APSEC Updates in EGNRET 56 Meeting

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The 56th Meeting of APEC Expert Group on New and Renewable Energy Technologies
Virtual meeting hosted the United States, 6-7 April 2022

OUTLINE

(Updates on selected research activities of Energy Transition Solutions since the last meeting)

1. **Workshop on Energy Transition and Low Carbon Green Development**

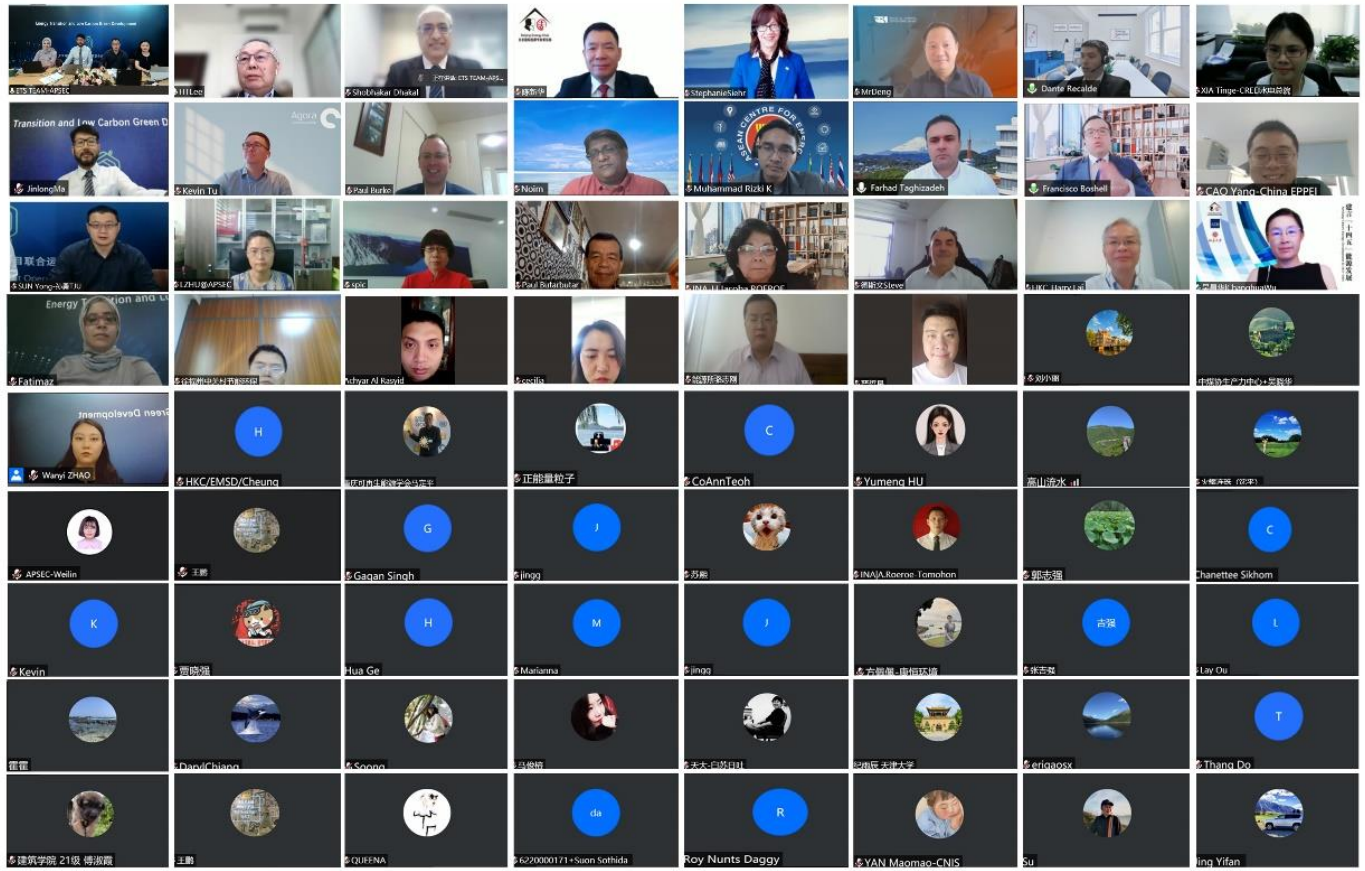
2. **Projects**

   APEC Self-funded project
   APEC funded projects

APSEC Research Areas:

- Energy transition solutions
- Sustainable cities
- Clean energy technologies (under development)

Workshop on Energy Transition and Low Carbon Green Development



- The Workshop was held on **17 Sep 2021**, which was organised by Energy Transition Solutions (ETS) Team.
- As part of **the 7th Asia Pacific Energy Sustainable Development Forum,** 15-17 September 2021, Tianjin, China (virtual)
- **Dr. Hom-Ti Lee**, Chair of EGNRET of APEC EWG, delivered opening remarks.
- Participants: approximately **70 experts, scholars and researchers from 9 APEC economies**
- **Speakers**

  Green Growth Institute (GGGI)
  ASEAN Centre for Energy (ACE)
  International Renewable Energy Agency (IRENA)
  World Forum Offshore Wind (WFO)
  Agora Energiewende
  Energy Exemplar Pty Ltd
  Australian National University
  Tokai University
  University of San Francisco,
  Tianjin University
  Beijing Energy Club
  China Renewable Energy Engineering Institute
  China Electric Power Planning & Engineering Institute

- The workshop was divided into two sessions of "**Supporting and Accelerating Energy Transition Through Innovation and Technology**" and "**Regional Experience and Practices of Low Carbon Development**".
- The participants comprehensively shared valuable experience in achieving energy transition from multiple respects such as energy efficiency, technological innovation, and green finance etc.

Energy Transition Solutions (ETS) Sub-forum

Energy Transition and Low Carbon Green Development

Time/Date	Beijing Time (GMT+8) Pacific Time (GMT-8) Central European Summer Time (GMT+2)	09:00-17:25, September 17, 2021 18:00-02:25, September 16, 2021 03:00-11:25, September 17, 2021
Online Platform	Platform: VOOV meeting Software Download Address: https://www.voovmeeting.com Online Meeting ID: 726 459 895	
Test Run for the Online Platform Beijing Time (GMT+8): 08:30-09:00		
Chair: Prof. Jinlong MA, Vice President of APEC Sustainable Energy Center (APSEC)		
Online Group Photo		
Opening Remarks 09:00-09:10	Dr. Hom-Ti (Tom) Lee, Chair of Expert Group on New and Renewable Energy Technologies (EGNRET), APEC Energy Working Group (EWG), APEC	
Session I: Supporting and Accelerating Energy Transition Through Innovation and Technology Beijing Time (GMT+8): 09:10-12:10 Pacific Time (GMT-8): 18:10-21:10; Central European Summer Time (GMT+2) : 03:10-06:10		
09:10-09:30	Prof. Shobhakar Dhakal, Vice President of Asian Institute of Technology (AIT), Thailand Topic: Optimizing Urban Energy System and Infrastructure with Climate Change	
09:30-09:50	Dr. Xavier Chen, CEO of Beijing Energy Club, China Topic: Facilitate Energy Tarnation Through Innovation and Technology	
09:50-10:10	Prof. Stephanie Siehr, Professor, Environmental and Energy Programs, University of San Francisco, The United States Topic: Energy Services and Efficiency in the United States	
10:10-10:30	Dr. Joseph Deng, Representative, Great China, World Forum Offshore Wind (WFO) Topic: Offshore Wind Development in Asia and Pacific	
10:30-10:50	Dr. Dante Recalde, Lead of Solutions, Energy Exemplar Pty Ltd, Singapore Topic: Hydrogen as a Profitable Decarbonization Pathway into the Future	
10:50-11:10	Dr. XIA Ting, Senior Engineer, International Business Department, China Renewable Energy Engineering Institute (CREEI), China Topic: Development and Perspective of Renewable Energy in China	
11:10-11-30	Dr. Fatima Zahra Ainou, Researcher of APEC Sustainable Energy Center (APSEC), China Topic: Improving Energy Access Through Application of Renewables: the Case of PNG	
Panel Discussion 11:30-12:10	Chair: Prof. Jinlong MA, Vice President of APEC Sustainable Energy Center (APSEC)	

Test Run for the Online Platform Beijing Time (GMT+8): 13:30-14:00	
Session II: Regional Experience and Practices of Low Carbon Development Beijing Time (GMT+8): 14:00-17:25 Pacific Time (GMT-8): 23:00-02:25; Central European Summer Time (GMT+2) : 08:00-11:25	
Chair: Dr. SUN Yong, Researcher of APEC Sustainable Energy Center (APSEC) ZHAO Wanyi, Associate Researcher of APEC Sustainable Energy Center (APSEC)	
Online Group Photo	
14:00-14:20	Dr. Kevin Tu, Head of China Program, Agora Energiewende, Germany Topic: Experience of energy transition in Germany
14:20-14:40	Dr. Paul Burke, Associate Professor, Crawford School of Public Policy, Australian National University (ANU), Australia. Topic: The Economics of the Energy Transition in Australia
14:40-15:00	Dr. Noim Uddin, Senior Advisor, Global Green Growth Institute (GGGI) Topic: Support Energy Transition Through Effective MRV
15:00-15:20	Muhammad Rizki Kresnawan, Energy Modelling and Policy Planning Officer, ASEAN Centre for Energy (ACE), Indonesia Topic: Renewable Energy Plan and Development in Southeast Asia
15:20-15:40	Dr. Farhad Taghizadeh-Hesary, Associate Professor of Tokai University, Japan Topic: Green Finance Support Energy Transition and Low Carbon Green Development
15:40-16:00	Dr. Francisco Boshell, Senior Analyst, International Renewable Energy Agency (IRENA) Topic: Recent Renewable Energy Technology Development and Applications
16:00-16:20	Dr. CAO Yang, Director Engineer, International Cooperation Division, International Business Department, Electric Power Planning & Engineering Institute (EPPEI), China Topic: China's Plans and Actions to Build Innovative Power System with Primarily New Energy
16:20-16:40	Dr. SUN Yong, Researcher of APEC Sustainable Energy Center (APSEC), China Topic: Promote Energy Transition by Final Energy Management and Energy Efficiency Improvement
Panel Discussion 16:40-17:25	Chair: Prof. Jinlong MA, Vice President of APEC Sustainable Energy Center (APSEC)

APEC Self-Funded Project (EWG 04 2020S):

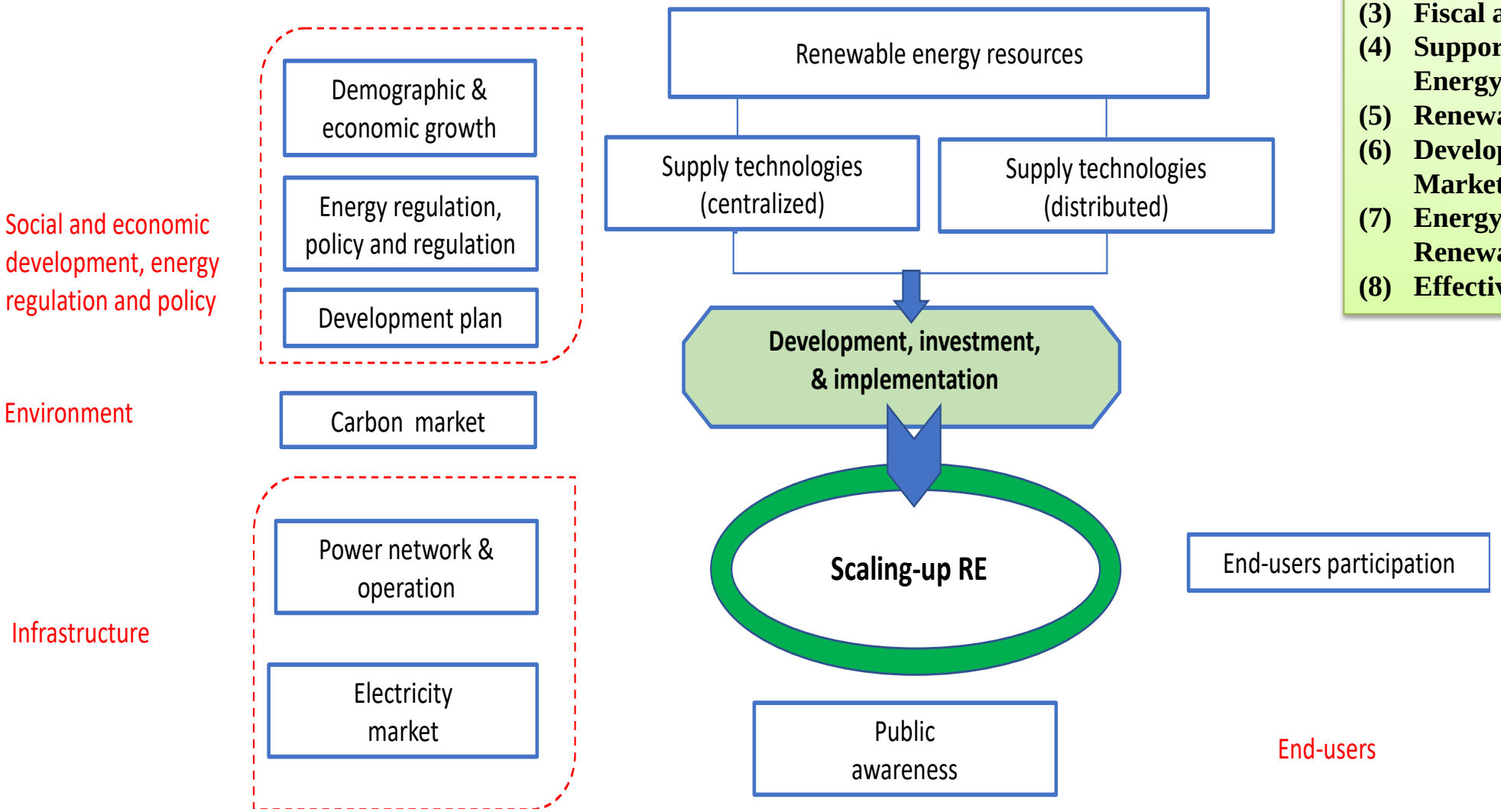
Innovative Approaches for Scaling-Up Renewable Energy Deployment in APEC Region

- **Proposing economy:** China
- **Co-sponsoring economy:** Hong Kong, China
- **Expected start/completion date:** 01/11/2020 - 30/04/2022
- **Project Overseer:** Prof. Jinlong MA

Scope proposed

- The project focuses on RE power generation and **aims to explore innovative approaches for scaling-up RE application** in APEC region, which **facilitates achieving the APEC RE goal.**
- Through review, investigation and stakeholder consultation, the project assesses the RE development from performance of energy system, sustainability and energy access perspectives.
- Barriers and drives for RE development are analyzed, suggestions and recommendations on innovative approaches will be put forward through analysis of policy, technologies, business environment, case study, etc.
- **Research results to be synthesized in project report and shared**. Presentations on the findings will be made in EGs' meeting and APSEC's events for members to exchange experience and disseminate relevant know-how.

Framework of the Study

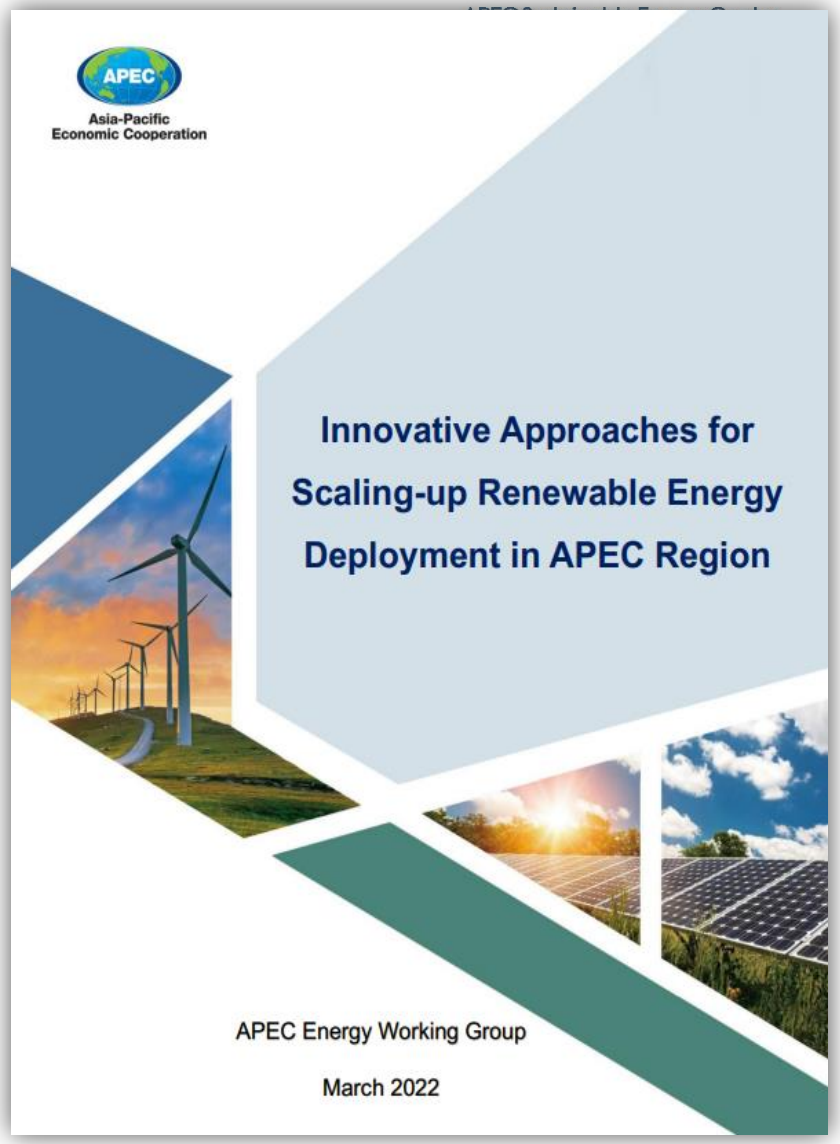


(1) **Innovation and Technological Development**
(2) **Policy Environment and Regulatory Framework**
(3) **Fiscal and Financial Tools**
(4) **Support Investment in Renewable Energy Project**
(5) **Renewable Power Grid Integration**
(6) **Development and Implementation of Market Mechanism**
(7) **Energy Access Supported by Renewable Energy**
(8) **Effective Regional Collaboration**

Status: draft Project Report submitted to APEC Secretariat for review and approval on 25 March 2022

Report Summary

- The project assesses the status and current situation of RE development in APEC region, focusing on renewable electricity supply
- Through a holistic approach, the project examines the RE related domestic policies, regulations and development targets, analyzes the conditions for RE deployment, namely resources endorsement and factors associated with the costs of RE technologies, their composition and recent trends. The role of innovation and technology advancement are evaluated, as well as the infrastructure support for RE development such as measures to raise the flexibility of power system and effective electricity market operation.
- The barriers and drives for RE development are analyzed from the perspectives of investment environment and business condition. With its increased importance, the potentials and issues related to the applications of distributed RE resources are addressed. The workable methods supporting to achieve universal electricity access are detailed through case studies.
- The report ends with the case studies on the solar PV sector development and solar PV project deployment.
- Suggestions and recommendations are put forward to effectively promote and accelerate RE development, and scaling-up RE applications in APEC region.

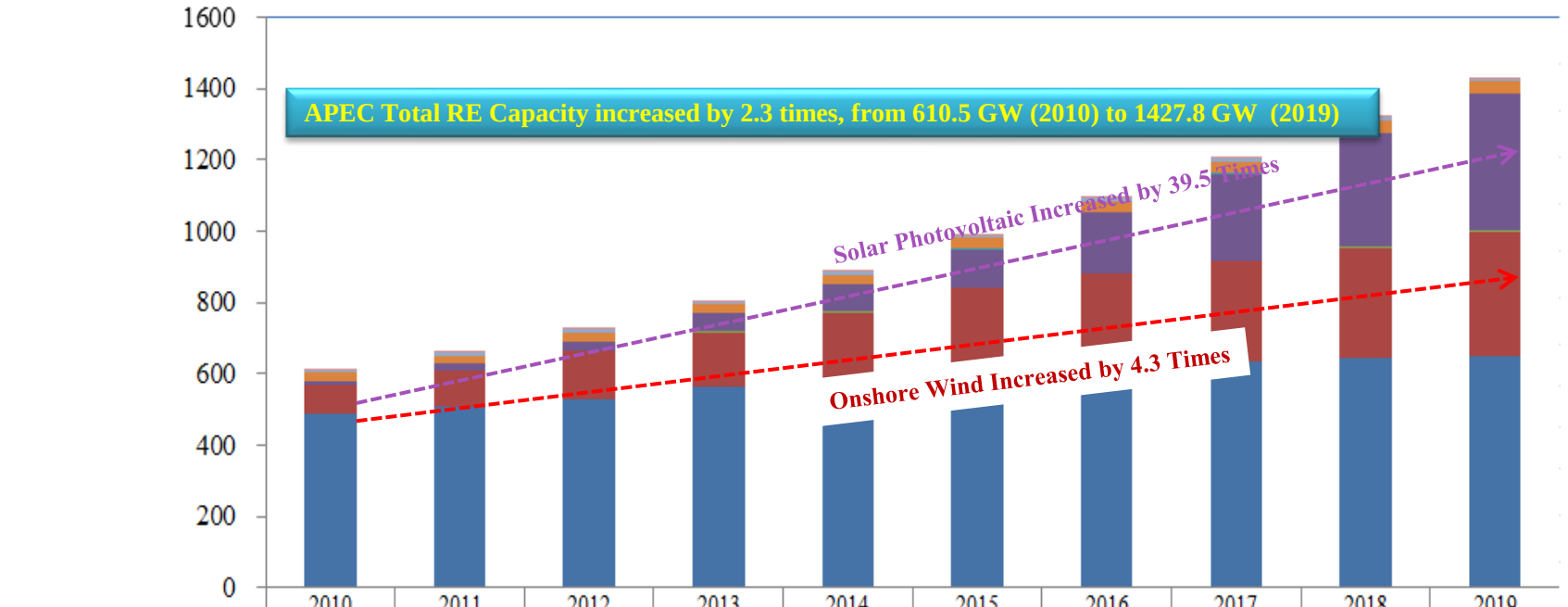


Status of Renewable Energy Development

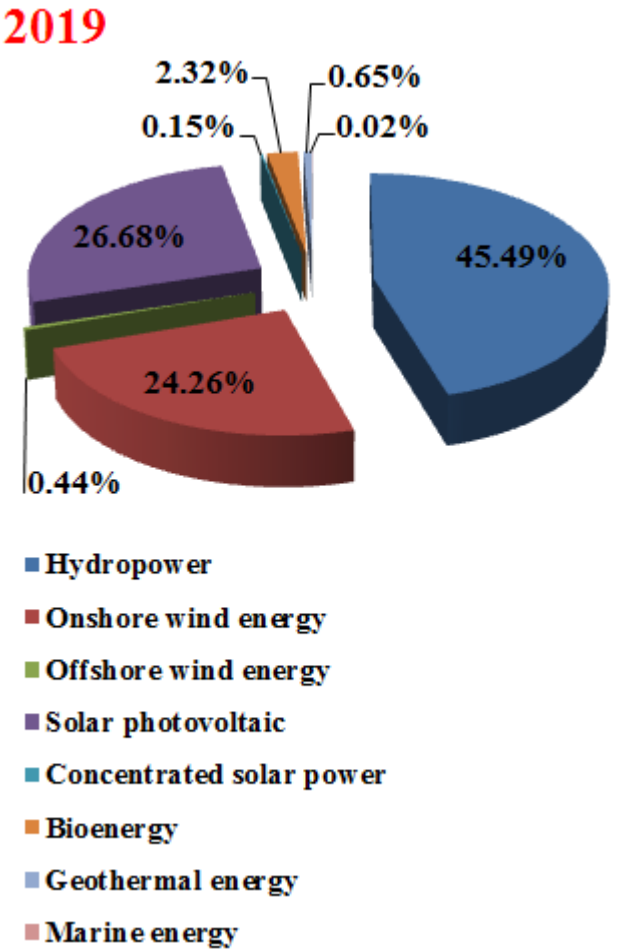
APEC Sustainable Energy Center

Renewable Capacity Statistics of APEC (2010-2019)

Unit: GW



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Marine energy	0.03	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Geothermal energy	7.83	7.80	8.00	8.09	8.24	8.42	8.63	8.74	9.02	9.21
Bioenergy	25.48	22.74	23.80	24.55	27.54	29.79	30.47	31.78	32.65	33.06
Concentrated solar power	0.48	0.48	0.49	1.31	1.69	1.78	1.79	1.79	2.00	2.20
Solar photovoltaic	9.63	17.15	27.71	50.53	75.99	109.66	169.73	241.39	316.59	380.88
Offshore wind energy	0.13	0.24	0.32	0.49	0.52	0.72	1.71	3.04	4.86	6.32
Onshore wind energy	78.91	103.95	135.54	154.44	182.78	228.57	256.52	279.25	308.01	346.32
Hydropower	488.03	506.93	527.86	562.23	589.34	609.72	623.16	636.34	645.02	649.47



Raw data from IRENA and APEC Energy Database, analyzed by APSEC

Status of Renewable Energy Development

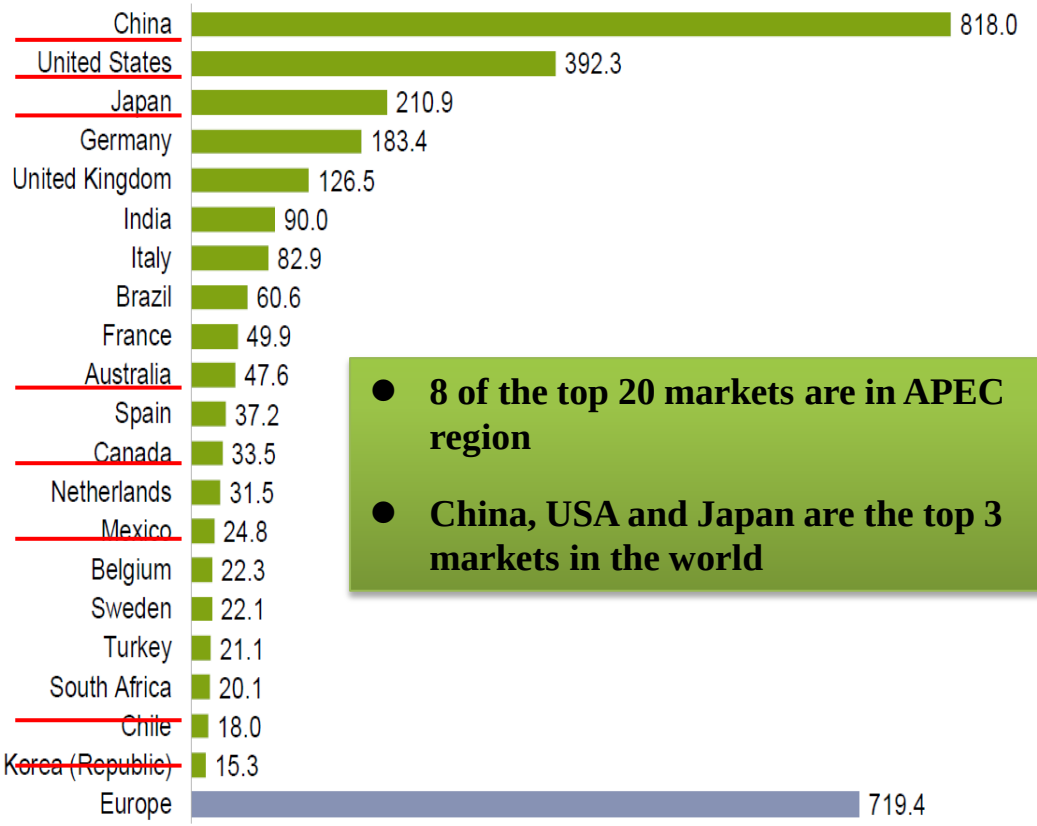
Global Share of APEC's Renewable Installation Capacity (2010-2019)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hydropower	52.76%	53.22%	53.70%	54.66%	55.30%	55.50%	55.22%	55.06%	54.80%	**54.60%**
Onshore wind energy	44.38%	48.07%	51.82%	52.76%	53.63%	56.50%	56.69%	56.35%	57.02%	**58.26%**
Offshore wind energy	**4.09%**	6.22%	6.02%	6.81%	6.09%	6.16%	11.92%	16.11%	20.58%	**22.34%**
Solar PV	23.91%	23.82%	27.29%	37.22%	44.31%	50.48%	58.33%	62.93%	65.54%	**65.65%**
Concentrated solar power	37.60%	27.86%	18.89%	33.97%	37.47%	37.41%	36.77%	36.02%	35.25%	**35.06%**
Bioenergy	38.82%	36.98%	37.10%	36.56%	38.04%	39.01%	37.99%	38.90%	38.97%	**40.06%**
Geothermal energy	78.36%	77.32%	76.33%	75.50%	73.83%	71.27%	70.42%	68.79%	68.06%	**66.30%**
Marine energy	11.20%	56.06%	55.40%	55.29%	54.97%	54.97%	53.82%	53.41%	53.31%	**53.30%**
Total REs	**49.76 %**	**49.79 %**	**50.41 %**	**51.77 %**	**52.76 %**	**54.00 %**	**54.84 %**	**55.62 %**	**56.40 %**	**56.93 %**

Renewable Energy Investment

RE capacity investment from 2010 to 2019, top 20 markets

Unit: $bn



- **8 of the top 20 markets are in APEC region**
- **China, USA and Japan are the top 3 markets in the world**

Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

Source: Global Trends in Renewable Energy Investment 2020

Pathways to Scaling-up Renewable Energy Development

APEC Sustainable Energy Center

- Institutional and Regulatory Framework
- Power System
- Electricity Market

- Business Model
- The Public–Private Partnership
- The Cooperative Model
- The RESCO Model

Renewable Policy and Plan

Support Infrastructure

Business Environment

Distributed Energy Utilization

Renewable Energy Technology

- Renewable Energy Resource Assessment
- Availability of Renewable Energy Resource
- Cost Component of Renewable Energy
- Technological Learning and Cost Reduction
- Research and Innovation
- Supply Chain of Renewable Energy Technology
- Technology Development and Cost Reduction Support

Cost and Financing

- Investment in R&D
- Renewable Energy Investment Trend
- Trend of Capital Cost of Renewable Technology
- Impact of COVID-19 on Renewable Energy Investment
- Financing Sources for Renewable Energy Projects
- Financing Challenges and Recommendations on Mobilizing Capital for RE Development

Investment Condition

- Existing Policies
- Licensing and Permit
- Procurement Model
- International Support
- Barrier and Recommendation

- Distributed Energy Development Plan
- Policy for Distributed Generation
- Technical Standard for Distributed Generation and Microgrid
- Consumer Affordability
- Policy Support for Low-income and Remote Area Customer

Pathways to Scaling-up Renewable Energy Development: Support Infrastructure

(1) Institutional and Regulatory Framework

The majority of APEC economies have adopted a supervision paradigm that separates the government from the business. The design of macro policies and market regulation is achieved at the government level by establishing of relevant government authorities, such as the Ministry of Energy, the Energy Bureau, and the Energy Commission.

In terms of public services, power transmission and supply are realized through grid companies.

A robust electricity market monitoring system and development policy are the prerequisites for ensuring the sustainable and healthy development of renewable energy power generation. Different economies in the region have different legal frameworks when it comes to regulating procedures.

Table Regulatory Systems and Policies for Renewable Energy in Selected APEC Economies

Economies	Feed-in tariff	Quota System for Renewables	Electricity price settlement policy	Renewable energy certificates (RECs)	Competitive bidding policy
Australia	☆·	●	◖	●	◖○
Canada	◖	◖	◖	☆	◖
Chile	●	●	●	●	●
Japan	●	--	--	●	●○
Korea	--	●	●	●	--
New Zealand	--	--	◖	--	--
Singapore	--	●	--	--	●
The United States	◖	☆·	☆·	◖	◖
China	☆	☆	--	--	◖○●
Malaysia	●	●	☆	--	●○
Indonesia	●	●	--	--	●
Thailand	●	--	●	--	--
Papua New Guinea	--	--	--	--	--
Chinese Taipei	☆	--	--	--	--
Peru	●	●	●	--	●
Russia	●	--	--	--	●○
Mexico	--	--	●	--	●○
Viet Nam	●	●	●	●	○

Note: ☆ Revision Policy; ☆ *Local revision policy; ● Existing national policy; ◖ existing local policy; ○ National auction will be help in 2019.

Source: REN 21, Renewables 2020 Global Status Report.

- Chile, Japan, Malaysia, Indonesia, Thailand, Peru, Russia, and Viet Nam have established feed-in tariff policies over the whole level of the economy.
- Local renewable energy feed-in tariff rules are prior policies for Canada and the United States.

(2) Power System: System Flexibility

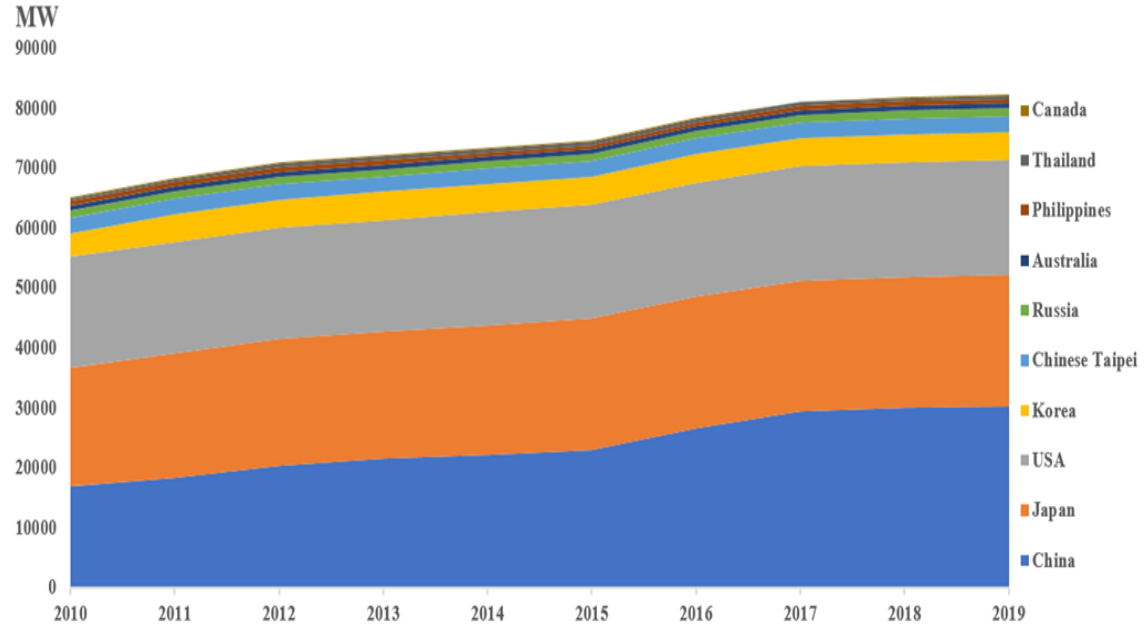
The enhancement of the flexibility of the power system is very crucial for the absorption of renewable energy and promotion of the large-scale use of renewables, which can be achieved through the following aspects.

Raise the flexibility of thermal power unit: Thermal power, particularly coal-fired power, continues to play an essential role in many APEC economies. The methods raise the flexibility of the thermal power plants includes deep peak-regulation, ramping capability and the speed for starting and shutting-down. Flexible thermal power units can help absorb renewable energy by forming a complementary effect with variable renewable energy sources.

Development of pumped storage: Currently pumped storage is the utility-scale energy storage technology with the largest installed capacity. With the increased capacity of renewable energy, pumped storage hydropower plants have become one of the important strategies to improve the flexibility of the power system.

Enhancing power grid flexibility: Increasing power grid flexibility is one of the significant requirements for absorbing renewable energy.

Strengthening demand side management: The flexibility of the power system can be improved by utilizing the demand-side resources.



Source: IRENA, Renewable Energy Statistics, 2020

Figure The Installed Capacity of Pumped Storage in Selected APEC Economies

Table Demand Side Response and Management in the US and Canada

Economies	Operators	Electricity Market	Ancillary Services Market		Capacity Market
			Frequency Regulation	Backup	
The United States	CAISO	√	×	√	√
	ERCOT	√	√	√	√
	ISO-NE	√	×	×	√
	MISO	√	√	√	√
	NYISO	√	√	√	√
	PJM	√	√	√	√
Canada	ASEO	√	×	√	×
	IESO	√	×	√	√

Pathways to Scaling-up Renewable Energy Development: Support Infrastructure

(2) Power System: Renewable Power Plants Integration

- A large proportion of intermittent and fluctuating renewable energy connected to the grid will have a significant impact on the power system's safety and stability.
- One of the key issues in the large-scale development of renewable energy is effective renewable energy-related connection standards and rules.
- Renewable energy standards can be divided into generating unit grid-connection standards, operating standards, power planning standards and power market standards.

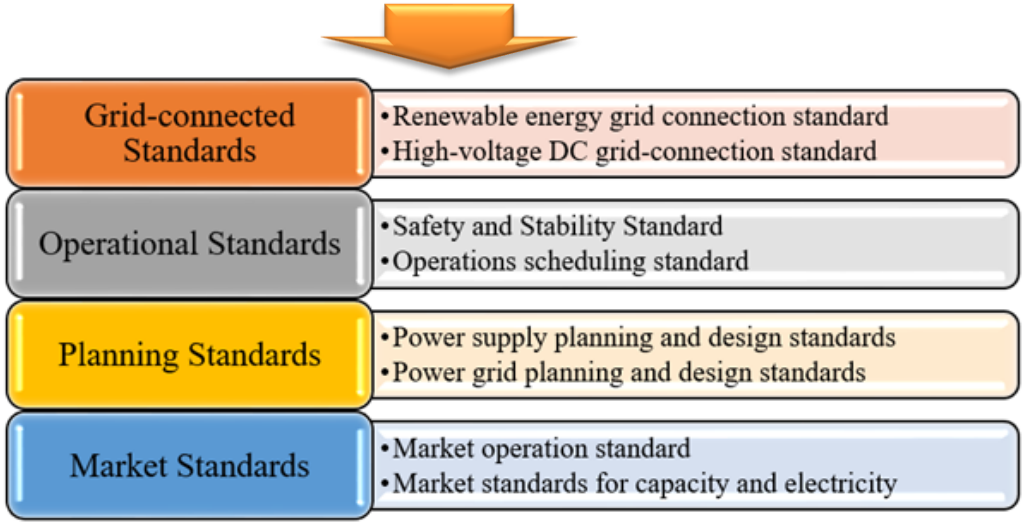


Figure Renewable Power Generation Related Standards

Table Renewable Energy Grid-connected Standards in Some APEC Economies

Standard requirement	China[1]	The United State[1]	Australia[2]	The Philippines[2]
Electric power quality	Flicker, harmonics, voltage deviation ±10%.	Flicker, harmonic, voltage deviation steady state ±5%, transient ±10%, which is greater than the power system (161kV), ±2.5%.	Flicker, harmonics, voltage fluctuations.	Flicker, harmonics, voltage fluctuations.
Reactive power output	Power factor 0.95 between lag and lead; When the reactive power does not meet the requirements, it is necessary to configure the reactive power compensation device.	The power factor of 0.95 lags between the lead, and at 0 active output can be a certain voltage control.	Under any voltage level and active output, it must be able to provide 39.5% of reactive power Q.	For large-scale wind farms with an active power output higher than 58%, it must be possible to ensure that the reactive power Q is within ±20% of the active power range.
Frequency support	When the system frequency is higher than 50.2Hz, it must be able to reduce the active output.	Units are required or encouraged to provide active frequency response support when the frequency is too high or too low。	Frequency-power curve requirements.	When the frequency is too high, it must be able to limit the active output; large power plants must be able to limit the ramp rate.
Low voltage ride through (LVRT)	When the voltage is low at 20%, it should be kept connected for 0.625 seconds without tripping. When the system voltage is restored to 90% within 2S seconds, the unit shall be continued to operate without tripping.	Not tripping for 0.625 seconds at 15% lower than voltage; continuous operation without tripping at 90% of the normal voltage。	When the voltage is low, it must be kept for 0.430 seconds grid connection; it can provide reactive power support for 0.1 seconds when it fails.	Wind power must be grid connected for 0.625 seconds at 20% low voltage; it can provide 0.15 seconds of reactive power support; photovoltaics can keep off the grid for 0.15 seconds at 0 voltage, and 0.625 seconds at 30% low voltage.
Wide area communication	Bi-directional communication capability; capability of accepting commands from the control center.	Capability of uploading operating data in real time; support emergency energy management.	Bi-directional communication capability; a large renewable power plants must be able to receive power control instructions and report various status information.	Bidirectional communication ability, capability to receive power control, voltage control instructions and start and stop instructions.

Source: 1. NREL, Comparison of Standards and Technical Requirements of Grid-Connected Wind Power Plants in China and the United States, 2016; 2. IRENA, Scaling up Variable Renewable Power: The Role of Grid Codes, 2016.

(2) Power System: Dispatching and Power Grid Operation

System dispatching is important to realizing the large-scale absorption of renewable energy. An optimal scheduling of "source-grid-load-storage" allows for flexible absorption of increased amount of renewable electricity.

(1) Measures for effective grid operation and dispatching

- **Enhancing the grid capacity**
- **Improving inter-provincial connection**
- **Reinforcing urban and rural smart distribution network**
- **Exploring joint dispatching strategy of multiple energy resources**
- **Increasing the stability and reliability of the power system**

(2) Renewable energy curtailment

Renewable energy curtailment, and at the same time, insufficient power supply in some load centers exist in various places of some economies.

Power supply reliability deteriorated, and power system frequency and voltage stability issues came up, and power blackouts happened

Increasing forecasting accuracy of renewable electricity generation, deploying storage capacity.

(3) Power network reinforcement and development

- **Financial burden:The main financial challenge is the economy's loan repayment capacity. For the power transmission project development, possible application for low-interest loans, and other new financing mechanisms are needed.**
- **Political issues:** The approval procedures are directly linked to the timeline of the power line projects, while government support and commitment are among the key factors to the success of the projects.
- **Regional interconnection:** The insufficient connection capacity would affect the regional power flow and limit regional energy transaction of the system.
- **Other barriers:** The difficulty of acquiring confidential data and information and the lack of a consistent legal framework on this and information security need to be addressed

Pathways to Scaling-up Renewable Energy Development – Support Infrastructure

(3) Electricity Market: Market Structure

- In APEC economies, the structure of the electrical market varies widely, with different levels of openness and competition.
- In general, the reform and development of the electricity market has been in the direction of further improving a fair and orderly competitive condition of electricity trade..

Source : IRENA, Renewable Energy Market Analysis Southeast Asia

Figure: Electricity Market Model in Selected APEC Economies

(3) Electricity Market: Market Operation

- With the development of UHV transmission technologies, one of the concerns of APEC economies is to reasonably formulate electricity market operation rules, promote large-scale RE consumption, create a fairer electricity market condition and electricity pricing.
- In terms of electricity pricing mechanisms, Japan, Canada, Korea, Peru, and other economies have adopted the single market pricing mechanism, while the United States adopted node pricing model and Australia regional pricing method.
- The difference between the wholesale electricity prices and the retailer prices reflect economy's regulation on and policy in power sector, and electricity market structure.

Table: Wholesale Electricity Prices in Selected APEC Economies

Economies		2017 ($/MWh)	2018 ($/MWh)
China		54.53	54.20
The United States	New York ISO ZJ	39.15	47.37
	New England ISO	37.68	50.11
	PJM West	34.25	41.79
	Indiana	34.22	39.01
	Southwest Power Depot	30.43	30.43
	Northern Texas	26.44	41.51
	Northwest Mid-C	26.17	37.94
	California ISO NP15	38.04	42.22
	California ISO SP15	38.50	47.35
	Palo Verde, Southwest	33.03	40.96
	Southern part	29.62	30.80
Canada	Alberta	16.43	37.26
	Ontario	--	17.98
Japan		94	94
Australia	Queensland	75	83
	New South Wales	85	92
	Victoria	99	124
	South Australia	109	128
	Tasmania	88	88

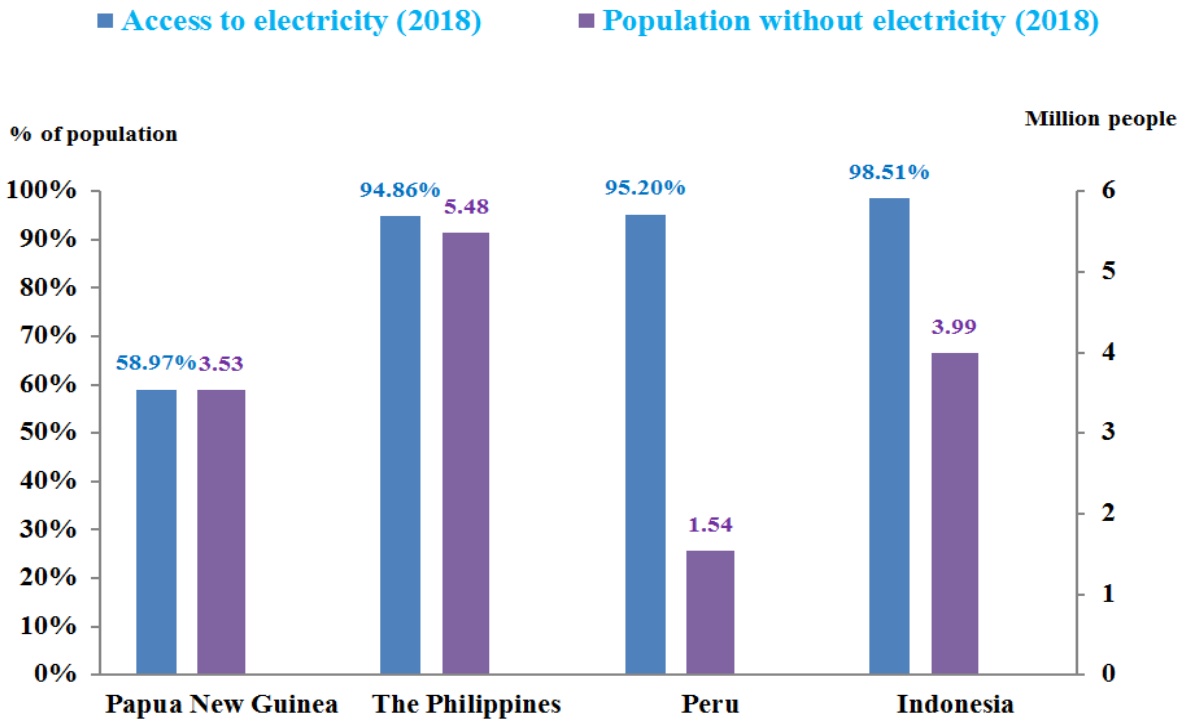
Source: 1. National Energy Administration, Regulatory Bulletin on National Electricity Prices in 2017 and 2018; 2. State Grid Energy Research Institute Co., Ltd., analysis report on domestic and foreign power market reforms, 2019.

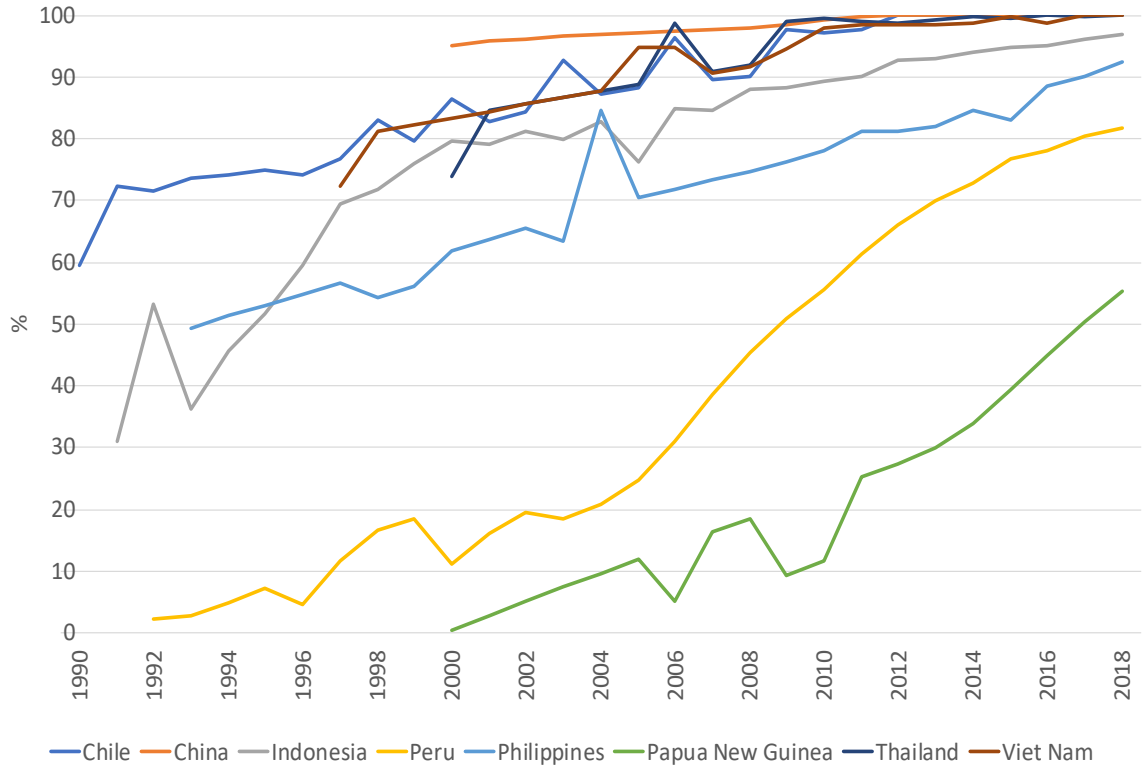
Table: Retail Electricity Prices in APEC Economies (2019)

Economies	Residential ($/kWh)	Commercial ($/kWh)	Differences in residential and commercial ($/kWh)
China	0.08	0.10	-0.02
United States	0.14	0.11	0.03
Canada	0.11	0.09	0.02
Japan	0.28	0.21	0.07
Russia	0.06	0.09	-0.03
Australia	0.23	0.19	0.04
Mexico	0.07	0.14	-0.07
Viet Nam	0.08	0.08	0
Korea	0.11	0.10	0.01
Thailand	0.12	0.12	0
Chile	0.19	0.14	0.05
Indonesia	0.10	0.07	0.03
Malaysia	0.06	0.10	-0.04
Chinese Taipei	0.10	0.13	-0.03
New Zealand	0.22	--	--
The Philippines	0.20	0.13	0.07
Peru	0.20	0.14	0.06
Singapore	0.18	0.14	0.04
Papua New Guinea	--	--	--
Brunei Darussalam	--	--	--
Hong Kong, China	0.14	0.14	0

Source: www.globalpetrolprices.com/

Renewable Energy to Support Energy Access





Source: World Bank, analyzed by APSEC

Renewable energy offers the opportunity and solutions toward universal electricity access in the region

- Renewable based rural electrification policy and programs
- Sound regulatory framework
- Cost-effective power distribution grid extension
- Off-grid solutions, along with distributed renewable energy resources and micro- and mini-grid technology
- Support productive use of electricity in rural community
- Feasible business models for electricity supply

Renewable Energy to Support Energy Access: case of PNG

APEC Sustainable Energy Center

Abundant Renewables

Hydro	Geothermal	Solar
•Potential 15000MW •Current 230 MW •136 MW Under development	•21.9 TWh •54 MW	•Average: 3.59 kWh/kWp •Max: 4.33 kWh/kWp

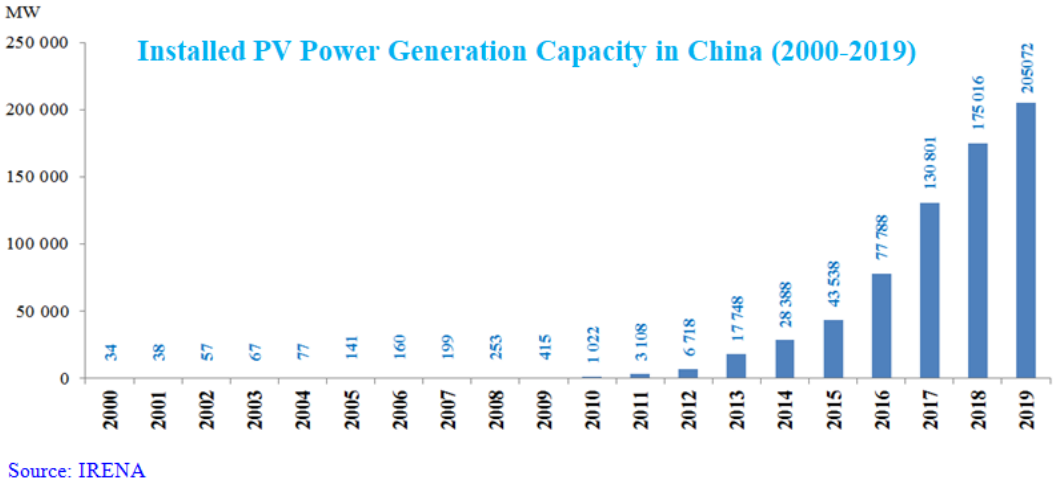
Sources: APEC Statistics, IEA, EGEDA Database / UN- Energy Statistics Yearbook, 2018

Summary

- PNG is among the lowest in terms of rural electricity access, while outdated transmission and distribution infrastructures lead to frequent outages in urban centers. In PNG, the low electrification coverage reflects a combination of high network cost, as a result of the dispersion of the population and geographic features.
- **A holistic approach is required to address the issues**, which covers government policy, regulatory framework, fiscal measures, institutional setting and operations, performance of power utilities, mobilizing private sector actors, local communities' participations, and support of rural productive use of energy
- **Off-grid energy solutions** include solar home systems (SHS) and larger solar PV installations, micro-hydro plants and solar pumps, are needed to meet rural household needs.
- **Mini-grid** can be deployed, with necessary energy storage capacity, to supply reliable and affordable electricity to a large number of the villagers and local communities.
- **Lessons learned from successful experiences** in the region and beyond while taking systematic approaches are necessary for governments, international development partners, the private sector, civil society organizations, and practitioners to develop interventions to narrow the electricity access gap.

Case Study of the Development and Deployment of RE Technology: Solar PV in China

- **China has made significant progress in the development of RE in recent years, ranking the first in world in terms of solar PV, wind power, and hydropower installed capacity.**
- **The development of the solar PV sector in China can be classified into the following phases:**
  - Small-Scale Demonstration (before 2001)
  - Raising Manufacturing Capacity (2002-2009)
  - Large-scale development of the whole industrial value chain (2009-2015)
  - Quality improvement and efficiency improvement (2016 to the present)



Source: IRENA

Main drives for the solar PV sector's development and establishment in China

- Implementing the domestic strategy is an important prerequisite for the rapid development of new and renewable energy
- Planning industry development
- Supporting the progress of the renewable sector
- Boosting the development of renewables through the diversification of market participation
- Market competition has boosted manufacturing capacity and efficiency
- Industrial development through international collaboration
- From pilot and demonstration to scaling-up the deployment of renewables

■ Summary and conclusion remarks of the study in order to further support scaling-up renewable energy in the APEC region.

(1) Strengthening Policy Support

Strengthen market supervision policies and achieve a balance between macro policymaking, market operation, and effective regulation. Based on the specific conditions, improve policy framework, and set appropriate strategies and goals apocopate to enable more businesses in renewable energy sectors.

(2) Promoting Technological Progress and Cost Reduction

Continuous expansion of government investment in R&D, support scientific and technological research, demonstration and application, and enhance renewable energy industry development. Support technological breakthrough to eliminate the barriers toward safe and affordable renewable energy. Through market competition, giving a full play to the key role of enterprise research and development innovation is a key driver to achieve technological progress and cost reduction as well as affordable energy access..

(3) Reenforcing Financial Support

To minimize renewable energy project cost in the process of project development, project license and permit applications and project grid connection application, government's related management costs in the process of project development should be suitably reduced, which will contribute to the reduction of renewable energy projects. Supporting private enterprises and renewable energy generation businesses through renewable energy development funds would be an option. The introduction of new fund scheme can go along with directing social funds toward renewable energy investment. This will not only effectively promote the development scale of renewable energy but will also improve social welfare through the creation of more job vacancies.

(4) Innovating Financing and Business Model

Establish effective financial mechanisms to ensure low-cost financing for renewable energy projects and encourage innovation in business and financing models. Subsidy policies should be appropriately utilized to lower financing expenses. As the primary source of funding, green finance can help businesses lower their financing costs and extend business models. Building up the capacity of local banks and practitioners to finance sustainable energy projects should be considered..

(5) Improving the Business Environment

Update relevant policies in a timely manner according to market development and the needs, further simplify, standardize, and accelerate the approval procedures of renewable energy projects. The relevant competent authority shall continuously conduct land space inventory and support renewable energy development, encourage wind power, solar and other projects to use land in a compact way, minimize land use and reduce land cost of renewable energy projects. Innovation of renewable energy project development mechanism and bidding method shall be adapted to select project investment when the conditions are appropriate. Strengthen the implementation and supervision of policies and eliminate the potential investment risks caused by policy uncertainty, which will lift up investors' confidence in renewable energy project..

(6) Improve the Flexibility of the Power System

On the power supply side, improving the flexible adjustment ability of coal power units is recommended in economies where coal power generating units account for a large share of total electricity generation capacity while existing units must be continuously upgraded to be more flexible, and new units must have deep regulation capacity. It is suggested that economies with suitable conditions accelerate the development of pumped storage power plants and other storage capacity. Concerning the power grid, it is recommended that measures be undertaken to increase the security, dependability, and stability of the power supply as well as to ensure the absorption of electricity from renewable energy resources.

(7) Accelerating the Deployment of Distributed Energy System

The key to developing distributed energy is policy support. It is advised that policy support for distributed energy be strengthened, different policy toolkits are improved, and technical standards are better aligned. Also, assessing development potential of distributed energy and investigating economic viability and technical routes and development modes for distributed energy systems help accelerate the development.

(8) Promoting Energy Access through Renewable Energy Resource

This includes economies with rural areas that are sparsely populated and have poor geographic conditions with less electricity access. Based on renewable energy resources, relying on distributed energy technology, including micro grid, with right support policy can be a better solution to improve energy access. Also, adjustment of relevant regulation and electricity pricing policy, provision of corresponding technical support for stakeholders through capacity building, exploring the suitable business model, and making such projects profitable and financially sustainable are among the critical.

(9) Learning from Advanced Experience

Implementing domestic strategies is an important prerequisite for the rapid development of new energy and renewable energy. APEC economies, especially developing economies, should learn the best practice and experiences from other economies. Taking the solar PV project as an example, the development experience of China and Thailand can be drawn upon, formulating and implementing the development own strategies and plans.

(10) Fostering Stronger Regional Cooperation

Developing renewable energy has become one of the prior policies of all economies in energy sector, facing the pressing challenges of climate change and emission reduction, also in the light of the COVID-19 pandemic and economic slow-down. Green economic recovery should be powered by renewable energy. While renewable energy is still in the early stages of the broader market, economies with different advantages and requirements in the field of renewable energy can achieve benefits by strengthening international cooperation, making full use of renewable energy development; this will enhance the economy's manufacturing capacity, advancement in technology, and resulting in market development. One of the major ways for the large-scale growth of renewable energy in APEC is to encourage demonstration projects, increase personnel capacity building, and optimize resource allocation through international exchanges and collaboration.

APEC funded project:

Support Offshore Wind Deployment and Grid Connection in APEC Region (EWG 06 2021A)

- **Proposing economy:** China
- **Co-sponsoring economy:** Hong Kong, China; Indonesia; Korea; Singapore; Thailand
- **Expected start/completion date:** 01/11/2021 - 31/12/2022
- Project Overseer: Prof. Jinlong MA

Project Objectives

The project is to review and analyze the experience of OSW power development and synthesize recommendations to accelerate OSW development in the APEC region. More specifically, the objective of the project consists of:

- **Review relevant policies and development plans, and planning mechanisms.**
- **Analyze the challenges, barriers, and opportunities for OSW project investment.**
- **Support OSW grid integration.**
- **Provide recommendations on policies and technical solutions to promoting OSW in the APEC region.**
- **To build up relevant capacity, the project will disseminate the knowledge on innovative approaches, best regulatory and policy framework, and market mechanism for supporting OSW development among the key stakeholders in APEC economies, including government authorities, financing institutions, power utilities and project developers.**

Outputs

The project outputs include the Research Work, the Project Workshop, Project Report and Information and Dissemination:

1. **Research Work:** The method of the Research Work includes information and data gathering, literature review, stakeholder consultation, case study, and synthesis and assessment. The main target APEC economies of the research include China; Korea; Japan; Chinese Taipei; Viet Nam and the US.

2. **Project Workshop:** The purpose of the Project Workshop is to engage renewable energy experts, government officials and industrial sectors (technology and OSW power equipment suppliers) to discuss the current technology development and industry supply chain, project development and plant operations in the APEC region.

3. **Project Report:** The Project Report will encapsulate the key finding of the Research Work as well as the Workshop. The Project Report will be a reference supporting OSW deployment and grid connection in the APEC region.

Research Task 1: Information and data gathering

a) Policies, regulations, and incentives for OSW development in related member economies.
b) Related institutional framework, planning mechanism and project development procedure.
c) Development plans for OSW
d) Grid connection requirements

Research Task 2: Synthesis and assessment

a) Review and assess of the current practice: policy support, incentives, planning practices, grid connection technologies and grid reinforcement for wind farm operation and electricity market integration.
b) Analyse technical issues on OSW grid connection
c) Identify key drives, barriers and barrier-removal analysis for OSW development.
d) Comparative analysis to assess the development of OSW

Research Task 3: Analysis and case study

a) Case study on OSW power project from selected APEC economies, including project development and wind farm operation
b) The OSW plant grid connection
c) Power grid enhancements
d) Best practices analysis.

Status: draft RFP submitted to APEC Secretariat, to be finalized

APEC funded project :

Impacts of COVID-19 on Renewable Energy Development in APEC Economies (EWG 07 2021A)

- **Proposing economy:** China
- **Co-sponsoring economy:** Hong Kong, China; Malaysia; Singapore; Thailand
- **Expected start/completion date:** 01/12/2021 - 31/12/2022
- Project Overseer: Prof. Jinlong MA

■ Project Objectives

- The COVID-19 pandemic has caused significant impacts on the APEC economies, resulting in slacking of economic activities and reduced energy consumption, curbing investment, disturbing supply value chain of the energy industry, delaying energy project construction and interrupting operation of the existing energy plants. Efforts have been made by different economies to control the spread of the virus, aiming at bringing back social and economic conditions of the societies. Across the region, different economies have formulated programs and stimulus packages for the economic recoveries.
- The project will gather, analyze, and assess the key issues and recovery strategies, the priority and approach addressing sustainability and supporting renewable energy sector development, which include energy policy, investment environment, and adjustment of relevant regulatory framework. Through the Research Work, capacity building activities, namely the Project Workshop, and information dissemination, relevant experience and knowledge will be shared among the APEC economies toward sustainable and green economic recoveries, enhancing the resilience of the energy systems, sustaining and accelerating renewable energy development, and facilitating to achieve the renewable energy doubling goal of the APEC region.

Outputs

The project outputs comprise the products and services as listed below, including primarily the Research Work, the Project Workshop, Recommendations, and the Project Report:

1. **Research Work**

2. **Project Workshop:** Purpose of the Project Workshop: i) exchange information and experiences regarding supporting RE development on the trajectories of economic recoveries; ii) presenting findings of the Research Work and receive comments and feedbacks from the member economies' representatives and participants of the Workshop; iii) capacity building for relevant policy making process and policy implementation.

3. **The Project Report:** The Project Report will encapsulate the key findings of the Research Work as well as the Workshop. The project will contribute to knowledge dissemination and information sharing: the Project Report will be uploaded to APEC and APSEC websites, available to all members and non-member economies to access.

a) Information and data gathering and literature review

i. Energy supply and demand: energy supply and consumption before during the COVID-19 Pandemic and structure of energy supply.
ii. Renewable energy project operation, and situation of renewable energy projects under development and these at the planning stage.
iii. Stated economic recovery policies, plans and strategies: the components related to renewable energy development, relevant incentives and programs.
iv. The information and data will be sourced from the relevant economic development and energy authorities of the economies.

b) Survey and investigation

i. Develop questionnaire on key concerns, issues of recovery strategies, priority and approach addressing sustainability and supporting renewable energy envelopment, including policy, investment supporting and regulatory framework, main drives, and obstacles.
ii. Survey will be conducted online among the APEC economies..
iii. Target sample group covers policy makers form energy authorities, departments or ministries, technical experts, energy producers and equipment suppliers.
iv. Response to the questionaries will be gathered. Seeking for clarification if required through emails and other media.

c) Research and analysis

i. Literature review
ii. Statistical analysis on the data and information gathered, identifying constraints, barriers and challenges faced toward sustainable recoveries.
iii. Research: identify renewable energy development status and trends, synthesize impacts of the COVID-19 pandemic observed and expected from experts, energy suppliers and equipment suppliers as well as member economies government official.
iv. Case study and best practice: Conduct case study on the best practice of sustainable recovery practices in the selected economy

Status: draft RFP submitted to APEC Secretariat, to be finalized

THANK YOU!