ensure more direct delivery of electricity output to corporate consumers rather than going through a state electricity company.



- Governments should be more open to trade and investment in the energy sector to attract foreign capital for the development of solar power plants across the economies.
- Land use right has been a challenge for investors in this field. Therefore, it is necessary to accelerate the licensing of commercial plans in the early stage and to put in place enabling policies on it.
- The government should use the auction or tendering processes for projects that do not qualify for FIT to support the most price competitive growth.
- Exemption of Value Added Tax (VAT), import duties, income taxes, export taxes, etc. is advisable to reduce upfront costs of market players.
- Solar power sustainability should be ensured. Specific laws that apply to businesses in this industry should be issued in advance and constantly improved to catch up to real time advances. As a result, net metering, capacity limit and standardization should be carefully reviewed.
- Continued and substantial interaction between governments and private sectors. The government can provide some funding, but the expertise and additional funding needs to come from the private sector. This is particularly true for transportation (electric and fuel cell vehicles) and industry (reduction of fossil fuels for industrial heat).
- More work needs to be done to determine how intermittent renewables such as solar and solar + storage fit into maintaining grid reliability and stability. As more and more electricity is required for transportation and industry, grid stability and reliability is increasingly important.

## **2. Activities and/or interventions recommended for APEC in the next 1 – 2 years in this effort**

- Continue multi-economy efforts, including these types of workshops, for exchange of information.
- Set up a forum for “lessons learned” to update APEC economies on advances made in other economies.
- Consider interchanging experts among economies. It would speed up transfer of information.
- Form an APEC group to focus on multi-disciplinary attribute analysis. Due to competing demands and issues, just choosing the least costly technology or project may no longer be sufficient for planning purposes. This analysis should be flexible. Important attributes to one economy may not be important in another. Thus, development of a set of guidelines will be important.
- Develop public private partnerships on solar and renewable energy.
- Organize workshops to get lessons learned, ideas and experience from different experts and economies in the related sectors.

- In the context of the global COVID-19, the immediate target for most APEC members would be a quick economic recovery. APEC should promote the liberalization and facilitation of trade and investment, which enables the private sector to share a hand with the governments to support the economy and achieve interconnected development. This is very important for interconnection among APEC members in this issue, too.
- Travel restriction has been a major barrier to investment for the last two years. The new visa waiver that Viet Nam has offered since March 2022 does not only lift the burden on the tourist industry but also attracts cross-border investor attention to Viet Nam. APEC members should also collaborate and release appropriate adoption to encourage cross-border trade and investment activities, including those in the solar power sector.
- Innovation is an important driver for human progress. APEC members should speed up scientific, technological and institutional innovations, promote commercialization of scientific and technological advances and foster new drivers of growth, innovation inputs in both economic development and rule transition. APEC should try to set up more dialogues and forums for exchange among APEC members on how to drive up the innovation and have specific policies in this field.

## **VI. CONCLUSIONS**

In her closing remarks, Ms Pham Quynh Mai (Viet Nam' Senior Official to APEC) recognized that although it still remains a long way to reach the APEC's aspirational goal of doubling the share of renewables in the APEC energy mix, including in power generation, from 2010 levels by 2030, APEC member economies have made significant efforts to facilitate the development of renewable energy including solar energy in particular. For example, Hong Kong, China has set the Climate Action Plan 2050 (CAP2050) setting out the vision of "Zero-carbon Emission – Liveable City – Sustainable Development", targeting to increasing the share of renewable energy in the fuel mix for electricity generation 7.5% to 10% by 2035, 15% by 2050. The US has rejoined the Paris Agreement with efforts to tackle the climate crisis both at home and abroad, reaching net-zero emissions economy-wide by no later than 2050. Also, Viet Nam has set the strategic goals in the development of renewable energy, which aims to reach 44% of renewable energy in total primary energy consumption in 2050.

The Senior Official highlighted that the Workshop has come up with a number of good recommendations, including but not limited to: addressing relevant technical and economic issues to facilitate solar energy, promoting clear and predictable policies on renewable energy in general, solar energy in particular, promoting governments' support and incentives on development of solar energy, developing capacity building for relevant manpower including managers and operators who are in charge of operation of solar energy, so on.

By hosting this Workshop, Viet Nam wishes to join and strongly support APEC's common efforts on accelerating renewable energy development, including solar energy toward this end.

## VII. ANNEX 1: FINAL AGENDA OF THE WORKSHOP

<b>24 March 2022 (Thursday)</b>	
08:30–09:00	Registration and Test Run
09:00–09:10	<b><u>Opening Ceremony</u></b> <i>Welcoming Speech by Mr Nguyen Van Vy, Deputy Chairman, Viet Nam’s Energy Association</i>
09:10–09.50	<b>Session 1: STRATEGIES TO DEVELOP SOLAR ENERGY IN SOME ECONOMIES</b>  <b>Moderator:</b> <i>Ms Nguyen Huong Tra, National University, Viet Nam</i> <b>Speakers:</b> <ul style="list-style-type: none"> <li>- <i>Mr Takao Ikeda, Senior Economist, New and Renewable Energy and International Cooperation Unit, The Institute of Energy Economics, Japan;</i></li> <li>- <i>Dr Xia Ting, Senior Engineer, China Renewable Energy Engineering Institute (REEI), China</i></li> </ul>
09:50–10.20	<b>Discussions (Q&amp;A)</b>
10:20–10:30	Coffee Break
10:30–11:10	<b>Session 2: CASE STUDIES FROM SUCCESSFUL SOLAR ENERGY PROJECTS ON BUILDINGS</b>  <b>Moderator:</b> <ul style="list-style-type: none"> <li>- <i>Dr Cao Thi Hong Vinh, Foreign Trade University, Viet Nam</i></li> </ul> <b>Speakers:</b> <ul style="list-style-type: none"> <li>- <i>Ms Ku-Hsiu Hsiung, Project Director, Photovoltaic Technology Division, Green Energy and Environment Research Laboratories, Industrial Technology Research Institute (ITRI), Chinese Taipei;</i></li> <li>- <i>Mr Gukhan, Solar Business Developer, Canadian Solar Inc (CSIQ), Canada;</i></li> <li>- <i>Mr Daniel Lee-Wai Ying, Project Specialist Engineer, Electrical and Mechanical Services Department, Hong Kong, China.</i></li> </ul>
11:10–11:30	<b>Discussions (Q&amp;A)</b>

<b>25 March 2022 (Friday)</b>	
08:30–09:00	Registration and Test Run
09:00–10:00	<b>Session 3: CASE STUDIES FROM SUCCESSFUL SOLAR ENERGY PROJECTS ON ISLANDS</b>

	<p><b>Moderator:</b> <i>Professor Terrence Surles, Senior Advisor, Hawaii Natural Energy Institute, USA.</i></p> <p><b>Speakers:</b></p> <ul style="list-style-type: none"> <li>- <i>Mrs. Andriah Feby Misna, S.T., M.T., M.Sc, Director of New Various Energy and Renewable Energy, Directorate General of New, Renewable Energy and Energy Conservation, Ministry of Energy And Mineral Resources, Indonesia;</i></li> <li>- <i>Dr Marissa E. Morales-Rodriguez, Technology Manager, Systems Integration, Solar Energy Technologies Office, Contractor to U.S. Department of Energy, USA;</i></li> <li>- <i>Mr Taeil Kang, CEO, One Energy Island Co., Ltd, Korea;</i></li> <li>- <i>Ms Elena Villanueva, Senior Analyst for Electricity Access in the Energy Access and Social Development Division, Ministry of Energy, Chile.</i></li> </ul>
10:00 – 10:30	<b>Discussions (Q&amp;A)</b>
10:30 – 10:40	Coffee Break
10:40 – 11:30	<p><b>Session 4: RECOMMENDATIONS FOR GOVERNMENTS TO DEVELOP SOLAR ENERGY</b></p> <p><b>Moderator:</b> <i>Ms Nguyen Huong Tra, National University, Viet Nam</i></p> <p><b>Panelists:</b></p> <ul style="list-style-type: none"> <li>- <i>Professor Terrence Surles, Senior Advisor, Hawaii Natural Energy Institute, USA;</i></li> <li>- <i>Dr Nguyen Hoai Nam, Viet Nam Academy of Science and Technology;</i></li> <li>- <i>Associate Professor Dr Prapita Thanarak, Senior Lecturer, School of Renewable Energy and Smart Grid Technology, Naresuan University, Thailand.</i></li> </ul>
11:30 – 11:40	<p><b><u>Closing Remarks</u></b></p> <ul style="list-style-type: none"> <li>- <i>Ms Pham Quynh Mai, Viet Nam’s Senior Official to APEC</i></li> </ul>