Asia-Pacific Economic Cooperation

Impacts of COVID-19 on Renewable Energy Development in APEC Economies

APEC Energy Working Group

September 2023

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APEC PROJECT: EWG 07 2021A

PRODUCED BY:

APEC Sustainable Energy Center (APSEC)
Tianjin University
216 Yifu Building, 92 Weijin Road, Nankai District, Tianjin 300072
China
Tel: + (86) 022-2740 0847
Email: apsec2014@126.com

and

DNV Singapore Pte. Ltd
16 Science Park Drive, Singapore 118227

PRODUCED FOR:

Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

APEC#223-RE-01.7 ISBN: 978-981-18-8280-7

APEC PROJECT

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

PROJECT OVERSEER

Prof Jinlong MA, Tianjin University /APSEC

PROJECT TEAM

Tianjin University

Prof Jinlong MA	Team Leader
Dr Yong SUN	Project Assistant
Shengnan LIU	Research Assistant

Project Contractor

DNV Singapore Pte. Ltd

ACKNOWLEDGEMENT:

The Project Overseer and the Project Team are grateful for the insightful inputs and valuable comments provided by the member economies of EWG on the draft report. The guidance from the APEC Publication Unit for preparation of the final version of the publication has been greatly appreciated.

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List of Abbreviations and Acronyms

APAC	Asia Pacific
APAEC	ASEAN Plan of Action of Energy Cooperation
APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APSEC	APEC Sustainable Energy Center
APVI	Australian PV Institute
ASEAN	The Association of Southeast Asian Nations
AUD	Australian Dollar
BCSE	The Business of Sustainable Energy
CAPEX	Capital Expenditure
CAREC	Central Asia Regional Economic Cooperation
CCUS	Carbon Capture, Usage and Storage
CEC	Clean Energy Council
CEC	California Energy Commission
CEN	National Electrical Coordinator
CES	Clean Energy Scenario
COP26	26th UN Climate Change Conference of the Parties
COVID-19	Coronavirus Disease 2019
DOE	Department of Energy
ECQ	Enhanced Community Quarantine
EIA	U.S. Energy Information Administration
ENECHO	Agency for Natural Resources and Energy
ESSP	Effective Spot Settlement Price
EU	European Union
FiP	Feed-in-Premium
FiT	Feed-in-Tariffs
FTAA	Financial and Technical Assistance Agreement
FY	Financial Year
FYP	Five-Year-Plan
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GW	Gigawatt
GWEC	Global Wind Energy Council
GWh	Gigawatt hour
Hydro	Hydropower
IDR	Indonesian Rupiah
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
ITC	Investment Tax Credit
JEPX	Japan Electric Power Exchange
JPEA	Japan Photovoltaic Energy Association
kW	kilowatt
LCOE	Levelized Cost of Energy
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
METI	Ministry of Economy, Trade and Industry
MM	Millions

MOIT	Ministry of Industry and Trade
MSME	Micro-sized Establishment
MTOE	Million Tonnes of Oil Equivalent
MW	Megawatt
NCRE	Non-Conventional Renewable Energies
NDC	Nationally Determined Contribution
NDRC	National Development Reform Committee
NEDA	National Economic and Development Authority
NEM	National Electricity Market
NTT	Nippon Telegraph and Telephone Corporation
NZE	Net Zero Emission
OCSP	Open and Competitive Selection Process
OECD	Organization for Economic Co-operation and Development
PDP	Power Development Plan
PHP	Philippine Peso
PLN	Perusahaan Listrik Negara
PMGD	Small Means of Distributed Generation
PPA	Power Purchase Agreement
PREMS	Philippine Renewable Energy Market System
PT	Potential Transformer
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
RE100	Renewable Energy 100 initiative
REDS	Renewable Energy Development Strategy
REF	Reference Scenario
REN21	Renewable Energy Policy Network for the 21st Century
RMB	People's Renminbi
RPS	Renewable Portfolio Standards
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik (Indonesia's long-term electricity supply plan)
SEIA	Solar Energy Industries Association
SME	Small Medium Enterprise
TFEC	Total final energy consumption
TWh	Terawatt hour
UN	United Nation
USD	United States Dollar
VA	Volt Ampere
WFH	Work From Home
WHO	World Health Organization
YTD	Year-to-date

EXECUTIVE SUMMARY

The COVID-19 pandemic affected the health, living and working of the people and economic activities globally at the unpreceded level and scale. The APEC economies have encountered a diverse range of circumstances since the beginning of the pandemic. The economy-wide, including the energy sector, was disturbed in a myriad of different ways. Some of the effects started to wane, while others persist to these days or have even been exacerbated by the confliction in Ukraine, which has created more uncertainty in terms of energy security, energy demand and supply, prices, renewable energy development and investment. The COVID-19 pandemic has affected the growth in renewables by intensifying the challenges with project financing, grid integration, and policy uncertainty in many economies.

This study reviews and assesses the impacts of the COVID-19 pandemic on the renewable development in the APEC region, analyses the economic recovery strategies, and the role of renewable energy in economic growth and job creation, as well as the policies, measures and steps taken by the governments bringing the clean energy on the track towards sustainable growth in the post-pandemic period.

As diversified as the APEC economies are, the context of energy system in each economy differs due to varying social and economic background, energy market structures, industry capability, resources availability, the COVID-19 control measures applied, as well as the governmental organisations and agencies involved. Eight APEC economies are included in the study, namely Australia; Chile; China; Indonesia; Japan; the Philippines; the US and Viet Nam.

Impacts on renewable energy development

There have been a range of impacts due to the COVID-19 pandemic and the war in Ukraine on the renewable energy development globally and in the APEC region. The impacts include these on overall energy demand and supply, renewable project development and investment, energy plant operation, employment and job conditions in the renewable energy sector. Each economy has different social and economic background and context, used strategies and measures to deal with the crisis, and the impacts experienced differ as discussed in the case studies. The main impacts can be summarised as the following aspects:

- Energy demand – with the COVID-19 restrictions in place, there were limiting movements and mobility which inevitably affected all the aspects of living, working, economic activities, as well as the electricity consumption. Overall, all economies experienced declines in the electricity demands. Where it is observed that the energy demand was shifted from the industrial and commercial sectors to the residential and/or household sector(s). For economies with open electricity market, this resulted in lower electricity prices such as the cases in the economies like Australia and the Philippines. Furthermore, several economies experienced increased renewable energy curtailment due to the fall in electricity demand, which were evident in the economies such as Japan and Chile;
- Fundings and investments – due to the unstable economic recovery trajectories and higher interest rates, banks were more cautious in providing fundings for renewable

energy projects. Financing institutions prefer more safer renewable energy projects with success track records. Investments in the renewable energy sector also experienced delays in some economies due to postponed tenders. Overall, the investment in the new renewable power generation still accounted for 69% of total energy power capacity. Amidst the pandemic, solar PV was the only source that recorded a growth in investment;

- Renewable jobs – Employment in the renewable energy sector experienced a drop in the first half 2020 due to the restricted movement. However, in most economies it either increased or stabilized when the industries adapted to the new way of working during the COVID-19 pandemic such as special permits for workers on site and working from home. Overall, jobs in the renewable energy sector increased since most economies announced their decarbonization targets, increasing renewable generation capacity and number of the renewable energy projects. There are only few sectors and economies where the employment in renewable energy sector fell after the peak of the COVID-19 pandemic since the number of jobs were already high prior to the pandemic, such as in various sectors in Japan and the geothermal sector in the Philippines. In addition, an observation on the overall energy sector indicates that a decline in the number of jobs were mostly related to coal, oil and gas industries;
- Technology development – learning curves of renewable energy technologies did not stop, and solar PV modules became more efficient, wind turbines had larger size and increased unit capacity, and there were continuous improvements in manufacturing efficiency and scale, and the levelized cost of electricity of utility-scale solar PV, and wind power has declined significantly to the level of lower range of fossil fuel generation technologies;
- Supply chain – the travel restrictions and border closures have greatly strained the supply chains resulting in supply shortages, causing various project delays over the period of pandemic. This resulted in delayed projects progress and completion (such as the solar PV installations in Japan), and increasing CAPEX prices (e.g. the wind blade turbines which were originated from China). An example of such issues is in China, where shipping times from China to the US and European ports increased from 40 to 100 days following the breakout of the COVID-19 pandemic. However, it is observed that the prices have started to gradually recover in early 2022.

Renewables in the economic recovery

For renewable energy development, all APEC economies, have their renewable energy targets set, and many of have carbon neutral goals in place, but tools implemented to achieve the targets vary between regulatory and pricing policies, fiscal incentives, and public investments, with the regulatory and pricing policies among the most applied.

In terms of the recovery strategies and the role of renewables in the economic recoveries, many APEC economies have implemented a short-term measure for the COVID-19 recovery as well as coping with the recent energy crisis as the result of the war in Ukraine. The governments of many economies adopted the short-term measures to assist the developers in their project completion pace.

One example is the extension of the solar investment tax credit for two years and wind production tax credit for one year in the US for the renewable developers. The Japanese

government also released JPY1.0 billion to help the renewable projects that were bounded by the PPAs under the RE100 initiative. The government of Indonesia spent USD40.6 billion in 2020 to the schemes that levelled to amount spent for the COVID-19 recovery. To deal with hardship caused by the pandemic, a large amount of the spendings in Indonesia was used for energy subsidies in the form of free and discounted electricity tariffs for various consumer classes in the economy.

As part of the economic recoveries, many economies in the region adopted some sorts of fiscal stimulus to push the economy back on the track, and part of which were allocated to the renewable energy projects. For instance, the Australian government launched three economy stimulus packages in March 2020, with the bulk of which aimed at helping households and creating jobs, and AUD2.3 billion of the entire package was spent on clean energy infrastructure investment. In the Philippines, the households that consumed not more than 50kWh had their electricity fees waived off to cope with the pandemic situation. The US also allocated USD39.62 billion out of USD900 billion of the relief package to the Department of Energy in FY2021, which is one billion more than FY2020.

The economies discussed employed different strategies for their renewable development in line with the economic recoveries, though some were similar. From the examples, the strategies used resulted in the positive outcome such as the accelerated growth of the solar PV sector in Viet Nam and meeting the renewable targets in California. Some of the measures however could yield better outcomes considering different scenarios such as the case in Viet Nam in which renewables might be in a better position if there were a matching upgrade to its power grid infrastructure. For the case of China, if more relaxed personnel movement policy and measures were adopted which can be seen in Viet Nam as mentioned in the previous section, there could be less delays for other economies in receiving renewable parts for their projects from the suppliers in China.

Economic recoveries indeed provided a momentum for the investment in renewable and clean energy technologies, thanks for the greatly improved techno-economic performance of these technologies, particularly solar PV and wind, and accumulated experience and capacity along the value chains over the last decade or so. In general, the policies and measures to control the virus and boost economic recovery of individual economy largely depended on the decisions made of the government, based on the specific situation then, and the action plans of energy transition towards renewable energy, many of which were in place and started their implementations before the breakout of the pandemic.

To recover the global economic loss associated, more than USD17 trillion for the financial stimulus was announced in response to the COVID-19 pandemic. It has been observed that renewable energy can play a bigger role in recovering the global economic situations, providing more job opportunities, bringing back the economic growth while ensuring energy security and reducing the costs of energy supplies. However, renewable energy investments in the COVID-19 recovery packages were nearly six times less than those made in the fossil fuels sector, indicating that much more to do, to accelerate and scale-up renewable energy development towards green energy transitions in the post-pandemic period.

With all these efforts, the paces and levels of the economic recoveries seems have not been as good as expected in general globally and in the region, and this have been partly also due to the geopolitical situations and recent the war in Ukraine. However, the trend is much clearer than before, the economies in the region have been moving towards the low-carbon or/and

carbon neutral, and the energy systems are transitioning towards more clean and renewable energies, and more and stronger supports are needed to further accelerate the transitions so to face and mitigate the challenges of climate change.

Support renewable energy development

While the COVID-19 pandemic has significantly impacted global economy, it presented a unique opportunity for the governments to reshape their energy policies towards clean energy. Given potentially greater role of renewable energy in helping the economic recovery, along tackling the climate change challenge, the economies have taken this as an opportunity and a momentum to encourage and support the switching to more renewables in their energy systems. Each economy has different context and conditions, took different methods to cope with the pandemic, and implemented varying policy tools and measures for the development of renewable energy as part of their recovery strategies.

The APEC economies have implemented the recovery measures to rebuild their economies by pledging unprecedented amount of fiscal supports. Besides the recovery plans, many of which focused on short- to medium-term stimulus packages, the measures to support the growth of renewable energy and clean energy transition, which has been identified by many economies as a priority among their fiscal support measures.

Energy and environmental policies and a strong commitment are expected to play a key role in supporting the development of renewable energy, addressing the crisis and shape the overall energy transition. There are four main categories of related polices:

- Economy-wide government strategies – which provide a long-term policy signal by setting roadmaps with targets, technology priorities, and timelines. This includes, for example, greenhouse gas (GHG) reduction targets, carbon neutrality and carbon neutrality targets, renewable energy targets, goals for fossil-fuel phase out, etc.;
- Technology push policies – which take the form of public financing such as grants or loans from the government to support technology innovation and advancement;
- Demand-pull policies – which could play a key role in creating demand for renewable energy and low-carbon technologies and switching away from fossil-fuel technologies. This type of policy also involves economic/pricing instruments such as Feed-in-tariffs (FiT) and renewable tax incentives and others;
- Fiscal policies – which can increase the competitiveness of low-emission alternatives against conventional fossil-fuel base options. Examples include fossil-fuel phase-out subsidies and carbon pricing.

APEC had set a combined regional renewable development target, the “renewable doubling goal", and has been on the track achieving the goal based on the recent assessment. All of the member economies have their economy-wide strategies in the form of renewable energy targets, and many have set the goal of carbon neutrality, although the level and targeted years vary. Most of the APEC economies have been using the regulatory and pricing instruments such as FiTs/FiPs and auction schemes for renewable energy project development with varying degree of ambitions and successes. The pandemic had resulted some economies extending the deadlines of the pricing instrument measures, including FiT and auction schemes.

Based on the survey conducted in this study with policy makers and the private sector in the APEC economies, demand-pull policies in the form of pricing instruments (i.e. FiT/FiP, auctions) and fiscal incentives (i.e. tax incentives, subsidies) are viewed as the preferred policy options. Many APEC economies already have some forms of pricing instruments in place to promote renewable energy, although with different degrees of ambitions.

In recovering from the pandemic and boosting renewable energy development, the majority, including both the public and private sectors, believe that the fiscal incentives (i.e. tax incentives, subsidies) are among the most attractive policy options to retain and raise the confidence and encourage investment in the renewable projects. Over the medium to long term, the pricing instruments, particularly the competitive auction schemes, are likely to be one of the main mechanisms since it drives down the price of renewable electricity while boosting the deployment which benefits the overall economy in the long term. This should be used together with some fiscal incentives to promote technology improvement and enhancing overall efficiency.

The holistic approaches are needed towards renewable energy development and green energy transition, including implementation of the integrated planning mechanisms, reinforcement and expansion of the needed infrastructure particularly power transmission network and raising the capacity of the power grid to accommodate increased proportion of variable renewable electricity in the energy mix, and increasing the flexibility of the energy systems. The public investment can be directed to supporting the R&D efforts, research into new energy and enable technologies such as energy storage, green hydrogen and the sector coupling efforts, as well as demonstration of these new technologies so to scale up their wide deployments. The market-oriented reforms in the power sector could raise the economic efficiency and provide a better platform for more renewables.

There are ongoing collaborations among the APEC economies to accelerate the energy transition and recovery from the COVID-19 pandemic and the energy crisis. Such collaborations include high level commitments, studies and analyses and recommendations on innovative tools and approaches for the deployment of renewable energy technologies and sharing the practical experience on renewable energy project development. The collaborations are also related to the energy sector such as high-level exchanges and best-practice sharing on the effects of the COVID-19 pandemic and related policies responding to the unprecedented situations. More effective regional collaborations among the member economies, through dialogues, information-sharing and knowledge-dissemination could further facilitate the renewable energy growth in the region.

1 INTRODUCTION

The COVID-19 was first officially reported to the World Health Organisation (WHO) by China in December 2019, then spread rapidly to all regions worldwide since the beginning of 2020. The COVID-19 has created an unprecedented shock to the economies across all sectors, including the energy sector, worldwide. The implications for the energy sector are wide ranging and have affected energy demand and supply, energy prices, renewable investment and project development, employment in the sector due to the restriction measures imposed and supply chain disruptions caused. The energy sector, particularly electricity supply, played an essential role in responding to the crisis as evidenced during the time of lockdown by enabling the essential services and activities to continue to operate, including hospitals, remote working from office and home schooling and others.

Globally, including the APEC economies, have faced a diverse range of experiences since the beginning of the pandemic. Global energy demand significantly declined during the first year of the pandemic, but the demand in some economies has rebounded since the beginning of 2021. Following the first year of the COVID-19 breakout, the majority of the delayed renewable energy (RE) projects began to come online, resulting in a rebound in new renewable generation installations. However, the war between Russian and Ukraine started in early 2022, deteriorated the situation and affected negatively on economic recoveries, with insufficient energy supply, high commodity prices, which dampened economic growth globally, resulting in further uncertainty in the energy sector, including availability of energy supply, supply chain of the industry, renewable energy project development, at least in the short to medium term.

The world is now on in the post-pandemic period, with the COVID virus still existing, it has been widely viewed that the pandemic likely has left a permanent mark on the economy and the energy sector and lessons for both the public and private sector in terms of energy development. Along the economic recovery measures, it is expected that energy and environmental policies will play a key role in shaping the energy transition towards low carbon clean and energy future.

This study provides an analysis on the impacts of the COVID-19 pandemic and key challenges that could prevent sustainable recoveries and renewable energy development, and policy options that could address these challenges. The analysis of the key barriers covers key aspects of energy sector, including economic, technical, policy and regulatory frameworks. This study also identifies the current status and trends (short to medium terms) on the development of renewable energy, which takes into consideration of the impacts of the COVID-19 pandemic and the Russian-Ukraine war as well as the relevant policy measures. The focus of the analysis is on the selected APEC economies, with case studies from Australia; Chile; China; Indonesia; Japan; the Philippines; the US and Viet Nam.

The project team organised a survey to investigate the key issues, analyse and get insights from the key stakeholders in both the public and provide sectors in relation to the impacts from the pandemic, government responses, and appropriate policy tools and measures to support renewable energy development.

This report is one of the main outcomes of the study, which is organised in such a manner, after the introduction section, the following main sections are presented:

- Section 2: Impact analysis of the COVID-19 pandemic and more recent energy crisis on renewable energy development plans, project development and operation, including case studies of the selected APEC economies;
- Section 3: Economic recovery strategies and the role of renewable energy including case studies;
- Section 4: Survey and investigation of key issues in relation to sustainable economic recovery and renewable energy development, as well as recovery path and the role of renewables on low carbon energy transition in the APEC economies;
- Section 5: Summary and the policy options and recommendations to facilitate the sustainable development and low carbon energy transition in the region.

The questionnaires used for the survey are provided in the Annex.

2 IMPACTS OF COVID-19 ON RENEWABLE ENERGY DEVELOPMENT

With more than two years into the COVID-19 pandemic between 2020 to 2022, myriad effects on the economy and the energy sector have been experienced globally. Some of the effects were disappearing but some are still ongoing and even exacerbated due to the Russian-Ukraine war at the beginning of 2022.

This section analyses the impacts of the COVID-19 on overall demand and supply; renewable energy development plan, and renewable energy project implementation; employment and job creation in renewable sector; public and private spending on renewables. The case studies of eight APEC economies are provided, including Australia; Chile; China; Indonesia; Japan; the Philippines; the US and Viet Nam.

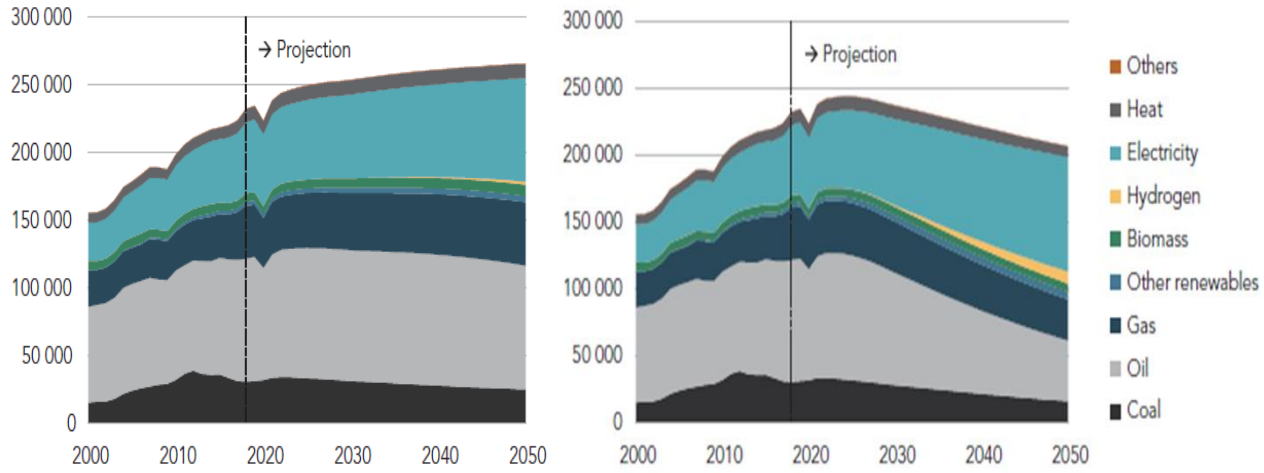
The impact analysis in this section provides the context and background of renewable energy sector that leads to the implementation of policy measures and recovery measures that are further explained and assessed in Section 3.

2.1 Impacts on renewable energy project development and plant operation

With the widespread of the COVID-19 virus globally, the governments around the world had to react in order to limit the spread, such as locking down the entire economy, or certain states or cities, and imposing restrictive movement orders on people. Many non-essential businesses and activities were forced to halt operations, and workers were made to work from home. The economy was negatively affected as well, and energy sector was one of the areas that was getting the hard hit (Pak, 2020). It was estimated that by mid-April 2020, the economies with complete lockdown saw their weekly energy demand plunged by as much as 25% (IRENA, 2020). In addition, there was lower demand for energy for transportation as well, which directly reduced the needs for oil and gas (IEA, 2020).

The graph below shows the changes in energy demand in the APEC economies (and also future projection under the Reference Scenario) which showed how the pandemic had greatly affected the energy demand in 2020. The US experienced the largest drop in energy demand in 2020, which was around 10% (APERC, 2022).

Following the drop in demand in 2020, global energy demand has rebound strongly since the second half of 2020, led by China, before encountering high energy prices as a result of the war in Ukraine started in early 2022.

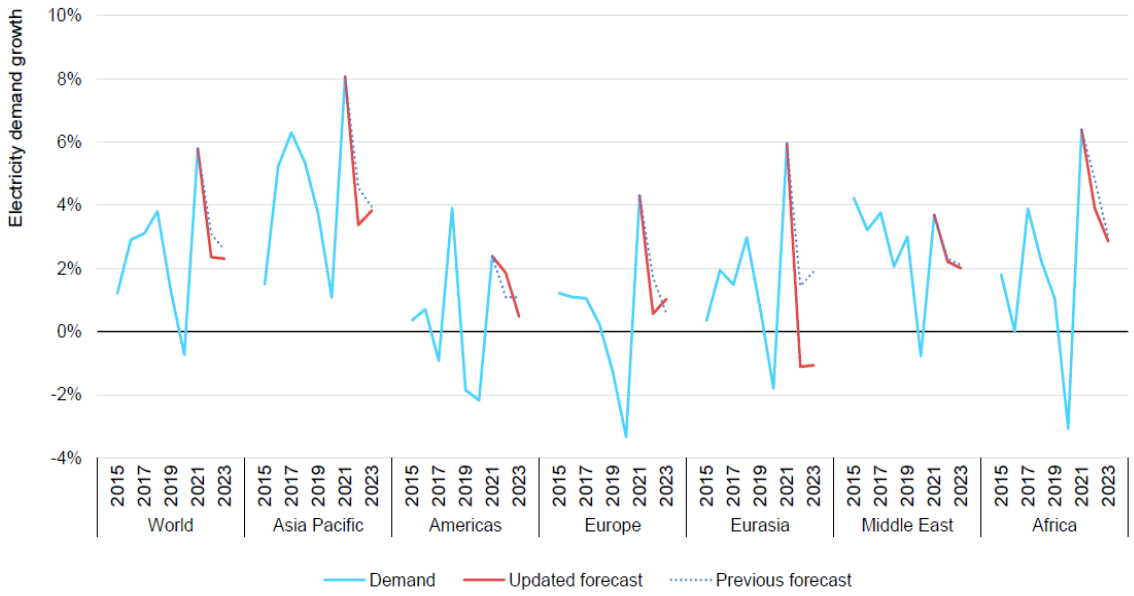


Source: APERC (2022)

Figure 2-1: Historical and projected primary energy demand (PJ) by fuel in APEC economies: Reference Scenario (left); Carbon Neutrality scenario (right)

The global electricity demand also experienced a large decline in 2020, which was the first year of the pandemic, with Europe faced the largest decline (IEA, 2020). In Asia Pacific region, electricity demand still as a whole grew in 2020, which is the first full year of the pandemic. The economies such as China, which initially faced a significant decline in energy demand during Q1/2020, have been experiencing a strong growth since Q3/2020, as shown in Figure 2-2. On the other hand, economies such as Indonesia and Thailand are still facing the stagnated growth in energy demand due to the changes in the working environment and the new way of living.

The pandemic has also completely changed the daily demand profiles in many economies where the system operators were required to adapt how they utilise power generation resources in the systems. In the economies with competitive markets, the reduction in energy demand plunged electricity prices such as the case in Japan. The low spot prices deterred the generators with high variable costs of plant operation. Renewable resources which have lower variable costs were actively bidding into the markets, and including other factors, it was gaining a larger share in the generation mix of the energy system.

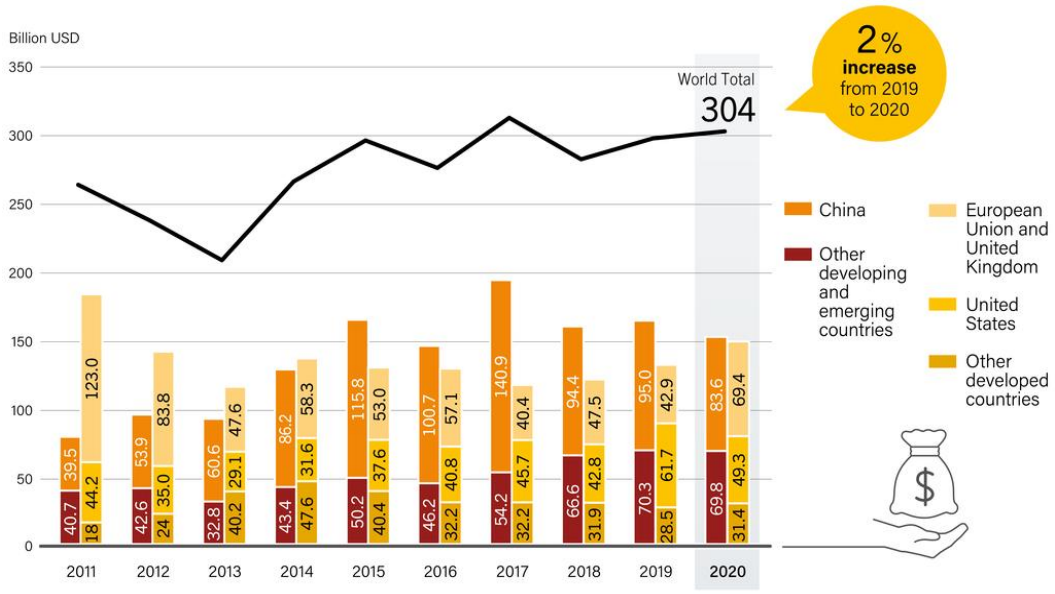


Source: IEA (2022)

Figure 2-2: Global change in electricity demand, 2015-2023

The COVID-19 pandemic also affected the growth in renewable generation capacity across the region. The pandemic has intensified the challenges of financing, project grid integration and policy uncertainty of renewable development in many economies. However, compared to other energy technologies, solar and wind power generation still achieved the growth in terms of capacity addition (IEA, 2021). Energy policy deadlines in some economies, such as in China (FiT and competitive auctions) and Viet Nam (FiT) resulted in significant renewable energy generation capacity additions in 2020. Relevant policy measures are further discussed in more detailed in Section 3.

In general, it has been noted that, despite the challenges faced from the pandemic, the global investment in new renewable capacity showed remarkable level of resilience. As part of the broader response to the COVID-19, many governments have allocated funds to support investment in renewable energy. Even the first half of 2020 affected the renewables production and construction chains as many economies experienced lockdowns and restricted movement in labour. Overall, global investment in renewable power capacity climbed 2% in 2020 from 2019 levels, as illustrated in the graph below.

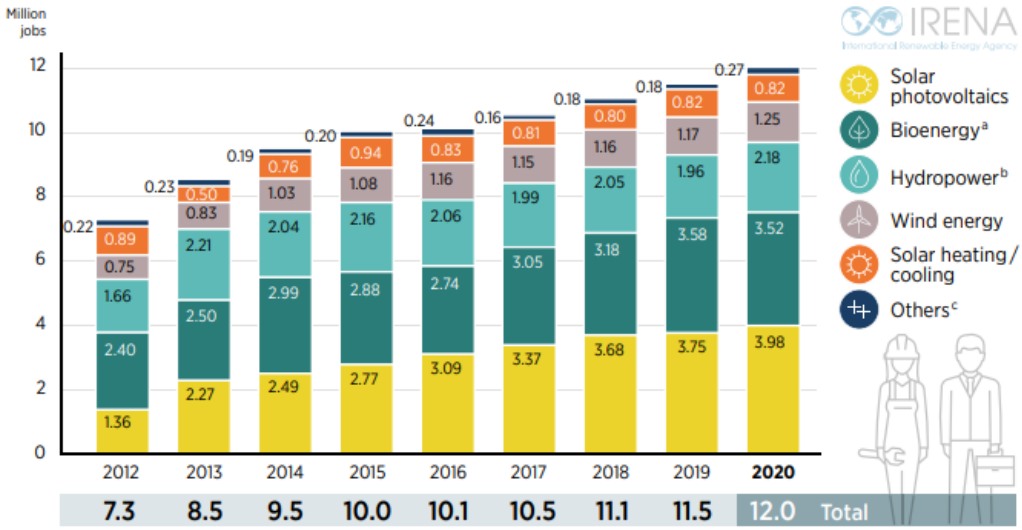


Source: REN21 (2021)

Figure 2-3: Global investment in renewable power capacity

Amongst the renewables, solar power was the only source that recorded a growth in investment in 2020, while others fell with varying degrees (REN21, 2021). As solar makes up nearly half of global renewable energy capacity investment in 2020, any changes in its investment result in a significant impact (IEA, 2021). Possible reasons for the increase could be the potential of adopting solar on residential rooftops as it is much cheaper to install as compared to investing in larger projects such as large scale solar and wind. On top of which, energy policies in some economies indicated the requirement to include solar PV on new buildings, such as the case of the United States. By September 2020, 30% of USD11.8 trillion fiscal funding in COVID packages had been allocated globally to assist sectors in energy transition (REN21, 2021).

During the COVID-19 pandemic, layoffs and retrenchment in the energy sector were common, particularly in oil and gas supply. In 2020, the renewable energy sector had a total employment of 12 million worker, approximately 500,000 more than 2019. Out of which, 30% of the jobs were related to solar technology as shown in graph below. The increase of employment was contributed to the worldwide increase of renewable addition in 2020, 10% up from 2019 (IRENA, 2020; IRENA, 2021).



Source: IRENA (2021)

Figure 2-4: Global renewable jobs per technology

Renewable jobs related to project planning and design, operation and maintenance received little impact from the COVID-19 as the former were able to work through remote means, while the latter are mostly classified as the essential service and the project sites often have enough space for social distancing measures (IRENA, 2020). Higher impact was towards renewable jobs that are related to transportation, engineering construction and installation, as well as manufacturing due to the classification of non-essential services which resulted in some factories were ordered to close during the lockdown. The supply parts shortage from Viet Nam and China were observed due to the border controls particularly during the peak period of infection (IRENA, 2021).

Energy sector employment has recovered strongly and has now exceeding the pre COVID-19 given the rapid growth in clean energy industry in most economies. More than half of energy sector employment is in the Asia Pacific region has been the result of rapid growth energy infrastructure and lower-cost labour, which China accounts for almost 30% of the energy workforce worldwide (IEA, 2022).

2.2 Impacts on technology development and industry supply chain

As highlighted in Section 2.1, the total renewable capacity flourished despite the ongoing pandemic. However, there were challenges faced during the initial period of the pandemic. Travel restrictions and border closures have strained supply chains, resulting in supply shortages and causing project delays. During 2020 the number of new renewable power installations declined for the first time in about 20 years, reflecting the severe supply chain disruptions caused by lockdown measures and limited international movement over the period (IEA, 2020).

The impact of technology development and renewable industry supply chain among APEC economies and the rest of the world have been influenced by the situation in China, as it is the world's largest producers of some key equipment of the industry, including wind turbines and solar panel (Marsh, 2022; IEA, 2022). There was a supply shock when factories were forced to halt operations in January and February 2020. Coupled with border controls in China during

the same period, economies with ongoing solar projects which required solar PV units from China had to pause their installation operations (IEA, 2020). Fortunately, the production in China resumed in March but factories closures were shifted to region such as India and certain parts of Europe when the virus spread further. Another instance was the lockdown in Ecuador which largely involved in the production of a core raw material for wind turbine blades. On top on which, many economies have introduced certain degrees of border controls which significantly affected the transportation and logistics. Ongoing renewable energy projects were unable to proceed with further stages of the projects as there was unavailability of the supply parts that were essential towards the construction and installation process of the projects. Hence, there was high pressure placed on project developers whose projects were subjected to strict deadlines based on expiring FiT in some economies. Based on a report from EIA (Jarrett & Chen, 2020), there were 21% of electricity projects in the United States that experienced delays in March 2020, and 29% in April 2020 in the presence of the COVID-19.

The potential of renewable technology development among the APEC economies is reflected by the projection of generation capacity as shown in Figure 2-5. Renewable energy resources, particularly hydro, wind and solar generation are expected to account for almost 50% of total installed capacity under the reference case. If the APEC economies were to commit to carbon neutrality target, the share of renewable technologies could account for close 80% of the total installed capacity (APERC, 2022).

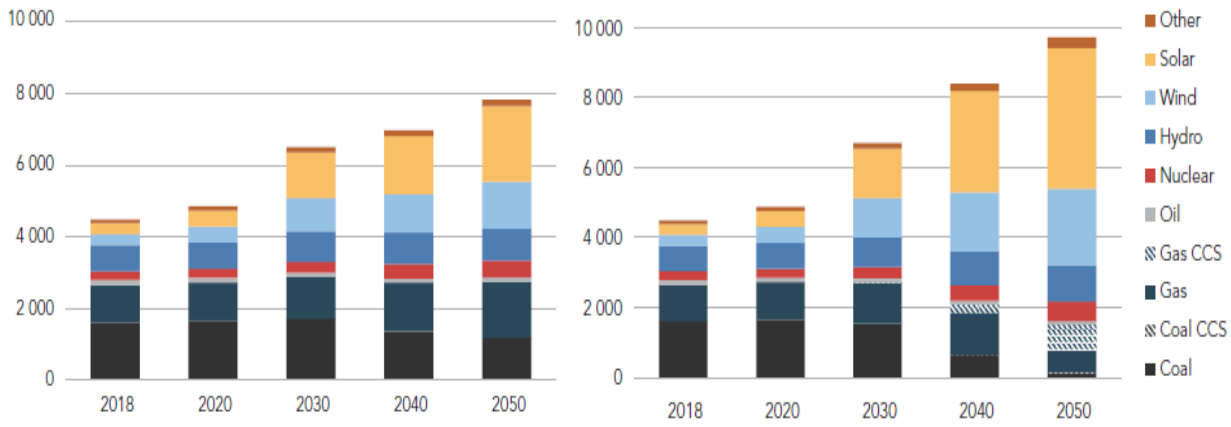
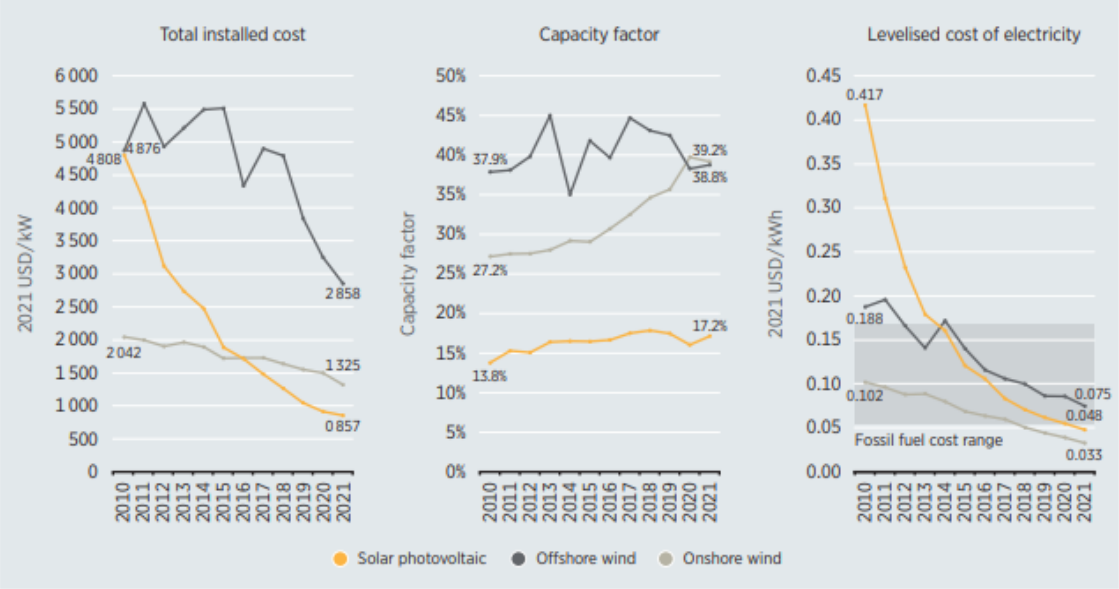


Figure 2-5: Installed generation capacity (GW) in APEC economies by fuel sources

Commodity prices on materials essential for solar PV and wind turbines play a key role in the development and deployment of renewable technologies. The COVID-19 pandemic and the recent energy crisis have a significant impact to not only the commodity prices, but also the material costs since Q4 2020 due to issues related to supply chain disruption. However, the weighted average cost of electricity globally on new solar PV and onshore wind fell, as shown in Figure 2-6.

The Renewable Power Generation Costs report from IRENA suggested a few reasons that contributed the fall in costs (IRENA, 2022). Firstly, many projects commissioned in 2021 had already placed orders before the increased costs as the overall equipment costs increase affected late 2020 and early 2021. Also, there were technology improvements such as having more energy efficient PV modules and larger wind turbines, and continuous improvements in manufacturing efficiency and scale. Furthermore, China being the dominant market for new solar and wind capacity had lower commodities prices and lower transport costs, while wind

project developers reduced cost by squeezing turbine manufacture's margin in 2021. Despite the rising material and equipment costs, there will be a significant time lag towards the total installed costs, and this could be felt for new renewable projects. The decline of LCOE from utility scale solar projects had come a long way, from being more than twice as costly as the most expensive fossil fuel generation to reach the lower range for new fossil fuel fired capacity, which suggests that huge effort have been placed towards the progression of renewable, even before the COVID-19 happened.



Source: IRENA (2022)

Figure 2-6: Global weighted average of total installed cost, capacity factors and LCOE of new commissioned large solar PV and onshore wind

2.3 International collaboration conditions

In recovering from the COVID-19 pandemic and the energy crisis, it is important for the economies in the region to collaborate and work together and rebuild the economies through a green recovery to scale up renewable energy development and be less reliance of fossil fuels. International collaboration has evolved since the COVID-19, which unite several economies to cooperate and coordinate, not only on information exchange and developing vaccines and treatment of the COVID-19 virus, but also on tackling the challenges in the energy sector and global warming. International partnership in the energy sector has further been adjusted and strengthened in responding to the new situation with the ongoing energy crisis due to the war in Ukraine.

In responding to the COVID-19 pandemic, the APEC economies have been implementing a number of recovery initiatives which aim to overcome the challenges and boost economic growth. Collaborations among the APEC economies include high level commitments, analysis and recommendations on innovative tools and practical projects. The collaborations also related to the energy sector which includes high level exchanges and sharing best practices on COVID-19 effects on energy policy. Such collaborations took place among the APEC economies, private stakeholders and international organisations. The collaborations that are related to the energy sector, either directly or indirectly include the followings:

- Analysis, exchanges and best practices on the COVID-19 response and recovery strategies;
- Support industry supply chains for essential goods and services which include targeted analysis and training of supply chain resilience, and measures to mitigate international trade disruptions;
- Increasing transparency for COVID-19 response measures.

In Southeast Asia, in which many are APEC member economies, a range of activities that support the growth of renewables have been implemented under different work plan including joint research studies in the aspect of policy development, technology transfer and knowledge sharing and capacity building that benefits the ASEAN region. During the COVID-19 pandemic, the collaboration had further strengthened, even without physical meetings. ASEAN Plan of Action of Energy Cooperation (APAEC) Phase II: 2021-2025 with regional renewable targets of 23% in total primary energy supply by 2025. Under this plan, there are several international engagements on regional energy policy and planning to advance energy policy and planning mechanisms to accelerate the low carbon energy transition in the region.

In terms of collaboration at a global level, the UN Climate Change Conference in Glasgow (COP26), which was held in November 2021, was the first major high-level international event since the break-out of the COVID-19, which brought together world leaders to work together and raise the ambition in reducing emissions where renewable energy plays a key role. One of the key goals of COP26 was financing the energy transition for the poorest economies. The IEA, in collaboration with the IMF, has developed a short-term sustainable recovery plan in response to calls from many governments around the world with the aim to boost economic growth, creating jobs and building more resilient and cleaner energy systems. This near-term recommendation is also aligned with the pathway towards the net zero emissions goal (IEA, 2020).

One of the notable collaborations to tackle the energy crisis is the European Union (EU). European Commission announced in May 2022 the REPowerEU Plan in order to combat the difficulties from the market disruption from war in Ukraine. The plan requires the EU members economies to transform their energy system to minimize the dependency on Russian fossil fuels and more rapid green transitions. It aims to quicken Europe's switch to renewable energy resources, diversify the sources of energy supply, promote energy savings, then ultimately strengthen the Europe's energy security and autonomy.

In order to save the energy, the European Commission desires to enhance long-term energy efficiency measures, including raising the mandatory Energy Efficiency Target under the "Fit for 55" set of European Green Deal laws from 9% to 13%. Then, the plan is working on diversification of the sources of energy supply by building a platform called "EU energy platform" that enables voluntary common purchases of natural gas, LNG and hydrogen by pooling demand, optimising infrastructure use and coordinating outreach to suppliers. Furthermore, they are expecting to develop this into joint purchasing mechanism, that they will negotiate and contract the gas on a member state. On renewable energy, the plan points out the accelerating of the renewable energy roll out, that mainly by increasing their target for renewables 40% to 45% by 2030. This ambition includes initiatives such as: double the solar photovoltaic capacity by 2025 and reach 600GW in 2030; setting a target of 10 million tonnes of domestic renewable hydrogen production by 2030, and a Commission recommendation to

address the slow and complicated regulatory processes for significant renewable energy projects (European Commission, 2022).

In other regions such as Central Asia, 11 economies initiated the partnership programmed called The Central Asia Regional Economic Cooperation (CAREC). The program offers technical assistance for clean energy capacity development, aims to build or upgrade transmission lines and substations of the power systems, and introduces CAREC as a single market to suppliers of clean energy technologies. In 2022, CAREC formed a co-operation between seven interconnected focused economies that the project investigated if the participating economies could cooperate regionally to share the backup capacity reserves in order to reduce the fluctuating availability of renewable energy generation and reduce generation costs.

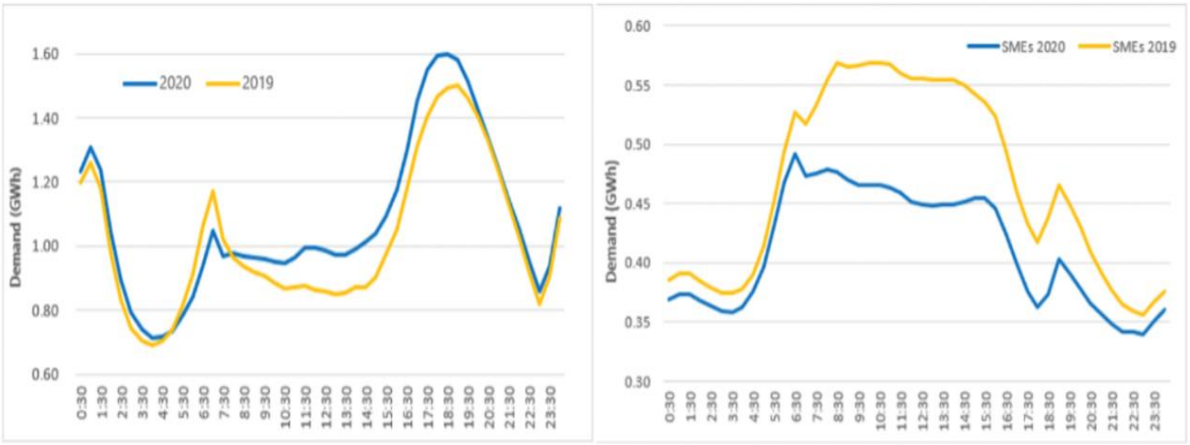
2.4 Case study on the impact of the COVID-19

2.4.1 Australia

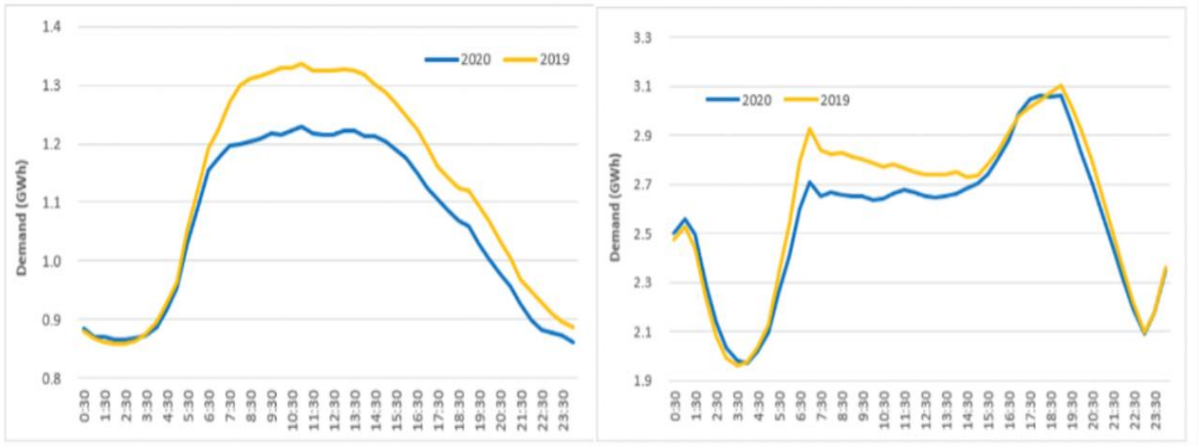
2.4.1.1 Impact on electricity demand and supply

At present, the generation mix in Australia consists of around 65% coal, 7% gas, 7% hydro, 10% wind and 11% solar PV (including grid-scale and distributed solar PV). Although, fossil-fired generation still represents majority of generation mix at present, renewable generation has been growing significantly and is expected to become the main generation sources as Australia transitions to a low-carbon economy.

Due to increasing cooking and digital device use, there has been a considerable rise in the COVID-19 related energy consumption in Australia compared to the pre-pandemic state. Despite this, families used less energy overall during the lockdown compared to before, primarily because they used less air conditioning. During the lockdown, residential areas experienced a shift in the distribution of electrical demand away from commercial metropolitan centres. As an example, while Victoria's residential consumption grew by 14%, the state's overall electricity demand decreased by 6.7% in March 2020. The reduction in energy use between March-May relative to February–March was less in 2020 than the same period in 2019, because of the effects of the lockdown. However, the additional power needed for cooking, reheating, entertainment, working from home, and learning during lockdown was still insufficient to make up for the decrease in air conditioning demand from period of February–March to March–May.



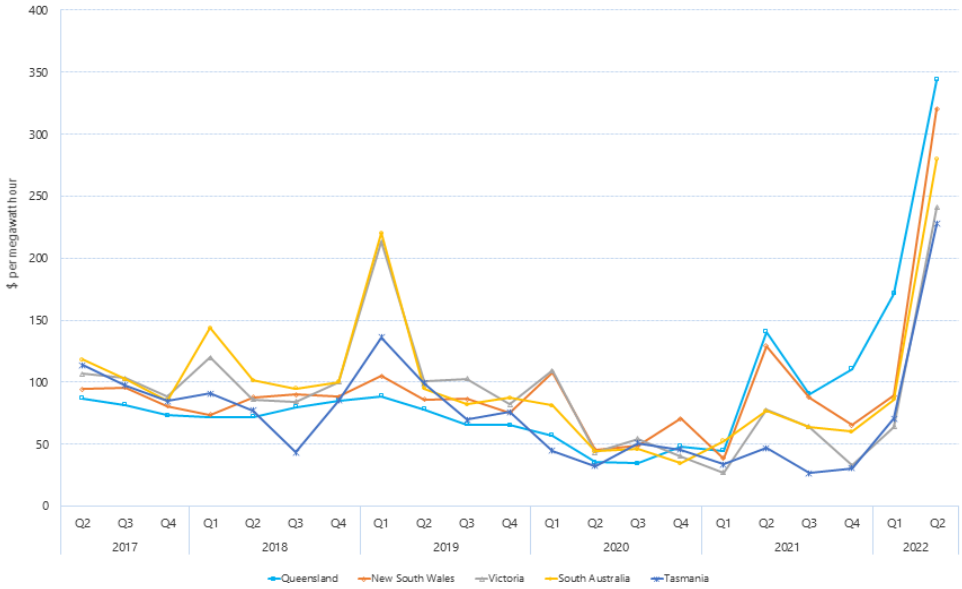
Left graph: Residential Daily Demand (March Average); Right graph: SME Daily Demand (March Average)



Left graph: Large Business Daily Demand (March Average); Right graph: Total Daily Demand (March Average)
Source: Energy Networks Australia (2020)

Figure 2-7: Changes in daily electricity demand pattern in different sectors during COVID-19

Demand reductions during the COVID-19 Pandemic in 2020 was one of the factors that caused electricity prices in the Australian National Electricity Market (NEM) to fall to the lowest level since 2015. In addition to the decrease in demand, increased hydro output due to high rainfall, lower fuel prices and new wind and solar generation capacity also contributed to the low electricity prices. However, electricity prices have been increasing since 2021, reaching extremely high price in Q2 2022 due to the increased demand, high fuel prices due to the situation in Ukraine as shown in Figure 2-8. In Q2/2021, the electricity prices have increased by almost 180% compared to Q2/2020. In Q2/2022, the price increased by another 200% due to the colder than average weather condition that caused high demand, as well as coal plant outages occurred.



Source: AER (2021)

Figure 2-8: Quarterly volume weighted averages wholesale electricity prices in the Australian NEM

2.4.1.2 Impact on renewable project development and investment

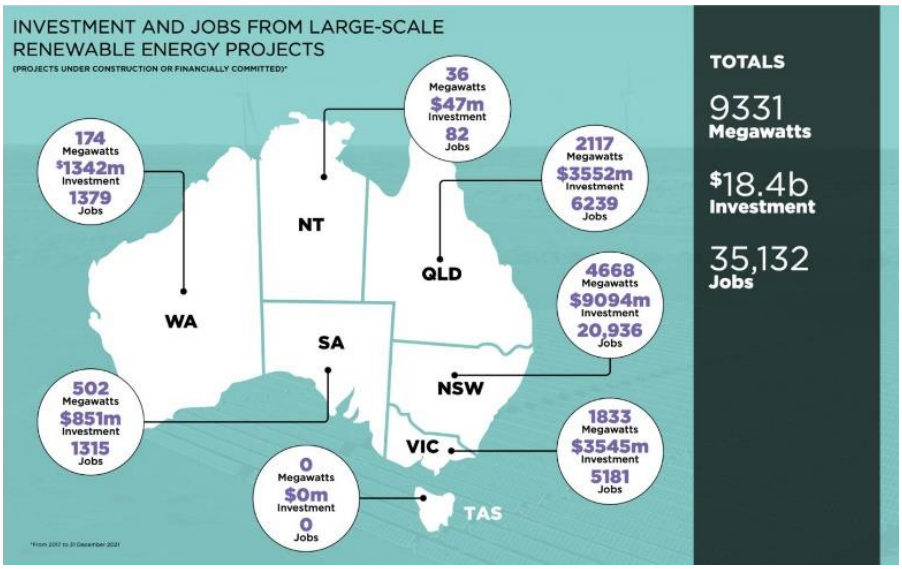
Investment in large-scale renewable energy projects increased significantly in Australia between the period of 2016 and 2019 and was completed almost entirely by the private sector. The renewable energy investment has supported economic activity and employment, particularly in the regional areas where large-scale renewable generators tend to be located. The main reason for this significant increase in new installed capacity was the completion of some of Australia's largest wind and solar projects in 2021.

Investment in new renewable energy projects over recent years has been broadly evenly split between wind and solar farms. Queensland, Victoria and New South Wales have accounted for most projects. The government has also invested USD1.4 billion in renewable electricity generation and energy storage.

Varying degree of lockdowns and restrictions during the pandemic impacted business especially in Melbourne and wider area of the state of Victoria where the Stage Four rules were endured over an extended period of time since March 2020. Most construction and trade activities were notified to stop their operations, but solar installations were allowed to continue during the peak of the pandemic in 2020 (Energy Matters, 2021). During a similar time period in July 2020, there was an announcement by the New South Wales government to develop a second 8GW renewable energy zone in the New England region to expand the power transmission network through attracting AUD12.7 billion worth of investments for new renewable energy projects. This was followed closely after a strong investor confidence of 7.3 out of 10 at the end of June 2020 from the Confidence Index in CEC Clean Energy 2020 Outlook (CEC, 2020).

Despite the booming economic uncertainties faced during the COVID-19 pandemic, the investor appetite for renewables remained strong. From January to October 2020, auctioned

renewable capacity was 15% higher than for the same period of the last year based on an IEA report (IEA, 2020).



Source: Clean Energy Council(2022)

Figure 2-9: Investment and job from large-scale renewable projects in Australia

Australia's solar PV capacity grew by more than 20% in 2021, more even than Europe's record rate of the expansion. According to the Australian PV Institute (APVI), the economy passed a major milestone at the end of 2021 with more than 25GW of solar installed. In 2021, the growth of renewable energy in Australia was led by small-scale solar PV that was made possible with the amendment to the State Environmental Planning Policy in New South Wales on April 2020, creating more leniency on the requirements on solar PV installations which the new amendments allowed households to install solar PV panels without the approval from the State Council (Energy Matters, 2022). As such, many of these small-scale solar PV investments were done by the households rather than the businesses. The sector added 3.3GW of new capacity during the year, representing the fifth year in a row that it set a record for new installed solar PV capacity. Small-scale solar accounted for 24.9 % of Australia's total renewable energy generation in 2021.

2.4.1.3 Impact on jobs in renewable sector

Before the pandemic, the clean energy sector in Australia employed around 25,000 workers in 2019, with 37% of them working in rooftop solar PV. Impacted by the COVID-19, the construction capacity for solar PV dropped in the first half of 2020, but it started to bounce up again in the second half, and the annual total ended with 4.4GW, close to the volume added in 2019. The decline happened mainly in the utility-scale solar PV segment, and on the contrary, the rooftop solar capacity increased from 2.2GW to 2.6GW. At the end of 2020, 76 large-scale wind and solar projects, representing 8GW capacity, were under construction and supplying more than 9,000 jobs. Continually in 2021, according to the Clean Energy Council (CEC), 68 additional projects, representing more than 9GW of new installed capacity, and more than 35,000 jobs, are under construction. At the same time, at the Federal level, to establish Australia as one of global leaders, the government invested roughly AUD464 million (USD313 million)

to construct seven regional hydrogen hubs, and it is expected that this effort could create 130,000 jobs by 2030 (Clean Energy Council, 2022).

Even with the relatively sturdy development progress during the pandemic, the renewable sector had concerns about a shortage of engineers, electrical line workers, electricians, and skilled wind power technicians. The COVID-19 pandemic has significantly impacted the availability of skilled workers in Australia, with both state and international border closures preventing the arrival of much-needed expertise at some renewable energy projects in different states.

2.4.2 Chile

2.4.2.1 Impact on electricity supply and demand

The energy demand in Chile is divided between regulated (capacity lower than 500kW pays regulated tariffs) and free (capacity over 5MW), and for which the capacity between 500kW and 5MW, they can choose to be regulated or free clients (this can be done through negotiating a PPA with generators and distribution companies). The regulated demand fell due mostly to migration from the regulated to free clients, which explained an increased number of the free clients. Basically, there is no total growth of demand in 2020 due to the COVID-19 pandemic as compared to previously years (demand grew 0.6% compared to 3%).

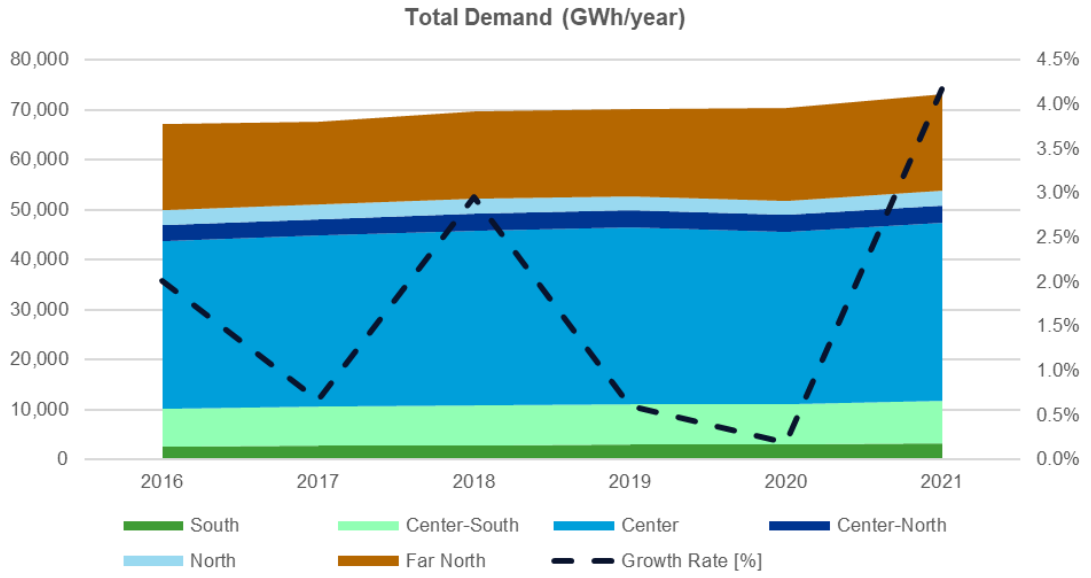
Table 2-1: Annual demand in Chile between 2016 – 2021

Annual demand (GWh)	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Free clients	34,550.05	36,451.64	41,169.96	43,844.73	44,497.03	45,068.98
Regulated clients	32,703.64	31,246.79	26,527.94	26,271.94	25,753.13	28,115.88
Total	**67,253.70**	**67,698.44**	**69,697.90**	**70,116.67**	**70,250.16**	**73,184.87**

Source: DNV with CEN[1] information

As shown in the figure below, energy demand growth in Chile has been in accordance with GDP, until 2020, where due to the exceptional difficulties caused by the COVID-19 pandemic, the economic activities and growth were severely affected economy-wide, leading to a sharp drop in GDP.

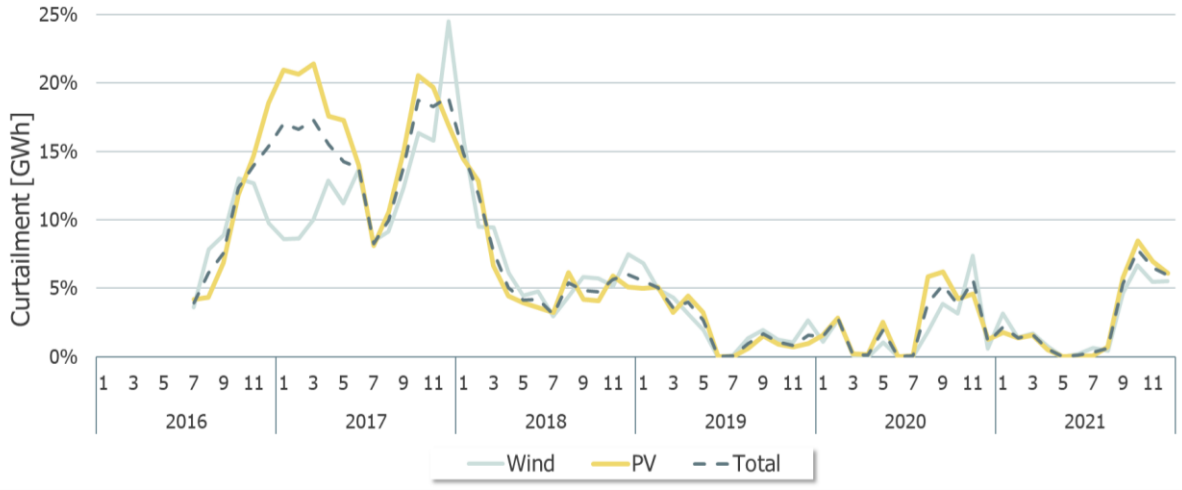
[1] CEN stands for Coordinador Eléctrico Nacional (Chilean Independent System Operator).



Source: DNV with CEN information

Figure 2-10: Annual demand and growth rate

Increased capacity of wind and solar generation but lack of sufficient transmission capacity in the energy system, and the need to keep thermal power plant at the minimum stable load, put immerse pressure on the grid system which resulted in high volumes of energy curtailment in the North of the Chilean system (solar PV plants in Chile are mainly concentrated in the North). As shown in Figure 2-11, coupled with the low demand during the pandemic period, electricity prices were kept low during the solar hours.



Note: Considering curtailment and generation from Nogales to the North
Source: CEN

Figure 2-11: Monthly curtailment rates of solar and wind energy

During the second half of 2020 monthly curtailment rates increased again to around 3 to 5% for solar and 1 to 5% for wind (economy-wide) as a combination of increasing renewable capacity, presence of inflexible gas, and demand lower than expected due to the COVID-19 pandemic. Then in September 2021, curtailment started increasing again.

2.4.2.2 Impact on renewable energy project development and investment

The investments in Chile were somewhat affected by the COVID-19. Tenders for 2,310GWh of renewables and energy storage by the Chile National Energy Commission was supposed to took place in 2020, however, due to the COVID-19 pandemic, it was first postponed to May 2021 then again to June 2021 as the result of restriction on movement in Santiago Metropolitan Region by the health authorities. Awarded projects will start delivering power from 2026 and sign a 15-year PPA.

The Financial Report by the National Energy Commission in May 2020 projected the investment for the energy sector to be USD1,254 million (higher than all quarters of 2018 and 2019) before the effects of the COVID-19 pandemic, however the actual figures of investment turned out to be USD808 million which was much lower than expected value. In 2021, the investment climbed back, and improved 15.5% from 2020 levels which was optimistic.

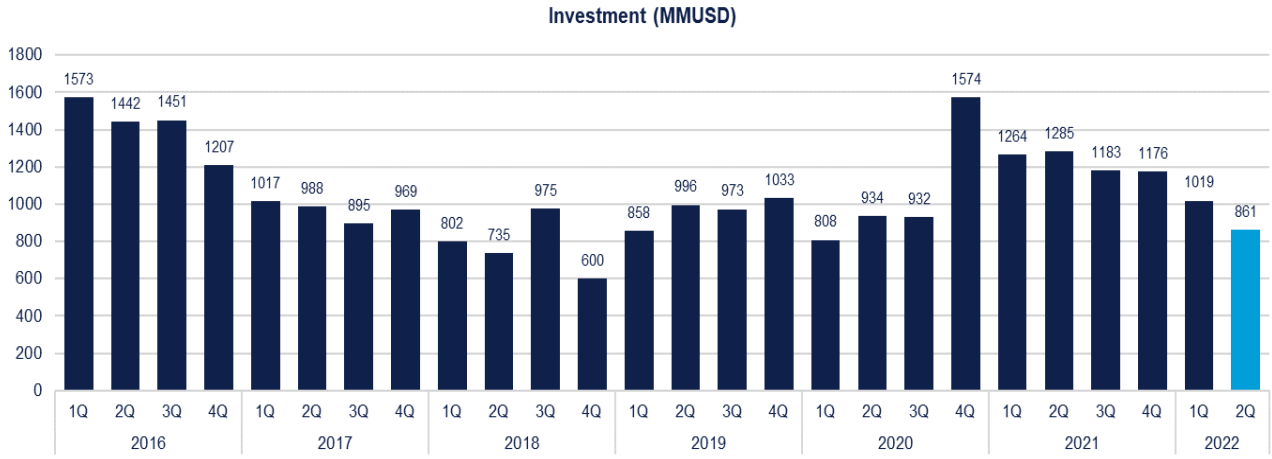


Figure 2-12: Investment in the energy sector in Chile

The owner or operator of Chile's PMGD[2] distributed generation segment that participates in the balance of injection and withdrawal can chose between i) selling its energy to the power system at the instantaneous marginal cost, or ii) selling the energy at a stabilized price. Until October 2019, the stabilized price had shown little variation since 2008 even in a context of highly fluctuating spot prices in the market. However, a significant decrease was observed in April 2020, as a result of the social protests in Chile in the end of 2019, which led to changes in future social and economic development expectations, particularly in terms of GDP growth, energy consumption and electrical demand growth, which were then confirmed due to the COVID-19 pandemic.

With the growth of wind and solar generation, the trend of marginal costs for each node in the system have been decreasing until 2021 when the fuel prices started to rise as shown in Figure 2-13. However, with more renewable energy projects in the SEN[3] (supported by the reduction of their LCOEs), marginal costs are expected to decrease in the long term.

[2] PMGD are defined as generation units which power capacity surplus is equal or lower than 9MW, are connected to the grid of a licensed distribution company or to any distribution line that uses public land.
[3] SEN is the National Electric System.

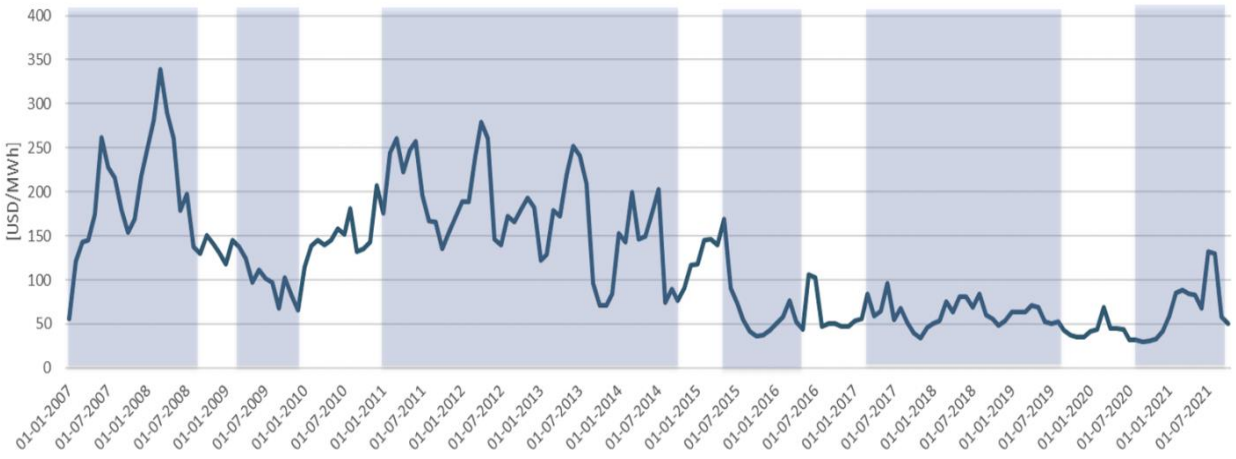


Figure 2-103: Marginal costs in Alto Jahuel node in the central zone of the economy

2.4.2.3 Impact on jobs in renewable sector

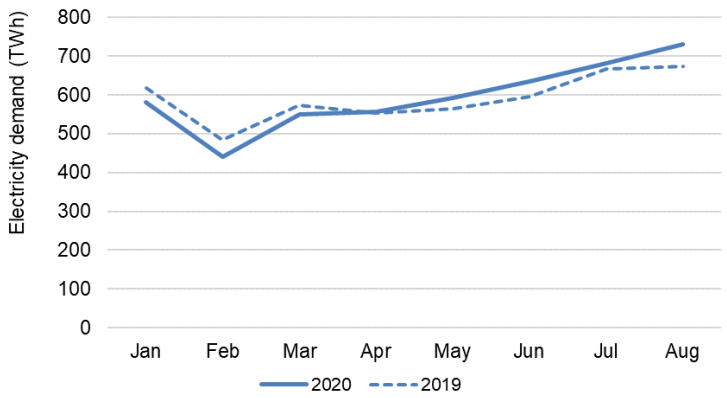
Chile is amongst the economies with the most renewable generation capacity installed in South America. Despite postponed investments, jobs in the renewable sector in Chile increased between 2019 to 2021. By 2021, there are 35,448 jobs in Chile in the renewables sector, mostly from the solar (34%), wind (31%), hydropower (27%), and CSP (4%) technologies (IRENA, 2022).

In addition to that, Chile has one of the largest copper and lithium reserves and mining industry, which contribute to about 10% of the economy's GDP. About half of the export from Chile comes from the mining sector. With more electrification for decarbonization purposes upcoming, energy storage demand will increase along with demand for critical minerals, contributing to Chile's economic growth.

2.4.3 China

2.4.3.1 Impact on electricity supply and demand

China is among the largest economies globally, accounting for over 20% of the world's electricity demand and generation. China was the first economy that experienced the impact of COVID-19 on the energy sector, arising from the restriction measures that limit economic activities as well as domestic and international movement. With lockdown measures to contain the spread of virus, electricity demand dropped sharply by almost 10% in Q1 2020 year-on-year. Overall, the industry sector was the most hit. In the electricity sector, coal-fired generation was mostly affected by the demand reduction during the same lockdown period which resulted a 10% decline in generation when compared to 2019 (Figure 2-14). While generation from most fuel sources fell sharply during the lockdown, wind and solar PV generation however increased 20% in the first quarter of 2020 when compared to same period in 2019.



Source: National Bureau of Statistics China, n.d.

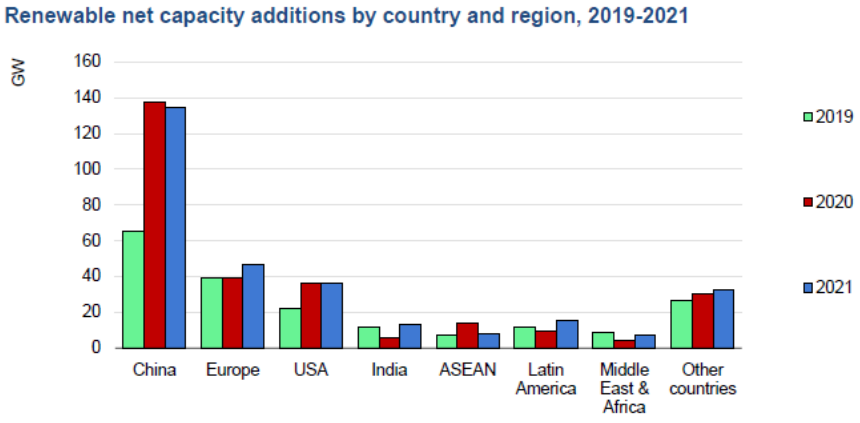
Figure 2-14: Monthly electricity demand in China in 2020 and 2021

China was also the first economy that began recovery form the COVID-19 pandemic that started from Q2 2020 when energy consumption started to pick up, which was supported by economic stimulus measures which eventually led to the overall annual energy demand growth. The main contribution for the demand growth was from the industry sector, the largest contributor to the economic worth.

In 2021, electricity demand increased close to 10% from the 2020 figure, which was mainly driven by the continuation in recovery on the domestic economy and the rapid growth of foreign trade exports. Also, with the expiry of the government subsidy policy for China's offshore wind power projects on the last day of 2021, the wind developers rushed to install China's offshore wind power projects throughout the year in 2021, which resulted in a year-on-year growth of over 400%.

2.4.3.2 Impact on renewable energy project development and investment

As illustrated in the chart below, China has the highest installed renewable capacity globally. In 2021, the economy accounted for nearly 50% of renewable capacity additions worldwide (IEA, 2022).



Source: IEA (2022)

Figure 2-15: Renewable net capacity additions by region

China has a major share in the global PV component manufacturing capacity and is one of the economies where most manufacturing of the wind industry takes place, along with EU, the US and India. China is the leading producer of solar PV equipment, include cells and panels, and has the largest installation market which contributed to around 58% of the employment in solar PV sector worldwide, or some 2.3 million jobs.

The impacts of the COVID-19 on renewable project development and investments have been affected in China as well as in global market, as mentioned that China is the major supplier of solar panel and wind turbine and parts. Some of the impacts from the COVID-19 include blocked logistics, operation delay on the industrial chain, and low turnover efficiency where these impacts have led to price increases in the industrial chain and subsequently resulted in a decline on the growth rate for the downstream demand.

For the case of the market for solar PV, the price of silicon material had risen sharply in 2021 due to supply chain interruptions and rising commodity prices that resulted in a lower-than-expected demand for new photovoltaic installations over the year. The manufacturing capacity experienced gradual recovery since 2021, but due to the rebound of the pandemic in Jilin, Shanghai, and Guangdong in China in 2022, normal photovoltaic business activities have been restricted, and the terminal photovoltaic installation market has also been affected by the strict control of personnel flow.

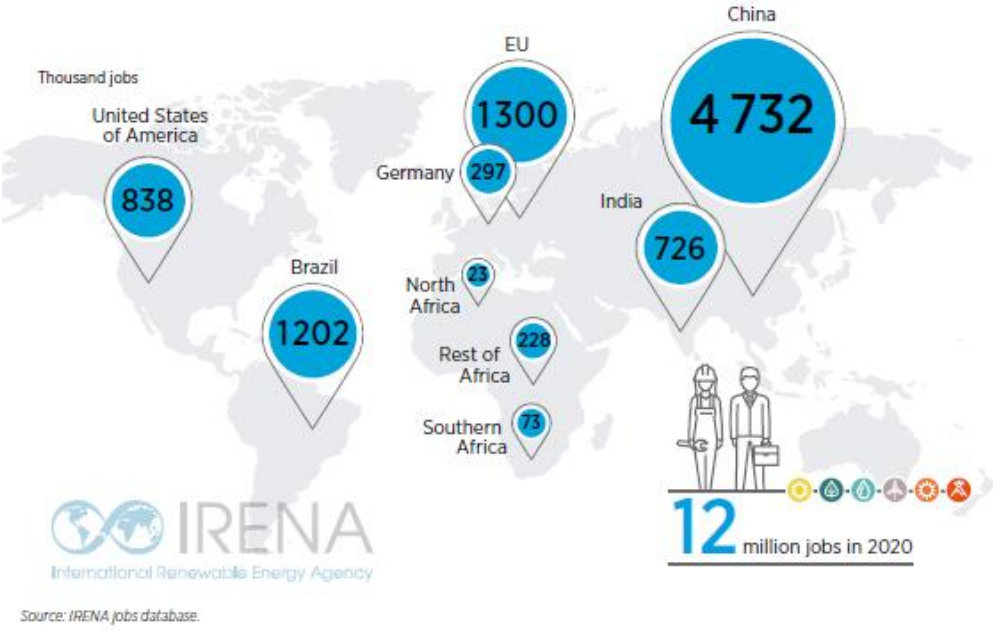
For the wind market, the main supplier of blade adhesives is situated in Shanghai. Although the supply chain had experienced temporary delivery difficulties in 2020 due to the impact of the pandemic, the low price of wind turbines in China started to rebound in early 2022. However, due to COVID-19 variant Omicron, static management and control were carried out in Shanghai from March to June 2022, which affected the full completion of some wind power projects.

With the deepening of China's "3060" carbon policy, the photovoltaic industry has gained policy inclination. Driven by the increased policy support and the economic improvement of photovoltaic projects, China's photovoltaic demand remains strong, and the industry is expected to usher in accelerated growth.

2.4.3.3 Impact on jobs in renewable sector

The employment growth in the energy sector of China ranks the largest as compared to Brazil, India, the United States, and the European Union. China remained its leading role in renewable energy employment worldwide with a share of 38% of the world's total employment in the 2019. Despite the effects of the COVID-19, China further extended its global lead at 39% for renewable energy employment in 2020. China's employment in the energy field increased from 4.4 million jobs in 2019 to 4.7 million jobs in 2020.

The reason for the large number of new employees in China was due to the resilience towards the impacts of the COVID-19, which added 136GW of renewable capacity in 2021. In which, the additions include 72GW of wind power and 49GW of solar PV, with the new generation assets that contributed to significant amount of job vacancies.



Source: IRENA (2021)

Figure 2-16 Renewable energy employment in China

As mentioned previously, China is the leading producer of solar PV equipment and has the largest installation market, with a major share in solar PV jobs. As for the wind sector, most wind employment is concentrated in a relatively small number of economies, and China alone already accounted for 44% of the global total, as the economy holds a relative comprehensive and complete components production line such as nacelles, blades, towers, generators, gearboxes and bearings. Amongst the estimated total number of 800 factories worldwide that produce wind-turbine components, 45% of them are in located in China. In addition, close to 40% of the total number of generators manufacturing plants are in China, with a similar share in Europe.

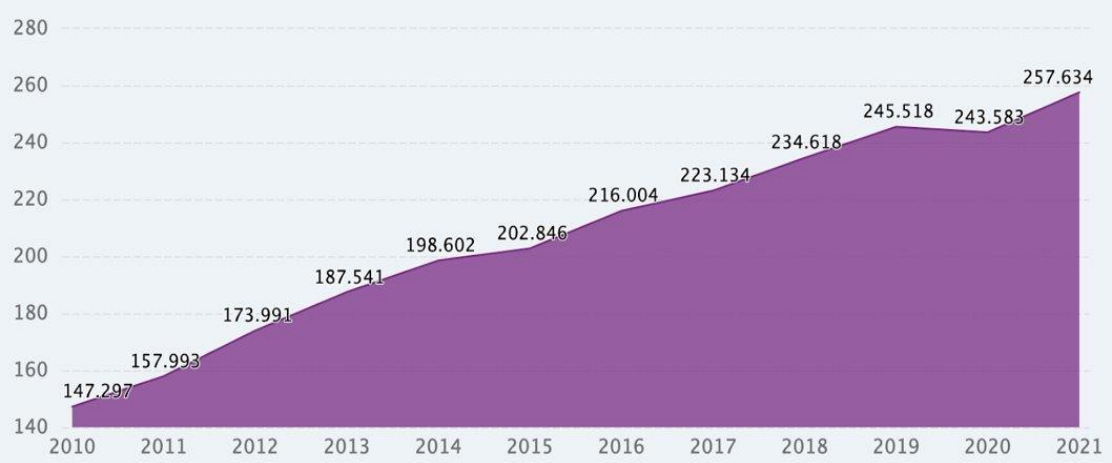
2.4.4 Indonesia

2.4.4.1 Impact on electricity demand and supply

With a distribution of 42%, household was one of the sectors in Indonesia with the highest electricity demand prior to the COVID-19 pandemic in 2019, followed by the industrial (32%) and business sectors (19%) (PLN, 2020). It is anticipated that the household sector would continue driving up electricity demand in Indonesia, which has the fourth biggest population in the world and is expected a significant growth in population in the coming years. With the aid of the internet, which offers countless options like remote employment, the residential building has evolved into the hub of all activities throughout the pandemic. On the one hand, it is inevitable that energy use in residential structures would rise, while on the other, energy use in the transport sector and energy particularly electricity usage at industrial and commercial sectors were significantly lower in 2020 due to the COVID-19 outbreak in early March that year.

People were confined to their homes due to the implementation of large-scale social restriction policy to stop the spread of the COVID-19 virus, which has led to an increase in domestic

electricity usage at the expense of the consumption in the industrial and commercial sectors. As a result, the overall usage of electricity has decreased as much as 1,935.42GWh (0.79% decrement) from 2019 to 2020 (PLN, 2021). By 2021, the electricity demand trend increased back (Figure 2-17), yet in a slower growth projection than forecasted previously, which is reflected in the updated the power provider PLN (Perusahaan Listrik Nasional)'s Indonesia's long-term electricity supply plan (RUPTL) 2021-2030. The projected electricity demand growth in the next 10 years was modified from an average of 6.5% to 4.4% per year. Along with this modification, the renewables share to new power generation capacity targets by 2030 was increased to 51.6% (20.9GW of 40.6GW). This was done to support the economy's objective of achieving a 23% share of renewable energy in the energy mix by 2025 (OECD, 2021).



Source: CEIC (2022)

Figure 2-17: Annual electricity consumption (MWh)

Another implication of the pandemic is electricity oversupply in the Java-Bali region due to lower-than-expected electricity demand growth. Going forward, this condition would be a challenge for renewables integration to the energy systems that may lead to the curtailment in smaller systems that are not interconnected, highlighting the need to invest in infrastructure as well including to build connection between different islands in Indonesia to ensure the stability and reliability of the energy system (IRENA, 2022).

2.4.4.2 Impact on renewable energy project development and investment

Renewable energy deployment in Indonesia has been lagging in targets, and the value of investment in renewable energy has been insufficient (as shown on Figure 2-18). Renewable energy projects were delayed in 2020 due to limited mobility of people and materials from the pandemic response measures. Although below the target, there in an increment in installed capacity for renewable energy, with solar and mini hydro growing by 17.9% and 20.7% respectively. In total there is an additional renewable capacity of 66MW of hydroelectric plants, 12.1MW mini hydro plant, 3.5MW biomass power plant, and 13.4MW rooftop solar PV power system (Ministry of Energy and Mineral Resources of Indonesia, 2021).

In 2020, there is an overall 42.1% drop in investments in energy sector, with a 20.6% drop for renewable energy project specifically. While fossil fuels command the largest share of the overall investment in energy (around 65% in 2020) (IRENA, 2022), investment in renewables

is still directed more toward geothermal rather than other renewable sources. It is expected that more investment is needed if Indonesia is to achieve the established NDC target of a 23% share of new and renewable energy by 2025. As the end of 2021, the renewable energy's share in Indonesia's energy system was at 12% (Ministry of Energy and Mineral Resources of Indonesia, 2021).

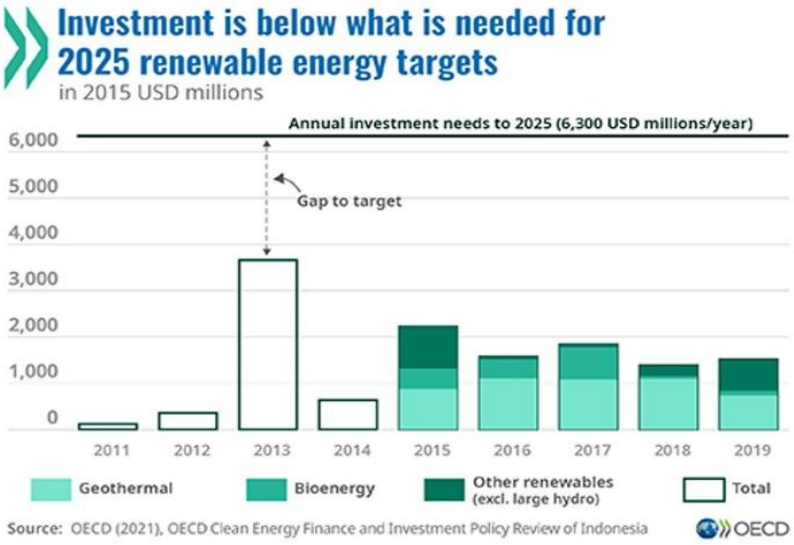
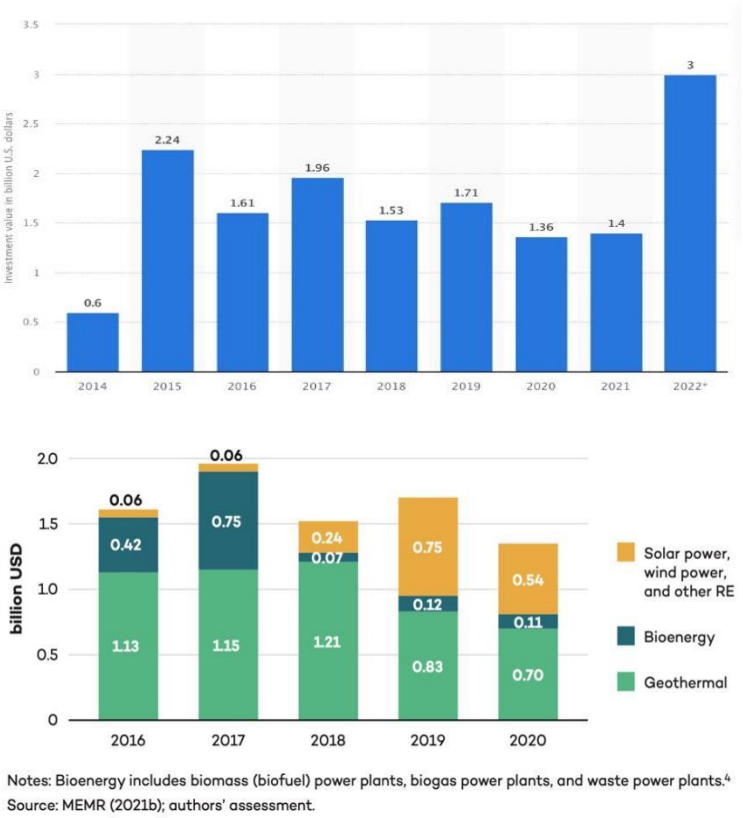


Figure 2-18: Investment below what is needed for 2025 renewable energy target

The renewable energy investment in Indonesia includes investment made by Independent Power Producers (IPPs) and other developers. Private investment continues to play a central role to fund power generation expansion plans. As in other plans, IPPs have a greater role in developing planned capacity than PLN. Of the total 40.6GW of planned additional capacity, 26.3GW or 65% are private investments. In 2020, these investors made IDR20 trillion (USD1.4 billion) investment in renewable power, representing 7.8% of the total investment in the energy sector, which is significantly lower compared to the investment in fossil fuels, at IDR237 trillion (USD16.5 billion).

Furthermore, the 2021 ASEAN Power Updates (ASEAN Centre of Energy, 2021) reported that renewable energy played a significant role in the power sector during the COVID-19 pandemic as around 82% of total ASEAN new generation capacity in 2020 came from renewable energy, in which Indonesia contributed 1.3GW only of the 22GW addition, while Viet Nam and Lao PDR are 12.55 and 5.48GW respectively. This implies that more investment is required to further increase the renewable energy capacity in Indonesia, which is consistent with previous statements saying that Indonesia needs more investment to achieve the 23% renewable energy mix target by 2025.



Notes: Bioenergy includes biomass (biofuel) power plants, biogas power plants, and waste power plants.[4]
Source: MEMR (2021b); authors' assessment.

Top: Value of investments in renewable energy (in billion USD); Bottom: Investment in renewable resources

Source: Statista (2022); IISD(2022)

Figure 2-19: Investment in renewable energy

2.4.4.3 Impact on jobs in renewable sector

As one of the largest biofuel suppliers globally, Indonesia has an established biofuel industry where employment in this sector accounts to 20% of biofuel jobs globally. IRENA (2020) estimated the employment in biodiesel in Indonesia at 494,400 in 2019 which was over than 108% increase from 2018. The employment in biodiesel stayed similar after the COVID-19, at about 475,000. The biofuel consumption in 2020 increased by 20% as Indonesia's biodiesel blending mandate rises from 20% to 30%, while the overall consumption of biofuel reduced due to the COVID-19 restriction measures (IRENA, 2021).

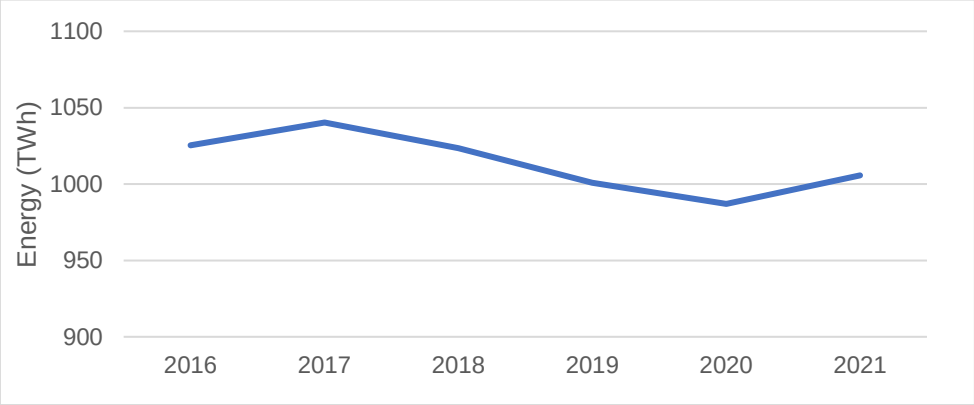
By the end of 2021, renewable energy employment recorded in Indonesia was 550,900 for liquid biofuels, 24,260 for hydropower, 7,000 for geothermal respectively, accumulating to a total of 587,000 workers (IRENA, 2022). The number of workers in the renewable energy sector was estimated to grow due to various upcoming projects in the other renewable energy technologies as well. The Solar Archipelago (Surya Nusantara) plan is one of these, where 1.0GW of solar PV per year will be installed until 2025. It was estimated that up to 22,000 people per installation would be needed. In addition, to utilize Indonesia's mineral resources availability, the Indonesia Battery Corporation was established to focus on the development and growth of the energy storage sector. A battery manufacturing facility has been planned to be built, aiming to produce 140GWh of battery storage and will create more job opportunities in the energy sector (IRENA, 2022).

2.4.5 Japan

2.4.5.1 Impact of COVID-19 on electricity demand and supply

Japan has been relying heavily on energy imports to meet its electricity generation due to its geographical location and limited resources. The pressure for energy imports increased after the devastating nuclear incident that hit the northeast coast of Japan as nuclear was a critical source of electricity energy at that time (METI, 2019). Since then, the Japan government ventured into sustainable resources such as renewables in addition to energy imports to meet the needs for electricity of the economy.

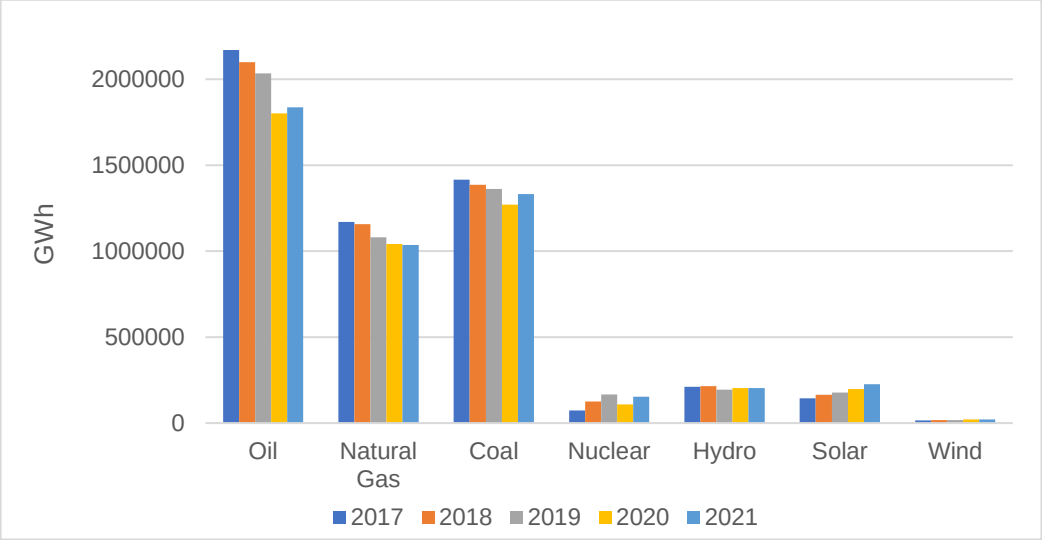
In Japan, the first confirmed COVID-19 case was recorded in mid-January 2020 and more cases followed thereafter. The government declared a lite-lockdown from April-May 2020 for the non-essential services to stop their operations. Consequently, annual electricity demand fell to the lowest point in 2020 when the COVID-19 hit Japan the hardest, as seen in the figure below.



Source: IEA, n.d.

Figure 2-20: Electricity demand in Japan

The day ahead price was recorded near to zero in February 2020 (Reuters, 2020) in the JEPX market (JEPX, n.d.), and more occurrences of such events in April 2020 following the rise of the number of the COVID-19 cases and the associated lite lockdowns. These were largely contributed by the halt in economic activities (Reuters, 2020) in the manufacturing and service sectors, as well as increased solar power supplies into the power grid. Generators with higher operating costs reduced their trading activities in the JEPX due to extremely low electricity prices. On the other hand, renewables such as solar PV and wind power that had lower operating costs and increased their production and activities in the trading market as reflected in the figure below.



Source: BP (2022)

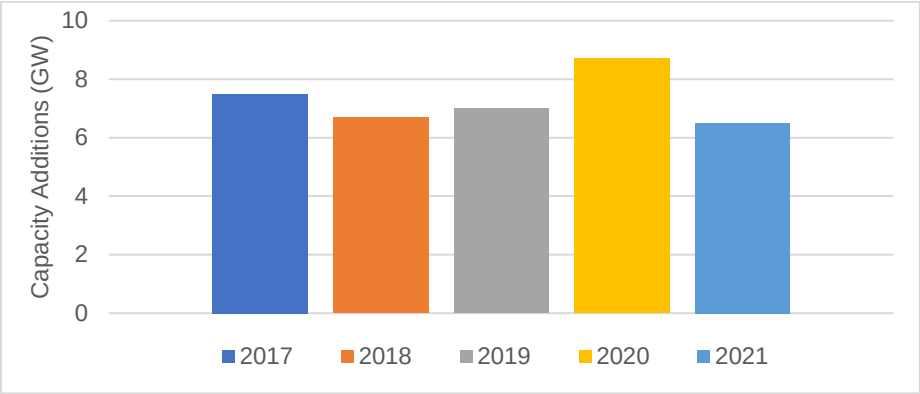
Figure 2-21: Electricity demand by sources in Japan

Along with increasing renewable penetration in the energy system and its impact on the JEPX market prices, there have been more electricity curtailments in Japan especially in the Southern Islands Kyushu region. The first curtailment in the Kyushu region happened on October 2018, with its peak curtailment reaching up to 925MW afterwards in November (Renewable Energy Institute, 2019). Ever since, Kyushu has an average of 3% solar energy curtailment, and has been increasing annually. In 2018, a total of 23GWh renewable energy were curtailed, and afterwards in 2019 a total of 311GWh (Bunodiere & Lee, 2020). By 2022, other regions such as Shikoku, Cugoku, and Tohoku experienced solar curtailment as well (NTT Anode Energy Corporation, 2022).

The curtailment rates in Japan are expected to worsen with increasing renewable energy penetration. Therefore, there has been heavy emphasis on the importance of energy storage and raising the interconnection capacity between the regions. Energy storage is essential for balancing and is the key to allow further renewable energy grid integration without experiencing further energy and financial losses. It has been estimated that, technically, a 100% renewable grid integration is feasible with Japan's available resources, but energy storage is essential. According to a study by Esteban et al., a 41TWh of energy storage is required to balance the varying renewable energy generations. In addition, with future nuclear-phasing out and the carbon emission reduction goal, high capital investments will be required (Cheng, Blakers, Stocks, & Lu, 2022).

2.4.5.2 Impact on renewable energy project development and investment

As part of its efforts towards a cleaner environment and building an economy towards sustainable energy, Japan has been active in renewables investment. One of Japan's most effective practises in the introduction of Feed-in-Tariffs in 2012 (IGIIC, n.d.).which encouraged investment into solar energy. Many power companies saw the opportunities and tendered for large scale solar PV projects, which contributed to the capacity additions as shown in figure below.



Source: IRENA (2018); IRENA (2019); IRENA (2020); IRENA (2021); IRENA (2022)

Figure 2-22: Solar capacity addition in Japan

However, many solar PV projects faced delays due to China being part of the supply chain in shipment of solar PV modules (Farmer, 2020) when several provinces within China entered a lockdown phase (The Straits Times, 2021), and transport were limited on international borders. These solar PV projects have strict deadlines to reach commercial operation as per Renewable Energy Act (JD, 2017). Nonetheless, in 2020 and 2021, Japan was ranked the third worldwide in its cumulative solar PV installed capacity (IRENA, 2021).The economy has also seen capacity additions in offshore and onshore wind sector though in limited quantity and capacity due to geographical constraints.

Other than the COVID-19, Japan was impacted by the increased in oil prices due to the war in Ukraine, as Russia is one of its exporters for oil and coal. In order to deal with the potential long-term impacts of oil prices, Japan aims to hasten its efforts towards renewable energy, such as developing its offshore wind power projects. The tender processes for the wind farms have been investigated by METI in terms of the timeline of project development and the prices for such projects (REN21, 2022).

2.4.5.3 Impact on jobs in renewable sector

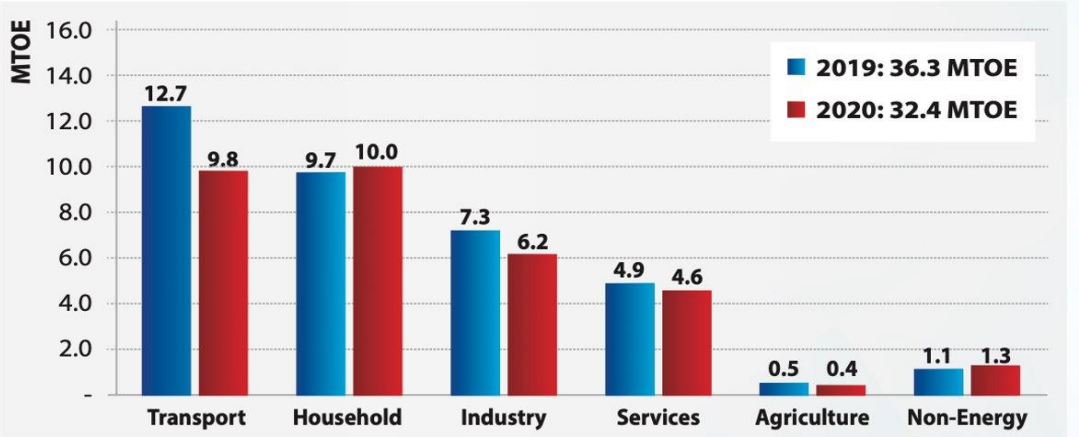
There was a decreasing trend for jobs related to solar PV from 302,000 jobs in 2016 (IRENA, 2017) to 220,000 jobs in 2020 (IRENA, 2021). The reason was largely due to the reduction in feed-in-tariffs and bankruptcies of the companies that entered large scale projects on impulse at earlier stages and felt the need to increase jobs from the Zero Energy Homes policy (Joson, 2022), which required the new buildings to integrate solar PV and energy efficiency technologies by 2030. The Japanese government had since then shifted stance towards residential solar PV additions on rooftop of new buildings as suitable land is limited for large scale solar projects.

The shifting effect expanded when the government puts a premium on distributed solar PV based on remaining suitable lands in 2020. Foreign produced modules accounted for 95% of the total shipments (JPEA, 2021) which reduced the need for the domestic manufacturing jobs. Jobs in the solar community were affected greatly as many solar projects faced delays as they lacked foreign produced modules due to international border restriction on travels and the manufacturing halt in China (Reuters, 2021) as a result from the COVID-19.

2.4.6 The Philippines

2.4.6.1 Impact of COVID-19 on electricity demand and supply

Following the declaration of the State of Public Health Emergency in March 2020, various levels of community quarantines halted major economic activities, including public and private transportation, which reduced energy consumption of end-use economic sectors, except for households in the Philippines. In 2020, total final energy consumption (TFEC) was 32.4 million tons of oil equivalent (MTOE), down 10.7% from the 36.3MTOE level of the previous year.



Source: DOE (2021)

Figure 2-23: Total final energy consumption by sector (MTOE)

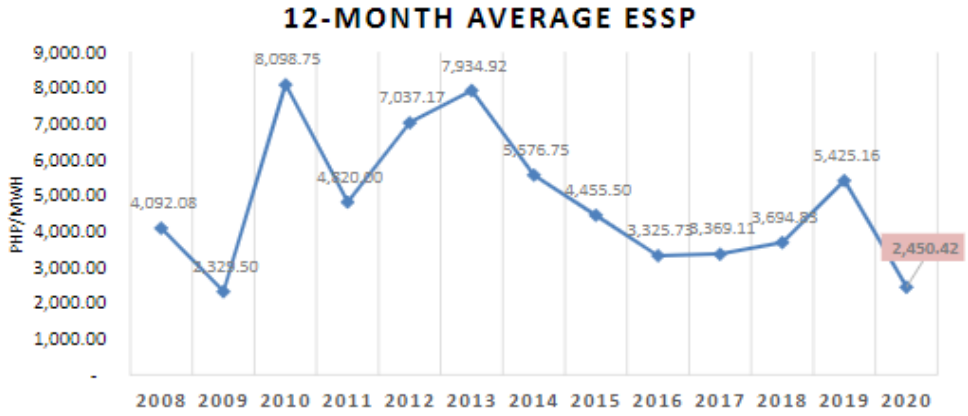
Due to the limits placed on the movement of people, products, and services to stop the spread of the COVID-19 virus, the transport sector experienced the largest reduction in energy use, falling by 22.5%. The government only permitted the manufacturing of the necessities, causing the total industry output to decrease by 13.2%. The sector's energy needs decreased by 15.1% from 7.3MTOE in 2019 to 6.2MTOE in 2020.

Mandatory company closures were put in place as the government tried to prevent overloading the healthcare system. While the reduced capacity of public transportation created mobility and accessibility issues for the consumers and workers alike, as well as travel restrictions that hampered the domestic tourism demand, it crippled large-, medium-, small-, and micro-sized establishments (MSMEs), particularly those engaged in wholesale and retail trades. Residences used 10.0MTOE and contributed 31.0% of the final energy consumption in 2018, up from 26.8% in 2019. The majority of this was accounted for by electricity usage, which climbed dramatically by 12.2% as a result of alternative work-from-home (WFH) schemes and adherence to "stay-at-home" legislation that was put in place to stop the spread of the COVID-19 virus.

During the lockdowns and restricted movement, electricity consumption dropped by around 30% as the Enhanced Community Quarantine (ECQ) measure implemented in Luzon area in March 2020. Ample supply margin was observed given the lower demand with the average market price also dropping down due to more instances of lower prices during the quarantine period. The restricted industrial and commercial activities in 2020 had led to the decline in the electricity peak demand of almost 2%, from around 15,600MW in 2019 to 15,300MW in 2020. As coal-fired power generation represents the largest share in the electricity generation mix,

the reduced electricity demand during the COVID-19 pandemic required less coal-fired generation, hence consumption of coal.

Another impact of the decreasing electricity demand is on the electricity price. The Effective Spot Settlement Price (ESSP), the effective rate paid by customers in the electricity market in the Philippines significantly decreased by 54.883% between 2019 to 2020. Furthermore, this year-to-date (YTD) decrement is the biggest since 2009 (ERC, 2020).

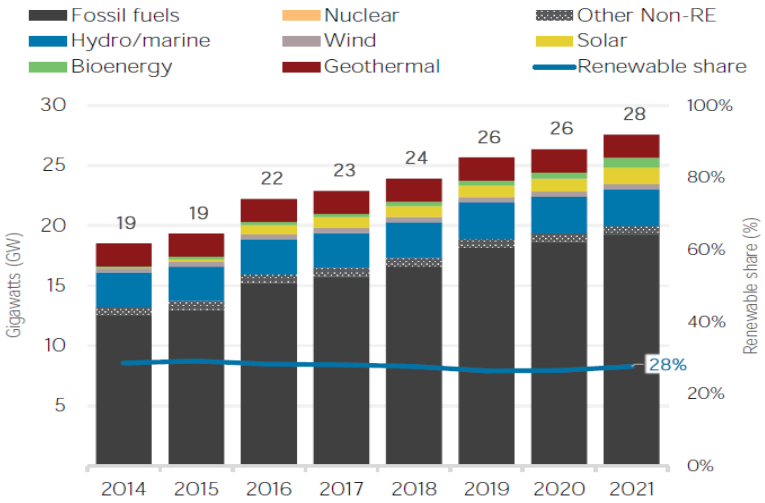


Source: DOE (2021)

Figure 2-24: Average effective spot settlement price (ESSP) 2008-2020

2.4.6.2 Impact on renewable energy project development and investment

While the Philippines attracted USD1.0 billion of investment in renewable energy in 2016 (all investments in energy was USD2.48 billion), it experienced a significant investment decline to USD0.3 million in 2017 and USD0.16 million in 2018. By contrast, Viet Nam received USD5.2 billion of investment in 2018 alone. The Philippines had 7.9GW of installed renewable capacity as of the end of 2021.



Source: IRENA (2022)

Figure 2-25: Total installed generation capacity in the Philippines

Under the Philippines Energy Plan (PEP) 2020-2040 Clean Energy Scenario, an additional 73.8GW of renewable electricity generation capacity is needed until 2040, which requires an investment of more than PHP25.3 billion (USD485 million) (IRENA, 2022).

The Philippines has promoted renewable energy investment opportunities since prior the COVID-19 pandemic, promoting the development of solar PV hybrid, green bonds, and investments on power grid interconnection between the regions (DOE, 2021). It was estimated that as much as USD20 billion of potential investments can obtained from auctions over the period of 2020–2030 in the Philippines, where the ASEAN Centre of Energy suggested the improvements to be made in order to achieve this potential. Among the recommendations, the investment roadmap and facilitation of market entry for renewable energy investors are highlighted. One example to facilitate the market entry is to reduce the bureaucratic processes involved to attract investors (ASEAN Centre of Energy, 2020).

2.4.6.3 Impact of COVID-19 on jobs in renewable sector

The Philippines had 33,700 jobs in solar PV sector, 18,780 jobs in the wind, more than 11,000 in solid biomass, and 11,980 jobs in geothermal in 2019 before the pandemic (IRENA, 2020). In 2020, even with the impact of the COVID-19, the number of jobs continued to increase, solar PV jobs rose to 41,035, wind power jobs rose to 23,800, solid biomass rose to 11,200, but the number of jobs in geothermal slightly declined into 8,300. This was because that the COVID-19 hit delays in many activities especially in the geothermal sector (IRENA, 2021).

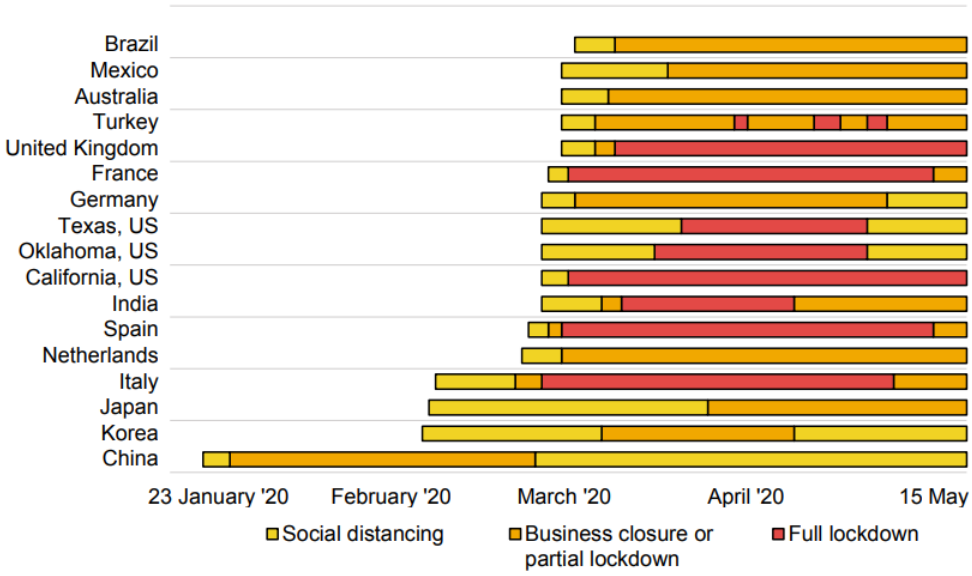
With the upcoming renewable energy development, the Philippines is estimated to have an additional 117,000 jobs in the sector by 2025 (ASEAN Centre of Energy, 2022). On the other hand, development of new coal plants has declined since 2015, and is expected to even decrease further to achieve the decarbonization goal. There needs to be a transition of skilled workers from the coal sector into fields of renewable energy, CCT, and gas, which was addressed by the government through the Philippines Green Jobs Act in 2016 (ASEAN Centre of Energy, 2022). The Philippines Green Jobs Act promotes and provides incentives to companies that create green jobs.

Existed the movement restrictions over the Philippines slowed wind and solar project development and delayed some constructions at the project sites, while operations were affected relatively less. However, there were special permits for the workers to be declared as the essential personnel, and the energy industry expedited the permitting process so the delays could be subsided.

2.4.7 The United States

2.4.7.1 Impact of COVID-19 on electricity demand and supply

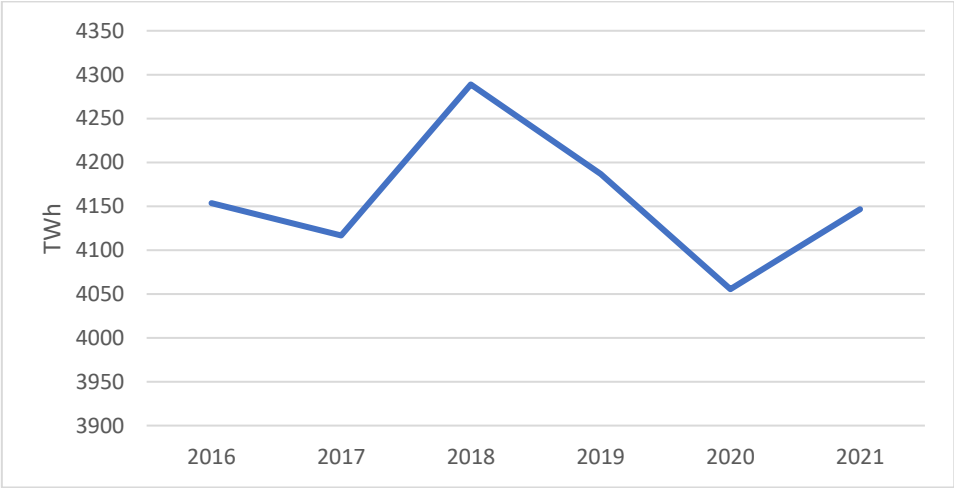
The first few reports of COVID-19 cases surfaced around mid-January 2020 from the local health organisations in some states where the virus was later spread at an exponential pace to all other states of the United States. In order to control the spread of the virus, the US government, along with other governments, imposed various movement restriction measures in that year as seen in figure below.



Source: IEA (2020)

Figure 2-26: Partial or full lockdown of selected states

With varying degrees of the lockdown and social distancing measures, the commercial and industrial sector took a great hit. Commercial activity took an even larger hit in the first half of 2020, at about 11% drop during the lockdown period, but it subsequently picked up when restriction measures are more relaxed in the second half of the year. The industrial sector had a 4.3% fall in electricity consumption in 2020, as compared to the 2019 numbers (EIA, n.d.). Slight recovery on electricity demand in the second half of 2020 could be due to summer season and more relaxed restrictions in the period. Overall, with the impact of COVID-19, electricity demand was the lowest in 2020, as compared to recent years as reflected in figure below.

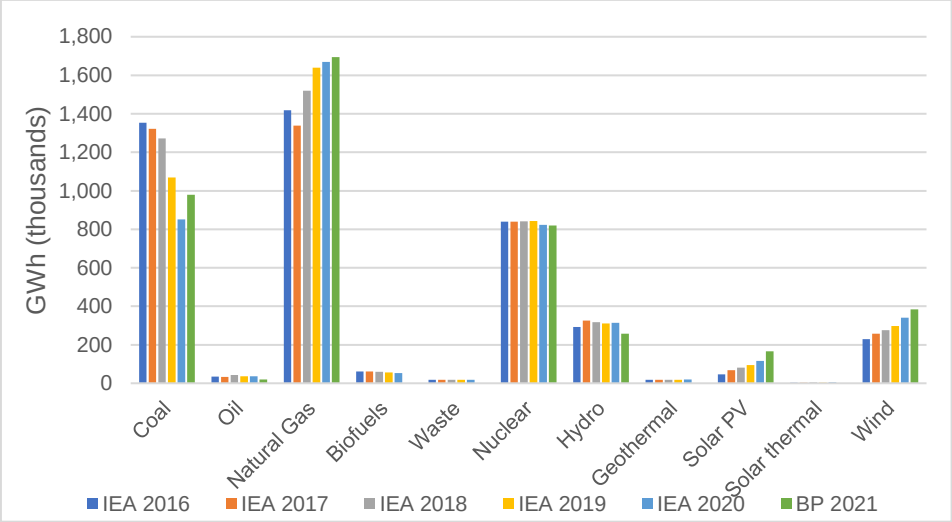


Source: IEA, n.d.

Figure 2-27: Annual electricity demand in US

Following the lockdown measures in early 2020, there had been more contribution from renewable resources and fall in coal sources due to depressed electricity prices from the reduced electricity demand. In Q2 and Q3 of 2020, coal and nuclear picked up to respond to growing

demand based on seasonal changes. Over the period natural gas remained as the leading source for electricity generation. The annual changes of electricity generation are shown in figure below.



Source: IEA, n.d.; bp (2022)

Figure 2-28: Annual generation of electricity by sources

2.4.7.2 Impact on renewable energy project development and investment

Annual increase in solar PV capacity reached 13GW in 2019 due to economic attractiveness of both large-scale solar PV and residential solar. Solar PV capacity additions improved 30% to reach 19GW in 2020 as compared to 2019 level despite the effects of the COVID-19 (IRENA, 2021; IRENA, 2020). The reason could be due to that the existing solar projects were subjected to tight deadlines and the developers took advantage of the solar investment tax credits that was supposed to expire in 2021, but later extended to 2023 (IRENA, 2020; Pickerel, 2020). New solar PV installations of both commercial and residential solar PV in general slowed down after the social distancing measures were put in place as well as the economic uncertainty following the peak of COVID-19 (SEIA, 2020). Large-scale solar growth is however showed an accelerating trend with increasing economic attractiveness and renewable targets across various states.

Similar situation was seen in wind deployments in 2020 where the developers started early and rushed to complete projects before the extension of production tax credits for another year despite the social distancing measures and lockdown during the COVID-19 pandemic (IRENA, 2021; BCSE, 2022). Capacity addition for onshore wind were expected to exceed 2019 levels of 9.1GW (DOE, 2021). Offshore wind had almost doubled its capacity addition in 2020 from the 2019 level which reached close to 17GW (DOE, 2021). The growth was still strong despite the risk of the delays related to the COVID-19 as there were strong market fundamentals and renewable goals from the government.

2.4.7.3 Impact of COVID-19 on jobs in renewable sector

Total renewable energy employment improved close to 11% (IRENA, 2021) from the 2019 level (IRENA, 2020) to 838,000 jobs. Jobs in the wind sector expanded 1.8% in 2020 which

aligned to the pace of new wind capacity installations. However, the operational delays (IEA, 2020; EIA, 2020) faced during the pandemic would mean lower full-time jobs for the year. Many wind projects were already close to commissioning before the social distancing and lockdown measures came in, hence did not require extensive additional labour to deal with the operations.

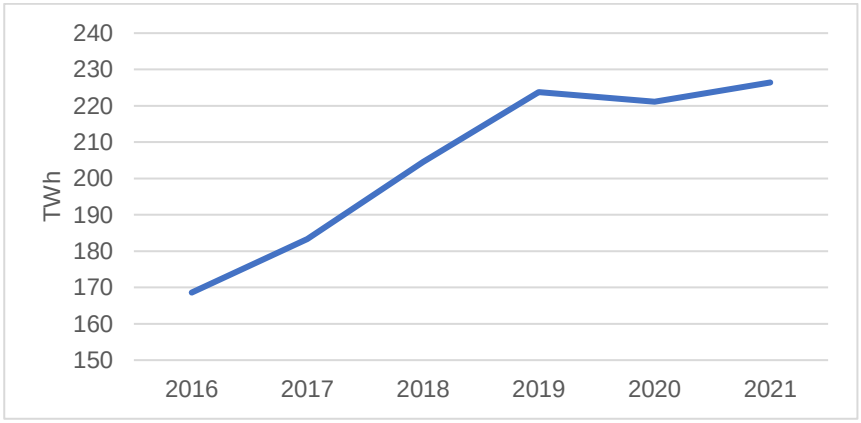
On the other hand, job for solar PV sector fell. Due to the COVID-19 pandemic, the outlook for solar PV has changed greatly with the industry employment 188,000 less workers as compared to forecasted data (SEIA, 2022). The Solar Foundation mentioned in the IRENA report (IRENA, 2020) suggested that the impact of lower solar jobs could be due to two reasons, and one of which is the shift from in-person sales to online marketing to meet with the requirements of the social distancing measures while the other was the improvement in labour productivity of the workforce in general.

Nonetheless, in 2020, large scale solar projects were classified as the essential services hence works could be continued, and these projects account for three-quarter of all new solar PV capacity additions (SEIA, 2021). In addition, most solar jobs were related to the installation and construction in solar projects and only a small fraction of solar jobs was related to local solar manufacturing. In the US, the solar projects rely on PV modules from overseas manufacturers due to its relatively small solar manufacturing capability. Despite having delays in receiving overseas produced PV modules with international cross border restrictions due to the COVID-19, it seems did not impact heavily on the operation for solar installation and construction of the projects, as the required modules were mostly received prior to the tightened travel and border controls.

2.4.8 Viet Nam

2.4.8.1 Impact on electricity demand and supply

In the earlier stages of the COVID-19 pandemic, Viet Nam placed some forms of restrictions on flights which eventually evolved to the suspension of most international routes from March 2020 when the pandemic situation overseas became uncontrollable. After which, Viet Nam implemented the strict social distancing rules and limited the gathering of large groups. By mid-April, some industries and business were allowed to operate under strict rules to contain the spread of the virus. There were no plans (CNA, 2020) for the widespread lockdown of the economy, but restrictions were still applied in areas that were marked as high-risk. As such, demand for electricity fell slightly to 221TWh in 2020 as compared to 2019, marking a 1.2% decrease, shown in figure below.

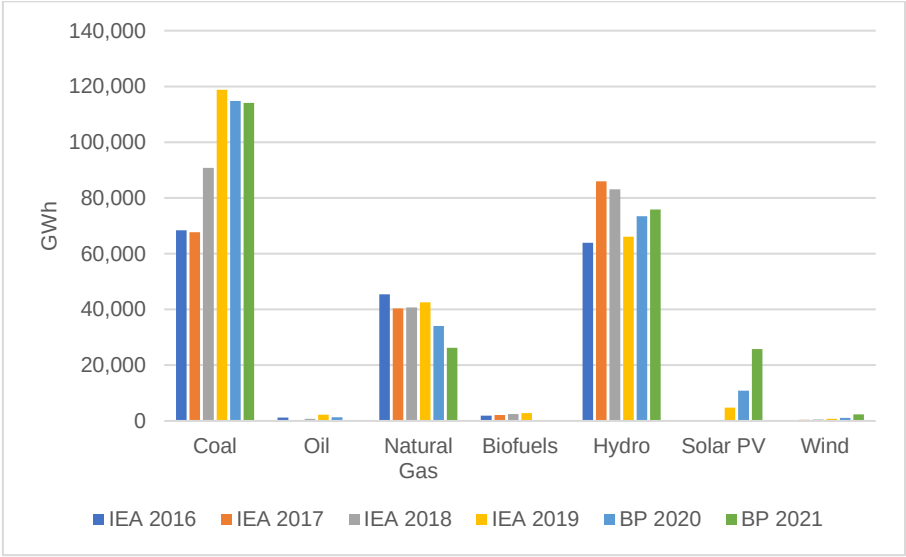


Source: IEA, n.d.

Figure 2-29: Annual electricity demand in Viet Nam

The decrease in electricity consumption was mainly contributed by the industrial and commercial sectors (IEA, n.d.) which could be resulted from delayed supplies from other economies, social distancing measures as well as overseas and domestic travel restrictions from the COVID-19. However, residential consumption increased as work shifted to a hybrid work structure, and people were generally advised to stay and work from home (VB, 2021; Vietnam News, 2021).

Though demand for electricity had a slight drop, it remained strong in 2020 and it was expected to grow in coming years. On the electricity generation side, natural gas has been on a downwards trend due to the depletion of reserves and production. Electricity from coal had a slight drop as well, due to delays on resources from the overseas suppliers as part of their restriction measures. In contrast, electricity supply from renewable resources such as wind and solar had a remarkable increase to keep up with Viet Nam's electricity demand. There was a capacity boom in solar during 2019 and 2020 which provided alternative resources of electricity supply. The generation data is presented in the figure below.



Source: IEA, n.d.; BP (2022)

Figure 2-30: Annual electricity generation from various sources

2.4.8.2 Impact on renewable energy project development and investment

Viet Nam is one of the few manufacturers and exporters of solar PV modules which explains greater ease of completing solar projects in the economy. In 2020, it added additional 11.6GW of solar capacity which included both large-scale and rooftop solar PV due to its ideal location for solar investment (IRENA, 2021). The addition was about 2.3 times more than the total installed solar PV capacity in 2019 (IRENA, 2020). Solar developers rushed to complete projects as Viet Nam planned to switch from feed-in-tariffs to an auction-based (Lexcomm, 2020) scheme.

However, large-scale installation is set to slow down due to the uncertainty in timing of the shift in tariffs scheme as well as the congestion in the power grid hence the focus of solar investment was towards more rooftop solar PV installations. Viet Nam had a good control on the COVID-19 situation, hence solar projects domestically did not face many issues as compared to other economies which had worse COVID-19 situation and relied on overseas import of solar PV modules.

Investors also saw opportunity (Mckinsey, 2021) of wind deployment in Viet Nam, after the solar boom. Based on a report from GWEC, 7GW of wind projects were approved by June 2020, and MOIT proposed to add another 6.4GW into the power development plan (GWEC, n.d.).Some of the approved projects were undergoing construction, however due to the COVID-19, the supply chain faced some difficulties and delays which affected the project construction that could cause some projects to miss the November 2021 FiT deadline. Fortunately, there was an extension (Enerdata, 2020) of the deadline to end 2023.

2.4.8.3 Impact on jobs in renewable sector

As Viet Nam holds a significant role as an exporter of solar PV modules to many economies and a major solar installer in the recent years in the region, there was high demand and supply for jobs in the renewable energy space. In 2020, the number of renewable energy jobs for solar PV, rooftop solar PV was 126,300 and 99,700 respectively according to an IRENA report (IRENA, 2021). The number of jobs for solar PV was close to twice the amount recorded in 2019 (IRENA, 2020). This was made possible with the huge solar PV capacity addition in 2020 and the government's careful plans and implementations on containing the COVID-19 virus.

The manufacturing sector was allowed to continue to operation in 2020, with some form of restrictions but it did not affect most operations for manufacturing activities, and workers were needed to keep up with the growing demand for solar PV modules from other economies. Another reason for the increase could be, as mentioned, due to developers rushing to complete the solar projects before the switching of feed in tariffs scheme to auction-based hence workers were needed to complete the projects. Likewise, for the wind sector, it was poised for further growth which creates the need for more people and jobs for approved projects in 2020 and future projects for the years ahead. The pandemic, however, did create some delays in the supply chain, and inconvenience in people's movement for wind projects, and these caused construction delays (IRENA, 2021; IRENA, 2020).

Nonetheless, as wind investment gains attraction in Viet Nam, the demand for wind jobs would continue to grow. Based on the IRENA estimates, there was 43,000 jobs for wind jobs in 2021, much higher than 3,500 jobs in 2020 (IRENA, 2021). In general, despite the challenges of the

COVID-19, Viet Nam handled the situation well and created job opportunities in the renewable energy sector.

2.4.9 Summary

Eight APEC economies are analysed in this section, where every economy experienced different impacts from the COVID-19 due to different situations and contexts. The context of each economy differs due to varying energy market structures, industry capability, resources availability, the COVID-19 control measures applied, as well as the governmental organisations and agencies involved.

There are several general trends observed when looking at the impacts of the COVID-19 towards the energy sector in the following categories:

- Electricity demand and supply;
- Renewable energy project development and investments in renewables;
- Jobs in the renewable energy sector.

With the COVID-19 restrictions in place, there were limiting movements and mobility which inevitably affected all the aspects of living, working, economic activities, as well as the electricity consumption. Overall, all economies experienced a decline in the electricity demand. Where it is observed that the energy demand was shifted from the industrial and commercial sectors to the residential and/or household sector(s). For economies with open electricity market, this resulted in lower electricity prices such as the cases in the economies like Australia and the Philippines. Furthermore, several economies had increased renewable energy curtailments due to the fall in electricity consumption, which were evident in the economies such as Japan and Chile.

Furthermore, quite some renewable energy projects experienced supply chain disruptions caused by the COVID-19 restrictions and border control imposed. This resulted in delayed projects progress and completion (such as the solar PV installations in Japan), and increasing CAPEX prices (e.g. the wind blade turbines which were originated from China). However, it is observed that the prices have started to gradually recover since early 2022.

Investments in the renewable energy sector also experienced delays in some economies due to postponed tenders. However, in Australia, despite uncertainties and delays, investments still increased (15% more auctions in 2020), mostly from the private investors. This was not the case for most other economies, as the investment level rose but the amount was still below the targets and the planned timelines.

Employment in the renewable energy sector experienced a drop in the first half 2020 due to the restricted movement. However, in most economies it either increased or stabilized when the industries adapted to the new ways of working during the COVID-19 pandemic such as special permits for workers on site and working from home. Overall, jobs in the renewable energy sector increased since most economies announced their decarbonization targets, more renewable energy projects and increasing renewable generation capacity. There are only few sectors and economies where the employment in renewable energy sector fell after the peak of the COVID-19 pandemic since the number of jobs were already high prior to the pandemic, such as in various sectors in Japan and the geothermal sector in the Philippines. In addition, an

observation on the overall situation in the energy sector indicates that a decline in the number of jobs were mostly related to coal, oil and gas industries.

Table 2-2 summarises the impacts of the pandemic on electricity demand and supply, renewable energy project development and investment, and employment situations in the economies included in the present study.

Table 2-2: Summary of the impacts from the COVID-19 pandemic

Economy	Impact on electricity demand and supply	Impact on renewable energy project development and renewable investment	Impact on jobs in the renewable sector
Australia	• A shift in the distribution of electrical demand away from commercial metropolitan centres to residential regions. • Due to increasing cooking and digital device usages, there has been a considerable rise in COVID-19 related energy use compared to the pre-pandemic state.	• During the COVID-19 pandemic, despite the booming economic uncertainties, investor appetite for renewables remained strong. • From January to October 2020, auctioned renewable capacity was 15% higher than for the same period last year.	• At the end of 2020, 76 large-scale wind and solar projects representing 8GW capacity were under construction and supplying more than 9,000 jobs.
Chile	• During the second half of 2020 monthly curtailment rates increased again to around 3 to 5% for solar and 1 to 5% for wind (at economy level) as a combination of increasing renewable capacity, presence of inflexible gas, and demand lower than expected due to the COVID-19 pandemic. Then in September 2021, curtailment started increasing again.	• Tenders of renewables and energy storage projects was supposed to take place in 2020, however, due to the COVID-19, it was first postponed to May 2021 then again to Jun 2021.	• Despite postponed investments, jobs in the renewable sector in Chile increased between 2019 to 2021.
China	• Affected by the lockdown, electricity demand dropped sharply by almost 10% in Q1 2020 year-on-year, where the industry sector was the most hit.	• Although the supply chain had experienced temporary delivery difficulties in 2020 due to the impact of the pandemic, the low price of wind turbines in China started to rebound in early 2022.	• Despite the effect of COVID-19 China still further extended its global lead and shared 39% in renewable energy employment worldwide in 2020. • China's positions in the energy field increased from 4.4 million jobs in 2019 to 4.7 million jobs in 2020.
Indonesia	• Energy use in residential sector was rising, while on the other hand, energy use in the transport sector and electricity usage at industrial and commercial industry was significantly lower in 2020 due to the COVID-19 outbreak in early March that year.	• Renewable energy projects were delayed in 2020 due limited mobility of people and materials from the pandemic measures. • Although below target, there was an increment in installed capacity for renewable energy, with solar and mini hydro growing by 17.9% and 20.7% respectively.	• The employment in biodiesel in Indonesia was at 494,400 workers in 2019. The employment in biodiesel stayed similar after the COVID-19, about 475,000.

Japan	• Overall, the energy demand in Japan in 2020 decreased mainly due to the COVID-19 restrictions.	• Many solar projects faced delays due to China being part of the supply chain in shipment of solar PV modules when several provinces within China entered a lockdown phase. • In 2020 and 2021, Japan was ranked third worldwide in its cumulative solar installed capacity.	• There was a decreasing trend for jobs related to solar PV from 302,000 jobs in 2016 to 220,000 jobs in 2020.
The Philippines	• In March 2020, various levels of community quarantines halted major economic activities, including public and private transportation, which reduced energy consumption of end-use economic sectors, except for households in the Philippines. • In 2020, total final energy consumption was down 10.7% from the level of the previous year and the average electricity price decreased by 54.83% to PHP2,450.24/MWh (app. USD44/MWh) in 2020.	• The impact on renewable project development and investment are less felt compared with other economies.	• In 2020, even with the impact of the COVID-19, the number of solar PV, solid biomass and wind power jobs continued to increase, but the number of jobs in geothermal slightly declined.
United States	• Commercial activity took a larger hit in the first half of 2020, at about 11% drop during the lockdown period, but subsequently picked up when restrictions are more relaxed in the second half of the year. • Industrial sector had a 4.3% fall in electricity consumption in 2020 as compared to the 2019 numbers.	• Solar PV capacity additions improved 30% to reach 19GW in 2020, as compared to the 2019 level despite the effects of the COVID-19. • Similar situation was seen in wind deployments in 2020 where developers started early and rushed to complete projects before the extension of production tax credits for another year despite the social distancing measures and lockdown during the COVID-19 pandemic.	• Jobs in the wind sector expanded in 2020 which aligned to the pace of new wind installations. • The operational delays faced during the pandemic might mean lower full-time jobs for the year. Job for solar PV fell due to the pandemic, the outlook for solar has changed greatly with the industry employment 188,000 less workers as compared to forecasted figures.
Viet Nam	• The decrease in electricity consumption was mainly contributed by the industrial and commercial sectors and could be resulted from the social restriction measures. • Residential consumption increased as work shifted to a hybrid work structure, and people were generally advised to stay home.	• In 2020, additional 11.6GW of solar PV capacity was added which included both large-scale and rooftop solar due to its ideal location for solar investments.	• In 2020, the number of renewable jobs for solar PV, rooftop solar was 126,300 and 99,700 respectively. • The number of jobs for solar PV was close to twice the amount recorded in 2019.

Having an overview on the impact of the COVID-19 pandemic towards the selected APEC economies, the next section discusses further on the recovery strategies employed by these economies. Many economies saw renewable energy as an opportunity helping boost the recovery of their economy from the pandemic, while at the same time contributing the

economy to achieve the energy transition and decarbonization targets. How renewable energy plays an important role in supporting those strategies are discussed.

3 ECONOMY RECOVERY STRATEGIES AND THE ROLE OF RENEWABLE ENERGY

3.1 Introduction

Policies play a key role to promote renewable energy over the past decade and will continue to be critical for achieving cost reductions and cultivating innovation. Renewables and other clean energy technologies are a policy driven market therefore new investments or installations are driven by the relevant policy support schemes. Policy support for renewable energy development remained strong despite the COVID-19 pandemic. The impact of the economy and the energy sector due to the COVID-19 pandemic and the recent energy crisis have led many economies to develop measures including recovery plans and policies to support the economy, citizens as well as the growth of renewable energy sector, and to support sustainable development. Investment and technology innovation in renewables are also among the key components in recovery plans and to the commitment to achieve carbon neutrality goal at the COP26 in November 2021.

Many governments, including APEC economies, have been responding to the COVID-19 pandemic and the recent energy crisis by implementing measures and recovery plans with the aim to boost the economies, which include several stimulus packages and other policies. The recovery plan also presents an opportunity to support the growth of renewable energy and clean technology innovation in the long term. Therefore, energy and climate change policies and a strong commitment will play a key role to support the development of renewable energy as part of the clean energy transitions and decarbonisation processes. Climate change policies can directly or indirectly stimulate renewable energy deployment and the development and deployment related clean technologies.

Economies with renewable policies and carbon neutrality targets have increased significantly since the COVID-19. At present, there are more than 130 economies, including most APEC economies, which have some forms of carbon neutrality or NZE targets, which include all levels of implementations, ranging from regulations, legislation, declaration and pledges (REN21, 2021). The level of implementation varies across the economies as the targets are not always backed by the legislations and/or mandates.

This section provides an overview of economy recovery strategies including police measures and recovery packages as well as the role of renewable energy in the energy transition in the post COVID-19 era. There are case studies from eight APEC economies including Australia; Chile; China; Indonesia; Japan; the Philippines; the US and Viet Nam.

3.2 Recovery policies and strategies

There are five main categories of polices which play a key role in addressing the energy crisis and shape energy transitions as shown in Figure 3-1.

- Strategies of the members' governments are the foundation for fostering energy-system transformation. They provide a long-term policy signal by setting roadmaps with the targets, technology priorities, and timelines, which is the first step towards creating a

stable planning horizon to provide directions and some certainty for the stakeholders, particularly investors. This includes, for example, GHG emission reduction targets, renewable energy targets, fossil-fuel phase out plans and others.

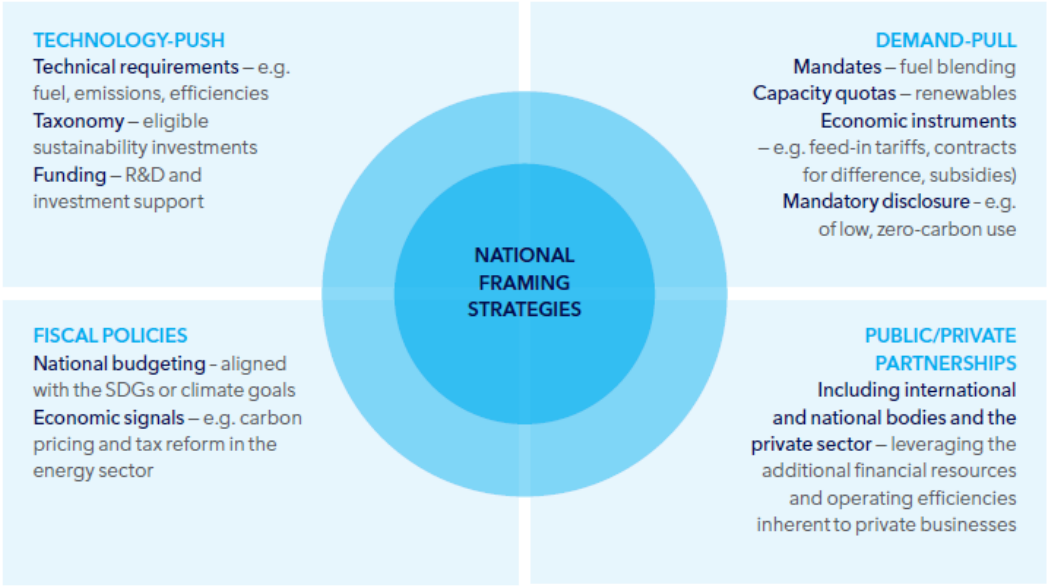
- Technology push policies take the form of public financing which include the grants or loans from government to support innovation of new technologies, which are the dominant early-stage form to support the efforts such as R&D and demonstration projects in order to scale up the applications.

- Demand-pull policies play a key role in creating demand for renewable energy and low-carbon technologies and switching from unabated fossil-fuel technologies. Examples include binding targets and obligations on certain sectors such as biofuel blending mandates, renewable capacity quota. This type of policies also involves pricing instruments such as FiT, tax incentives. FiTs has been the most widely used financial mechanism for driving the deployment of renewables.

- Fiscal policies can increase the competitiveness of low-emission alternatives against conventional fossil-fuel based options. Review and reform of the tax systems and budgetary expenditures also form part of a holistic policy package to transform energy systems. Examples include fossil-fuel phase out subsidy and carbon pricing.

- Public and private partnership provides a platform for the policymakers and commercial stakeholders to cooperate and coordinate the efforts to achieve carbon neutrality targets.

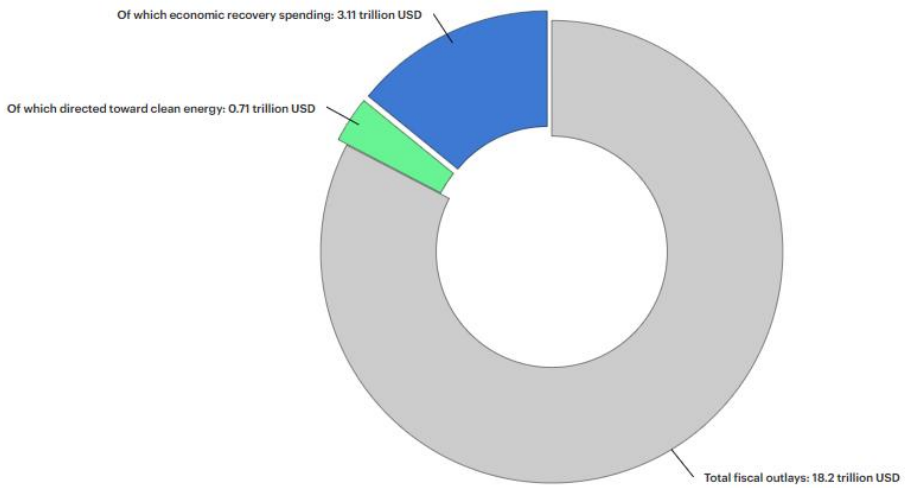
Given the urgency of energy transition, a mix of the policy categories have been deployed by many economies at different stages of development to achieve the transition from fossil fuel resources towards clean energy.



Source: DNV (2022)

Figure 3-1: Policy categories for supporting renewables and shaping clean energy transition

Many governments have been introducing measures to increase the share of renewable in their energy mixes. These came in the form of regulations and policies towards power generation plants, infrastructure and some of these supports are in the forms of fiscal funding or rebates. In addition, many economies had to make sure their current power grid systems and technology advancements were capable to match the increase in renewable generation capacity. This can be seen from energy policies including new building standards such as the case of California (CEC, 2021) and the grid enhancement plans such as in China, Viet Nam, and the Philippines. Many APEC member economies also introduced the COVID-19 packages with substantial amount funds towards innovation, research and development. For example, China's 14th Five-Year-Plan released in March 2021 has a focus on expanding the power infrastructure development and energy storage (CSET, 2021). The United States announced USD100 million funding for clean energy technology research and development, while the Green Innovation Fund in Japan allocates USD19 billion to low carbon technology demonstration until 2023 (in addition of USD15 billion in tax credits for the private involvement in these projects). The following figure shows the structure of long-term economic and sustainable recovery spending as for March 2022.



Source: IEA's Sustainable Recovery Tracker

Figure 3-2: Long-term economic and sustainable recovery spending as of March 2022

With the experiences from the COVID-19 pandemic and the current energy crisis, the common themes from most economies are to increase energy security, reduce costs and enhance environmental sustainability. Since the beginning of the COVID-19, global economy has spent trillion of dollars on recovery measures including wage supplements and recovery of economic and industrial activities. Several economies have also used this unique opportunity to accelerate the transition of energy systems towards clean energy with relevant policies to support the investment in renewable energy including R&D, demonstration projects and strategies to foster job creation and re-skill existing workforce for the renewable industry.

However, recovery from the COVID-19 pandemic and the development in post-COVID era have been uneven across the region. There is a large gap between industrialised and emerging economies on the government spending on sustainable recovery and development measures as a result of the variance in the focus of the policy supports and the recovery packages. Although

the COVID-19 pandemic has provided a unique opportunity for a green recovery where stimulus packages held the potential to accelerate the energy transition, many economies have not directed the recovery spending towards renewable energy projects and decarbonization efforts. Some of the COVID-19 recovery packages only focused on the short-term measures rather than decarbonisation despite the commitments to carbon neutrality and net zero by many economies. In addition, the fossil-fuel industry has benefited from the stimulus packages and policy measures such as fossil-fuel finance including tax relief injection into the vulnerable oil and gas industries, which has led to higher oil and gas production.

3.3 Case study on recovery policies

The case studies of the eight selected APEC economies in this section outline the recovery measures, policy measures and initiatives that the economies have been implemented to support the development of renewable energy. Since, mostly, the recovery measures related to the COVID-19 do not primarily focus on the renewable energy sector, the section outlines the measures of each economy in general and then discusses the implications on the energy sector where they are relevant and applicable. This section also looks into the government strategies and relevant policy measures that aim at supporting the growth of renewable energy such as roadmap, emissions reduction and renewable targets, technology push, demand pull and fiscal policies and others. Although some of these measures may not be directly to the COVID-19, they may take into consideration of the relevant experiences during post-COVID and the recent energy crisis.

3.3.1 Australia

According to Global Recovery Observatory, Australia has spent USD281.34 billion on their recovery spending, and among those 11.9% spent on green recovery. In Australia, the Federal government included USD47.2 million in environmental measures in its COVID-19 Relief and Recovery Fund (Australian Government, 2020). This spending included measures to rebuild shellfish reefs subject to overfishing and measures for the conservation of the Great Barrier Reef. The programs aim to accelerate projects already in advanced stages of planning, reducing administrative barriers for quick implementation and a swift boost for local jobs.

The Australian government announced the long-term emission reduction plan with a strategy to deliver net zero emissions by 2050, and said that the economy has been on the course to surpass its 2030 objective. The plan is technology-driven with five main principles: technology not taxes; expand choices not mandated; drive down the costs of a range of new technologies; keep energy prices down with affordable and reliable electricity; and be accountable for the progress. As part of its efforts, the government planned to spend AUD20 billion in low emissions technology by unlocking AUD80 billion investment on both private and public investment in green technologies, which include clean hydrogen, carbon capture and energy storage.

The Australian Government, both Federal and State, issued some measures to stimulate the economy in responding to the COVID-19. One example was the launch of the Modern Manufacturing Strategy (MMS) in Q4 2020 by the Federal Government that aimed to help manufacturers in scaling-up their outputs to become more competitive in the market, not only during the COVID-19 pandemic, but also beyond. To address the challenges in the short-term during the pandemic, the energy market bodies which include the Australian Energy Regulator

(AER), the Australian Energy Market Commission (AEMC) and the Australian Energy Market Operator (AEMO) launched a COVID-19 power plan for energy market adjustment during the pandemic. The plan was aimed to ease the regulatory pressure on the industry and to ensure the security of the power system while continue to deliver cheaper and lower emission energy to the consumers.

The Long-Term Emissions Reduction Plan also seeks to achieve a net zero economy through a technology-based strategy while safeguarding the pertinent sectors, geographic areas, and employment opportunities. It is a component of a comprehensive plan for reducing carbon emissions that is based on a technology-led strategy and the Low Emissions Technology Statements and a Technology Investment Roadmap. Under the Technology Investment Roadmap, the Australian government will invest AUD20 billion in low-emission technologies over the next 10 years as the efforts to spur AUD80 billion in further corporate and public spending on green technologies. A five-year reviews processes have been outlined to evaluate the Plan's implementation and progress of the technological innovation necessary to meet the goals. The following table lists selected policies and measures in Australia supporting green energy development.

Table 3-1: Australia policies and measures to support clean energy

Name of the policy and scheme	Stage	Date of entry into force / announcement	Mian policy background
Far North Queensland Daintree renewable energy microgrid	Electricity storage or transmission or distribution	11/05/2021	• Federal Budget allocated AUD19.3 million over three years to develop a renewable energy microgrid including hydrogen in the Daintree in Far North Queensland.
Large-scale Pilbara renewable energy project granted ‘major project status’ from the Federal government	Electricity generation		• Large-scale Pilbara renewable energy project granted the 'major project status' from the Federal Government, which allows fast-track approval processes and increase the possibility of additional government funding. • project will be financed with AUD50 billion from the Asian Renewable Energy Hub.
Advancing Hydrogen Fund	Several energy stages	04/05/2020	• This fund provides the finance to projects looking to grow Australia’s renewable hydrogen sector, including developing new domestic supply chains, exporting infrastructure, and helping grow domestic demand for hydrogen energy.
Regional Hydrogen Hubs	Exploration or production or processing or storage or transportation	25/10/2022	• Planned investments of up to AUD526 million to support the rollout and development of regional hydrogen hubs across Australia.

3.3.2 Chile

Chile has defined a Non-Conventional Renewables Energies (NCRE) as part of its energy regulation which includes small hydro power (<20MW), solar, wind, geothermal and biomass energy. Policy that was approved in 2008 requires the utility companies to produce 5% of their electricity from NCRE resources by 2014 with yearly incremental targets to reach 10% by 2024. Another policy that was approved in 2013 sought to increase annual NCRE targets to 12% by 2020 and 20% by 2025. In 2020, annual generation from NCRE participation reached 22.1%

which is exceeded the initial target, followed by 26.63% in 2021. The government, the Ministry of Energy, thereby set a new unofficial target of 40% by 2030.

In the draft National Energy Policy (2021), the top initiative is to achieve the carbon neutrality goal by 2050, phasing out the coal-fired power plants by 2040, and targeting 80% of renewable energy electricity in the generation mix by 2030. In 2050, 100% of the electricity produced by the economy should come from renewable resources or zero emission energies. Further, in December 2020, the Ministry of Energy released the National Green Strategy with the aim of, globally, making Chile among the top exporters of hydrogen by 2050.

The Chile government launched a Flexible Strategy in September 2020 which aims to provide better incentives to provide the relevant services and favour energy storage installations. The strategy includes changes in the capacity recognition methodology for the service. The National Commission of Energy published a draft regulation in September 2021 for a new capacity payment methodology subjected to the public consultation. In the regulation, sufficiency targets will be defined, and probabilistic computation method will be used for the capacity recognition for all relevant technologies.

3.3.3 China

The leadership in China has imposed different citywide lockdowns and multiple control measures since 23 January 2020, when the COVID-19 first broke out. Within the 12weeks following the outbreak of the COVID-19, there was a 32% decline, or CNY329.84 billion decrease, in offline consumption in 214 cities in China. China is the first economy affected by the outbreak of the COVID-19 virus but due of the strict enforcement of the "dynamic zero-case" policy that was established after the rapid spread of the virus, the economy effectively contained the spread of the virus.

In terms of environment sustainability, the long-term goal is that, by 2060, China will have fully established a green, low-carbon and circular economy and a clean, low-carbon, safe and efficient energy system. It has been planned that China will reach the peak of carbon emissions by 2030, and achieve carbon neutrality before 2060. The roadmap for China's low carbon neutrality goal is illustrated in Figure 3-3. As an example, in 2021 China withstood the economic pressure and launched a complete official guidance towards the CCUS roadmap. Following which, the priority of the CCUS was further elevated during the 20th National Congress of the Communist Party of China in October 2022.

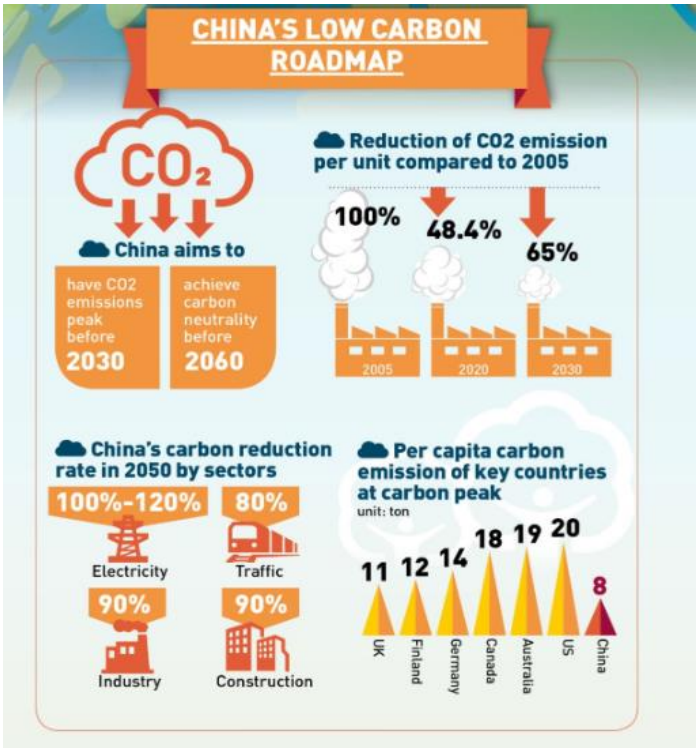


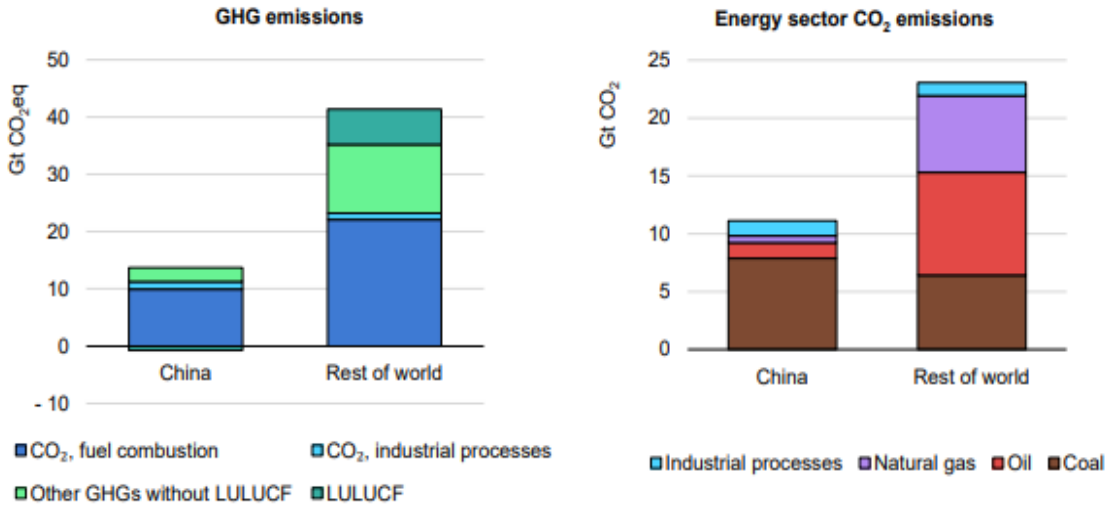
Figure 3-3 China's low carbon roadmap

The policy in the near term focuses on 2025 targets as China would have created an initial framework for the green, low-carbon and circular economy and expected to have a substantial improvement on energy efficiency of key industries as highlighted in the 14th Five-Year Plan 2021-2026. The energy consumption per unit of GDP is targeted to decline 13.5% from the 2020 level while carbon emissions per unit of GDP is expected to decrease 18% from the 2020 level. The share of non-fossil energy consumption will reach around 20%. Based on the targets, the share of non-fossil energy power generation should be lowered to 39% by 2025. Towards the mid-term, China will see significant accomplishments from the comprehensive green transformation in economic and social development, with energy efficiency in key energy-consuming industries reaching the advanced international levels by 2030.

In response to the impact of the COVID-19 pandemic, the Chinese government has invested huge sums of money to stimulate economic recovery over the period of 2020-2022. Investments for social recovery over the pandemic include vaccines, subsidies for resumption of work, subsidies for enterprises operation, and social security. In 2020, China introduced and implemented a large-scale COVID-19 rescue policy to hedge the impact of the pandemic with greater policy strength and ensure proper development in clean energy sector. The Chinese government had issued an additional USD137.5 billion in special anti-pandemic treasury bonds, which are mainly used to safeguard employment, people basic livelihood, and various markets. The government assistance covers tax supports, fee reductions, rent and interest reductions, and consumption expansion. On top of which, China has implemented large-scale tax and fee reductions in stages, and along with institutional arrangements, there was a reduction of the financial burden on market players by more than USD357.5 billion during the year.

The 14th Five-Year Plan (FYP) that focuses on the overall energy sector covering the period 2021-2025 was officially endorsed in March 2021 and has addressed issues on the impact of

the COVID-19 pandemic. This FYP clarifies China's energy development policy, set the main goals and tasks as well as measures to promote green development and renewable energy. The document possesses the overall blueprint and the action plan for China's energy development. In June 2022, the 14th FYP of Renewable Energy was announced by the National Development Reform Committee (NDRC) to support the growth of renewables.



Source: IEA (2021)

Figure 3-4 Carbon dioxide emissions in China

Globally, China is the largest economy that emits greenhouse gases (GHGs), accounting for around 25% of world's total emissions. To deal with the emissions, China has implemented a series of investment policies towards carbon neutrality and further development of clean energy. The central government continued to allocate funds for the prevention and control of air, water, and soil pollutions.

There was an allocation of USD3.781 billion on air pollution prevention and control funds, an increase of 10% from previous spending, with focus on supporting clean heating in northern China in winter season, and to "winning the battle to defend the blue sky". Furthermore, there was an allocation of USD2.984 billion on water pollution prevention and control, with an increase of 10.2% from the prior spending, which was mainly aimed at the prevention and control of water pollution in key river basins such as the Yangtze River. Special funds for soil pollution prevention and control were allocated amounting to USD600 million, an increase of 10%, to support the control on soil pollution and restoration purposes. In addition, in September 2022, the Chinese government issued the third batch of central infrastructure investment budgets for pollution control and energy conservation and carbon reduction (with in the category of energy conservation and carbon reduction), with a total value of USD33 million.

3.3.4 Indonesia

Indonesia has set its target of having a 23% renewable energy in their energy mix by 2025, announced in their latest RUPTL (long term electricity supply plan). By 2021, the renewable energy mix in Indonesia was at 12%. Indonesia has a big potential on renewable energy which has not yet been fully utilised, due to lack of related infrastructure and insufficient enforced regulations, which caused that many renewable energy projects do not show profitability. Most renewable energy projects in Indonesia are in hydropower, geothermal energy and biomass

sectors. Wind and solar are about 1.5% of the renewable energy each, which means that they are not as significant as the others (as of April 2021). The economy is also aiming to achieve net-zero emissions and fully-decarbonized power sector by 2060 with the expected international supports.

The goal towards a fully decarbonized power sector, with a total installed generation capacity of 587GW by 2060, is set with the following measures: 361GW in solar facilities, 83GW in hydro power, 39GW in wind farms, 37GW in bioenergy plants, 35GW in nuclear power capacity, 18GW in geothermal power capacity and 13.4GW in ocean current electricity generation capacity.

The pathways are in line with 2050 net-zero emissions and global 1.5°C goal where Indonesia's coal power generation should reduce by 11% in 2030, by over 90% in 2040, and coal-fired capacity is planned to be completely phased out by 2045. The Southeast Asian archipelago is the world's fourth-most populous economy and the eighth biggest emitter of greenhouse gas. Coal making up about 65% of its energy mix, and Indonesia is also the world's biggest coal exporter. In the region, Indonesia is the largest economy and emitter among the ASEAN member economies.

Agreements are required between the government (PLN, which produces 60% of all electricity of the economy) and the private energy corporations (IPPs, which produces 30% of all electricity). In November 2022, Indonesia signed the New and Renewable Energy Bill agreement at G20 summit, that will bring USD20 billion in funding to help the economy increase its use of renewable energy and reduce its reliance on coal. With this new agreement in effect, several coal power plants are proposed to be phased out/retired by 2030 (IEEFA, 2022). Furthermore, based on the ministry's blueprint, all power plants built in Indonesia after 2030 will be renewables-based. The latest policy framework in Indonesia to support the growth of clean energy is the Presidential Regulation 112/2022 on Acceleration of Renewable Energy Development for Electricity Supply, declaring that it will be Indonesia’s target to; i) increase investment in the renewable energy sector; ii) accelerate the achievement of renewable energy mix targets; and iii) reduce greenhouse gas emissions.

Outside of the renewable energy targets and commitments in place, the government of Indonesia spent USD40.6 billion in 2020, USD48.6 billion in 2021 for the recovery from the COVID-19 pandemic. The scheme has five pillars of spending, which include health, social protection, priority program, SME finance, and business incentives. In 2020, the social protection which includes the electricity subsidy got the highest financial support. In 2020, USD912 million was used for energy subsidies to support poor households, mostly in the form of free and discounted electricity tariffs for consumer classes defined as 450VA and 900VA and the subscription electricity tariffs. In addition, PLN attracted USD3.2 billion to support their business amid the COVID-19 pandemic.

The spike in energy prices led to an increase in the number of subsidies and compensations allocated by the Indonesian government and was deemed to threaten the energy security of Indonesia. Indonesia applies the price subsidies to energy commodities, such as fuel, LPG, and electricity, in a bid to maintain a low-cost supply of energy to the public. It is estimated that every increase in Indonesian Crude Price of USD1 per barrel has an impact on additional subsidies and electricity compensation of IDR295 billion (USD19 million).

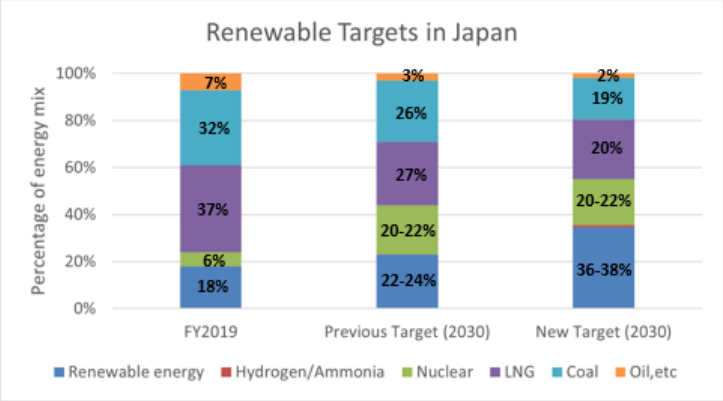
2020 Energy Subsidies	Trillion IDR	Billion USD Eq.
Yearly subsidy	**97.4**	**6.8**
Electricity subsidy	49.7	3.4
LPG subsidy	32.8	2.3
Fuel subsidy (BBM)	14.9	1.0
COVID recovery packages	**108.5**	**7.5**
Fossil fuel SOEs	**95.3**	**6.6**
PT PLN	45.5	3.2
PT Pertamina	37.8	2.6
PT Garuda Indonesia	8.5	0.6
PT Kereta Api Indonesia	3.5	0.2
Poor households	**13.1**	**0.9**
Electricity discount	11.5	0.8
Electricity subscription tariff	1.7	0.1
Total	**205.8**	**14.3**

Source: Ministry of Finance (2021a)

Figure 3-5: Summary of 2020 quantifies subsidy & COVID-19 recovery for Indonesia`s energy sector

3.3.5 Japan

Japan relies heavily on energy imports to sustain the economy's electricity demand as it lacks natural resources. This came after the nuclear disaster back in 2011, which was one of the main sources of energy then. In order to be more energy sustainable (METI, 2019), Japan has enacted numerous targets in its energy mix, in which the government plans to integrate more renewable energy and bring back nuclear capacity. In the latest energy strategic plan approved in October 2021, the new targets of renewable energy were expanded to 36-38%, up from 22-24% from its previous 2030 target, while reducing the proportion of LNG and coal sources in the energy mix as seen in the figure below. This is in line with international goal on moving towards a cleaner environment.



Source: METI (2021)

Figure 3-6: Target changes in energy mix in Japan

Japan had also made commitments along with other economies to be carbon neutral by 2050 which is one possible reason why targets for renewables were increased. Prior to the 26th United

Nations Climate Change Summit held in Glasgow, Japan had made commitments to reduce greenhouse gas emission by 46% in 2030 from the 2013 levels back in October 2020. However, in April 2021, the government made an announcement to take up to challenge to reduce greenhouse gas emissions by 50% instead closer to the meeting date October 2021 (METI, 2021). As part of support efforts to reach these targets, the Prime Minister of Japan announced an economic stimulus package in December 2020, and more than half of the budget were aimed towards direct fiscal spending and initiatives to reduce carbon emissions and also promote digital innovation.

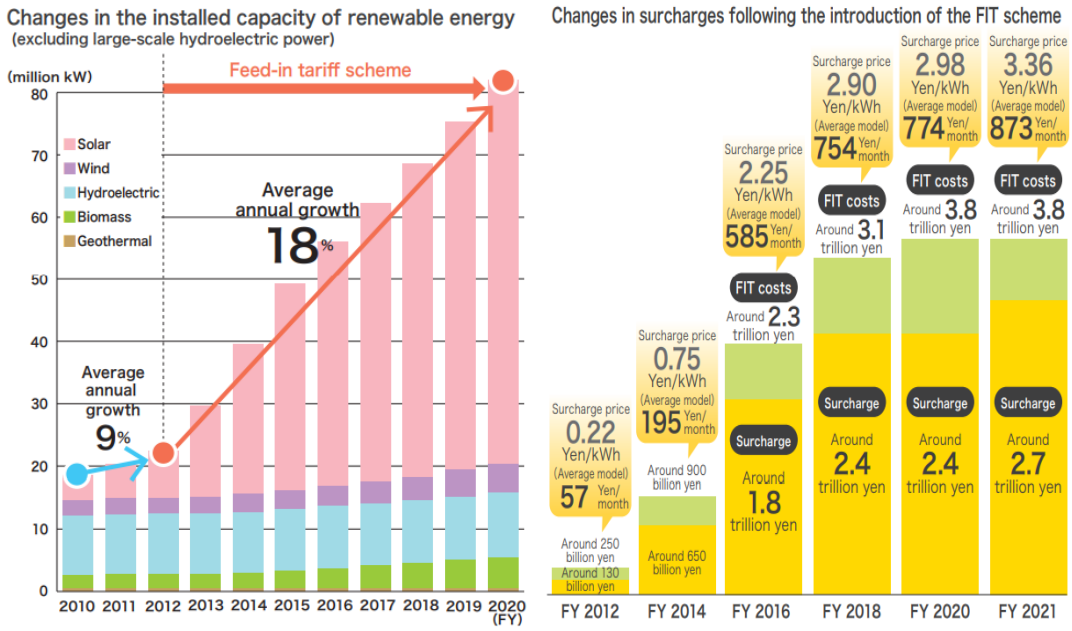
As per the Renewable Energy Act, solar projects faced strict deadlines of completion (JD, 2017), and the COVID-19 pandemic caused some effect on the progress of these projects. Hence, to help the development of onsite renewable projects which are expected to support the corporate PPA under the commitment towards the RE100 initiative, the government released an aid of JPY1 billion to help projects bounded by the PPAs (TYN, 2020).

Extensive efforts have been made by the government to push renewable energy development and ensure energy sustainability through cleaner methods. In the latest strategy energy plan approved in October 2021, there was a clear path towards realizing carbon neutrality goal by 2050. The policy focused on the reconstruction of Fukushima nuclear plant and integration of "S+3E" concept that includes energy security, economic efficiency and environmental protection without compromising on safety. Through this concept, main efforts will be aimed towards growing renewables in order to attain a greater share of renewable energy resources in the power generation mix while suppressing the burden on the people and promoting acceptance by the local communities. Though the costs of renewable energy are decreasing over the years, it remains relatively high. Hence, tenders for renewable projects will still be utilised under the FiT system. There will be more coexistence with the local communities by promoting local stakeholders' understanding, ensuring business operations to relevant follow protocols, and strengthening the safety measures. The purpose of the concept is to target climate change and promote harmony with natural surroundings, as well as ensuring economic efficiency of energy use (METI, 2021).

Renewable resources will be promoted under the Act on Promotion of Global Warming Countermeasures by setting up renewable energy promotion zones (The Government of Japan, 2021). Offshore wind projects will be accelerated through Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities. As of April 2019, the first round of auctions of offshore wind was completed, and Mitsubishi won 1.7GW of the wind projects. There are 7 promising zones and 10 preparation zones. The Japan government also created the Green Innovation Fund, worth JPY2 trillion to support the industries on decarbonization processes and innovations to enhance their competitiveness (METI, 2021; METI, n.d.).

Japan adopted the feed-in-tariff (FiT) system back in 2012 to encourage renewable energy deployment, and developers saw the opportunities to enter the market as the rates were lucrative. Since then, METI has made multiple revisions on the rates on an annual basis for each renewable energy technology (AMP, 2022). Based on the IEA forecast, capacity growth for solar in Japan is expected to slow down due to the lower FiT pipeline for the utility-scale and distributed solar PV projects commissioning over the period from 2024 to 2026. The solar PV expansion will be led by the commission of previous projects based on previous FiT with total capacity of 18.5GW in June 2021 in addition to the auction projects.

The FiT rates for solar projects are decreasing every year as competition for available solar capacity increase and the consumers suffered from increase taxes (IEA, 2021). FiT has been proven effective from the figure below, but the increased costs are eventually passed down to the consumers and it will be detrimental to their electricity bills if it grows indefinitely and might impact the government plans to expand renewable growth to reach carbon neutrality in 2050.



Source: METI (2021)

Figure 3-7: Left: Changes in renewable energy installed capacity. Right: Changes in surcharge after introduction of FiT.

Therefore, in addition to FiT, Japan introduced (Dla Piper, 2020) a feed-in-premium (FiP) system from April 2022 to promote independence of renewable energy and make it fully competitive with other power generation sources and projects. Companies will be forced to innovate to create a sustainable renewable energy industry. As compared to the FiT system which prices are fixed by the agreed PPA, the FiP system will be subjected to the electricity market price in JEPX in addition to a fixed premium rate hence revenue will be subjected to the spot market electricity prices.

3.3.6 The Philippines

As of December 2021, the Philippines has 959 ongoing renewable power projects, including both commercial and individual uses. The installed capacity of current renewable energy projects is 5,585MW and it has potential to grow to 48,069MW with the ongoing projects. The government set its sustainable agenda called The National Renewable Energy Program (NREP) to achieve its interim targets to deliver renewable energy within the timeframe of 2020 to 2040. The program shows its RPS goal of at least 35% renewable energy share in the total generation mix by 2030, and furthermore achieving greater than 50% by 2040. NREP emphasizes to increase the mandated one percent RPS starting 2023 to allow the entry of the new renewable capacities in the system and to meet the aspirational 35 and 50% renewable energy share in the total generation mix.

The program lists four pillars for its roadmap and targets by 2040, which include: i) accelerating renewable energy positioning; ii) building a conducive business environment; iii) establish a reliable and efficient infrastructure; and iv) promoting and enhancing research, design and development agenda.

The details of the plan entail the renewable energy policies and mechanisms that can be used by the government to support renewable deployment, including renewable energy market (REM) rules, which establishes the market for renewable energy certificates trading, renewable portfolio standard (RPS) rules, feed-in-tariff system (FiT), net-metering. The Philippines Renewable Energy Market System (PREMS) was also launched to operate. Also, it includes general incentives for renewable energy development, such as tax holiday for registered developers and projects, tax exemptions for hybrid and co-generation systems, and exemptions from duties on the related equipment and materials.

Under the Philippines' plan, there are two scenarios, namely the Reference Scenario (REF) and the Clean Energy Scenario (CES). Both scenarios maintain conservative incremental capacity goals for most of the renewable technologies in relation to available technical resources and investor interest. Compared to 2020, the Clean Energy Scenario calls for an increase in solar power capacity of 18.6GW, but it only calls for an increase in wind power capacity of 0.77GW (there are 443MW existing installed capacity). Other energy resources include 1.99GW of hydro power, 0.4GW of geothermal power, 0.22GW of biomass energy, and there is no reference target for ocean energy (IRENA, 2022). The economy needs pre-development investments of about PHP17.9 billion under the REF, and PHP25.3 billion under the CES. These green investments are expected to generate the employment of 26,439 personnel under the REF and 40,149 under the CES. According to the REF, overall capacity increase will reach 69.4GW by 2040, demanding a PHP5.2 trillion investment. On the other hand, the CES anticipates the introduction of more renewable energy power plants, with a capacity expansion of 92.3GW by 2040, representing investments worth PHP5.8 trillion. This investment will create more of the nation's labour force, the REF generates roughly 601,707 job openings, while the CES adds 898,747 new job positions (DOE, 2022).

The energy sector is guided by the directives of the Filipino President's AmBisyon Natin 2040 (NEDA, 2017). To realise the vision, a sectoral roadmap has been crafted for each energy subsector containing long-term objectives, deliverables and targets consistent with the Strategic Directions and the Nine-Point Agenda (APEC, 2021).

The recent renewable energy started from pointing out the NDC target which was set in 2015, that aiming for the reduction of greenhouse gas emissions by 75% economy-wide by 2030. This target is in relative with 'business as usual scenario' from 2011 to 2030. Along with this target, there are varying policies made to promote the increment of renewable energy in the energy mix (DOE, 2021).

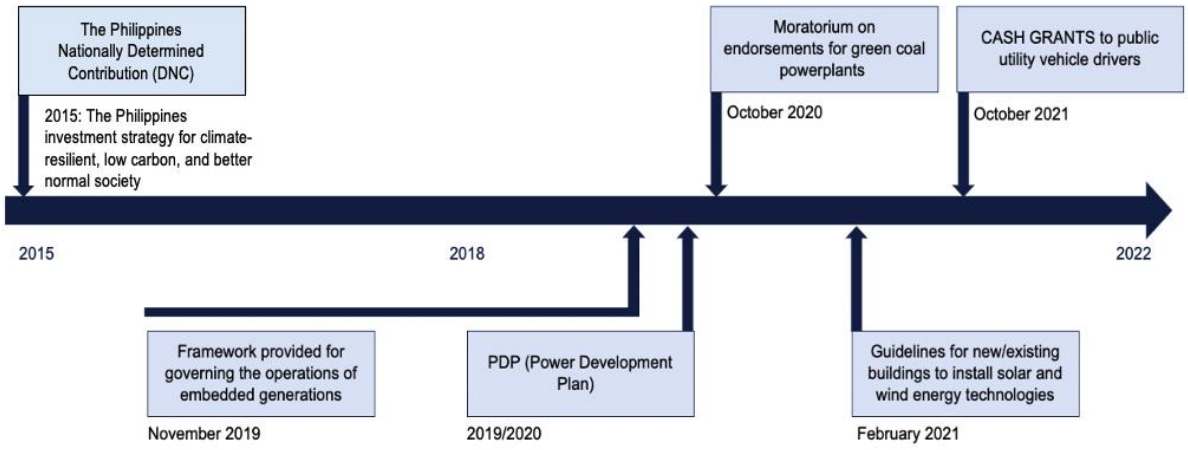
As part of the Power Generation Roadmap under Philippines Energy Plan (PEP) 2020-2040 which was launched by taking into consideration of the COVID-19 situation, there are action plans categorised into short-term and long-term. One of the plans is to implement coal moratorium and utilize cleaner technologies in power generation in the long-term (DOE, 2021). The Philippines government has publicly declared preference on renewable energy over coal, which is opposite to the original stance of the government that consider the coal as prerequisite for the rapid economic development. According to the Energy Secretary of the government, the recent assessment revealed that the economy needs to shift towards more flexible power

supply mix. The economy is expecting the execution of the coal moratorium plan to help accelerate the investment in the renewable energy sector.

At the same time in October 2020, the Department of Energy published a circular on the guidelines for the third Open and Competitive Selection Process (OCSP3) in the awarding of renewable energy service contracts. The circular allows for 100% foreign ownership in exploration, development, and utilization of large-scale geothermal projects. However, there are some conditions that foreign investors should meet if they wish to participate in the related activities. These include: i) the investment should be large-scale, with a minimum investment of about USD50 million; and ii) it should be implemented under the Financial and Technical Assistance Agreement (FTAA) as provided under the Constitution (DOE, 2020).

The government also declared to switch to local source for energy supply and avoid importing energy resources. The Philippines currently has 58% imported energy resources, while only 43% of the sources are supplied by domestic, however the economy is aiming to reduce the dependence on energy imports.

A timeline of policies and measures in the Philippines over the period of 2015-2022 is provided in the figure below.



Source: various articles [4]

Figure 3-8: Policies and measures timeline between 2015-2022 in the Philippines

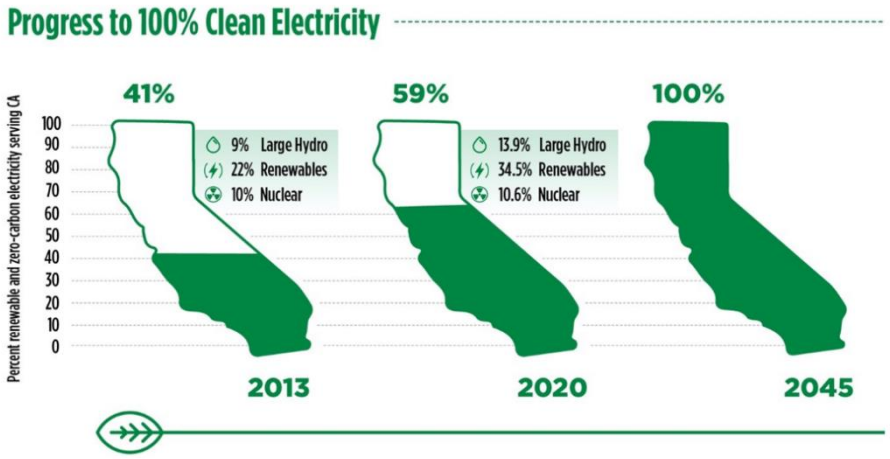
3.3.7 The United States

The United States has ambitious goals towards a decarbonised economy to tackle climate change challenges. The government aims to achieve 100% carbon pollution free electricity use by 2030, and half of which will be locally supplied clean energy to meet demand 24/7 in an executive order released in December 2021 (White House, 2021a; White House, 2021b). To reach the goal, the Federal government will work with relevant entities such as power utilities, developers etc to purchase electricity generated from renewable resources. The government expects the initiative will push development of at least 10GW of new clean electricity generation by 2030 to move closer towards the goal of achieving a carbon pollution free

[4] Green/Clean coal technology: Any technology to reduce pollutants associated with the burning of coal that was not in widespread use prior to the Clean Air Act Amendments of 1990.

electricity sector by 2035, as well as creation of more union jobs. One example is an air force base in California to add 520MW of solar electricity to the power grid, marking one of the economy's largest solar PV projects which aimed to create 1,000 jobs as well. Another example is the construction of the first phase of California's biggest hybrid renewable power generation and energy storage project in October 2021, which includes 482MW of solar PV and 394MW of battery energy storage (Colthorpe, 2021).

California is one of the leading states in the United States in the path towards net zero emission. In 2020, data from the California Energy Commission (CEC) suggests that 59% of the state electricity came from renewable and non-carbon sources (CEC, 2022). There was a slight drop as compared to the 2019 levels due to delays of the renewable energy projects, but the percentage remained high, as compared to other states and economies (CEC, 2022). The pathway towards 100% clean energy by California is shown in the figure below.



Source: CEC(2022)

Figure 3-9: California pathway to 100% clean electricity

To facilitate the recovery process from the COVID-19 pandemic, and targeted commitments towards a clean energy environment, the Congress has passed a legislative package which includes a USD900 billion COVID-19 relief package, with some energy policy changes (NCSL, 2021).The fiscal package that was passed in FY2021 had significant increase as compared to the package in FY2020, and more spending were allocated on energy related sectors, especially in terms of renewable development and energy efficiency. One example of such is USD39.62 billion out of the USD900 billion package that was allocated towards the Department of Energy and this amount was USD1.0 billion higher than the fiscal package released in FY2020. Within the budget of USD39.62 billion, USD2.86 billion were for energy efficiency and renewable energy projects. This means that, despite the pandemic crisis, there is a still strong support from the government to promote the growth of renewables and push through its commitments towards the clean environment goal.

Over the period, renewables and clean energy have been on an accelerated growth path, and this would not be possible without the relevant policies that were presented many years back that softened the impacts on the energy market (IEA, 2020). There was huge project financing on renewables through 10 largest private green investment funds combined. In 2008, policy makers identified energy infrastructure as a promising area for stimulus as it had the potential to provide large macroeconomic multiplier impact. Besides that, through past experiences,

intensive labour was required in the deployment of clean energy technology, hence there was targeted education and training programmes for the workforce in the early stages to equip the necessary skills for the programme deployment.

Previously, it was mentioned that many renewable projects faced delays during the COVID period due to disruptions in supply chain and restriction in residents' movement. To tackle the problem faced by the developers in completing projects within the stipulated deadline, the government announced a legislation that provided an extension of additional two years to the solar Investment Tax Credit (ITC) (Wagman, 2020) and one year of production tax credit for wind and other renewables projects. On top of these measures, there are tax incentives for the technologies such as fuel cell vehicles, biofuels and carbon sequestration, which are among the alternatives for a cleaner environment.

California has commendable efforts that aligns with the United States roadmap towards the carbon neutral target. In its 2022 Energy Code, most buildings are required to install solar PV as part of their building requirements (CEC, 2021). New non-residential and multifamily residential buildings higher or equal to four stories permitted on or after the first day of January 2023 will need to install solar PV as part of their premises. This allows an expansion of residential solar PV which are more cost efficient and cheaper to install, as compared to large scale solar PV projects that are relatively more costly. There are also requirements for non-residential and high-rise multifamily to adopt certain battery storage facilities in addition to solar PV installation as extra energy can be saved for lowering electricity purchasing the from high-rise multifamily.

In addition, energy retailers are required to procure a minimum quantity of renewable electricity in their electricity products, and this is performed in stages under the Renewables Portfolio Standard Program. This program was started in 2002 with an initial target of 20% electricity sales to include renewable resources by 2017. The targets were either met or exceeded by December 2017. Further changes were implemented along the way where the targets were set to replace previous targets to reach 50% by December 2026 and 60% by December 2030 (CLI, 2018). The Senate Bill also requires eligible renewable energy resources and zero carbon resource to supply 100% of the retail sales to the California end-use customers, and 100% of electricity from similar resources to serve all state agencies by December 2045 (CLI, 2018). The Bill highlights the key steps for the retailer to encourage them to adopt cleaner energy resources for the purpose of the goals set in the Energy Code.

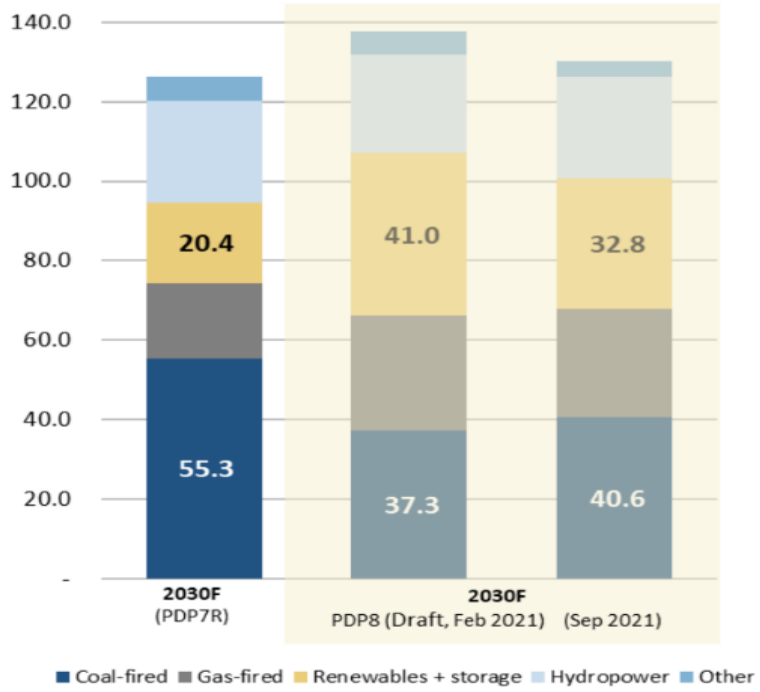
The state has also been active in the renewable scene. In February 2022, the data from the California Energy Commission suggested that in 2020, 59% of the state's electricity were from renewables and zero carbon sources, and bulk of which came from solar and wind (CEC, 2022). There was a slight drop in 2020 from 2019 due to decline in hydro power generation from droughts and the COVID-19 related delays to new renewable energy projects. Despite that, the RPS goal set for 2020 was already surpassed in 2018, which showed the huge commitments and direction by the state towards promoting renewable advancements.

3.3.8 Viet Nam

Viet Nam has various commitments and targets regarding the renewable energy development. In November 2015, the Viet Nam government adopted the Renewable Energy Development Strategy (REDS) for 2016-2030 and included an outlook until 2050 (IEA, 2016). The strategy

looks at medium to long term goals with focus set on biomass, wind and solar technologies. Overall, renewable power generation is targeted to cover 10% of total generation in the economy in 2030.

Within the same strategy, it also targets a strong reduction in imports for oil and coal to reduce greenhouse gas emissions by 25% by 2030 and 45% by 2050. The Green Growth Strategy approved in 2021 also set medium to long term targets on greenhouse gas emissions (MOIT, 2021). It is targeted to reduce greenhouse gas emission intensity, measured by emission per unit of GDP, by at least 15% compared to the 2014 levels by 2030, and at least 30% by 2050. However, in the proposed PDP8 draft plan released in September 2021, the government planned to increase coal-fired power capacity by 3GW by 2030 as compared to the draft released in February 2021 (ETA, 2022). This includes a reduction of renewables from 41.0GW to 32.8GW for the same comparison period as seen in the figure below.



Source: IEEFA (2021)

Figure 3-10: Proposed PDP8 energy capacity

Despite that, when the September 2021 draft was compared to PDP7, there were still improvements made to the previous commitments hence outlook of the renewable space in Viet Nam is not that dull. Following that, there are developments to the PDP8 plans, and the more recent reports (4,967 and 5,709) were released in August 2022 and September 2022 respectively (DL, 2022). In Report 5,709, the MOIT proposed to include approved solar power projects with investors selected in the past, hence reducing the total capacity to 2,360.42MW from 2,428.42MW as 3 investors decided not to continue with project implementations. Based on the proposal, there will be no cap to the scale of rooftop solar PV if those projects are for self-consumption without the requirement to connect to the power grid. There will be more development for wind farms. MOIT proposed to add 700MW more onshore wind power in

Report 5,709 on top of the proposed 2,816MW in Report 4,967 to the power grid in the northern region. However, the PDP8 has yet to be approved and there might be adjustments over time.

Over the years, the Viet Nam government has introduced various policies and measures to support the growth of clean energy, and one of the successful examples is the "solar-boom" in Viet Nam starting from 2017. Adding on the previous section, the REDS is supported by the Sustainable Renewable Energy Fund which made use financing from the government, and a Renewable Portfolio Standard as a policy measure to allow large generation companies to include certain percentage of renewable energy in their power capacity over targeted years (IEA, 2016).

For the past few years, the boom in large scale solar PV capacity has placed immerse pressure on the grid infrastructure in Viet Nam (Vietnamnet, 2019). As such, there were uncertainty towards solar investments for large scale projects. Hence, Decision 13 was announced in April 2020 to encourage the development of solar energy projects in Viet Nam that includes the mechanism as well as a new feed-in-tariff (WFW, 2020). The announced decision provides more flexibility for smaller scale rooftop solar systems by providing them a new route to the market and the ability to negotiate their own PPAs. The new FiT tariffs under this decision places more focus on rooftop and floating solar which likely to address land issues and difficulties in agreement compensation with the local authorities for construction of resettlement areas. Though the new FiT rates are lower than the rates in Decision 11 (World Bank, 2021), it is still higher than other economies which serves as an interim measure before the auction mechanisms kick in. MOIT has also put forth a proposal to start auctioning solar and wind energy projects that did not complete the technical test phase prior to 31 October 2021 (Vietnam News, 2022). The ministry has voiced out the objections against Viet Nam's current preferential policies that are reserved for renewable energy development which includes FiTs, and emphasizing the need for the economy to adopt a more market-oriented approach as renewable energy has become more affordable and competitive in the market in the recent years.

On a separate document, the MOIT submitted Proposal 544 to the government to suggest a pilot program to allow direct PPAs between both solar and wind power generators and electricity consumers for projects involving renewable energy (BK, 2020). Though the pilot program's max capacity is only 1,000MW, it is a kickstart of effort to allow both generator and off-taker entering into PPAs with EVN for power to be sold at the spot market rates. In light of the COVID-19 situation, which Viet Nam has been relatively successful in containing the spread of the virus, there are still extensions to the FiT deadlines on solar and wind projects as these were affected by the global supply chains disruptions and travel restrictions that were in place.

The ongoing development of PDP8 proposal highlights the changes to the energy capacity mix as compared to the PDP7 (ETA, 2022). From a high-level point of view, it seems that coal still play an important role in Viet Nam's future planning, but it has been noted that the coal projects are mainly based on the planned projects in PDP7 and there will be no room for new investors in new coal-fired power projects. There are also improvements made to the renewable sector. One such example is the focus in wind power development that has been included in the plan up till 2030. Foreign investment in onshore wind farms will be welcomed with the compliance of applicable law related to the selection of developers and investors.

3.4 Summary

A compilation of policy tools and measures used in the selected economies is given in the table below. All eight economies, namely Australia; Chile; China; Indonesia; Japan; the Philippines; the USA and Viet Nam have renewable energy targets set, while tools implemented vary between regulatory and pricing policies, fiscal incentives, and public investments, with the regulatory and pricing policies among the most applied. Details of these policy measures and tools and the perspectives of the public and private stakeholders on these policy options are discussed in the next section.

Table 3-2 List of policies implemented in each economy

	RE targets	Regulatory and pricing policies		Fiscal incentives		Public investment (i.e. loans)
		FiT/FiP	Auctions	Tax incentives	Subsidies	
Australia	✓	✓	✓	✓		✓
Chile	✓		✓			
China	✓	✓	✓			
Indonesia	✓	✓	✓	✓		✓
Japan	✓	✓		✓	✓	
The Philippines	✓	✓		✓		
The USA	✓	✓		✓		
Viet Nam	✓	✓		✓		

In terms of the recovery strategies and the role of renewables in the economic recoveries, many APEC economies have implemented a short-term measure for the COVID-19 recovery as well as coping with the recent energy crisis as a result of the war in Ukraine. The governments of many economies adopted the short-term measures to assist the project developers on their project completions.

One example is the extension of the solar investment tax credit for two years and wind production tax credit for one year in the US for the renewable developers. The Japanese government also released JPY1.0 billion to help the renewable projects that were bounded by the PPAs under the RE100 initiative. The government of Indonesia spent USD40.6 billion in 2020 to the schemes that levelled to amount spent for the COVID-19 recovery. The scheme had five pillars of spending, including health, social protection, priority program, SME finance, and business incentives. To deal with hardship caused by the pandemic, a large amount of the spendings in Indonesia was used for energy subsidies in the form of free and discounted electricity tariffs for various consumer classes in the economy.

As part of the economic recoveries, many economies in the region also adopted some sorts of fiscal stimulus to push the economy back on the track, and part of which were allocated to the renewable energy projects. For instance, the Australian government launched three economy stimulus packages in March 2020, with the bulk of which aimed at helping households and creating jobs, and USD2.3 billion of the entire package was spent on clean energy infrastructure investment. In the Philippines, the households that consumed not more than 50kWh had their

electricity fees were waived off to cope with the pandemic situation. The US also allocated USD39.62 billion out of USD900 billion of the relief package to the Department of Energy in FY2021, which is one billion more than FY2020.

With all these efforts, the paces and levels of the economic recoveries seems have not been as good as expected in general globally and in the region, and this have been partly also due to the geopolitical situations and recent the war in Ukraine. However, the trend is much clearer than before that the economies in the region have been moving towards the low-carbon or/and carbon neutral, and the energy systems are transitioning towards more clean and renewable energies, and more and stronger supports are needed to accelerate the transitions so to face and mitigate the challenges of climate change.

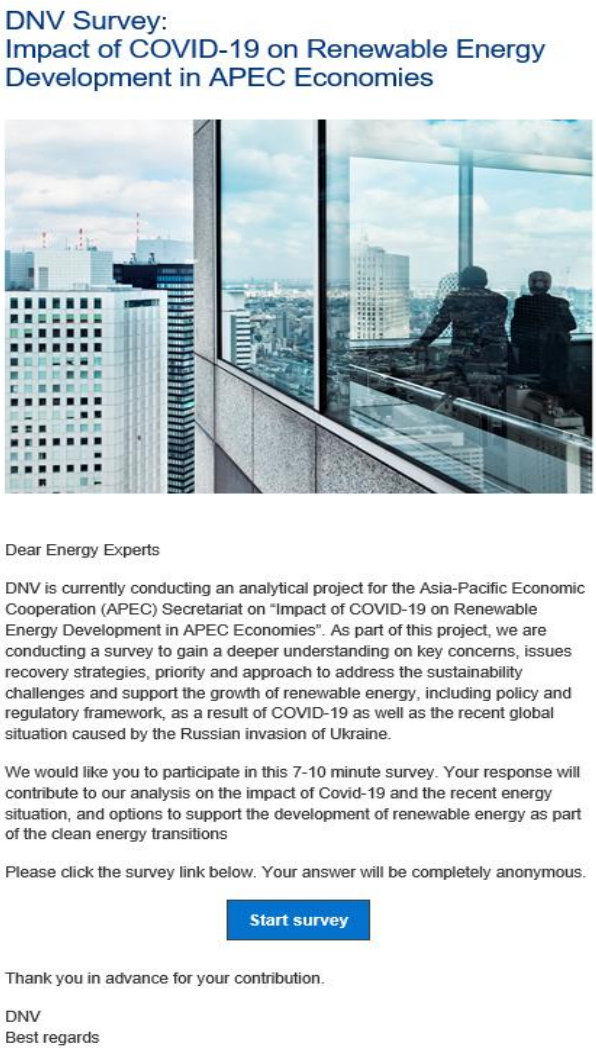
4 KEY ISSUES IN RELATION TO SUSTAINABLE ECONOMIC RECOVERY

4.1 Approach of survey and analysis

The research was conducted through an online questionnaire to gain insights and a deeper understanding on the key concerns, issues, recovery strategies, priority to address the sustainability challenges and support the development of renewable energy as a result of the COVID-19 pandemic and the recent energy crisis as a result of the ward in Ukraine.

The target respondents of the analysis include energy experts from both the governmental stakeholders or public sector (such as ministries and regulators, energy utilities, research institutions) and the private sector (manufacturers, project developer, suppliers, investors). With a diverse range of experiences and issues in different economies, along with the previous part of the project, the eight targeted economies include Australia; Chile; China; Indonesia; Japan; the Philippines; the USA and Viet Nam. However, it is likely respondents are working across many economies given the online nature of the investigation.

The survey was prepared and conducted in October 2022 using Microsoft Form platform. Survey respondents were drawn from the DNV (the project contractor) contact list by separating into relevant categories and economies. An introduction and invite emails were sent to the list of energy experts as shown in Figure 4-1. The goal was to gather around 20 to 30 responses for each set of the questionnaires. The initial duration of the survey was 10 business days, and it was extended for another 7 business days to obtain a reasonable number of responses. In total, there were 58 respondents, among which 39 respondents were from the policymakers or public sector, and another 19 were from the private sector.



DNV Survey:
Impact of COVID-19 on Renewable Energy Development in APEC Economies

Dear Energy Experts

DNV is currently conducting an analytical project for the Asia-Pacific Economic Cooperation (APEC) Secretariat on "Impact of COVID-19 on Renewable Energy Development in APEC Economies". As part of this project, we are conducting a survey to gain a deeper understanding on key concerns, issues recovery strategies, priority and approach to address the sustainability challenges and support the growth of renewable energy, including policy and regulatory framework, as a result of COVID-19 as well as the recent global situation caused by the Russian invasion of Ukraine.

We would like you to participate in this 7-10 minute survey. Your response will contribute to our analysis on the impact of Covid-19 and the recent energy situation, and options to support the development of renewable energy as part of the clean energy transitions

Please click the survey link below. Your answer will be completely anonymous.

Start survey

Thank you in advance for your contribution.

DNV
Best regards

Figure 4-1: Invitation call for energy experts to participate in the survey

4.2 Indicators and questions

There were two sets of survey questions that were prepared and furnished to the different groups of respondents. First of which was sent out to the respondents who are involved in regulations in the energy sector, including policymakers and government stakeholders, as well other non-profit organisations such as research and development institutes, and think-tanks. The other set of survey questions was aimed towards the private sector such as manufacturers, supplier, investors and project developers. Questions for each group of respondents were carefully tailored to obtain optimal results. All the despondences were made anonymously throughout the survey.

For respondents' ease of completing the survey, all questions were either in Likert Scale or multiple choices. Likert Scale was set from a range of 1 to 5, where 1 represents Strongly Disagree and 5 indicates Strongly Agree. Multiple choices either require a single option or multiple options depending on the requirement from the specific question. In addition, both set of survey questionnaires contain the basic information in order to find out the respondent's organisation area of focus, the economies they are actively involved in, and some other questions on the level of expertise in the related fields.

For the survey that were aimed towards the public sector, the questions involve finding out the following issues:

- Current status of existing policies and planning framework towards government commitment and goals;
- Main barriers and challenges to accelerate renewable energy deployment;
- Challenges faced towards current and future policies during unprecedent times and the types of policies that are effective;
- The impact on existing and future policies in the recovery process form the COVID-19 pandemic;
- Implications of the COVID-19 pandemic and the recent energy crisis on the transition towards clean energy system.

For the survey that were aimed towards the private sector, the questions were structured to investigate the following aspects:

- The challenges faced within the supply chain in the renewable energy sector during the unprecedent crisis;
- The measures in managing the orders and deliverables of the project during the COVID-pandemic;
- View on whether ample initiatives were taken to tide through various challenges and progress moving forward;
- Policies that the private sector thinks are the most effective in supporting the growth of renewable energy.

The full set of both questionnaires are provided in Annex A.

4.3 The target samples

Both sets of surveys were focused on the APEC economies and a few economies were selected as our area of focus to align with the investigation and findings in Section 2 and 3. These economies include Australia; Chile; China; Indonesia; Japan; the Philippines; the USA and Viet Nam. Each respondent may have more than one economy that they operate in. Based on 19 respondents from the private sector and 39 respondents from the public sector, there was a fair mix of responses in the above-mentioned economies, as well as other economies that did not fall within the list.

To gather more holistic results, both sets of surveys were sent to targeted groups of people. For the survey that was aimed towards the public sector, the targeted group covers governmental organisations, public utilities, private organisations, research institutes or think tanks and others. The respondents from the group have more contribution towards policy formulation, planning and implementation, whether directly or indirectly. The chart below shows the distribution of the sample in the group.

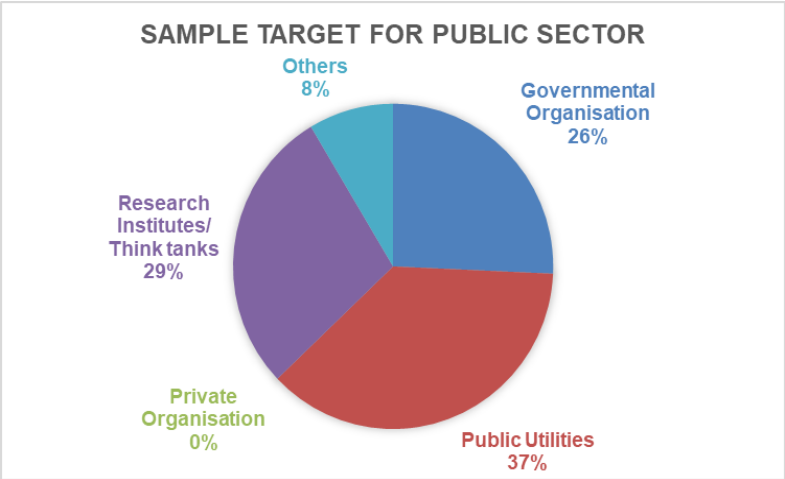


Figure 4-2: Distribution of the samples in the public sector

As for the survey that was aimed towards the private sector, the group that was targeted involves manufacturers, project developers, suppliers, investors and others. This group are more involved in manufacturing, the supply chain, financing, as well as the development of renewable energy projects. Below shows the distribution of the samples participating in the survey.

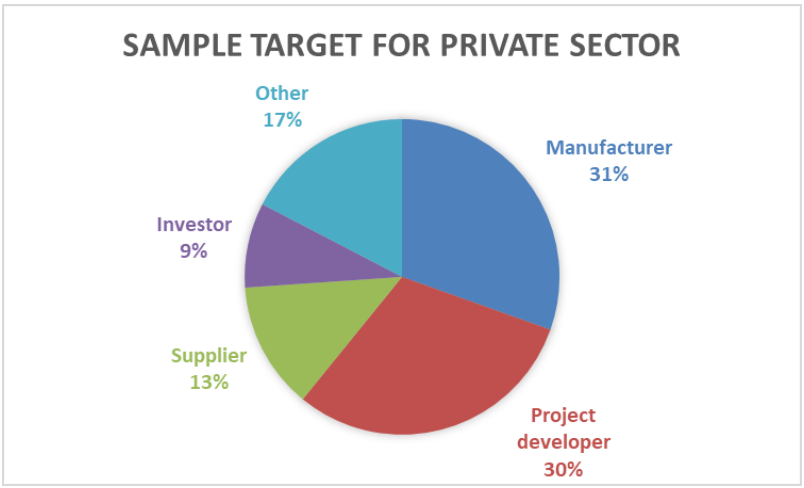


Figure 4-3: Distribution of the samples in the private sector

4.4 Results and implications for policy makers towards sustainable green recovery

Both respondents from the private and public sector agreed that the COVID-19 pandemic, including the Russia-Ukraine situation have changed the landscape of renewable energy projects. The insights obtained from each sector are presented separately in the following sections. From the public sector respondents, insights on the impact of the COVID-19 pandemic on renewable energy projects, drivers of renewable energy development in the economy, pre- and post-pandemic policies status, and implications for future sustainable recovery are presented.

Having discussed the public sector's insights, the private sector's survey is presented in the next sub-section. Respondents from the private sector provide more information on project development and operation challenges faced during the pandemic for renewable energy technologies, their take on existing policies and how the COVID pandemic has affected and changed their ways of working and business operation.

4.4.1 Insights from policy makers and governmental organisations

This section presents highlights from respondents from the public sector including governmental institutions, research institutes, and public utility companies. The survey focuses on: i) the impact of the COVID-19 pandemic and the Ukraine-Russia conflict on renewable energy projects; ii) the perception of the public sector experts on the government initiatives regarding renewable energy development; and iii) what does it imply for a sustainable green recovery. The aim of the analysis is to gain insights about the changes resulting from the COVID-19 pandemic, as well as the key concerns and issues of renewable energy development, and recovery strategies derived.

The majority, 67.6% of the respondents in APEC economies agree that there has been a push towards renewables in their economies recently. However, out of those who agreed, not everyone believes that the COVID-19 pandemic is the only driver of the clean energy transition, as showed in Figure 4-4. According to these results, the change is obvious but the reasons behind it cannot be restricted only to the COVID situation.

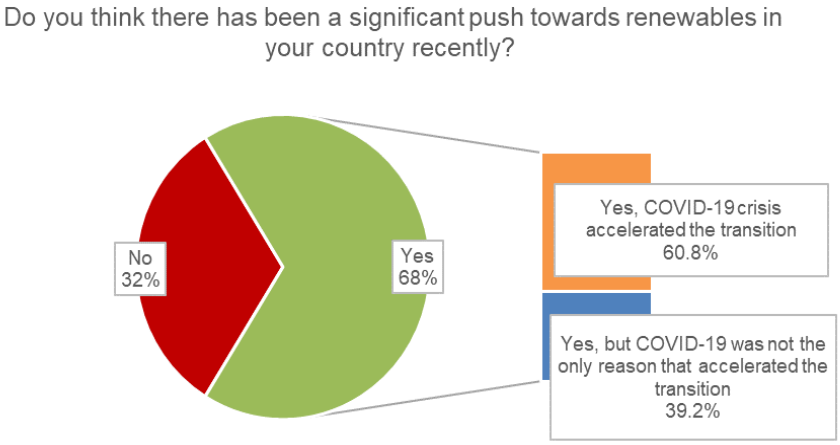


Figure 4-4: Public sector response on recent push towards renewables

Most of the respondents believe that the main reasons behind the recent push towards renewable energy include: the pressure from other economies to commit towards clean energy with strong policy support; international and geo-political tensions; and reducing import dependence of energy sources. Based on the survey results, 95% believed that the COVID-19 pandemic was not the primary reason behind the push towards renewable energy. Experts also agreed on the following answer options: i) all of the reasons listed, not one factor alone is responsible; ii) political changes and fuel cost pressure; iii) environmental concerns; iv) with the technology advancement, renewable energy have become more affordable when compared with the fossil fuels (refer to Figure 4-5).

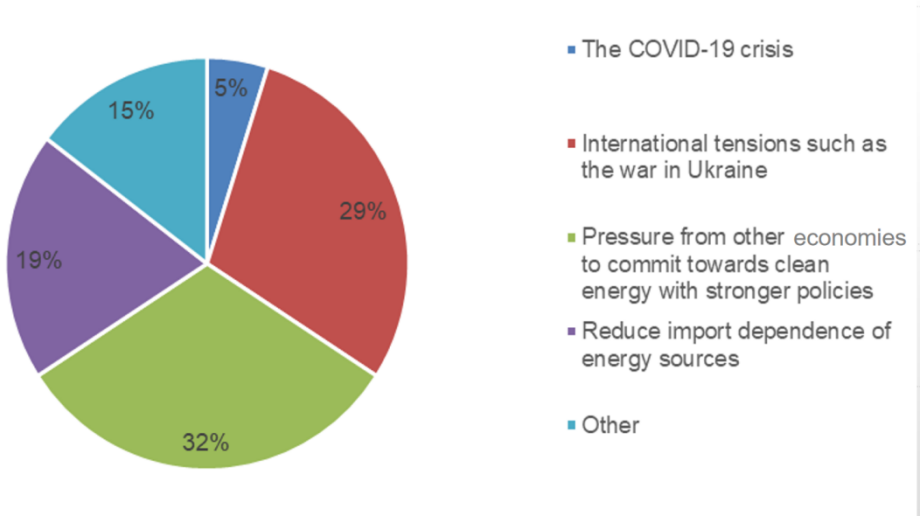


Figure 4-5: Public sector response on reasons behind renewables project acceleration

Not only the driving forces, but also the main challenges for the acceleration of renewable energy deployment are important to consider. As listed in Figure 4-6, experts from the public sector believe that there are varying challenges in the renewable energy sector, namely regulatory and policy uncertainties, inadequate electricity grid infrastructure, and lack of flexibility resources such as energy storage and demand response for renewable energy integration as the top three challenges.

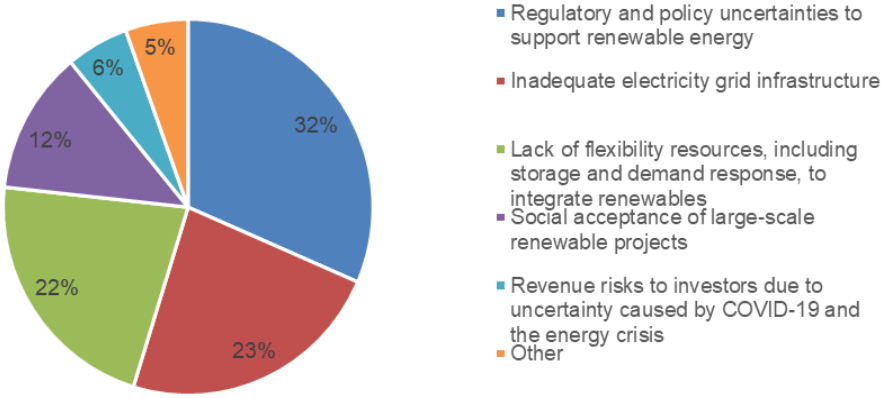


Figure 4-6: Public sector response on challenges on renewables acceleration

When investigating whether there are sufficient policies in place to support renewable development and achieving climate goals, the majority, close to 80% of the respondents, did not view that the current policies are sufficient. Overall, only 21% of experts from the public sector consider the current policies are sufficient in the APEC region, but none answered as 'strongly agree'.

The pricing instruments, such as FiT, FiP, and Auction schemes, are considered to be the most effective policy in supporting the growth of renewable energy, suggested by 44% of the experts

from the public sector. Fiscal incentives and public investments are also suggested (23% of the experts), but not as much as the pricing instruments, based on the results received as shown in Figure 4-7.

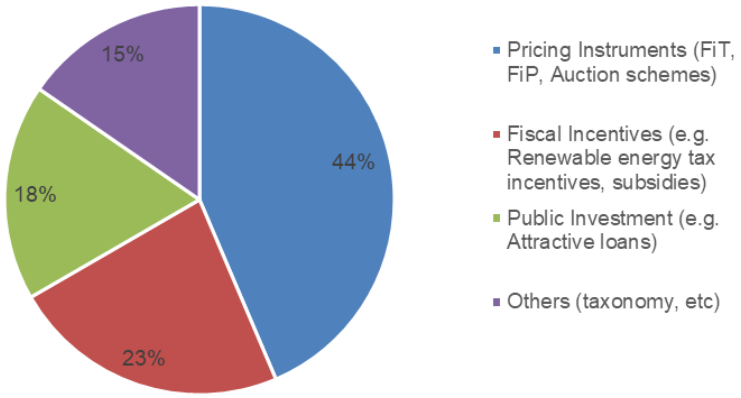


Figure 4-7: Public sector response on effective policies to support renewables growth

Public sector respondents claimed that there has been more policy supports for the non-renewable energy providers switching to low-carbon energy in the APEC region. When being asked regarding policy decision making, 75% of the experts considered potential risks of the curtailment in wind and solar PV energy in the processes. This means, that policymakers are more likely able to address the identified risks and mitigate them to increase the investor propensity of the projects. Maintaining the confidence of the investors and developers, 65% of the respondents agree that there are some increased uncertainties facing the renewable policies due to the COVID-19 pandemic and the Ukrainian war. This result possesses the questions such as whether the policy makers will be able to successfully execute the relevant supporting policies and plan for renewable energy development within the current more uncertain environment.

Going forward, the current policies and regulations are considered by the majority of the respondents being sufficient to encourage investments in renewable project development. 74% of the respondents agree that the attentions need to be paid on the high fuel and commodity prices in recent year and align it with the long-term goals in order to support the growth of renewables and facilitate clean energy transition in the region. According to these results, the t high energy cost and community prices are also incentivising the policymakers to fast track the shift towards renewables in the energy systems.

The conclusion coming from the survey results is that there is a clear push towards renewables in most of the APEC economies. A majority of the respondents agree that the COVID-19 is one of the contributing factors to this push, along with several interconnected circumstances as mentioned previously.

4.4.2 Insights from the private sector stakeholders

The COVID-19 pandemic has impacted renewable energy project deployment in various ways, including operational activities for players in the private sector. According to the survey,

supply chain disruptions, followed by fluctuating material costs, are among the top issues experienced during the pandemic. This led to the delays in procurement and delivery, project construction, operation and provision of the needed goods and services. Other factors involved include the lack of manpower for manual labour and less-skilled operations, tight deadlines, delays in receiving payment from the clients, as well as other measures that were related with restricted movements of the residents and social distancing. In general, most respondents in the private setor claimed that their projects and delivery timelines experienced about 4 to 7 months delay during the peak period of the COVID-19 pandemic, which may have led to any delay in project construction, operation and provision of goods and services.

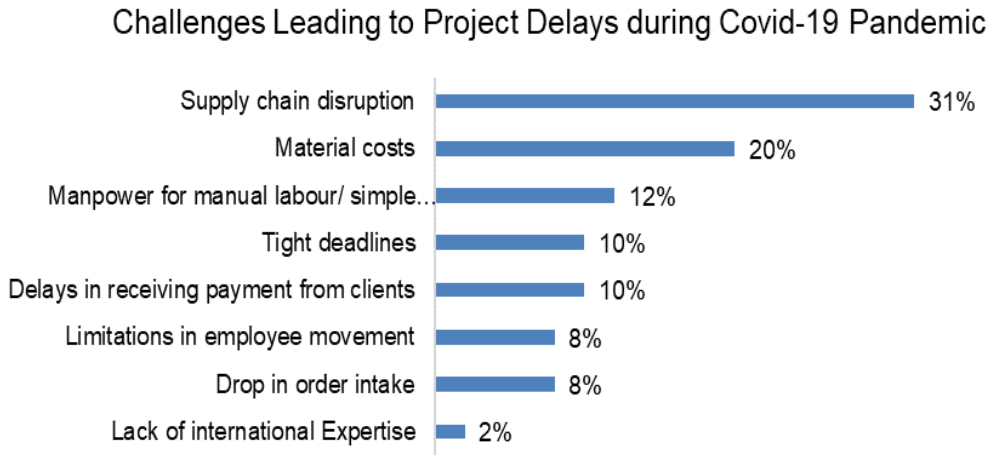


Figure 4-8: Challenges the private players faced during the pandemic

In responding to the workforce challenges during the pandemic, half of the respondents believes that the government has put in place adequate possible measures to allow the domestic workers to work without disrupting the progress of the projects. The other half do not agree, due to varying measures in different economies in the APEC region. Upon being asked on their own company's measures, the same response observed, and about half of the respondents feel that their company's measures were effective in managing the orders and deliverables during the pandemic (i.e. completion of orders by the stipulated time, pressure from clients). Despite the operational challenges faced, 74% of private sector respondents claim that they were able to rely on the domestic expertise and complete projects without the assistance from the international expertise during the pandemic.

In addition to the effects of the COVID-19 during the pandemic, the respondents gave their opinions on ongoing policies and initiatives for the renewable energy projects. More than 60% agree and strongly agree that there are sufficient initiatives in place for the renewable projects from the government over period of the pandemic, namely extension of the project deadlines, provision of government funding, while 16% disagrees, 21% answered neutral. In addition, also 63% agree and strongly agree that there are more recovery packages and supports provided for renewables than fossil fuels, even though the stimulus policies or supports were not all particularly branded with "green" or "sustainable".

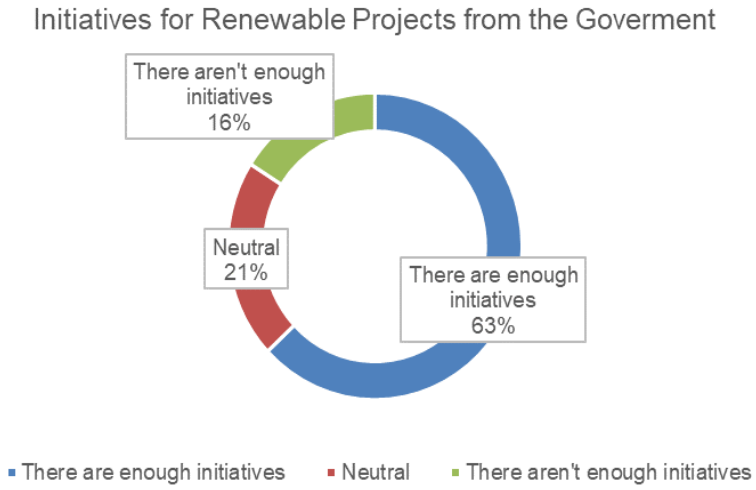


Figure 4-9: Private sector response on initiatives for renewable projects from the government

Most respondents from the private sector think that the fiscal incentives would be among the most effective policies to increase the investments in renewable sector and support renewable energy development in the region. This is a different view compared to that in the public sector, as discussed above, where the experts who suggested pricing instruments such as FiT, FiP, auction schemes and others as the most effective tool ahead of fiscal incentives to support renewables.

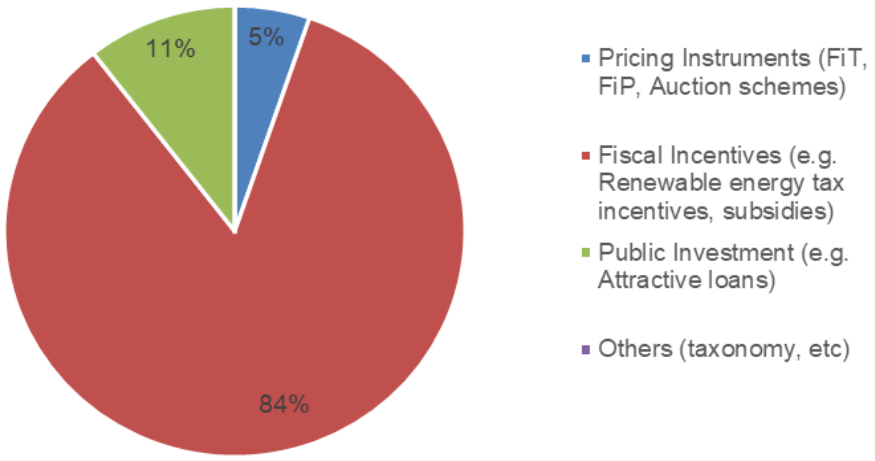


Figure 4-10: Private sector response on the most effective policies to increase renewables investment

When being asked on the government's ability to incorporate views from private sector in developing renewable energy policies, 69% respondents agree to some extent, yet 22% disagree. On the positive side, private sector respondents (95%) agree that the COVID-19 pandemic has changed the way that they plan and operate to be better prepared for extreme events. Along with this, a majority (58%) of respondents feel that the timeline to meet deadlines

for renewable projects are more comfortable since the pandemic, which reflects the necessity of adjusting relevant policies regarding project development.

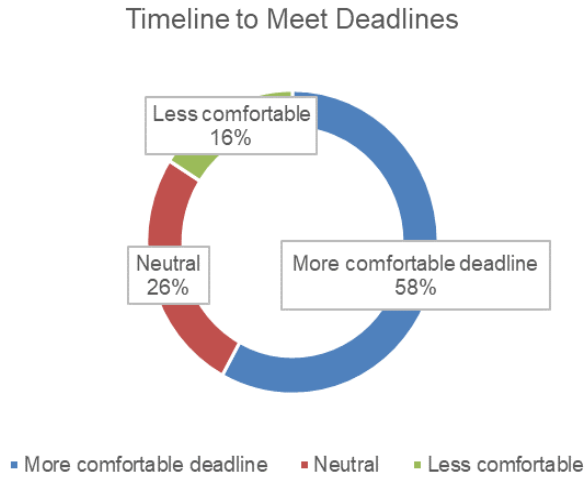


Figure 4-11: Private sector response on changes in timeline of renewable projects

Overall, 74% of private players report that the number of renewable projects has increased compared to the pre-pandemic period. Half of the respondents agree that, in addition to the pandemic, recent international tensions from the Russia-Ukraine situation, affected the progress of renewable energy projects. Looking forward, almost half of the respondents agree that, with the revision and adjustment of the relevant policies dealing with the pandemic and political issues, their companies will be in better shape (in all aspects) if the similar situations arise once again in the future.

4.5 Analysis of policy tools to support the growth of renewables

The most widely used policy categories to support the growth of renewables are pricing instruments and fiscal incentives. Prior to analysing policy implications of the survey results, an explanation on available pricing instruments and fiscal incentives is provided in Section 4.5.1. The preferred policies in the view of the public and private stakeholders based on the survey results are discussed in Section 4.5.2.

4.5.1 Pricing instruments and fiscal incentives

Pricing instruments are adopted by government as an initiative to pay project developers on renewable products. These range from the administratively set pricing instruments in the form of feed-in-tariff and/or feed-in-premiums (FiT/FiP) to competitively set prices in the form of auction schemes.

FiT is an energy supply policy focused on supporting the development of new renewable energy projects through long term power purchase agreements (PPA) for the sale of renewable electricity. These are usually in the form of a contractual agreement that offers a fixed attractive premium for a period of time. FiP however, is slightly different in a way where the premium is set above the average spot electricity market price. FiP is only applicable to the economies which have electricity markets as it provides incentives for renewable energy plants to reduce

their operation and management costs and improve their efficiency in their project development in relation to market price signals.

There are various types of renewable auction schemes such as demand auctions and reverse auctions that act differently from other tariff-based support schemes such as FiT and FiP. The scheme works in a way where only selected renewable-based electricity generators benefit from the support tariff, and the tariff level is based on the prices indicated by the project developers in their bids during the auction process. The process of auction involves the governments issuing the calls for tender to install renewable energy capacity, followed by the developers submitting their bids (USD/MWh). Once the bidders have been selected, PPAs are issued where the developers will be guaranteed the bid prices under the PPA. The strengths of the auction schemes are their cost-efficiency due to the competition and generators being guaranteed a fixed price with a long-term PPA. However, the renewable energy project investors face the risk of not winning the project, and the scheme seems to be more suitable for large-scale project developer. Large-scale project developers have the ability reduce the overall average costs due to economies of scale in their projects which gives them an edge above the rest in bidding processes at lower tariffs. As such, they have higher chance of getting their projects selected by the appointed government authority. Examples of economies adopting these measures are discussed further below.

Another measure that is widely adopted comes in the form of fiscal incentives such as renewable energy tax incentives, subsidies and green growth funds, to help with direct cost reductions for the developers and operators in implementing renewable energy projects. They can be aimed at promoting technological improvements to support renewables generation such as the integration of energy storage and more. Companies that do not generate renewable energy as their main business can also take advantage of such incentives to integrate some form of renewables in their generation mix to reduce their overall costs, and some examples of which will be discussed below as well.

Auction schemes can be beneficial for governments and the general public since it boosts renewable deployment while accelerating cost reductions of renewable energy technologies. However, from the private sector perspectives, there are risks of not winning the project. As a result, this scheme is more suitable for large-scale developer (as mentioned before) as it requires a range of feasibility studies and land permit applications, which can be too costly for small-scale project developers. On the other hand, the fiscal incentives (i.e. tax incentives, subsidies) reduce the cost of projects and other financial issues that would have hindered the investment in renewable technologies. This policy measure places risks on the public sector as money has to be spent before the completion of private sector projects and there is guarantee that such projects will be completed. Despite the different choices made by both groups of respondents, the aim of both pricing instruments and fiscal incentives will result in same goal of promoting renewable energy growth.

Examples of the economies in adopting these policies can be found in the case studies provided in previous two sections.

4.5.2 Renewable energy policies in the view of public and private stakeholders

Based on the survey results, there are several implications especially on the selection of policy tools to accelerate the low carbon energy transition. A similar question of the policy choice was indicated in the survey for both public and private sectors that addresses the most effective policy to support growth of renewable energy as part of the recovery process and the development in the post-COVID period.

Project developers in many economies faced some form of renewable energy project delays during the pandemic due to supply chain disruptions and limited movement restrictions as described in the previous sections. Economies such as Viet Nam, the United States and Japan already had pricing instruments prior to the pandemic and developers who wish to enjoy the pricing benefits are subjected to strict deadlines to complete their projects.

Based on a total of the responses from both surveys, the weightage of the responses was tabulated below.

Table 4-1: Weighted average of the responses on policy types

Policy Type	Private Sector responses	Public Sector responses	Total Weightage (%)
Pricing Instruments (FiT, FiP, Auction schemes)	1	17	31%
Fiscal Incentives (e.g. Renewable energy tax incentives, subsidies)	16	9	42%
Public Investment (e.g. Attractive loans)	2	7	17%
Others (taxonomy, etc)	0	6	10%
Total	19	39	100%

Pricing instruments and fiscal incentives appear to be the preferred strategies to support renewable energy growth based on the responses' weightage, followed by public investment. The responses gathered from the two groups of respondents highlighted some different views. Respondents from the public sector gave more support to the use of the pricing instruments while those from the private sector leaned towards the adoption of the fiscal incentives given the level of investment risks foreseen.

As mentioned previously, the two different groups of respondents differ in their responses. However, the results were not surprising as the trade-off between the advantages and disadvantages of these policy measures and tools are different for the private sector and policymakers in the public sector. The level of risk varies differently for the two groups of respondents depending on the policy types, and they would prefer the options that offer the lowest risk to them. For the adoption of the pricing instruments (i.e. FiT/FiP, auction scheme), the risks will be placed on the private sector as the capital expenditure has to be incurred before and during the project development phase. For the FiT, remunerations could be too low to attract investors and it could be too costly over time especially when the FiT is not adjusted for inflation. By now, FiT is considered as a simple renewable policy, because of which it has been the most widely used financial mechanism for renewable energy development, particularly in at the initial stage, in many economies.

From the combined survey results, the total weightage from the two groups of respondents for fiscal incentives were the largest as compared to other policy options, which suggests that such a policy is important for the growth of renewables. Governments from several economies already have the pricing instruments in place to promote renewable energy growth. In the economies that were explored in this study, the governments from China; Indonesia; Japan; the Philippines; the United States and Viet Nam use some form of pricing instruments as a strategy to support the growth of renewable energy. Economies such as the United States, Japan and especially Viet Nam saw remarkable additions to their renewable capacity over the years with the introduction of pricing mechanisms. However, renewable contracts that include FiTs often have strict deadlines to adhere to and many developers found it difficult to meet the deadlines during unprecedented times such as the COVID-19 pandemic. Hence, economies such as Viet Nam and the United States extended the FiT deadlines for certain projects to help developers cope with the short-term effects resulted by the COVID-19 pandemic.

Although FiTs could be attractive, the rates have been decreasing for those who already have the mechanism in place. Over time, higher overall operation costs as a result from lower FiTs will translate into high costs for consumers as the increased costs will be passed to them. Hence, moving away from the traditional FiT to FiP and auction schemes appear to be a preferred option of many governments. One example is the transition from FiT to FiP in Japan where a fixed premium is added on top of the spot market prices instead of relying on fixed flat rates. The scheme will motivate the companies to reduce their costs through R&D and technology advancements to capture higher difference from the spot market prices. Viet Nam has also proposed to move towards auction schemes from its FiT policy. Viet Nam's FiT policy's tight deadline has resulted in rapid solar PV capacity expansion in 2020, causing grid congestion as the grid infrastructure was not sufficiently developed in time to accommodate the capacity addition from wind and solar PV power generation. The power grid transmission capability and the addition of renewable electricity generation capacity should move in tandem, which requires the planning frameworks of the energy systems being well integrated. Scaling back incentives may allow the governments to control the capacity addition. As such, many governments prefer pricing mechanisms due to lower risks imposed on them as well as having successful examples in different economies.

As there are more uncertainties in the short term for new renewable energy investment, the governments from several economies adopted fiscal incentives policy as part of their recovery measures from the pandemic and in the post-pandemic period as well. Hence, in the short-term, government could consider implementing fiscal incentives to regain investors' confidence on ongoing and new projects, as well as rendering help to those who faced financial obstacles amidst and after the pandemic. Pricing mechanisms are still encouraged to be used over the medium and long term due to longer term feasibilities. Which pricing instrument - regulatory or competitive - is preferred depends on the current status of the economy as well as the goal they wish to achieve in the long run. Lastly, in addition to pricing mechanism, some fiscal incentives could be used as a strategy in the medium to long term in order to attract new investments, such as allocating a fund specifically towards the companies to promote improvement in clean technology, which can be seen in the case of the Green Innovation Fund in Japan, as well as reducing operational costs of renewable energy plants. Most economies adopt both strategies in their electricity system but whether it is essential for both strategies to be applied in tandem depends on the current energy systems, their development and future goals of the economy, as it has been seen that the successful economies such as Chile only relied on the pricing mechanism as a strategy.

4.6 Recovery path and role of renewables

As discussed in the previous sections, the governments of the APEC economies adopted strategies and policies towards economic recoveries. The strategies used and policies enacted can be found in Section 3.4, while the policies preferred by each of the two targeted groups of survey respondents are reflected in Section 4.5. Many of the APEC economies have seen the growth in their renewable energy sectors for the past few years, which have been contributing varying aspects as part of their recovery paths from the COVID-19 pandemic.

The policies and strategies used by some governments are discussed in the case studies on their supporting for renewable energy development and economic recoveries and their implications. As mentioned previously, it has been noted that some of the strategies may not focus directly or fully on sustainable energy when addressing the issues on economic recoveries from the pandemic, and some of the energy policies and strategies had been implemented prior to the pandemic.

Viet Nam has placed huge focus on growing their renewable energy which is evident from their solar PV capacity expansion since 2017. This was made possible due to the market potential for large-scale solar farms as well as availability of renewable energy incentives and attractive FiT that drew the investments. However, the rate of solar capacity additions in Viet Nam was not met with the matching grid infrastructure. There are many instances whereby the power grid encountered difficulties receiving electricity from the solar PV sources, which led to the curtailments and generated electricity were left unused. As a result, despite Viet Nam having good potential for future wind power projects and seems to be on the direction forward for growing its renewable energy capacity according to the PDP8 (draft), the investors and developers still face uncertainties in entering the market before the Viet Nam government addresses the power grid related issues. Though the strategies aimed to expand renewable capacity are effective to meet the projected energy demand, the infrastructure lacks the readiness to support renewable energy integration into the energy system. If equal or earlier efforts were placed on the improving and expanding of the power grid infrastructure in accordance with the expansion of renewable generation capacity, there may be better results in relation to the solar capacity additions and future wind energy development.

The US has been consistent in their growth on renewable energy since the focus of clean energy started many years back. Though they faced some difficulties from the COVID-19 pandemic such as supply disruption in parts required for the solar projects and labour movement restrictions, the extension of solar tax credits gave the developers some flexibility in completing their projects. In order to promote renewable growth after the effects of the COVID-19 pandemic, California made amendments to the Energy Code in 2022 with new building standards in both residential and non-residential buildings which diversified the methods to introduce more renewables into the energy system that are more cost-efficient.

The US government also came up with a higher fiscal budget towards clean energy development as part of the economic recovery measures from the pandemic. The budget rendered assistance in cost related issues faced by the renewable energy companies as the prices for raw materials increased while energy demand exceeded supply during the recovery period, as well as a higher budget for the government agencies and companies that were involved in innovation and research aiming at increasing the efficiency of renewable technologies, such as equipment manufacturing and plants operations. As the introduction of renewables was started

earlier in the US compared to other economies, it provided the governmental agencies more experience and knowledge in growing their renewable energy at a relatively comfortable pace while being cost-efficient and having the ability to adapt to some difficult situations as faced by other economies. As a result from these experiences and early market entrance, California has been meeting its renewable targets and holds a strong position in further development of the renewable resources.

Japan has been growing their renewables to ensure energy sustainability in their demand, as well as meeting the environmental and carbon emissions targets. Since 2012, the Japanese government enforced the pricing mechanisms to encourage both the utility-scale and distributed solar PV projects. Many companies entered the market to take advantage of the attractive FiT rates, however these rates fell over the years as the initiative to address land availability issues for these projects. This resulted in increased costs and stronger competition for the solar project developers that entered the market. As Japan has limited land available and the conditions for large-scale onshore wind development are constrained, the renewable policies have been aimed more towards offshore wind projects. This is another initiative to deal with land availability issues while growing renewables, harnessing offshore wind resources where projects were offered through the auction schemes.

Some solar companies declared the bankruptcy over the years as they were unable to cope with the increased costs from decreasing rates and other factors involved. The government then implemented the FiP which pays the renewable energy producers a premium above the market prices to encourage innovation in technology and efficiency in plant operations, so to achieve higher revenues through cost reductions. Companies were also given monetary funding supports when they adopt or integrate certain form of innovations to improve their technology. Japan also has certain early advantage in having a more reliable power infrastructure to support the renewable development since they had gained experience on ensuring high safety standards, particularly since the Fukushima nuclear incident. Such efforts place the renewable companies and the economy in general has been in a better position in economic recovery through renewable energy development.

Many economies depend on China for the solar PV components and wind turbine parts, and globally, China is a key major manufacturer of such components and parts. China started to impose strict lockdowns in some cities and movement controls since early 2020 to curb the spread of the COVID-19 virus, which has been widely regarded as rather successful. In order to assist companies and business that were affected by the lockdowns and the pandemic related policies, there were substantial economic stimulus measures given to the affected parties which created opportunity to reduce the impacts and for an early recovery from Q2 2020.

Many economies eventually imposed the lockdowns of any form and movement controls, which were imposed when the virus was spreading in their economies, as happened at the later period of the pandemic. However, event then China's essential manufacturing activities were still allowed to operate, and the economies that required China's solar PV components, wind turbine parts and other products were still able to continue their project implementations though at slower paces, yet not heavily disrupted, even affected by the movement controls and fewer healthy manpower available. Higher prices of the silicon materials in 2021 as a result from the supply chain disruptions and rising commodity prices could be alleviated more if there were more relaxed yet still strict movement controls.

In China, offshore wind capacity additions grew over 400% as the developers rushed through the projects due to the national subsidy policy that ended in end December 2021 in the midst of the pandemic. Though there are substantial growth in renewable energy, the rush may raise more issues related to the power grid infrastructure to sustain power system operation from the added renewable generation capacity. If the deadlines for subsides were extended for the projects, these related wind projects could be commissioned at a more comfortable pace which could be more helpful to the grid infrastructure, and more time allowed for the grid reinforcement and expansion and economic development in general.

In summary, the economies discussed employed different strategies for their renewable development as well as economic recoveries, though some were similar. As discussed, the strategies used resulted in the positive outcome such as the accelerated growth of the solar PV sector in Viet Nam and meeting the renewable targets in California. Some of the measures however could yield better outcomes considering different scenarios such as the case in Viet Nam in which renewables might be in a better position if there were a matching upgrade to its power grid infrastructure. For the case of China, if more relaxed personnel movement policy and measures were adopted which can be seen in Viet Nam as mentioned in the previous section, there could be less delays for other economies in receiving renewable parts for their projects from supplier in China.

Economic recoveries indeed provided a momentum for the investment in renewable and clean energy technologies with more renewable installations, thanks for the greatly improved techno-economic performance of these technologies, particularly solar PV and wind, and accumulated experience and capability along the value chains over the last decade or so. Having said that, the policies and measures to control the spread of the virus and back the economic recovery of each economy largely depended on the decisions made of the government based on the specific situation then, and the action plans of energy transition towards renewable energy, many of which started their implementations before the breakout of the pandemic.

5 SUMMARY AND POLICY OPTIONS FOR RENEWABLE ENERGY DEVELOPMENT

There have been a range of impacts due to the COVID-19 pandemic and the war in Ukraine on the renewable energy development globally and in the APEC region, which are highlighted in this report. The impacts include these on overall energy demand and supply, renewable project development and investment, plant operation, employment and job conditions in the renewable energy sector. Each economy has different social and economic background and context, strategies and measures to deal with the crisis, and hence the impacts experienced differ as discussed in the case studies. The main impacts in these fields can be summarised as the following aspects:

- Energy demand - due to the restrictions on people movement and the lockdown measure implemented in order to control the spread of the COVID-19 virus, it was inevitable that the overall energy demand decreased, along with the changes on the daily energy demand profiles and the structure of energy consumption in the economies;
- Fundings and investments - due to the unstable economic recovery trajectories and higher interest rates, banks have been more cautious in providing fundings for renewable energy projects. Financing institutions prefer more safer renewable energy projects with success track records. Overall, the investment in the new renewable power generation accounted for 69% of total energy power capacity. Amidst the pandemic, solar PV was the only source that recorded a growth in investment;
- Renewable jobs - overall, employment number in the renewable energy sector steadily increased despite the pandemic. Between 2019 and 2020, there are approximately 500,000 more jobs in the sector, adding to a total of 12 million employment globally working in the renewable energy sector;
- Technology development - learning curves of renewable energy technologies did not stop, and solar PV modules became more efficient, wind turbines had larger size and increased unit capacity, and there were continuous improvements in manufacturing efficiency and scale, and the levelized cost of electricity of utility-scale solar PV and wind power has declined significantly to the level of lower range of the fossil fuel generation technologies;
- Supply chain - the travel restrictions and border closures have greatly strained the supply chains resulting in supply shortages, causing various project delays over the period of pandemic. Example of such issues is in China, where shipping times from China to the US and European ports increased from 40 to 100 days following the breakout of the COVID-19 pandemic.

To recover the global economic losses associated with the pandemic, more than USD17 trillion for the financial stimulus was announced in response to the COVID-19 pandemic. It has been observed that renewable energy can play a bigger role in recovering the global economic situations, providing more job opportunities, bringing back the economic growth while ensuring energy security and reducing the costs of energy supplies. However, renewable energy investments in the COVID-19 recovery packages were nearly six times less than those made in the fossil fuels sector, indicating that much more to do, to accelerate and scale-up renewable energy development towards green energy transitions in the post-pandemic period.

Given potentially greater role of renewable energy in helping the economic recovery, along tackling the pressing challenge of climate change, all economies have taken this as an opportunity and a momentum to encourage and support the switching to more renewables in their energy systems. Each economy has different context and conditions, took different methods to cope with the pandemic, and implemented varying policy tools and measures for the development of renewable energy as part of their recovery strategies.

The main policy categories in the energy sector that can support the growth of renewables from short to medium term include:

- Economy-wide framing strategies such as greenhouse gas emissions reduction goals and renewable development targets;
- Pricing instruments such as FiT/FiP, and auctions;
- Fiscal incentives such as renewable tax incentives, subsidies;
- Public investment including loans and grants.

APEC had set a combined regional renewable development target - renewable doubling goal and has been on the track achieving the goal based on the recent assessment. All of the member economies have their economy-wide strategies in the form of renewable energy targets, and many have set the goal of carbon neutrality, although the level and targeted years vary. Most APEC economies have been using the regulatory and pricing instruments such as FiTs/FiPs and auction schemes for renewable energy project development with varying degree of ambitions and successes. The pandemic had resulted some economies extending the deadlines of the pricing instrument measures, including FiT and auction schemes.

In recovering from the pandemic and boosting renewable energy development, the majority of the stakeholders, including those in both the public and private sectors, believe that the fiscal incentives (i.e. tax incentives, subsidies) are the most attractive policy options to retain and raise the confidence and encourage investment in the renewable projects. Over the medium to long term, the pricing instruments, particularly the competitive auction schemes, are likely to be one of the main mechanisms since it drives down the price of renewable electricity while boosting the deployments of the technologies, which benefits the overall economy in the long term. This should be used together with some fiscal incentives to effectively promote technology improvement and enhancing economic efficiency.

A holistic approach is needed towards renewable energy development and green energy transition, including reinforcement and expansion of the infrastructure particularly power transmission network, raising the capacity of the power grid to accommodate increased proportion of variable renewable electricity in the energy mix; adopting advanced smart grid, modern control and telecommunication technologies and using integrated planning mechanisms, increasing the flexibility of the energy systems. The public investment can be directed to supporting R&D efforts, development of new and renewable energy technologies and enabling technologies such as energy storage, green hydrogen and the sector coupling efforts, as well as demonstration of these new technologies so to scale up their wide and large-scale deployments. The market-oriented reform in the power sector could raise the economic efficiency and provide a better platform for more renewables.

There are ongoing collaborations among APEC economies to accelerate the energy transition and recovery from the COVID-19 pandemic and the energy crisis. Such collaborations include high level commitments, studies and analyses and recommendations on innovative tools and approaches for the

deployment of renewable energy technologies and sharing the practical experience on renewable energy project development. The collaborations are also related to the energy sector such as high-level exchanges and best-practice sharing on the effects of the COVID-19 pandemic and related policies responding to the unprecedent situations. More effective regional collaborations among the member economies, through dialogues, information-sharing and knowledge-dissemination could further facilitate renewable energy growth in the region.

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ANNEX: SURVEY QUESTIONAIRES

A1 Public sector

Basic questions

1) Which category is the most applicable to your company/organisation? Private/Government/public utility / Research Institutes / Think tanks, others
2) Based on your works, which economies/regions are your area of focus?
3) How many years of experience do you have in this industry?

Specific questions

4) What do you see as the main barriers and challenges to accelerate renewables deployment in your economy/region?
    a. Regulatory and policy uncertainties to support renewable energy
    b. Lack of flexibility resources including grid, storage and demand response
    c. Social acceptance of large-scale renewable projects
    d. Revenue risks to investors due to uncertainty caused by COVID-19 and energy crisis
5) In relation to the current energy mix to meet present and future energy demand in the economy/state, do you agree that sufficient policies are in place to support RE development and achieving climate goals.
    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree
6) To what extent has COVID-19 pandemic contributed to the government decision to revise the renewable energy plans in your economy/state?
    a. Greatly
    b. To some extent
    c. Not at all
7) As a result of COVID-19 and the situation in Ukraine, in your view what would be the most effective policy in supporting the growth of RE
    a. Pricing instruments (i.e. FiT, FiP, Auction schemes)
    b. Fiscal incentives (e.g. Renewable energy tax incentives, subsidies)
    c. Public investment (e.g. Attractive loan)
8) Do you agree that current policies and regulations are sufficient to encourage investments in renewable development in your economy despite the effects of the pandemic and international tensions/dispute?
    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree
9) Compared to pre-pandemic levels, do you agree that policymakers have placed more emphasis to support renewable energy development in your economy/state?
    (1) Strongly disagree

(2) Disagree
(3) Neither agree nor disagree
(4) Agree
(5) Strongly agree

10) Do you agree that there are more uncertainties facing current and future renewable policies due to the COVID-19 pandemic and war in Ukraine?
    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree

11) Do you think there has been a significant push towards renewables in your economy recently?
    a. Yes
    b. No
    c. I don't know

12) What do you think could be a possible reason behind this push?
    a. COVID-19 crisis
    b. International tensions such as the war in Ukraine
    c. Pressure from other economies to commit towards clean energy with stronger policies
    d. Reduce import dependence of energy sources

13) Have the COVID-19 pandemic and Russia-Ukraine situation led to greater international collaboration between governments to support renewable energy development?
    a. Greatly
    b. To some extent
    c. Not at all

14) With the risk of curtailment in wind and solar PV energy, do you agree that this factor has been considered in policy decision-making to maintain confidence of investors and developers?
    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree

15) To what extent do you agree that there have been more policy support and incentives since the pandemic to encourage non-renewable energy providers to switch to low-carbon energy?
    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree

16) Considering government action to tackle high fuel and commodity prices in the short term. Do you believe these actions align with the long-term goal to support the growth of renewables and clean energy transition?
    a. Yes
    b. No
    c. May be

17) What impact do you think COVID-19 and the recent energy crisis have on the transition towards clean energy in your economy?
    a. Delay the transition
    b. Accelerate the transition
    c. No impact at all

A2 Private sector

1) Which category is the most applicable to your company/organization?
    a. Manufacturer
    b. Supplier
    c. Project developer
    d. Investor
    e. Other
2) Which economies/regions do you operate in?
3) What is the area of focus of your company/organisation? (Wind/solar/biomass/hydropower/other renewables/Non renewables)
4) How many years of experience do you have in this industry?
5) How strongly do you agree that there are sufficient initiatives for renewable projects from the government since the pandemic (i.e extension of project deadlines, government funding)?
    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree
6) During the peak period of COVID-19 (2020-2021), how much delay did you experience in delivering project or production, or supplying equipment
    a. Less than a month
    b. 1-3 months
    c. 3-6 months
    d. 6-9 months
    e. 9-12 months
    f. More than a year
7) Which of the following challenges you faced during the pandemic? Check the top 3 options that affected the company the most. (Multiple choice)
    - Manpower for manual labour/ simple operations
    - Domestic Expertise
    - Overseas Expertise
    - Raw domestic resources
    - Raw overseas resources
    - Limitations in staffs' movement
    - Suspension of company's operations
    - Material costs
    - Delays in receiving payment from clients
    - Tight deadlines
    - Others: Please Specify

8) To what extent do you agree or disagree that energy-related policy measures and recovery packages for COVID-19 provide more incentives to fossil-fuels than renewables?

    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree

9) In your view, to what extent does the government incorporate views from the private sector in its renewable policies?

    a. Greatly
    b. To some extent
    c. Not at all

10) Do you agree that your company was able to rely mostly on domestic expertise to complete projects without the assistance of international expertise during the pandemic? (1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree)

11) Thinking about the situation today, have you experienced an increase in projects related to renewables compared to the pre-pandemic period?

    a. Yes, renewable projects have increased
    b. No, renewable projects have decreased
    c. We have a similar number of projects as before

12) How effective were the measures of your company in managing the orders/deliverables during the pandemic (i.e completion of orders by the stipulated time, pressure from clients)? Scale 1-5

13) Do you believe that the government put in place adequate measures to allow domestic workers to work on projects without disrupting progress during the pandemic?

    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree

14) In general, the timeline given to meet deadlines for renewable projects was more comfortable and less risky before the pandemic, as compared to the current situation. (Scale)

15) Following the impact of COVID-19 and Ukraine-Russia disputes, which policies do you think would be the most effective in supporting the growth of renewables?

    a. Pricing instruments (i.e. FiT, FiP, Auction schemes)
    b. Fiscal incentives (e.g. Renewable energy tax incentives, subsidies)
    c. Public investment (e.g. Attractive loan)
    d. Others

16) To what extent do you agree or disagree that international tensions/disputes such as war in Ukraine affect the progress of renewable projects?

    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree

17) How strongly do you agree with this statement? With the revision of policies to deal with the pandemic and political issues, my company will be in better shape (in all aspects) if similar situations arise in the future.

    (1) Strongly disagree
    (2) Disagree
    (3) Neither agree nor disagree
    (4) Agree
    (5) Strongly agree)

18) Has COVID-19 and/or the war in Ukraine changed the way that your company plans and operates in order to be better prepared for extreme events, compared to pre-pandemic measures?

    a. Yes
    b. No
    c. I don’t know

Asia-Pacific
Economic Cooperation

APEC#223-RE-01.7 ISBN: 978-981-18-8280-7