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Energy security and resilience in the context of the coronavirus disease crisis

Energy security for a greener, more resilient and more inclusive energy future in the Asia-Pacific region

Note by the secretariat

Summary

The present document is in response to the recommendation by the Committee on Energy, at its second session, that the secretariat prepare an analytical paper on international energy security for the third session of the Committee on Energy, in 2021. Given the emergence of the coronavirus disease pandemic in early 2020, the issue of the resilience of the energy sector to pandemics and other crises, including how society's critical systems depend on energy, is also assessed in the present document as an integral part of energy security.

The Committee may wish to provide guidance to the secretariat and propose areas in which regional cooperation could enhance the security and resilience of the region's energy systems.

I. Introduction

1. The Asia-Pacific region is undergoing a transformation of its energy systems towards a sustainable and low-carbon energy model. Countries of the region have committed to targets for sustainable energy in the 2030 Agenda for Sustainable Development and for mitigating climate change in the Paris Agreement. New technologies and platforms have converged in areas such as solar and wind generation, decentralized power, smart grids, artificial intelligence, energy storage, hydrogen, and electric vehicles, which are transforming the energy landscape. Renewable technologies such as wind and solar have become mainstream and are being deployed at large scale and low cost in many countries. Emphasis is shifting away from coal-fired generation in many countries of the region as decarbonization concerns persist and the economic viability of carbon-intensive energy systems declines.

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* ESCAP/CE/2021/L.1.

2. Cross-border cooperation on energy is increasing in some subregions of Asia and the Pacific through the development of subregional integrated power grids. This approach can help some countries to capture the benefits of favourable technology costs and the large potential of renewable energy. Cross-border electricity infrastructure and trading can positively enhance energy security and resilience, but it depends heavily on the context. Cross-border electricity trade requires more advanced levels of cross-border cooperation and may be subject to geopolitical risks. In the longer term, other forms of cross-border energy trade may evolve alongside electricity, oil and gas, such as hydrogen derived from renewable electricity, with their own specific risks and opportunities.

3. Across the energy landscape, new paradigms and technologies affect energy security differently than in the past. Now, challenges lie in the areas of cybersecurity, supply chains for critical raw materials, stranded assets and climate risk. The present document contains an analysis of the energy security and energy resilience aspects of this new landscape.

II. Energy security

4. The definition of energy security differs by country, depending on each national context. With regard to fossil fuel energy systems, countries can be classified as producer, consumer or transit States. Each type of country may have differing objectives for energy security resulting in a different definition: for example, security of supply for energy-consuming countries; ensuring demand for energy exports for producer countries; and ensuring both supply and demand security for transit States.

5. As energy systems have evolved, more comprehensive frameworks for energy security have emerged. The term "energy trilemma" was proposed by the World Energy Council in 2010 to provide a broader view of energy sustainability. It includes three dimensions: energy security, energy equity and environmental sustainability.[1] The World Energy Council defined energy security as a nation's capacity to meet current and future energy demand reliably and withstand and bounce back swiftly from system shocks with minimal disruption to supplies. Energy equity reflects a country's ability to provide universal access to affordable, fairly priced and abundant energy for domestic and commercial use. Environmental sustainability describes the transition of a country's energy system towards mitigating and avoiding potential environmental harm and climate change impacts. Within this framework, it is clear that realizing the energy transition requires finding a balance between these dimensions.

6. The World Energy Council prepares an annual survey of how countries are performing against these dimensions and calculates an energy trilemma score for each. In the 2020 survey, Asia-Pacific countries are widely distributed across the index, with New Zealand rated the highest of Asia-Pacific countries at 10th place globally.[2] The table shows the World Energy Council energy trilemma score for all Asia-Pacific countries surveyed.

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[1] World Energy Council, *World Energy Trilemma Index 2019* (London, 2019), p. 13.

[2] World Energy Council, "Energy trilemma index". Available at https://trilemma.worldenergy.org/#:~:text=The%20World%20Energy%20Council's,and%20affordability)%2C%20Environmental%20sustainability (accessed on 22 November 2020).

Asia-Pacific countries – energy trilemma score

Country	*Index rank*	*Trilemma score*
New Zealand	10	79.5
Japan	24	75.7
Australia	25	75.4
Russian Federation	29	73.8
Republic of Korea	31	73.4
Malaysia	33	72.9
Azerbaijan	36	72.1
Singapore	40	70.5
Kazakhstan	42	70.3
Iran (Islamic Republic of)	47	69.3
Brunei Darussalam	51	68.8
Georgia	53	67.6
Armenia	54	67.4
China	55	67.0
Indonesia	56	66.8
Turkey	58	66.6
Thailand	64	65.2
Viet Nam	65	64.8
Sri Lanka	75	60.5
Philippines	76	60.3
Tajikistan	83	57.1
India	86	56.2
Mongolia	87	55.5
Myanmar	89	54.3
Cambodia	91	50.8
Pakistan	93	48.2
Bangladesh	94	47.8
Nepal	102	43.0

Source: World Energy Council. “Energy trilemma index”. Available at https://trilemma.worldenergy.org/#:~:text=The%20World%20Energy%20Council's,and%20affordability)%2C%20Environmental%20sustainability (accessed on 22 November 2020).

III. Energy resilience

A. Understanding energy resilience

7. Energy security and the energy trilemma are relatively well-established concepts. Meanwhile, the onset of the coronavirus disease (COVID-19) pandemic has brought the concept of resilience to the fore as an essential part of overall energy security.

8. Definitions of resilience vary but, in general, it is the capacity and ability of a system to withstand attacks, to cope with diverse disruptions and to be restored rapidly to full functionality. Resilience is a concept applied to social and economic systems as well as infrastructure such as pipelines and power generation, transmission and distribution systems. Considering that many systems depend on each other in systems of systems, the resilience of critical energy infrastructure is vital. Thus, resilience can be categorized as a pre-condition of energy security – in other words, an energy system cannot be secure if it does not have resilience built into its design and operation. Hence, resilience, when applied to energy systems, encompasses robustness, adequacy, adaptability, flexibility and reliability of energy systems, resources and infrastructures.[3]

9. The concept of resilience has traditionally been applied to the physical protection of critical infrastructure. However, with the growth of digital technologies to manage energy systems, resilience must now be expanded to include protection from cyberattacks and the capacity to restore systems to full operation as soon as possible after such an attack. As the digitization of the energy sector has accelerated, the mutual dependence of Internet access and power grids are clear. Key components of energy systems such as smart meters, smart grids, supervisory control and data acquisition systems[4] as well as blockchain technologies require the Internet in order to function. The resilience of the Internet is therefore increasingly important as the electricity sector plays a greater role in transport and industry as well as in powering buildings. In turn, all the systems and the economies on which they depend will be increasingly vulnerable to cyberattacks without the right safeguards in place.

10. Further, a stable electricity supply underpins the functioning of critical infrastructure such as the Internet, communications systems, public transport and health care facilities. More broadly, energy resilience is highly relevant in the current context of the COVID-19 pandemic as concerns persist about how essential services such as health care, logistics and education can manage and recover from the crisis.

B. New considerations for energy resilience

11. As the energy transition progresses, energy systems will have to adapt to new challenges. Subsection B contains information on four new frontiers in energy resilience: global pandemics, cybersecurity, the supply of critical raw materials and climate change.

1. Global pandemics

12. Pandemics are not a new phenomenon. However, COVID-19 is different to previous crises because globalization and the unprecedented mobility of populations have allowed it to spread to almost every country in a short amount of time. Its impact is accentuated by the simultaneous social, economic and health-care crises it has unleashed. It has prompted introspection on how social, economic and infrastructure systems can be made more resilient to pandemics and other future crises. A more detailed analysis of the impact of COVID-19 on the energy system security is provided in section IV of the present document.

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[3] Frank Umbach, *Energy Security in the Context of COVID-19* (forthcoming).

[4] Control system architecture to manage power stations and other complex systems.

13. Early indications are that most infrastructure, including energy infrastructure, has been very resilient in the face of the present crisis. Infrastructure can be impacted by pandemics in several ways, from loss of revenue, financial strain, operational constraints and supply chain disruptions that delay the construction of new infrastructure. In the case of energy infrastructure, lockdowns and travel bans can reduce energy demand and revenues, while social distancing and absence of essential workers can interfere with normal day-to-day operations, especially in complex systems like thermal and nuclear power facilities.

14. In the absence of specific studies on the Asia-Pacific region, an examination of infrastructure in the United Kingdom of Great Britain and Northern Ireland sheds some light on the topic. It shows that there is a broad spectrum of resilience to the pandemic with regard to different types of infrastructure.[5] Based on a framework of measuring infrastructure resilience by its resistance to disruption across five indicators – revenue, costs, financials, political and regulatory environments, and operations – clean energy sectors such as solar photovoltaics and wind are much more resilient than natural gas, nuclear power or coal-fired power. The revenue resilience of renewables is a key factor. These findings align with observations that demand for electricity has declined and the loss of demand has been borne disproportionately by dispatchable energy resources such as coal owing to its higher marginal cost in electricity markets in the Asia-Pacific region. For example, in India, the lockdown starting in March 2020 reduced coal use in the power generation mix, allowing renewables to gain a greater share.[6]

2. Cybersecurity

15. Sophisticated cyberattacks by State and non-State actors on corporations, governments and institutions are becoming increasingly common. The motivations for these attacks vary from accessing information and disrupting operations to extortion, but the increasing reliance on digital systems creates systematic vulnerabilities to cyberattacks. Critical energy infrastructure is often vulnerable to cyberattacks as in many cases it relies on outdated computer systems.[7] Electric utilities remain vulnerable across all parts of their systems, from generation, transmission, distribution to metering.

16. Resilience to cyberattacks is a new frontier for the energy industry, which historically evolved with a focus on disruptions such as natural disasters and physical attacks. Thus, the expertise that is needed to match the threat may be in limited supply and may need to be bolstered. Energy companies and utilities need to take a holistic approach to security that integrates physical risks and cyberrisks as part of their operations.

3. Supply of critical raw materials

17. Renewable energy systems such as those based on sun and wind do not require the continuous inputs of energy commodities to generate useable energy. However, the manufacture of components for new renewable energy systems relies on critical raw materials. These include rare earth metals such as lithium and cobalt that are used in clean energy systems such as wind turbine

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[5] Foresight Group LLP, “Infrastructure pandemic resilience”, September 2020.

[6] International Energy Agency, “COVID-19 impact on electricity”, November 2020. Available at www.iea.org/reports/covid-19-impact-on-electricity (accessed on 22 November 2020).

[7] Frank Umbach, *Energy Security in the Context of COVID-19*.

generators, solar panels, energy storage systems and also in electric motors in electric vehicles and in high efficiency lights. The use of these materials in the technologies that will be a core part of the energy transition will create a long-term need to extract and refine increasing quantities. In turn, this might create bottlenecks and supply shortages in each stage of their production – from mining to processing, refining and manufacturing. Currently, industries utilizing critical raw materials depend on a limited number of extracting and producing countries and companies. The sustained supply of critical raw materials at a stable price therefore will become a core component of the concept of supply security for clean energy. In many cases these materials are often not physically scarce, but supply risks and vulnerabilities stem from production being centred in a few producer countries and companies. The risks must be evaluated based on future growth scenarios for the industries that consume critical raw materials. Today some 50 per cent of critical raw materials are sourced in fragile States or politically unstable regions.[8]

18. There are solutions to ensure a secure supply of critical raw materials. As well as making timely and strategic investments, some solutions involve material reuse and recycling, for example, repurposing automotive batteries for stationary energy use; reduced use, for example technologies that require reduced quantities of critical raw materials in their manufacture; substitution, using an alternative material in place of a scarce material, for example replacing cobalt in batteries with nickel; and recycling, when materials are extracted for future use at the end of life stage.[9] Application of these strategies could enhance the security of supply for critical raw materials and can form part of the broader move towards circular economies.

4. Climate change

19. Climate change is an essential consideration in resilience as its impacts can increase the likelihood of damage to infrastructure and interruption to the supply of energy. As climate change drives more frequent and more intense extreme weather events, infrastructure design will have to evolve in step with these changes. The International Energy Agency noted that greater resilience to climate change impacts will be essential to the technical viability of the energy sector and its ability to cost-effectively meet the rising energy demands driven by global economic and population growth.[10]

20. However, catastrophic events that damage energy infrastructure are not the sole consideration when ensuring greater resilience. Changing weather patterns on a global scale can change wind, solar or rainfall patterns at the local level, thereby reducing renewable energy generation at some sites. Water shortages or higher temperatures and humidity can reduce the output of thermal power plants. Extreme heat can increase generator outages and reduce the capacity of transmission networks. Designers of these systems may have to take into consideration changing weather patterns caused by climate change in the viability assessment of projects in some areas. On the demand side, rising temperatures can push up demand for electricity through air conditioning, stressing the system with rising peak loads. It is essential that climate models are incorporated into the planning of energy infrastructure, particularly

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[8] Frank Umbach, *Energy Security in a Digitalized World and its Geostrategic Implications* (Hong Kong, China, Konrad-Adenauer-Stiftung e.V., 2018).

[9] Alexandra Leader, "Critical material supply risks and mitigation strategies in clean energy technologies", dissertation, Rochester Institute of Technology, 2020.

[10] International Energy Agency, "Energy security: ensuring the uninterrupted availability of energy sources at an affordable price", 2 December 2019.

infrastructure which has a long design life and may be operating many decades in a future environment of a changed climate. The Intergovernmental Panel on Climate Change has conducted research to understand better how climate impacts the energy system in order to include this in future modelling.[11]

IV. Impact of global megatrends

21. The megatrends that are shaping the trajectory of the energy sector in the twenty-first century include the expansion of renewable energy, the electrification of end uses and, as of 2020, the impacts of the COVID-19 pandemic.

A. Rise of renewable energy

22. Across the Asia-Pacific region and in many other global regions, renewable energy generation has expanded due to sharply falling costs, particularly of solar and wind power. Since 2010, costs of solar photovoltaics have decreased by 70 per cent, wind power by 25 per cent and battery costs for electric vehicles by 40 per cent.[12] Modern renewable energy (excluding the use of traditional biomass) in the Asia-Pacific region increased its share of total final energy consumption from 5.9 per cent in 2010 to 8.2 per cent in 2017, representing strong growth, especially considering the rapid energy demand growth over this time. Overall, renewables accounted for 23.8 per cent of the region's electricity generation in 2019. By 2040, they could account for at least 34 per cent of worldwide electricity generation[13] and even 50 per cent by 2050. According to Bloomberg New Energy Finance, solar and wind costs might further drop 71 per cent and 58 per cent respectively by 2050.[14]

23. Declining costs for renewables do not include a number of additional costs for grid modernization and for balancing the variability of renewables by other generators in a power system. Thus, an expanded use of batteries or other types of energy storage, energy forecasting and cross-border interconnection, together with demand-side management, are needed to guarantee stability of electricity supplies. These investments, together with the expansion of renewables, are often overlooked and need to be considered in the analysis of energy transition and energy security strategies.

B. Electrification of end uses

24. Electrification and digitization of the transport and heating sectors, as well as the technologies of the fourth industrial revolution, involving advances in automation, robotics and artificial intelligence systems, will significantly increase the demand for electricity in final energy consumption. This trend has already been under way in the Asia-Pacific region. Against a background of

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[11] Leon Clarke and others, "Assessing transformation pathways", in *Climate Change 2014: Mitigation of Climate Change – Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Ottmar Edenhofer and others, eds. (New York, Cambridge University Press, 2014).

[12] International Energy Agency, *World Energy Outlook 2017* (Paris, 2017), p. 281; and Christian Science Monitor, "Renewable energy at a 'tipping point'", 26 June 2017.

[13] Ed Crooks, "Wind and solar expected to supply third of global power by 2040", *Financial Times*, 16 June 2017; and Tim Buckley, "Cheap renewables are transforming the global electricity business", *Energy Post*, 14 February 2018.

[14] Robert Walton, "World on track for 50% renewables by 2050, says Bloomberg energy outlook", Utility Dive, 19 June 2018.

growing energy consumption, the proportion of electricity in energy consumed grew from 13.5 per cent in 2000 to 20.9 per cent in 2018. The International Energy Agency has forecasted a rise of 60 per cent in global electricity demand in its major policy scenarios – a rate twice that of the estimated total demand growth.[15] Some 85 per cent of the growth will come from developing countries. This increase in the share of electricity as an energy source can be explained by rising living standards, proliferation of household appliances such as air conditioners, and the increasing use of electricity in sectors such as heating, information and communications technology, and transport.

25. Electrification offers an effective low-carbon development pathway, since in many applications it implies substituting a low-carbon fuel for a more carbon-intensive one (for example, renewable electricity using a heat pump replacing oil heating) or an inefficient process with a more efficient one (such as an electric motor replacing an internal combustion engine). The process of electrification is an important source of emissions savings: many non-electricity end uses such as shipping and aviation are proving difficult to decarbonize, so a pathway of electrification combined with a renewably sourced electricity supply will in many cases be the simplest approach.

26. The electricity sector will also play a key role in supporting the economic recovery of countries and an increasingly important long-term role in providing the energy that the world needs for sustainable development. However, the power and electricity sectors' evolution into an energy system with lower carbon dioxide emissions will require a more resilient infrastructure ecosystem with enhanced 24-hour flexibility.

27. In its newest stated policies scenario, the International Energy Agency projected that global electricity demand will rapidly recover to and surpass pre-COVID-19 levels in 2021. Global electricity demand will outpace demand for all other fuels and is expected to grow the fastest in India, followed by South-East Asia. Between 2021 and 2030, China is expected to expand electricity generation from renewable sources by almost 1,500 terawatt-hours – equivalent to the electricity generated in France, Germany and Italy combined in 2019.[16] In the longer term, electricity could represent up to 70 per cent of global final energy demand by 2050.[17]

28. The stable supply of electricity that is needed to accommodate strong demand growth is dependent on the modernization and expansion of transmission and distribution grids and in many cases on cross-border interconnections. Those networks will require significant investments for modernization and expansion. By 2050, it is projected that global cumulative grid investments may reach up to $14 trillion, with almost half of this being spent in the Asia-Pacific region.[18] The risks from insufficient or untimely investments in electricity grids to ensure the future reliability and security of electricity systems may be compounded by the uncertainties of changing regulatory systems, underestimated demand and deteriorating financial conditions of energy utilities, particularly in many developing countries. In

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[15] International Energy Agency, *World Energy Outlook 2017*; and International Energy Agency, *World Energy Outlook 2020* (Paris, 2020).

[16] International Energy Agency, *World Energy Outlook 2020.*

[17] Energy Transitions Commission, *Making Mission Possible: Delivering a Net-Zero Economy* (London, 2020).

[18] Bloomberg New Energy Finance (BloombergNEF), *New Energy Outlook 2020* (New York, Bloomberg Finance L.P., 2020).

addition, flexibility in power plants, energy storage and demand-side resources are becoming the cornerstone of electricity security and resilience in modern power ecosystems.

29. The worldwide spread of information technology applications, including the more recent cryptocurrencies, blockchain technologies and cloud computing, has proved to be very energy intensive and have introduced uncertainty into many energy forecasts. One of the latest examples is the worldwide introduction of fifth-generation (5G) wireless networks and data centres, which could dramatically increase the electricity consumption of communications networks, as seen with third-generation (3G) and fourth-generation (4G) wireless systems deployment. Some experts have even estimated that the energy consumption of communication service providers will double.[19]

30. While electrification and digitization also promise substantial prospects for energy conservation and enhancing energy efficiency, it is unclear how they will counteract the additional power usage from the digital transformation. As a result, underestimating the increase of electricity demand could have wide-ranging implications for future energy supply and climate and efficiency targets at the national, regional and global levels.

C. Impact of coronavirus disease

31. The COVID-19 pandemic has unleashed multiple simultaneous crises across the world. Its effects will impact the energy sectors of the region for most of the coming decade, and this section contains a detailed examination of the implications for the energy sector, energy security and energy resilience. The pandemic has also brought a new series of challenges to the region, which requires fresh thinking on traditional energy security and energy resilience concepts.

32. As demonstrated by the current COVID-19 crisis and given the inevitability of future pandemics, as well as of more frequent natural disasters, the uninterrupted supply of energy is critical and a foundational element of national resilience. Electricity supply is particularly important for hospitals and health-care services, teleworking and remote learning. Energy systems must be able to offer resilience in the face of pandemics, natural disasters and other shocks that can disrupt supply chains, affect essential workers or close borders.

33. The direct impacts of the virus and the indirect impacts of efforts taken to control its spread, from lockdowns and social distancing to travel bans, are impacting social and economic systems in several ways. Gross domestic product (GDP) forecasts for countries across the region have been revised down dramatically, and key industries, such as aviation, are in freefall. For example, the Economic and Social Commission for Asia and the Pacific (ESCAP) forecasts that the GDP of developing Asia-Pacific economies

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[19] Davine Janssen, “Ericsson: 5G could ‘dramatically increase’ network energy consumption”, EURACTIV, 24 July 2020; and Pal Frenger and Richard Tano, “More capacity and less power: how 5G NR can reduce network energy consumption” in *2019 IEEE 89th Vehicular Technology Conference (VTC Spring): Proceedings* (Piscataway, New Jersey, Institute of Electrical and Electronics Engineers, 2019).

collectively could contract by 1.8 per cent in 2020. This compares to the pre-pandemic forecast of an expansion of 3.7 per cent.[20]

34. Uncertainty has been the prevailing sentiment and to date there is no clear narrative about how the world will transition out of the crisis. The International Monetary Fund's scenario for COVID-19 forecasts an extended recovery, with lockdowns and social distancing measures extending throughout 2021 and local transmission of the virus ending by the close of 2022.[21] With such uncertainty, concrete predictions on how the crisis will affect energy systems can be elusive.

35. While the supply of energy such as electricity, oil and gas has not been interrupted during the pandemic, energy demand has decreased dramatically. This effect is particularly notable for oil and gas but also for electricity. The COVID-19 pandemic may result in the weakest decade of growth in energy demand since the 1930s. The most notable difference in terms of COVID-19 and energy impact is between the oil- and gas-exporting and importing countries. The crisis has negatively impacted producers, while consumers have benefited from low prices. In many cases, consuming countries have used the opportunity to build up their strategic petroleum reserves. The uncertainty over the timing of the return from the crisis particularly affects the oil and gas sectors.

36. The International Energy Agency has predicted that in 2020, global energy demand will be reduced by 5 per cent from the previous year while global emissions will shrink by 7 per cent. The pandemic has impacted energy investment, which is predicted to decline by 17 per cent in 2020 compared to the previous year. However, investment in renewables has been impacted less than fossil fuel investment, with new renewables investment in 2020 predicted to decrease by only 10 per cent. Despite the fact that 2020 investment flows into renewables are down from the previous year, the International Energy Agency expects renewable electricity generation to grow by almost 7 per cent, in striking contrast to all other fuels. For 2021, renewable generation capacity has been projected to grow by another 10 per cent, and the sector has been described as relatively resilient to the effects of the COVID-19 crisis.

37. However, without decisive policy interventions, the economic impact of COVID-19 could also threaten the investments needed for achieving the goal of global carbon neutrality by 2050. Many of these decisive policy interventions may come in the shape of green stimulus packages to drive recovery from the COVID-19 crisis. However, across the region to date, neither the environment nor climate change has been a major factor in defining many countries' economic recovery plans. There are notable exceptions, such as New Zealand, the Republic of Korea and Singapore, while other countries such as China and India had very strong policies in place before the pandemic for stimulating low-carbon development. But, according to one analysis, many Governments have also used the pandemic to roll back environmental and climate regulations as well as to bail out their fossil fuel industries, leading to a net negative climate impact in all of the Asia-Pacific countries surveyed.

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[20] Zhenqian Huang and Sweta C. Saxena, "Can this time be different? Challenges and opportunities for Asia-Pacific economies in the aftermath of COVID-19", ESCAP, 11 August 2020.

[21] International Monetary Fund, *World Economic Outlook, October 2020: A Long and Difficult Ascent* (Washington, D.C., 2020).

However, there is still the possibility of improvement, as much of the COVID-19 stimulus spending has yet to be announced.

V. Balancing the energy trilemma in the Asia-Pacific region

38. Striking a balance across the three elements of the energy trilemma outlined in section II of the present document is a challenge for Governments across the Asia-Pacific region. They need to maintain a balance between the three objectives of the energy trilemma instead of simply favouring one at the expense of the other two. Without balancing the three objectives, neither national nor regional or global energy security can be guaranteed. New investments in coal-fired power generation may enable coal-producing and coal-exporting countries to address energy supply security in the short term, but the resulting greenhouse gas emissions will lead to the increased vulnerability of all countries to climate change and climate-induced disasters and possibly to economic vulnerability as assets become stranded as the world moves away from fossil fuels.

39. In addition, maintaining the balance has become even more difficult owing to issues such as public acceptance, ideological positioning and vested interests. Hence the three dimensions often compete with or contradict each other.

40. These dilemmas are intensified as countries move from the short-term perspective to a longer-term outlook of promoting the energy transition to a low-carbon energy system. In this context, an expansion of renewables allows countries to curtail their dependency on fossil fuel imports, diversify their energy mix and strengthen energy supply security. But many countries in Asia and the Pacific, especially developing countries, can become dependent on new global value chains and suppliers – either on exporters of renewable energy equipment or on countries that are producing and refining critical raw materials if they produce the renewable energy equipment themselves. In the short and medium term, expansion of renewables and the energy transition to a decarbonized system may offer diversification of the energy mix by adding various renewables to the energy mix. However, in the longer term, an energy system dominated by electricity will rely on power grids as the single transport modality. The net result could be a less diversified energy system, which presents vulnerabilities, as other subsystems, such as the Internet, are dependent on a stable supply of electricity.

41. An expansion of renewables in the energy and electricity mix demands massive investments in other energy infrastructures, such as smart grids, smart metering and cross-border interconnections as well as increased levels of balancing power which requires expensive fossil fuel power plants to operate at reduced capacity factors. The expansion of renewables ultimately is changing the entire energy system, which needs to be modernized. In particular, the storage of electricity is an ever-more-important challenge in the integration of variable renewables. Declining battery costs have made it possible to address the power sector's short-term storage challenges. But batteries, while cost effective at storing electricity on timescales measured in hours, are unable to do so over the days or months that may be needed in some power systems. In this light, governments and utilities need to consider not just the direct costs of renewables, but also the costs throughout the entire energy system.

42. Despite the declining costs of renewables and batteries, many governments have still invested in traditional fossil fuel projects such as coal power plants. But these new fossil fuel projects produce longer-term lock-in effects of stranded assets. Thus, the cheaper fossil fuel projects of today may prove much more expensive in the medium and long term. This dilemma, already present before the pandemic, is increasing as a result of the COVID-19 crisis.

43. The multifaceted COVID-19 pandemic is threatening the achievement of the Sustainable Development Goals as well as multilateralism and international cooperation. Although the global pandemic has affected all countries, they are not uniformly impacted. Moreover, their ability to resist and recover from multiple shocks is not equally distributed, due to the difference in the resilience of their health-care, energy or other sectors. That resilience depends on how much attention countries have spent on crisis planning as well as the extent of disruptions of services and supplies in the past. Too often, Governments have overlooked or marginalized potential supply crises and have either insufficient emergency plans or none. Investing in much-needed redundancies for cybersecurity or global pandemics comes at a cost. Insufficient investment in redundancies serve short-term interests but can undermine long-term interests as those crises may become more costly than mitigation policies and investments.

44. The pandemic provides an opportunity to review and re-evaluate existing emergency plans and concepts for enhancing resilience. Further, it is also reasonable to anticipate more severe and deadly pandemics in the future, which should be factored into future emergency scenarios for simulation and training. For example, a shortage of specialists and skilled workers would have been one of the most underestimated impacts of the current pandemic if it had been more severe. This issue would present important security challenges for the energy sector and other critical infrastructure in a future pandemic. If a more severe pandemic results in critical workers becoming unable to perform because of illness or death, the energy sector could face major challenges just to function.

45. Ensuring the functioning and reliability of a national electricity supply and grid stability for critical infrastructure, which includes redundancy in the professional workforce as well as disaster recovery operations as part of the process for restoring delivery mechanisms, will become an ever-more-important strategic task for governments and energy companies. Rising cyberrisks and their related vulnerabilities and the electrification of transport, heating and technologies associated with the fourth industrial revolution will compound these challenges. In such rapidly changing circumstances, the traditional supply services for critical infrastructure cannot be guaranteed during an enduring global pandemic. But without stable electricity supplies, no other critical infrastructure will function. A collapse of the energy sector could have cascading impacts on the functioning of those other systems.

46. The energy sector has traditionally planned for supply disruptions due to political instabilities in fossil-fuel-exporting countries or the potential for energy dependencies to be exploited for geopolitical objectives. As a result, there are a range of response strategies available for strengthening supply security, redundancy and resilience, for example:[22]

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[22] Frank Umbach, *Energy Security in the Context of COVID-19*.

- Diversification of the energy mix by expanding renewables: the broader the mix, the less dependent a country is on a single energy resource
- Diversification of oil and particularly gas imports to reduce dependence on a single supplier by expanding liquefied natural gas imports and import terminals, creating regional energy markets with common regulations to guarantee competition and political sovereignty on the regional market, and building transnational gas and electricity interconnectors to neighbouring countries to end national isolation or energy islands

47. In addition to these traditional considerations, new holistic strategies for coping with rising cybersecurity challenges are needed to increase the resilience of energy and electricity supplies to ensure the stability of other critical infrastructure, including redundancy capacities and backup systems.

48. The worldwide fallout of the pandemic has shifted political attention and resources to pandemic-related challenges. This has marginalized the issue of climate change. Even after the end of the pandemic, many governments may return to coal as a domestic, cheap and available energy resource at the expense of a rapid expansion of renewable energy as it fits into their short-term interests. There is a risk that political priorities will be focused on short-term economic revival that will inevitably increase the vulnerability of countries and their energy systems in the longer term.

VI. Enhancing energy security and energy resilience in the Asia-Pacific region

49. Traditional energy security concepts were based primarily on historic experiences with oil supply crises and have focused on the diversification of the energy mix and of fossil fuel imports to reduce oil dependencies on one single country or region.

50. The emergence of the energy transition and the ongoing technological disruption of the energy sector imply a new series of emerging energy security challenges, including the supply of critical raw materials; disruptive technologies and their wide-ranging impacts; new cybersecurity risks and resulting vulnerabilities; impacts of decarbonization on traditional oil- and gas-producing countries; stranded fossil fuel assets; new geopolitical dependencies as the result of the expansion of renewable energy technology and batteries; and a potential increase in worldwide electricity consumption.

51. These new challenges call for novel holistic concepts and strategies for energy security. Addressing these challenges in the Asia-Pacific region requires countries to systematically address them within energy security discussions and in an integrated manner. The lessons learned from the COVID-19 crisis need to be an integral part of those new holistic concepts for enhancing national, regional and global energy security as well as resilience.

52. Technology innovation remains a critical factor that also requires more regional and international collaboration. Developing new technologies and successfully deploying these at scale will take time.

VII. Issues for consideration by the Committee

53. The Committee may wish to provide comments and guidance on the future work of the secretariat on addressing the energy trilemma and promoting both enhanced energy security and energy resilience in the Asia-Pacific region.