Asia-Pacific
Economic Cooperation

Advancing Free Trade
for Asia-Pacific Prosperity

Workshop on Energy Resiliency Principle

Project Summary Report

APEC Energy Working Group

February 2023

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Economic Cooperation

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1. Executive Summary

The APEC Energy Working Group (EWG) conducted the Asia-Pacific Economy Cooperation (APEC) Workshop on Energy Resiliency Principle project from January to February 2022. A total of three virtual workshops were held to disseminate the APEC Energy Resiliency Principle, share knowledge and experiences on energy resiliency among APEC member economies, and solicit input for the development of the APEC Energy Resiliency Guidelines.

1.1. Workshop Overview

In recent years the Asia-Pacific region has experienced frequent natural disasters, causing severe damage to the energy infrastructure and economy. Thus, building resilient energy systems has emerged as a priority. In this context, the Energy Ministers of the APEC member economies adopted the Cebu Declaration on East Asian Energy Security in 2015, affirming the importance of energy resiliency for sustainable development. Consequently, the Energy Working Group (EWG), led by Japan, developed the APEC Energy Resiliency Principle, which was endorsed in August 2020. The Principle compiled norms and measures that stakeholders in each economy should voluntarily consider and implement in order to promote energy resiliency.

One of the action items identified in the Principle was to develop guidelines based on the Principle to support formulation of energy resiliency enhancement plans in APEC member economies. In order to ensure the guidelines reflect the regional diversity and variety of energy resiliency challenges in the APEC region, a total of three virtual workshops were planned for South America, Northeast Asia, and Southeast Asia to promote dissemination of the APEC Energy Resiliency Principle for capacity building and facilitate discussions on energy resiliency for the development of Energy Resiliency Guidelines.

A total of 293 individuals attended the three virtual workshops, including speakers and participants from 12 APEC economies, both developing and developed members (Chile, Chinese Taipei, India, Indonesia, Japan, Malaysia, Peru, Republic of Korea, Singapore, Thailand, the Philippines, and the United States):

- Government officials from energy agencies in Chile, Chinese Taipei, Japan, the Philippines and the United States, with technical and policy expertise relevant to energy resiliency challenges and measures to ensure resilient energy infrastructure in each economy: Ministry of Energy (Chile), National Energy Commission (Chile), Bureau of Energy (Chinese Taipei), Ministry of Economy, Trade and Industry (Japan), Department of Energy (the Philippines), and the United States Agency for International Development (the United States).
- Representatives of energy supply industries implementing various energy resiliency initiatives and measures: ISA InterChile (Chile), Taipower (Chinese Taipei), National Grid Corporation of the Philippines (the Philippines), and Pilipinas Shell Petroleum Corporation (the Philippines).
- Representatives of relevant energy consumers or financial institutions with interests in this topic: BHP Chile (Chile), AXA Climate (Chile), and Mitsui Fudosan (Japan).
- Research institutes, academia, NGOs, and nonprofits involved in R&D activities for energy resiliency policy and technologies: Asia Pacific Energy Research Centre (Japan), Ewha Womans University (Republic of Korea), and Philippine Disaster Resilience Foundation (the Philippines).

The workshops featured presentations and discussions on:

- Background of the Energy Resiliency Principle
- Draft Energy Resiliency Guidelines overview
- Government efforts to enhance energy resiliency
- Industry and other stakeholders' (energy suppliers, energy consumers, financial institutions, and NGOs) efforts to implement energy resiliency measures

In addition, moderated panel discussions and Q&A sessions were held during which attendees could ask questions to speakers, and speakers shared their thoughts and answered the questions.

1.2. Summary Proceedings

The summary proceedings of the three virtual workshops are as follow:

1.2.1. Chile Workshop

The opening session included opening speeches both from the project overseer (Japan) and the host economy (Chile).

Mr Tetsurou Ito, Director of International Affairs Division, Ministry of Economy, Trade and Industry, Japan, provided the background and purpose of the Workshop on Energy Resiliency Principle, including the development of the Energy Resiliency Guidelines.

Mr Francisco Lopez Diaz, Undersecretary of Energy, Ministry of Energy, Chile, highlighted Chile's needs to consider natural disasters and climate risks in its policies to develop a resilient energy sector.

The following sessions included presentations on the background of the Energy Resiliency Principle and the status of development of the APEC Energy Resiliency Guidelines.

Mr Shintaro Fujimori, Chief for Energy Supply and Demand Policy Office, Ministry of Economy, Trade and Industry, Japan, presented the background and purpose of the Energy Resiliency Principle, which aims to encourage voluntary efforts to contribute to energy resiliency across APEC economies in the Asia-Pacific region -- one of the regions most affected by natural disasters.

Ms Nanako Hisamichi, Project Manager, Washington CORE, presented the draft outline of APEC Energy Resiliency Guidelines to solicit input from the workshop participants. She explained the guidelines will specify the roles of stakeholders, including governments, energy supply industries, energy consumers, and financial institutions. The guidelines will discuss five key approaches including: energy resiliency plan, investment and financing for energy resiliency projects, proper asset management, adoption of emerging technologies, and multi-stakeholder knowledge sharing.

The panel presentations session included five presentations by speakers from various stakeholder institutions including government agencies, energy supply industries, energy consumers, and financial institutions.

Mr Daniel Charlin, Head of Resiliency and Risk Management, Ministry of Energy, Chile, provided an overview of Chile's policy making and implementation of energy resiliency and natural disaster risk management. Chile's energy sector is exposed to various vulnerabilities and risk factors, including dependency on imported fuels, few interconnections, and frequent natural disasters. To address those challenges, the Resiliency and Risk Management Unit under the Ministry of Energy coordinates energy resiliency efforts in cooperation with public and private organizations. The unit has also created risk management maps used for resiliency planning. The Ministry is now updating the economy-wide energy policy as well as disaster risk reduction policy in order to build resilient energy systems.

Ms Johanna Monteiro Zuniga, Electrical Engineer for Planning Department, National Energy Commission, Chile, discussed the resiliency assessment methodology used for transmission system planning. Chile has introduced a series of laws, regulations and grid codes that contain language directly related to resiliency in transmission planning. The National Energy Commission, as the regulatory body for energy systems in Chile, conducts a resiliency assessment as part of its annual transmission planning study. The Commission has developed a model to accurately project the likelihood and severity of natural hazards and to identify the types of threats and resiliency measures that should be prioritized. In addition to introducing new laws and regulations, economies can promote an ancillary services market as a way of encouraging resiliency projects in the distribution sector.

Mr Carlos Salamanca, Principal ISO of Interconnections and PPAs, BHP, discussed resiliency efforts by BHP, a global natural resources company that is one of the largest energy consumers in Chile. In 2007, a massive earthquake affected the transmission system, caused a power outage, and suspended copper production at BHP's mines, resulting in large economic losses. After the incident, BHP installed back-up generation plants at its mines, and voluntarily reduced electricity consumption to avoid a total economywide blackout. BHP also prepared and implemented a three-step energy resiliency planning process. In addition, BHP considers climate resilience as well as environment and community resilience as the basis of its energy resiliency concept, to improve the company's preparedness for climate impacts to energy resiliency.

Mr Oscar Alamos, Regulatory Specialist, ISA InterChile, presented energy transmission company ISA InterChile's efforts to strengthen the energy resiliency of transmission systems in Chile. ISA's transmission lines allow new renewable sources to be connected to the economy's grid system. Chile is pursuing an energy transition from imported fossil fuels to electrification based on renewable sources, but it requires a transmission system that can allow flexibility and accommodate fluctuations in power supply. In order to address such challenges, ISA has implemented innovative technologies, such as a new 500 kV substation that incorporates advanced measurement systems and gas-insulated technologies, and a 'smart' transmission system that can control electricity in a dynamic fashion.

Mr Stéphane Godier, Head of Americas, AXA Climate, introduced insurance company AXA Climate's four approaches to building disaster resiliency in the energy sector: Education, Services, Consulting, and Insurance. AXA provides an online education platform to help companies upskill their employees and the public on sustainability. AXA has created a hazard alert system to help companies monitor natural disaster risks globally. AXA helps companies understand how climate change may impact their businesses and advises them on how to adapt their assets and value chains to climate risks. Lastly, AXA offers insurance products that help companies mitigate volatility risks. In particular, AXA's parametric insurance, based on climate indexes, provides companies with compensation for non-physical damages caused by climate disasters – which contributes to energy resiliency by minimizing risks associated with investing in new energy projects.

Closing remarks were delivered by **Mr Ito** and **Mr Charlin.**

1.2.2. Chinese Taipei Workshop

The opening session included opening speeches from the project overseer (Japan) and the host economy (Chinese Taipei).

Mr Tetsurou Ito, Director of International Affairs Division, Ministry of Economy, Trade and Industry, Japan, provided background information on the Energy Resiliency Principle and an overview of the workshop agenda and goals, including the development of the Energy Resiliency Guidelines.

Mr Ming-Chih Chuang, Director, Bureau of Energy, Chinese Taipei, explained the importance of a robust power system for Chinese Taipei as an island economy. Chinese Taipei is now accelerating the development of smart grid, microgrid, distributed energy systems, and energy storage infrastructure. He mentioned that the workshop is intended to share knowledge and experience on energy resiliency in Chinese Taipei and partnering economies in Northeast Asia.

The following sessions included presentations on the background of the Energy Resiliency Principle and the status of development of the APEC Energy Resiliency Guidelines.

Mr Shintaro Fujimori, Chief for Energy Supply and Demand Policy Office, Ministry of Economy, Trade and Industry, Japan, presented the background and purpose of the Energy Resiliency Principle, which aims to encourage voluntary efforts to contribute to energy resiliency across APEC economies in the Asia-Pacific region -- one of the regions most affected by natural disasters.

Ms Nanako Hisamichi, Project Manager, Washington CORE, presented the draft outline of the APEC Energy Resiliency Guidelines to solicit input from the workshop participants. She covered the guidelines' background and objectives, development timeline, and the roles of stakeholder including governments, energy supply industries, energy consumers, and financial institutions. She also discussed five key approaches to energy resiliency, including:

1. Energy resiliency plan;
2. Investment and financing for energy resiliency projects;
3. Proper asset management;
4. Emerging technologies adoption; and
5. Multi-stakeholder knowledge sharing.

The panel presentations session included presentations by speakers from three economies in Northeast Asia – Chinese Taipei, Japan, and Republic of Korea.

Dr Chin-Chung Wu, Director of the Department of System Operations, Taipower, presented Taipower's efforts to strengthen its power system infrastructure resiliency. Faced with various types of energy resiliency risks, the government has implemented the relevant Critical Infrastructure Protection Act, which requires all critical infrastructure to implement risk assessment; prepare a protection plan; and conduct regular drills. Taipower's facilities are considered to be critical infrastructure, and thus are required to establish safety protection plans. To improve power system resiliency, Taipower introduced a number of measures for quick post-disaster recovery, including training employees for emergency response and implementing hardening measures for energy infrastructure. Taipower is the first power company in the world to establish a dual-master synchronous operation scheme system to ensure stable and reliable system operation. It also launched a new electricity trading platform to obtain sufficient ancillary services to address the challenges

caused by the intermittent nature of renewable energy to ensure stable electricity supply.

Mr Yukikazu Kawahigashi, Executive Manager of the Project Planning Division of the Environment and Energy Service Department, Mitsui Fudosan, discussed approaches the real estate company has implemented to strengthen energy resiliency in its Nihonbashi Smart City Project. The regional energy center utilizes a large-scale co-generation system fueled by pipeline gas from medium-pressure gas pipelines, which are resistant to disasters, to provide a stable supply of electricity and heat in the surrounding areas. The co-generation system installed underground enables the energy center to continue generating electricity and heat even if there is a widespread blackout caused by strong earthquakes or other disasters. The plant is also strengthened by concrete walls and a 30 cm-thick waterproof door for extra protection from flood waters. Lastly, the energy center incorporates the latest ICT to forecast energy demand and control equipment to improve operational efficiency.

Dr Jin Hur, Professor of the Department of Climate and Energy Systems Engineering, Ewha Womans University, introduced a proposed cascading outage analysis method and new energy resilience strategies in the Republic of Korea. Utility companies in the economy are required to perform an evaluation of possible cascading outages in accordance with the North American Electric Reliability Corporation (NERC) standard. Under the new resiliency strategy, prepared by Dr Hur's team and Korea Electric Power Corporation (KEPCO), a single transmission owner in Korea, will enable cascading mitigation and fast restoration using variable generating resources, such as wind and solar generating resources.

Closing remarks were delivered by **Mr Ito** and **Mr Chuang**.

1.2.3. The Philippines Workshop

The opening session included opening speeches from the project overseer (Japan) and the host economy (The Philippines).

Mr Tetsurou Ito, Director of International Affairs Division, Ministry of Economy, Trade and Industry, Japan, provided the background of the Energy Resiliency Principle and an overview of the Philippines workshop agenda and goals, including dissemination of the Principle, sharing of knowledge and experiences on energy resiliency in the economy, and the development of the Energy Resiliency Guidelines.

Mr Felix William B. Fuentebella, Senior Undersecretary of Energy, Department of Energy, the Philippines, emphasized the importance of a resilient energy sector due to the Philippines' vulnerability to natural and human-induced hazards. He emphasized the importance of multistakeholder and multilateral collaborations to improve resiliency through technical assistance and funding. Finally, he encouraged the participants to work together to achieve the common goal of achieving energy resiliency around the world.

The following sessions included presentations on the background of the Energy Resiliency Principle and the status of development of the APEC Energy Resiliency Guidelines.

Mr Yuya Uno, Deputy Director of Energy Supply and Demand Policy Office, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, Japan, presented the background and purpose of the Energy Resiliency Principle, which aims to encourage voluntary efforts to contribute to energy resiliency across APEC economies in the Asia-Pacific region -- one of the regions most affected by natural disasters.

Ms Nanako Hisamichi, Project Manager, Washington CORE, presented the draft outline of the APEC Energy Resiliency Guidelines to solicit input from the workshop participants. She covered the guidelines'

background and objectives, development timeline, and the roles of stakeholder including governments, energy supply industries, energy consumers, and financial institutions. She also discussed five key approaches to energy resiliency, including:

1. Energy resiliency plan;
2. Investment and financing for energy resiliency projects;
3. Proper asset management;
4. Emerging technologies adoption; and
5. Multi-stakeholder knowledge sharing.

The panel presentations session included five presentations by speakers from various stakeholders including a government agency, an energy supply company, a nonprofit organization, and an international aid organization.

Mr Giovanni Randolfo A. Galang, Assistant Vice President and Head of the Technical Management Department, National Grid Corporation of the Philippines, introduced the preparedness and resiliency measures of National Grid Corporation (NGCP) - the economy's sole transmission services provider - to mitigate the impact of disasters on its transmission facilities. NGCP's Integrated Disaster Action Plan serves as the general framework that prescribes end-to-end emergency and rehabilitation procedures. NGCP has implemented various disaster management measures, such as provision of sufficient backups for emergency, emergency restoration systems, steel poles, spare transformers, and mobile transformers as well as empowerment of partner communities through disaster risk reduction trainings. NGCP's Overall Command Center serves as its communication arm coordinating response, resource mobilization, and information management during disaster operations and other events. In addition, NGCP is using maps for various hazards as well as adapting emerging technologies, such as energy storage systems and smart grid, to support the integration of increasing amounts of renewable energy into the grid.

Ms Lorelie Quiambao Osial, President and CEO, Pilipinas Shell Petroleum Corporation, highlighted Pilipinas Shell's energy resiliency initiatives in the Philippines. Pilipinas Shell has been working to improve its supply chain to achieve a more affordable and reliable energy supply, for example, transforming the Tabangao Refinery to Shell Import Facility Tabangao, a world class import terminal which is pivotal in strengthening the supply chain. Shell PLC also invests in diversification of energy sources, including renewables and new energies, and manages the environmental impact of its terminals and depots, by complying with environmental regulations and standards for their emissions and effluence.

Mr Rene Jose Sayoc Meily, President, Philippine Disaster Resilience Foundation, presented a private sector-led energy resiliency effort in the Philippines. Philippine Disaster Resilience Foundation (PDRF) operates the first private sector-led Emergency Operations Center (EOC) in the region, which operates 24/7 using advanced communications software, and technology to monitor climate related and other natural hazards. In 2018, the government and PDRF updated the 2002 National Energy Contingency Plan. Based on the plan, PDRF and the government conduct joint planning, simulations, and drills in preparation for large scale earthquakes in Metro Manila. Also, PDRF supports building the disaster response capabilities of Task Force Kapatid, and offers training to help energy sector stakeholders be prepared for future catastrophes. PDRF is also promoting several disaster risk financing options, such as a climate resiliency bond and insurance.

Mr Michael O. Sinocruz, OIC-Director of Energy Policy and Planning Bureau, Department of Energy, the Philippines, introduced the Department's various policy measures to enhance the economy's energy resiliency. It issued the Department Circular No. DC2018-01-0001, which is called Energy Resiliency Policy

(ERP), that provides the legal basis for energy resiliency efforts in the economy and developing resiliency standards. To ensure continuous policies, the energy resiliency is integrated in the "Philippine Energy Plan" that covers the period of 2020 to 2040. ERP created the Task Force on Energy Resiliency, which is composed of various stakeholders in the energy sector and is automatically activated when an emergency or a natural disaster occurs to convene meetings to look at preparedness, stockpiling, systems, and related issues. ERP requires all energy industry stakeholders to submit a Resiliency Compliance Plan (RCP) that contains structural and non-structural measures to strengthen energy resiliency. Lastly, the Department is currently updating the National Energy Contingency Plan (NECP) in preparation for a large-scale earthquake in the greater Metro Manila area, aiming to harmonize the energy sector's system response with pre-identified disaster scenarios.

Mr John Aaron Edgar, Office Director for Environment, United States Agency for International Development-Philippines, introduced the tools that the United States Agency for International Development (USAID) has proposed to use in enhancing energy resiliency financing in the Philippines. In 2020, USAID, in partnership with the Philippine government, launched a key resilience initiative, called Energy Secure Philippines (ESP), to help the economy enhance energy reliability and security given the nature of its unified power system. Under the ESP, USAID is also implementing several energy resiliency activities, including a grant center contract and a review of RCPs submitted from over 230 facilities. USAID is now supporting the government to create an "Energy Resilience Scorecard", which depicts broader risk modeling and measures resiliency performance against the Philippines' and international resiliency benchmarks. The scorecard is expected to serve as a valuable guide for policy formulation, targeted training on energy resiliency, and evidence-based decision making on resource allocation.

Closing remarks were delivered by **Dr Kazumoto Irie, President, the Asia Pacific Energy Research Centre,** and **Mr Sinocruz**.

1.3. Participant Feedback

62 attendees completed the project evaluation surveys. The majority of survey respondents agreed that the workshops' objectives were met; they were well organized and easy to follow; and they provided a good opportunity to facilitate knowledge sharing as well as consider broad aspects of energy resilience-related activities. Some survey respondents suggested lengthening the event to allow more discussion; including viewpoints from a broader range of economies and professions; and hosting in-person events in the future instead of virtual workshops.

As key takeaways from the workshops, many respondents emphasized the importance of financing, use of emerging technologies, multi-stakeholder engagements, proper assessment, consideration of human-induced disasters in resiliency planning, diversification of energy resources, development of business continuity plans, and provision of proper training.

Regarding suggestions for future APEC capacity building activities, the respondents called for development of sector specific and disaster specific guidance, as well as knowledge sharing and trainings through further similar workshops and webinars to share best practices, data, and information related to energy resiliency.

1.4. Conclusion and Next Steps

1.4.1. Key Findings: Key Stakeholders' Roles and Energy Resiliency Approaches

The following sections summarize key takeaways for the roles of stakeholders and energy resiliency measures.

Governments

- Governments play key roles in supporting energy resiliency by recognizing its importance in policy statements and establishing relevant legal frameworks such as Chile's National Energy Policy 2018-2022, the Philippines' Energy Resiliency Policy, and Chinese Taipei's relevant Critical Infrastructure Protection Act, which set out energy resiliency as one of key pillars of the economy-wide energy policy.
- Regulators can promote energy resiliency by making it one of the key considerations during infrastructure planning. For example, the National Energy Commission of Chile integrates energy resiliency into transmission risk assessments. It is important to consider the cost impact of resiliency measures to ensure a stable and affordable energy supply.
- A multi-stakeholder approach is essential to enhance energy resiliency. Governments can facilitate a holistic approach for energy resiliency by establishing a centralized coordination group, such as the Philippine government's Task Force on Energy Resiliency (TFER), which promotes coordination between government agencies, energy supply industries, and non-government organizations for timely disaster response and recovery.
- Risk assessment provides the basis for effective resiliency planning. Governments can improve energy resiliency by providing stakeholders with tools to assess vulnerabilities of the economy's energy systems and to identify the gaps and areas for enhancement. The Chile Ministry of Energy's online platform provides risk maps that are used by the independent system operator (ISO) and energy supply companies, and the Philippines' hazard maps provide risk insights for the National Grid Corporation of the Philippines (NGCP).
- Governments play key roles in facilitating the formulation of energy resiliency plans in the energy industry as shown in the example of the Philippines' Energy Resiliency Policy, which requires all energy industry stakeholders, including electric cooperatives and distribution utilities, to submit a "Resiliency Compliance Plan (RCP)."
- Governments can encourage investment in energy resiliency through various financial incentives, such as tax credits, subsidies, or energy tariffs. For example, Mitsui Fudosan's Nihonbashi Smart City Project received partial subsidies from the central government of Japan and the Tokyo metropolitan government as the project contributes to improving Tokyo's resiliency.

Energy Supply Industries

- Energy supply industries can strengthen energy resiliency by taking a proactive approach to enhancing energy resiliency. Energy supply organizations, such as the National Grid Corporation of the Philippines (NGCP) and Taipower, have conducted risk assessments and developed energy resiliency plans that contain preparedness, response, and recovery measures to minimize the impact of disasters on energy systems.
- Training staff to build response capabilities is important to enable quick response and recovery from disasters. Taipower periodically conducts exercises and drills based on various risk scenarios to

improve disaster management capabilities. The Philippine Disaster Resilience Foundation (PDRF) offers training to help energy sector stakeholders be prepared for future catastrophes. It offers training courses on natural disaster response as well as business continuity. Training also provides an opportunity to review and make continuous improvement in energy resiliency planning.

- Energy supply industries play important roles in investing and deploying innovative technologies to enable the energy infrastructure to adapt, respond to, and recover from a disaster more quickly. For example, electricity supply industries have implemented smart transmission systems, energy storage, and distributed energy resources to enhance the flexibility of grids. AI and IoT are also used to improve the management of energy systems and resources.
- Energy supply industries can encourage financing in energy resiliency measures by creating and sharing business cases, which will help raise awareness of the importance of energy resiliency and build a consensus within organizations to invest in energy resiliency.
- Establishing a central coordinating body for crisis management can be an effective approach to coordinate multiple organizations' emergency responses and pool and allocate resources for quick response and recovery as shown in the cases of Taipower's Emergency Operation Center and NGCP's Overall Command Center.

Energy Consumers

- Energy consumers can strengthen energy resiliency by implementing hardening measures of energy systems as well as ensuring back-up generation. For example, Mitsui Fudosan has installed large-scale gas co-generation system (CGS) within their commercial buildings to enable business continuity during any unexpected power outages. The CGS systems can also supply electricity to nearby buildings.
- Energy consumers can improve energy resiliency by incorporating a systematic approach to asset management and resiliency planning. For example, BHP implemented energy resiliency measures using a systematic process of analyzing and evaluating disaster risk for its energy systems and business.
- Energy consumers can join forces to form a private sector-led disaster management organization, such as the Philippine Disaster Resilience Foundation (PDRF), to coordinate emergency preparedness, response, and recovery efforts as well as knowledge sharing for capacity building.

Financial Institutions

- Financial institutions can encourage funding in energy resiliency by developing indicators or measurement tools. For example, USAID partnered with the Philippine Department of Energy to launch the $34 million Energy Secure Philippines (ESP) initiative for various energy resiliency efforts, including an Energy Resilience Scorecard which will support evidence-based decision making on energy resiliency.
- Insurance companies can contribute to energy resiliency by developing and disseminating new insurance products that reduce the impacts of supply outages and natural and/or human induced disasters on social activities and businesses, taking into account risks in each region. For example, AXA Climate's parametric insurance provides companies compensation for non-physical damages caused by climate impacts.
- Financial institutions introduce alternative, innovate financing mechanisms to encourage investments in energy resiliency, such as a climate resiliency bond which is being proposed by the

UN Development Programme (UNDP) and BPI Capital and supported by the Philippine Department of Energy.

1.4.2. Next Step

- Develop an indicator or tools to evaluate the impacts of energy resiliency projects to encourage financing - energy resiliency projects are not always prioritized in the investment decision making process. Providing a matrix that indicates the measurable benefits of energy resiliency projects can aid decision making. Encouraging financial institutions to participate in the energy resiliency dialogue is also important to communicate the value of energy resiliency projects among financial communities and to facilitate partnerships to invest in such projects.
- Holding regular meetings or workshops to continue knowledge sharing and capacity building on energy resiliency - enhancing energy resiliency requires a holistic approach, which can be achieved through collaboration between the public and private sectors across different industries and segments. A hybrid virtual and in-person workshop would be desirable as many participants in this project's workshops expressed interest in having more interaction with experts and other participants. Collaboration and partnerships can further encourage sharing expertise, best practices, and lessons learned in energy resiliency. Sharing energy resiliency project outcomes among member economies can help create business cases which can be used to gain support for energy resiliency projects.
- Developing sectoral guidelines – the optimal energy resiliency approach can differ by the circumstances of sector. In the future – separate electricity, gas, and oil sectoral guidelines should be developed to provide specific guidance to stakeholders in each sector.
- Promoting public and private collaboration to develop energy resiliency tools – there are many technologies that can enhance energy resiliency efforts, including hazard maps, large-scale energy storage systems, microgrids, and distributed energy systems. Collaboration can help improve technology and bring down the cost of introducing these technologies to many parts of APEC region.

2. Background

Energy, ranging from oil, coal, natural gas to electricity, provides the basis for many social and economic activities. A stable and affordable energy supply is essential to achieve sustainable development in all economies and regions. In this regard, energy resiliency – the ability to secure a stable energy supply by effectively dealing with disasters (both natural and human-induced disasters) – is essential to achieving energy security and sustainable development. The Asia-Pacific region has been faced with frequent natural disasters, causing severe damage to the energy infrastructure and economy. Thus, building energy systems which are resilient against disasters in the APEC region has emerged as a priority.

In this context, the Energy Ministers of Member Economies of the Asia-Pacific Economic Cooperation (APEC) affirmed the importance of energy resilience to promoting energy security and achieving sustainable development in the 2015 APEC Energy Ministerial Meeting held in Cebu, Philippines. The meeting, focused on the theme "Towards an Energy Resilient APEC Community," resulted in the Cebu Declaration on East Asian Energy Security. Since then, the Energy Working Group (EWG) and Energy Resiliency Task Force (ERTF) have facilitated discussions on energy resiliency among APEC member economies. As a result, EWG, led by Japan, has developed the APEC Energy Resiliency Principle with the support of ERTF and APEC member

economies. The Principle, which was endorsed at the EWG59 meeting held in August 2020, compiled norms and measures that stakeholders in each economy should voluntarily pay attention to and implement in order to improve energy resiliency.

One of the action items identified in the Principle was to develop guidelines based on the Principle to support formulation of energy resiliency enhancement plans in APEC member economies. In order to ensure the guidelines reflect the regional diversity and variety of energy resiliency challenges in the APEC region, a total of three virtual workshops were planned for South America, Northeast Asia, and Southeast Asia to promote dissemination of the APEC Energy Resiliency Principle for capacity building and facilitate discussions on energy resiliency for the development of Energy Resiliency Guidelines.

3. Workshop Methodology

A total of three virtual workshops were held from January to February 2022 to disseminate the APEC Energy Resiliency Principle, share knowledge and experiences on energy resiliency among APEC member economies, and solicit input for the development of APEC Energy Resiliency Guidelines. Each workshop was held in partnership with a different host economy, covering three different APEC regions to ensure a diverse range of experience and viewpoints.

The workshops were held according to the following schedule.

Table 1 Workshop on Energy Resiliency Principle Schedule

Region	Date and Time	Host Economy
South America	Monday, 17 January 2022 9:00 AM-11:30 AM (Chile time)	Chile
Northeast Asia	Thursday, 20 January 2022 9:00 AM-11:00 AM (Chinese Taipei time)	Chinese Taipei
Southeast Asia	Wednesday, 16 February 2022 9:00 AM-11:30 AM (The Philippines time)	The Philippines

Each workshop invited key policy and industry stakeholders which support energy resiliency efforts in the respective APEC host economy. The workshops featured presentations and discussions on:

- Background on Energy Resiliency Principle
- Draft Energy Resiliency Guidelines
- Government efforts to enhance energy resiliency
- Industry stakeholder (energy suppliers, energy consumers, and financial institutions) efforts to implement energy resiliency measures

Please see the Appendix for the workshop agendas. The presentation slides are available in the Annex.

4. Participating Economies and Organizations

A total of 342 individuals registered for the three workshops, and a total of 293 individuals participated. The participants were from 12 economies including: Chile, Chinese Taipei, India, Indonesia, Japan, Malaysia, Peru, Republic of Korea, Singapore, Thailand, the Philippines, and the United States.

Representatives of the following organizations participated as speakers in the workshops:

Table 2 List of Speakers

Economy	Organization	Name	Gender
Chile	BHP Chile	Mr Carlos Salamanca	M
	Ministry of Energy	Mr Daniel Charlin	M
		Undersecretary Francisco Lopez	M
	National Energy Commission	Ms Johanna Monteiro Zuniga	F
	ISA InterChile	Mr Oscar Álamos	M
	AXA Climate	Mr Stéphane Godier	M
Chinese Taipei	Taipower	Dr Chin-Chung Wu	M
	Bureau of Energy	Mr Ming-Chih Chuang	M
Japan	Asia Pacific Energy Research Centre	Dr Kazumoto Irie	M
	Washington CORE	Ms Nanako Hisamichi	F
	Ministry of Economy, Trade and Industry	Mr Shintaro Fujimori	M
		Mr Tetsurou Ito	M
		Mr Yuya Uno	M
	Mitsui Fudosan	Mr Yukikazu Kawahigashi	M
Republic of Korea	Ewha Womans University	Dr Hur Jin	M
The Philippines	Department of Energy	Senior Undersecretary. Felix William B. Fuentebella	M
		Mr Michael O. Sinocruz	M
	National Grid Corporation of the Philippines	Mr Giovanni Randolfo A. Galang	M
	Pilipinas Shell Petroleum Corporation	Ms Lorelie Quiambao Osial	F
	Philippine Disaster Resilience Foundation	Mr Rene Jose Sayoc Meily	M
The United States	United States Agency for International Development	Mr John Aaron Edgar	M

Figure 1 Photo of Workshop on Energy Resiliency Principle (Chile Workshop, January 17, 2022)

Source: Washington CORE

5. Workshop Sessions Summary

5.1. Chile Workshop

5.1.1. Session 1. Opening Session

Opening Remarks from Project Overseer

Mr Tetsurou Ito, Director of International Affairs Division, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan

Mr Ito provided the background of the Energy Resiliency Principle. In recent years, various natural disasters have occurred across the world due to the effects of global warming. In APEC, the importance of energy resiliency was confirmed at the Energy Ministers' Meeting held in Cebu, the Philippines in October 2015. Furthermore, in August 2020, the APEC EWG formulated the "Energy Resilience Principle," a set of norms and concrete measures for enhancing energy resilience.

In this context, the Workshop on Energy Resiliency Principle was planned to improve the capacity of APEC members by disseminating the APEC Energy Resiliency Principle; and to share knowledge and experiences on energy resiliency in public and private organizations in order to develop APEC Energy Resiliency Guidelines.

Opening Remarks from Host Economy

Mr Francisco Lopez Diaz, Undersecretary of Energy, Ministry of Energy of Chile

Mr Diaz highlighted that in Chile, 77 percent of greenhouse gas emissions are linked to the energy sector. At the same time, the energy sector is leading Chile's decarbonization plan as the economy is committed to reaching carbon neutrality by 2050, focusing on the following steps:

1. Obtain 80 percent of energy needs from renewable generation by 2030;

2. Phase out all coal fire power plants by 2040;
3. Promote energy efficiency in construction and industry; and
4. Replace fossil fuels with electricity in the transportation sector. This includes requiring all new light and medium vehicles to be electric by 2035, and developing a green hydrogen economy.

At the same time, Chile faces the highest risk of disaster amongst OECD members, according to the World Risk Report 2021. The economy is exposed to a wide range of natural disasters, including earthquakes, tsunamis, tidal waves, volcanic eruption, floods, and landslides. That is why Chile needs to consider disaster and climate risk in its policies to develop a resilient energy sector. It is also highly important to work together with the private sector to consider the risks facing the economy's energy system and find a way to minimize the potential impacts.

The government of Chile hopes that this workshop helps to improve the dialogue between economies on energy resiliency in the APEC region, generating synergies between governmental and international agencies and private companies in order to improve energy resiliency, risk management, and risk reduction for disasters.

5.1.2. Session 2. Presentation of Energy Resiliency Efforts

Background and Purpose of the Energy Resiliency Principle

Mr Shintaro Fujimori, Chief for Energy Supply and Demand Policy Office, Agency for Natural Resources and Energy, the Ministry of Economy, Trade and Industry of Japan

Mr Fujimori presented the background and purpose of the APEC Energy Resiliency Principle, explaining that Asia-Pacific is one of the regions most affected by natural disasters. After the adoption of the Cebu Declaration that affirms the importance of energy resiliency, the Principle was formulated to encourage voluntary efforts to contribute to energy resiliency across APEC economies. Investing in energy resiliency should be regarded as a socially sustainable activity, contributing to the achievement of the UN Sustainable Development Goals.

Development of APEC Energy Resiliency Guidelines

Ms Nanako Hisamichi, Project Manager, Washington CORE

Ms Hisamichi presented the draft outline of APEC Energy Resiliency Guidelines to solicit input from the workshop participants. She covered the guidelines' background and objectives, development timelines, and the roles of stakeholder including governments, energy supply industries, energy consumers, and financial institutions. She also discussed five key approaches to energy resiliency, including:

1. Energy resiliency plan;
2. Investment and financing for energy resiliency projects;
3. Proper asset management;
4. Emerging technologies adoption; and
5. Multi-stakeholder knowledge sharing.

5.1.3. Session 3. Panel Presentations

Panel Presentation #1 – Policy Making and Implementation Addressing Energy Resiliency: Resilience and Risk Management

Mr Daniel Charlin, Head of Resiliency and Risk Management, Ministry of Energy of Chile

Mr Charlin provided an overview of Chile's policy making and implementation for energy resiliency and natural disaster risk management.

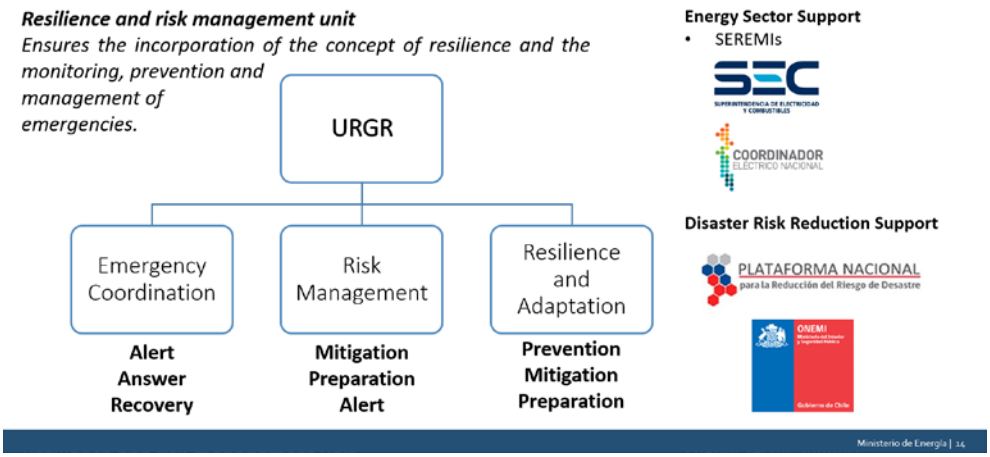
- Lessons learned from past natural disasters

Chile's energy sector is exposed to various vulnerabilities and risk factors, including a high dependency on imported fossil fuels, few electricity and gas interconnections, and frequent natural disasters such as earthquakes, tsunamis, volcanic eruptions, wildfires, and extreme weather. Chile has implemented a number of measures to enhance energy resiliency. For example, Chile has enhanced interconnection of electrical equipment, updated seismic technical specifications, and provided recommendations for seismic verification since the 8.8-magnitude earthquake on February 27, 2010, which resulted in large scale damage to the electricity infrastructure.

- Resiliency and Risk Management Unit

The Resiliency and Risk Management Unit established under the Ministry of Energy plays an important role in integrating the concept of resiliency into the energy policies as well as disaster prevention and management practices. The unit coordinates energy resiliency efforts in partnership with various public and private organizations in Chile as well as with international organizations. Chile has worked with the Coalition for Disaster Resilient Infrastructure (CDRI) to review how to improve the resiliency of generation, transmission, and distribution; and with the Inter-American Development Bank (IDB) and Latin American Energy Organization (OLADE) to develop a regional toolbox that guides the management of energy information.

Figure 2 Organization Chart of Resilience and Risk Management Unit

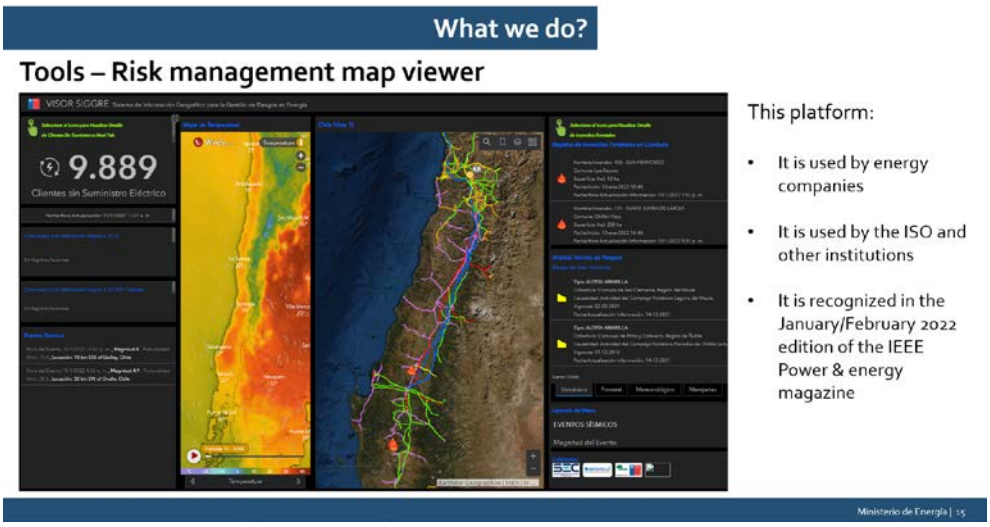


Source: Energy Ministry of Chile

- Creation of risk maps

The Resiliency and Risk Management Unit has created an online platform, which provides access to various risk management maps, which show the locations of transmission lines and natural disasters, such as fires or tsunamis. The maps are used for resiliency planning by independent system operator (ISO), energy companies, and other relevant institutions. For example, if a fire comes close to transmission lines, the platform automatically sends email alerts to advise private companies and institutions. The map also shows the number of people without electricity supply across different local jurisdictions.

Figure 3 Energy Ministry's Risk Management Map



Source: Energy Ministry of Chile

- Updating energy resiliency policies

The Ministry is now updating the economy-wide energy policy, titled "National Energy Policy 2018-2022", with three priorities: (1) monitoring security; (2) incorporating resiliency into development; and (3) promoting energy sufficiency, in order to build resilient and efficient energy systems.

In addition, Chile has developed the "National Policy for Disaster Risk Reduction for 2020-2030". This economy-wide policy for disaster risk reduction identifies five priorities:

1. Understanding disaster risk;
2. Strengthening the governance of disaster risk management;
3. Planning and investing in disaster risk reduction for resilience;
4. Providing effective and efficient response; and
5. Promoting sustainable recovery.

Panel Presentation #2 – Resilience Assessment Methodology in the Chilean Transmission System

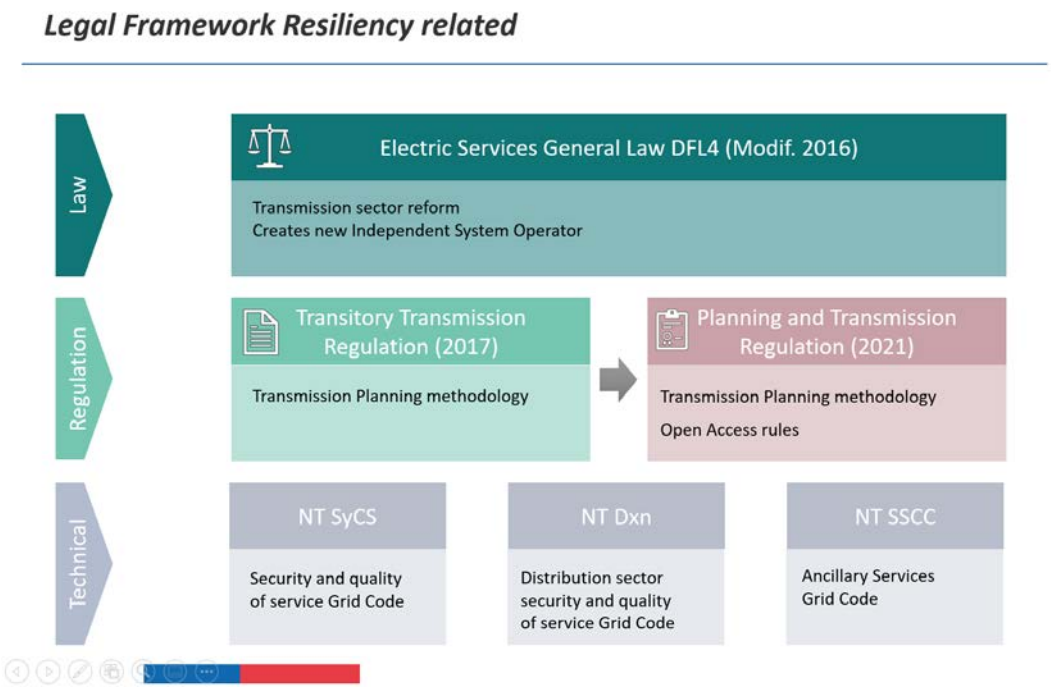
Ms Johanna Monteiro Zuniga, Electrical Engineer for Planning Department, National Energy Commission of Chile

Ms Monteiro discussed the resiliency assessment methodology that is used for transmission system planning in Chile.

- Legal framework for energy resiliency

Chile has introduced a series of laws, regulations and technical grid codes that guide transmission planning. The Electric Services General Law is the main law for the energy sector in Chile. The Law was modified in 2016, introducing a transmission sector reform and creating the new ISO. In 2017, the Transmission Planning Regulation was introduced to provide guidance in terms of planning methodology. In 2021, the Planning and Transmission Regulation was introduced, maintaining the transmission planning methodology as well as discussing open access rules to the electrical system. Finally, Chile has released a series of technical grid codes related with energy resiliency. Each of these regulations contain language directly related to resiliency in transmission planning.

Figure 4 Legal Framework Related to Resiliency in Chile



Source: National Energy Commission

- Resiliency assessment in transmission planning

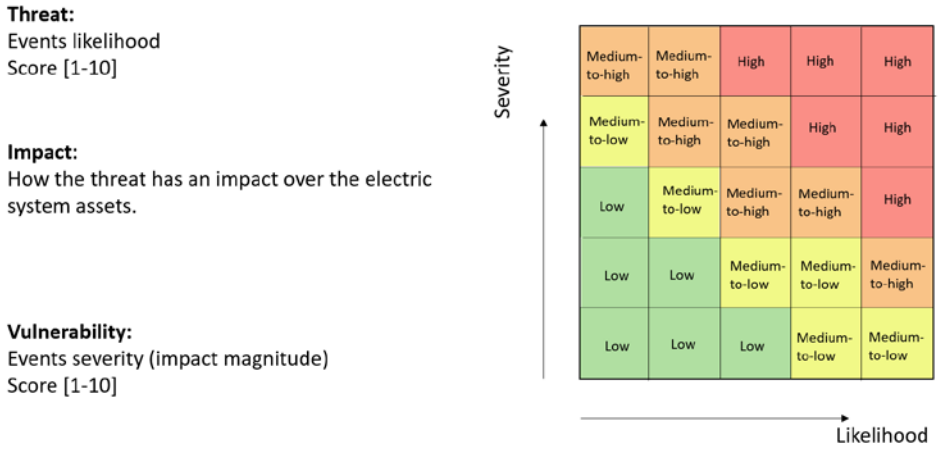
In accordance with the resiliency requirements from the legal framework for energy resiliency, the National Energy Commission (CNE), the regulatory body for energy systems in Chile, conducts a transmission planning study annually. Based on the results of the annual study, a transmission expansion plan is developed in collaboration with the transmission industry. A resiliency assessment is required as part of the transmission planning, and it considers the events such as tsunamis, fuel price shocks, delays in the commissioning of new

power plants, and extreme hydrological conditions.

The resiliency assessment methodology consists of four main steps: (1) set scope, (2) define impact, (3) define risk, and (4) define solution. The assessment evaluates natural disasters. To enhance the resiliency assessment, CNE seeks to secure historical data on past disasters from the Chilean ISO and other institutions and develop a model to accurately project the likelihood and severity of natural hazards based on the changing environment due to climate change.

Because it is not possible for CNE to address every threat, CNE uses a matrix to rate each threat by likelihood and severity and identifies the types of threats for which resiliency measures should be prioritized in a given year.

Figure 5 Risk Matrix Used for Resiliency Assessment



Source: National Energy Commission

There are also different resiliency measures required in different stages of an event, including: hardening measures (preparedness); operational measures (response); and quick recovery measures (recovery). Physical measures such as building new transmission assets are often very costly, so the resiliency assessment methodology suggests prioritizing the most cost-efficient solutions across different resiliency measures.

- Investment in the distribution sector

As it might be difficult to introduce a new law or regulation to ensure resiliency should be considered as a priority, economies can promote an ancillary services market as an approach to encouraging new projects in the distribution sector. Also, establishing a local-level system recovery plan – in addition to an economy-wide plan targeting the transmission sector – may encourage resiliency investments such as back-up generation in the distribution sector.

Panel Presentation #3 – Multi-Stakeholder Approach for Energy Resilience against Earthquakes and Other Disasters in Chile – Mining View

Mr Carlos Salamanca, Principal ISO of Interconnections and PPAs, BHP

Mr Salamanca discussed the efforts of BHP, an international natural resources company and large energy consumer, to enhance energy resiliency against earthquakes and other natural disasters in Chile.

BHP owns three large copper mines in Chile, including Escondida – the largest copper mine in the world. As of 2020, the three BHP mines represented 23 percent of copper production, and 8.7 percent of annual energy demand in Chile. In fact, Escondida is the biggest electricity consumer connected to the economy's grid system.

- Lessons learned from 2007 Tocopilla earthquake

On November 14, 2007, a 7.7-magnitude earthquake (Tocopilla) occurred in Chile, which severely affected the transmission system and caused a power outage for about 35 hours at BHP mines. The economic losses due to suspended copper production amounted to $34 million in total. This event made BHP more aware of the importance of energy resiliency to its business continuity as well as to its long-term business success.

Since then, BHP has taken various measures to secure a stable electricity supply and mitigate the impact of any natural disasters on copper production. The company installed back-up generation, which later become a common practice among all medium and large companies in energy-intensive industries in Chile, such as forestry and mining. Large companies like BHP sell back reductant electricity to the power grid. As the economy has high frequencies of natural disasters such as earthquakes, tsunamis and volcanic eruptions, Chile's energy consumers like BHP have voluntarily reduced their electricity consumption to avoid a total blackout in the event of any disruptions to power supply. Thanks to the post-2007 improvements, BHP is now able to restore electricity supply within an average of one or two hours after a natural disaster such as an earthquake.

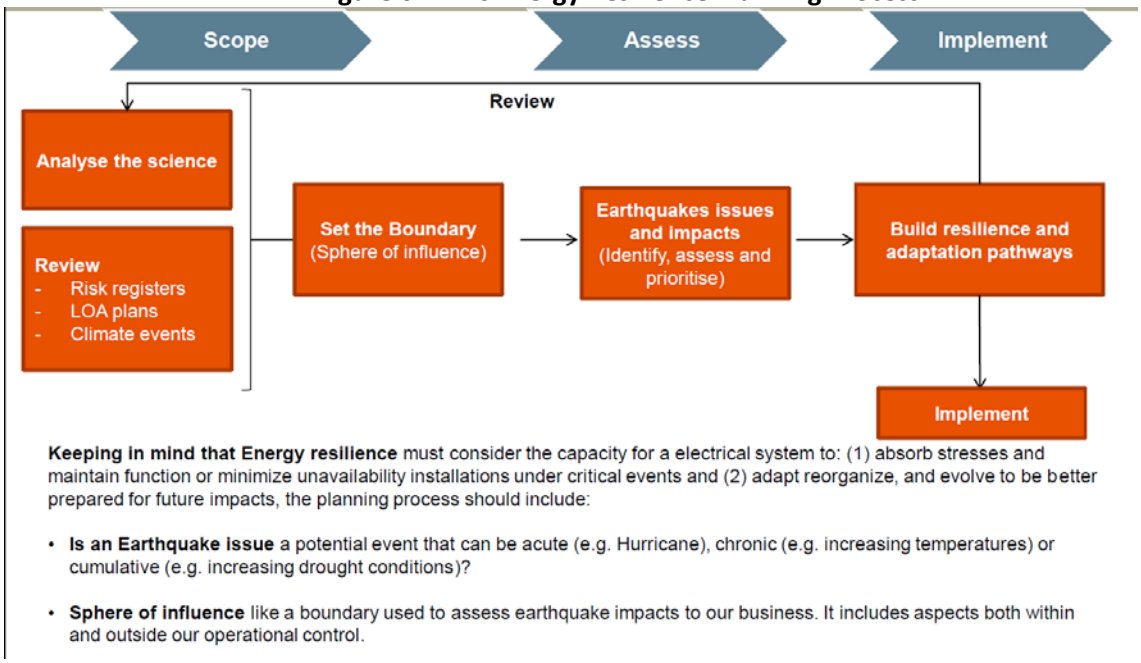
- BHP's energy resilience planning

BHP recognizes sustainability is integral to the company's business. Building energy resilience to the physical impacts of earthquakes and other disasters is essential to long-term business success with sustainability.

BHP's energy resilience planning process consists of the following three steps:

- (1) Scope: Analyze the problem (e.g., how historic events have affected the company's business), and set a boundary ("sphere of influence") of the event's impacts on the company's business.
- (2) Assess: Identify risks and assess how all the different actors within the company's sphere of influence view these risks.
- (3) Implement: Produce a guideline for these resiliency plans and implement these practices and plans in the company's processes.

Figure 6 BHP's Energy Resilience Planning Process



Source: BHP Chile

In addition, BHP has increased its preparedness for climate change in order to improve energy resiliency. As the basis of its energy resiliency concept, BHP considers other aspects that are also impacted by climate change, such as supporting resiliency planning in its host communities ("community resilience") or contributing to the resiliency of the environment ("environmental resilience"), together to improve the ability of its business to be ready for future impacts.

Panel Presentation #4 – Challenge of Resilience in the Energy Transition

Mr Oscar Alamos, Regulatory Specialist, ISA InterChile

Mr Alamos presented the energy transmission company ISA InterChile's efforts to strengthen the energy resiliency of Chile's transmission system.

The ISA Group is a business group with more than 50 years of experience in the energy and telecommunications sectors and is currently the largest electricity transmission company in South America, managing and operating more than 47,000 km of transmission lines through its affiliates.

- InterChile's transmission system in Chile

InterChile, an ISA affiliate in Chile, was created in 2012, after ISA received a contract from the Chilean government to construct, operate, and maintain 784 km of transmission lines, which have been in operation since May 2019. This project has allowed new sources of renewable energy, such as solar installations in the desert of Atacama in central Chile, to be connected to the economy's grid system.

Due to the intensifying natural disasters caused by climate change, Chile is seeking an aggressive energy transition from reliance on imported fossil fuels towards electrification based on renewable sources, which will also help reduce greenhouse gas (GHG) emissions. However, this transition will require a transmission system that allows flexibility in the network in order to accommodate fluctuations in power supply during

the transition to solar and wind energy. In December 2021, a consortium led by ISA Group was selected to build and operate the Kimal-Lo Aguirre project, one of the largest high-voltage electric power transmission projects in Chile and in South America.

- Innovative solutions in the transmission system

ISA has implemented innovative technologies to enable the network to adapt, respond, and recover more quickly to build more robust transmission systems. For example, a new 500 kV substation incorporates advanced measurement systems with fiber optics that improve the response time. It also uses gas-insulated technologies that reduce the space required for construction and maintenance requirements for of the facility.

ISA also introduced 'smart', flexible transmission systems, utilizing groundbreaking technologies from key global vendors such as GE, ABB, Siemens, and Hyosung. Incorporating cutting-edge technology allows the company to control electricity in a dynamic fashion and increase the protection capacity of the transmission line under certain conditions.

Figure 7 ISA's 'Smart' Transmission System

Source: ISA InterChile

Panel Presentation #5 – How the Energy Sector Can Build Resiliency by Adapting to Climate Change?

Mr Stéphane Godier, Head of Americas, AXA Climate

Mr Godier introduced the insurance company AXA Climate's approaches to helping the energy sector in Chile build resiliency against climate challenges, illustrating how financial institutions can help navigate investments in energy resiliency.

- Approaches to disaster resiliency in the energy sector

As an insurer, AXA Climate helps companies in the energy sector ensure energy resiliency against natural disasters and other catastrophes through four approaches:

1. Education: AXA provides an online platform to help companies engage and upskill their employees and the public for the transition to sustainability. The platform features six courses and over 50 microlearning chapters (videos and quizzes) on the science behind sustainability.
2. Services: AXA has created a hazard alert system to help companies monitor natural disaster risk

globally and deal with hazards. The alert system uses multiple communication channels to warn companies of hazards in advance (including floods, storms, earthquakes, wildfires, and tsunamis), so the companies can quickly respond and recover from the hazards.

3. Consulting: AXA helps companies understand how climate may impact their business and guides them on how they should adapt their assets and value chain to climate change – using climate change modeling resources, such as different scenarios of the Intergovernmental Panel on Climate Change (IPCC) and models from the Coupled Model Intercomparison Project 5 (CMIP5) over 2030 and 2050 horizons. The company leverages its climate expertise and data science knowledge to create a climate forecast and build climate indexes to better understand climate change and its impact on businesses. In particular, AXA's Climate Adaptation Advisory services, relying on insurance data and scientific modeling, help companies integrate climate risks into their prevention and insurance decisions and comply with climate-related disclosure objectives.
4. Insurance: AXA helps companies in the energy sector to ensure energy resiliency against natural disasters and catastrophes. Insurance is the way to mitigate risk on volatility and make sure that financial compensation is given.

Figure 8 AXA's Natural Catastrophe Risk Alert System

Source: AXA Climate

- Parametric insurance for climate risks

Insurance normally protects businesses from physical damage to their assets. It does not generally protect businesses from losses caused by a lack of renewable energy resources, such as wind, sunlight, or water. To cover such circumstances, AXA introduced parametric insurance based on climate indexes, to provide companies compensation for non-physical damages caused by climate disasters.

AXA's parametric insurance relates the volatility of a climate factor to a real loss in business operation. AXA calculates this correlation between the weather peril and the business losses based on the financial data of

its clients. For example, AXA measures how much wind or water is necessary for renewable energy production. Once AXA establishes the baseline on the required resources and available resources for energy production, AXA provides compensation to companies for the loss caused by lack of resources. Parametric insurance enables companies to minimize the risk associated with investing in energy projects that might be susceptible to natural disasters or climate change impacts.

5.1.4. Session 4. Moderated Panel Discussion and Q&A

Q1. How do you secure and justify investment in energy resiliency? Is there any mechanism to secure funding for energy resiliency? Are there any suggestions or concerns regarding how to secure funding for energy resiliency projects?

Mr Salamanca (BHP) pointed out that financial losses caused by natural disasters or climate change impacts can be large, and therefore a major incentive for private companies to implement energy resiliency measures. **Mr Godier** (AXA Climate) mentioned that climate insurance and other similar solutions can help encourage more large-scale investment in energy resiliency projects.

Ms Monteiro (CNE) said that the current payment structure for the transmission sector in Chile is relatively flexible compared to other sectors and allows companies to receive a certain return on their investment in resiliency. This has encouraged financial institutions to get involved in financing transmission resiliency projects. **Mr Alamos** (ISA InterChile) emphasized that it is essential to incorporate the importance of energy resiliency in energy policy. If price is prioritized more than resiliency in the infrastructure procurement process, private sectors might not invest in resiliency.

Mr Charlin (Chile Ministry of Energy) explained that the Ministry is working to introduce incentives to encourage investment in resiliency. Future procurement processes for transmission projects will place more emphasis on resiliency. He also mentioned the importance of considering the cost and benefit of energy resiliency projects to ensure an affordable energy supply.

Q2. For the government stakeholders, what are the most challenging issues in policymaking for energy resiliency? How have you addressed those challenges?

Ms Monteiro answered that it is important for the government to give the right signals to the private sector so that they are encouraged to invest in resiliency, for example, by setting appropriate resiliency standards. In 2021, CNE started an assessment of the transmission planning process in order to promote more reliable and resilient transmission systems in the economy. **Mr Charlin** explained that such revisions are possible in the transmission sector because the current framework in Chile allows certain flexibility. However, in general, it is challenging to revise the current methodology for assessment and planning in the power sector as it requires amendment of the existing laws. Chile is considering enhancing the integration of not only economic factors, but also social factors in future energy infrastructure planning.

Q3. How does Chile balance decarbonization and energy resiliency efforts?

Ms Monteiro said that Chile has plans to increase use of renewable energy to reduce reliance on imported energy sources. The Chilean ISO is currently conducting a study related to the grid requirements necessary to resolve intermittency issues related to implementation of renewable energy. Chile is also looking into the ancillary services market to introduce a mechanism to incentivize investment in energy resiliency and

improve electrical grid performance. **Mr Charlin** added that the Ministry of Energy is working to promote installations of large-scale batteries to enable more flexible grids to support renewable energy use.

5.1.5. Session 5. Closing Session

Closing Remarks

Mr Tetsurou Ito, Director of International Affairs Division, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan

Mr Daniel Charlin, Head of Resiliency and Risk Management, Ministry of Energy of Chile

Mr Ito and Mr Charlin thanked everyone for their participation. Mr Ito mentioned that Japan is planning to implement the "APEC Energy Resiliency Enhancement Project" as a continuation of this workshop project, aiming to identify indicators that can be used to assess energy resiliency in APEC economies as well as to develop sectoral guidelines focusing on energy infrastructure companies.

5.2. Chinese Taipei Workshop

5.2.1. Session 1. Opening Session

Opening Remarks from Project Overseer

Mr Tetsurou Ito, Director of International Affairs Division, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan

Mr Ito provided background information on the Energy Resiliency Principle and an overview of the workshop agenda and goals. He explained that the workshop aims to promote the understanding and dissemination of the Energy Resilience Principle, so that it can be used as a reference for economies as they pursue their own initiatives.

Opening Remarks from Host Economy

Mr Ming-Chih Chuang, Director, Bureau of Energy of Chinese Taipei

Mr Chuang explained the importance of a robust power system for Chinese Taipei as it is an island economy, which relies heavily on an isolated grid system. Chinese Taipei is now accelerating the development of smart grid, microgrid, distributed energy systems, and energy storage infrastructure as highlighted in the Energy Transition White Paper, which was approved in 2020. Mr Chuang mentioned that the workshop is intended to share knowledge and experience on energy resiliency in Chinese Taipei and partnering economies in Northeast Asia.

5.2.2. Session 2. Presentation of Energy Resiliency Efforts

Background and Purpose of the Energy Resiliency Principle

Mr Shintaro Fujimori, Chief for Energy Supply and Demand Policy Office, Agency for Natural Resources and Energy, the Ministry of Economy, Trade and Industry of Japan

Mr Fujimori presented the background and purpose of the APEC Energy Resiliency Principle. The Principle, formulated after the adoption of the Cebu Declaration, encourages voluntary efforts to contribute to energy resiliency across APEC economies.

Development of APEC Energy Resiliency Guidelines

Ms Nanako Hisamichi, Project Manager, Washington CORE

Ms Hisamichi presented the draft outline of APEC Energy Resiliency Guidelines to solicit input from the workshop participants. She covered the guidelines' background and objectives, development timelines, and the roles of stakeholder including governments, energy supply industries, energy consumers, and financial institutions. She also discussed five key approaches to energy resiliency, including:

6. Energy resiliency plan;
7. Investment and financing for energy resiliency projects;
8. Proper asset management;
9. Emerging technologies adoption; and
10. Multi-stakeholder knowledge sharing.

5.2.3. Session 3. Panel Presentations

Panel Presentation #1 – Chinese Taipei: Power System Infrastructure Resilience

Dr Chin-Chung Wu, Director of the Department of System Operations, Taipower

Dr Wu presented Taipower's efforts to strengthen its power system infrastructure resilience.

- Chinese Taipei's relevant Critical Infrastructure Protection Act

In Chinese Taipei, there are several types of risks that can endanger the power system and cause power supply instability, including natural disasters, extreme climate, intermittency associated with renewable energy, and human factors (e.g., terrorism, cyberattack). Therefore, the government has implemented the relevant Critical Infrastructure Protection Act, which requires that all critical infrastructure to: (1) implement risk assessment; (2) prepare a protection plan; and (3) conduct regular drills.

As an energy company that is responsible for power generation and grid operations of the entire power system of Chinese Taipei, Taipower's facilities are considered to be critical infrastructure. In accordance with the process illustrated in the figure below, Taipower has established safety protection plans.

Figure 9 Process of Critical Infrastructure Safety Protection Management in Chinese Taipei

Source: Taipower

- Ways to improve power system resilience

Taipower is dedicated to building power infrastructure resilience in the following ways: (1) speed up post-disaster recovery (e.g., emergency operation center); (2) repair equipment and train employees; (3) prevent disasters and reduce losses (e.g., risk assessment, regular drills, and exercises, strengthening of power grid).

During a disaster, Taipower's Emergency Operation Center (EOC) will coordinate available manpower and the resources as quickly as possible to restore power after outages. Its Disaster Prevention Management System (DPMS) will aggregate information on power outages, equipment status, and manpower to help shorten the time for power restoration.

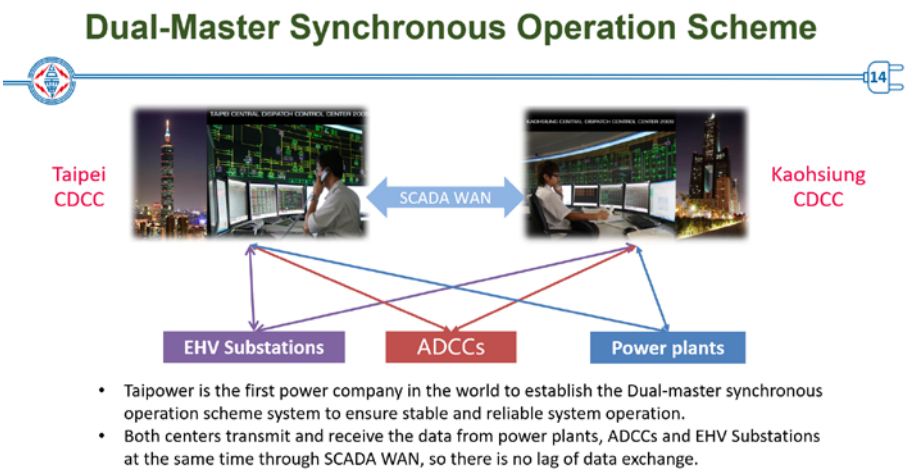
Under normal conditions, Taipower facilitates discussions on energy security issues, such as disaster prevention, counterterrorism, emergency repairs and smart grids with other economies around the world, and conducts regular drills based on various risk scenarios to improve disaster management capabilities

The scale and severity of damages to power systems caused by disasters has continued to worsen due to the impact of global climate change. Thus, Taipower has proposed three countermeasures: (1) strengthen utility poles (e.g. upgrade materials used for the utility poles to increase the engineering strength); (2) improve grid resilience (e.g. increase the number of automated feeders, expand the construction of smart substations, upgrade substations and distribution lines); and (3) implement underground power lines and grid enhancement projects.

- Dual-Master Synchronous Operation Scheme

Taipower is the first power company in the world to establish a dual-master synchronous operation scheme system to ensure stable and reliable system operation. The system consists of two separate centers located in the major cities of Kaohsiung and Taipei in Chinese Taipei. If any problem occurs in either city, the Central Dispatch Control Center (CDCC) in the other city is able to seamlessly take over and maintain the normal operation of power dispatch. Both centers can transmit and receive the data from power plants, Area Dispatch Control Centers (ADCCs) and Extra High Voltage (EHV) substations at the same time through SCADA WAN (Supervision Control and Data Acquisition Wide Area Networks), so there is no data exchange lag.

Figure 10 Taipower's Dual-Master Synchronous Operation Scheme



Source: Taipower

- Electricity Trading Platform

Taipower launched a new electricity trading platform to obtain sufficient ancillary services to address the challenges caused by the intermittent nature of renewable energy as the economy transitions to it. Qualified traders can participate in this trading platform with self-use or commissioned resources, such as self-use generators, renewable energy, basic power generation equipment, interconnected battery energy storage systems, and demand response (DR). This trading platform is expected to make available private decentralized resources to stabilize Taipower's power grid.

Figure 11 Structure of Taipower's Electricity Trading Platform

Source: Taipower

Panel Presentation #2 – Japan: Nihonbashi Smart City Project

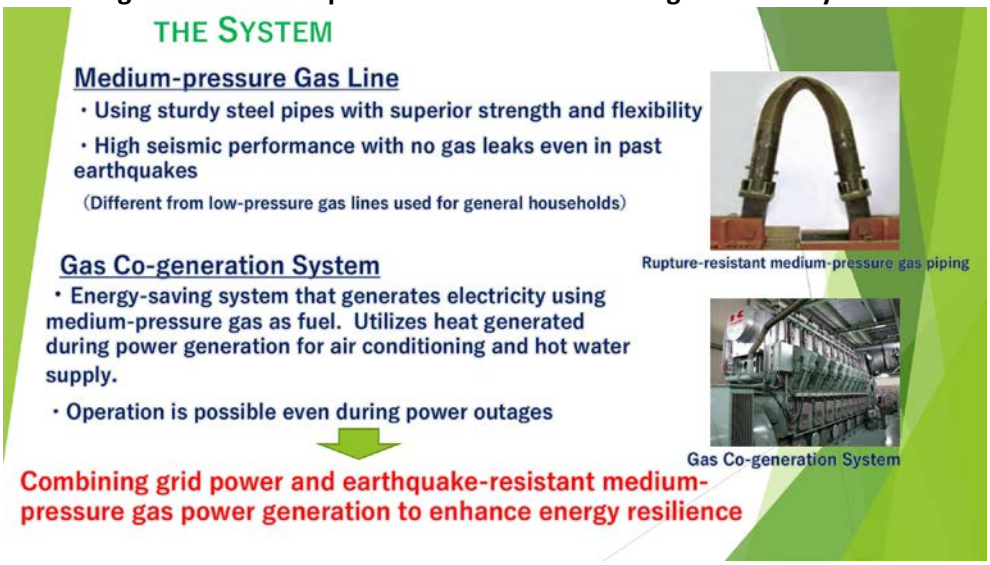
Mr Yukikazu Kawahigashi, Executive Manager of the Project Planning Division of the Environment and Energy Service Department, Mitsui Fudosan

Mr Kawahigashi focused on Nihonbashi Smart City, a project led by Mitsui Fudosan, a real estate company headquartered in Japan that develops and manages office buildings, retail properties and hotels. Mr Kawahigashi discussed approaches energy consumers can implement to strengthen energy resiliency.

- Back-up power generation from gas co-generation system

The Nihonbashi Smart Energy Project is a regional energy center. It utilizes large-scale co-generation system (CGS) fueled by pipeline gas to provide a stable supply of electricity and heat to areas surrounding Nihonbashi Muromachi district in Tokyo, including to existing buildings. The three-gas-engine CGS receives fuel from medium-pressure gas pipelines, which are resistant to disasters. The CGS offers highly efficient electricity and heat, which helps to reduce CO_2 emissions. The CGS generates a maximum of 23,000 kilowatts of electricity and a maximum of 116 gigajoules of thermal energy. The heat generated from the system is used for hot water supply and heating.

Figure 12 Medium-pressure Gas Line & Gas Co-generation System



Source: Mitsui Fudosan

- Disaster-resilient energy infrastructure and technologies

The Nihonbashi Smart City Project was initiated as a result of the 2011 Great East Japan Earthquake. The Nihonbashi Energy Center can continue to generate electricity and heat using CGS even if there is a widespread blackout caused by strong earthquakes or other disasters. The CGS was installed underground to minimize the impact of earthquakes. Concrete walls reaching up to the second floor in a pot-like structure were also constructed to ensure extra protection from flood and other water damage. The plant is sealed by a 30 cm-thick waterproof door at its opening to prevent flood waters from entering.

The Nihonbashi Energy Center was built with its own high security communications network that operates 24/7. It uses an energy management system, which incorporates the latest ICT to forecast energy demand and control equipment to improve operational efficiency. It uses information including past operational

data, weather forecasts, and event schedules to forecast the next day's electricity demand.

Buildings in the areas surrounding Nihonbashi Energy Center can receive sufficient energy from the center in times of crisis to sustain building operations, including 25 percent of lighting needs and 50 percent of air conditioning and elevators. Mitsui Fudosan is planning three more projects in Tokyo, aiming to improve the city's competitiveness by enhancing energy resiliency.

Panel Presentation #3 – Republic of Korea: New Resilience Strategies based on Cascading Outage Analysis to Enhance Power Grid Security

Dr Jin Hur, Professor of the Department of Climate and Energy Systems Engineering, Ewha Womans University

Professor Hur introduced a proposed cascading outage analysis method and new energy resilience strategies in Korea.

- Cascading outage simulation for energy grid security

A team led by Professor Hur is developing a new cascading outage analysis method to enhance power grid security. The team is proposing a new resiliency strategy to enable cascading mitigation and fast restoration using variable generating resources, such as wind and solar generating resources.

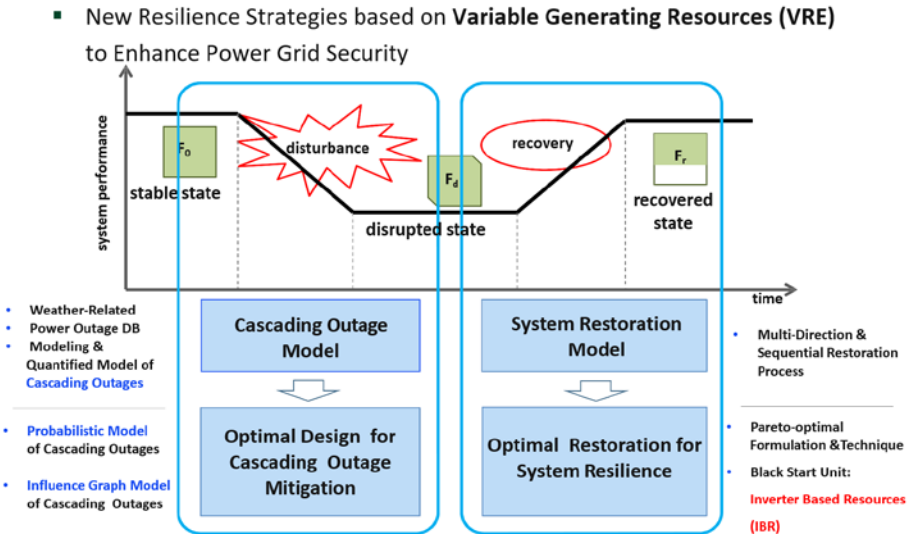
In Korea, utility companies are required to perform an evaluation of possible cascading outages caused by extreme events to meet the requirements in the North American Electric Reliability Corporation (NERC) standard, NERC TPL-004-4: Transmission System Planning Performance Requirement.

Utility companies evaluate the possibility of outages and impact on the energy system using simulations to develop a mitigation strategy. The evaluation is based on the analysis of an outage due to initial disturbances and consequent cascading outage (i.e., widespread electric service interruption). The strategy includes methods to minimize damage to power, such as system stabilization through load shedding.

- Future work for implementing power grid resilience

Korea Electric Power Corporation (KEPCO), a single transmission owner in Korea, is currently preparing a power grid resilience framework based on variable generating resources. Professor Hur's team, along with KEPCO, will enhance the optimal design for cascading outage mitigation and develop the system restoration model.

Figure 13 Future Work for Power Grid Resilience Framework in Korea



Source: Ewha Womans University

5.2.4. Session 4. Moderated Panel Discussion and Q&A

Q1. Smart energy projects and infrastructure modernization require substantial investment. How do you secure and justify investments when implementing energy resiliency?

Mr Kawahigashi (Mitsui Fudosan) answered that the basic scheme for the Nihonbashi Smart City Project was to recover investments in generation equipment and other facilities through an energy tariff over a useful life of 20 years, with the initial investment financed by financial institutions. In addition, the company received partial subsidies from the Japanese government as well as the Tokyo metropolitan government as the project contributes to improving resiliency. **Dr Wu** (Taipower) said that because the Chinese Taipei government's "Smart Grid Masterplan" designated Taipower as an implementer of the plan, the government funded Taipower's grid resiliency measures.

Q2. While energy resiliency planning involves multiple steps such as stakeholder engagement, risk assessment, identifying critical infrastructure, etc., what are the key elements that require special consideration to develop effective resiliency plans?

Dr Wu pointed out that it is important to incorporate climate challenges into resiliency planning. Thus, Taipower's smart grid implementation aims to improve the climate resiliency of power systems in all aspects, such as establishing countermeasures in preparation for the occurrence of multiple disasters at the same time. **Professor Hur** emphasized the importance of defining the concept of resiliency, as Korea is now determining the definition and the method of power grid resilience. **Mr Kawahigashi** added that it is difficult to get people to cover the cost of energy resiliency projects because resiliency tends to be considered as an insurance against future disasters and lower in priority. Therefore, it is important to promote the economic and environmental benefits of energy resiliency efforts.

Q3. The intermittent nature of renewable energy was identified as one of energy resiliency challenges. What measures have your organizations taken to address the challenge?

Dr Wu said that Taipower is actively introducing 5G, AI, IoT, and big data technologies to build a smart grid and promote demand-side management. It also uses machine learning and other technologies to obtain real-time demand and supply data in order to tackle the intermittent nature of renewable power generation. Taipower installed 1.1 million smart meters in 2020, which are used to provide customers with electricity consumption data and visualization, encouraging them to reduce power usage based on real-time energy supply data. **Professor Hur** added that it is important to introduce appropriate decision-making support tools (e.g., AI, IoT, or power grid control room) and help employees acquire knowledge through training and experience. **Mr Kawahigashi** said that Mitsui Fudosan also widely utilizes IoT technologies in its energy management systems for demand forecasting and optimal operation control. The company is now seeking to improve computation speed, which would enable more precise site control.

Q4. Are there any other stakeholder categories that should be considered to engage in the discussion of energy resiliency?

Dr Wu answered engagement with stakeholders is important to secure sufficient resources to enhance grid resiliency. Taipower launched a new electricity trading platform in November 2021 to incentivize utilization of external resources, including demand response, self-use generators and battery energy storage systems in order to ensure stable power supply through seasonal demand fluctuation.

Q5. In addition to the five approaches in the draft energy resiliency guidelines, are there any other approaches that should be added to the list?

Dr Wu pointed out that asset management is key among the five approaches. Taipower has prepared for climate change and green energy transition in its asset management plans by replacing equipment and strengthening maintenance efforts. **Professor Hur** said that risk analysis is important for managing power facilities, especially transmission substations and transformers. In Korea, power utility company KEPCO and power system operator Korea Power Exchange (KPX) are developing a mathematical index or matrix for grid resilience risk analysis.

Q6. Based on your experience, what is the most effective energy resiliency approach? What is the most critical aspect to be included in the Energy Resiliency Guidelines?

Dr Wu said that diversification of energy resources and securing of sufficient energy reserves are crucial to achieving a stable power supply. For this purpose, Taipower is acquiring power from an electricity trading platform, and utilizing cutting edge energy technologies, such as carbon capture, utilization, and storage (CCUS), offshore wind farms, and battery energy storage systems. **Professor Hur** said that securing investments in energy resiliency is the most important. Governments may experiment with a competitive energy market to promote investment from financial institutions. For example, the Korean government is planning an electricity market pilot in Jeju Island, a remote island in Korea, as part of the economy's efforts to encourage investments in smart grid technology.

5.2.5. Session 5. Closing Session

Closing Remarks

Mr Tetsurou Ito, Director of International Affairs Division, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan

Mr Ming-Chih Chuang, Director, Bureau of Energy of Chinese Taipei

Mr Ito and Mr Chuang thanked everyone for their participation. Mr Ito stated that Japan is planning to implement the "APEC Energy Resiliency Enhancement Project" as a continuation of this workshop project, aiming to identify indicators that can be used to assess energy resiliency in APEC economies as well as to develop sectoral guidelines focusing on energy infrastructure companies.

5.3. The Philippines Workshop

5.3.1. Session 1. Opening Session

Opening Remarks from Project Overseer

Mr Tetsurou Ito, Director of International Affairs Division, Ministry of Economy, Trade and Industry of Japan

Mr Ito provided the background of the Energy Resiliency Principle and an overview of the Philippines workshop agenda and goals. The workshop aimed to disseminate the Principle, and share knowledge and experiences on energy resiliency in the Philippines.

Opening Remarks from Host Economy

Mr Felix William B. Fuentebella, Senior Undersecretary of Energy, Department of Energy of the Philippines

Philippines' Department of Energy Senior Undersecretary Fuentebella recognized the importance of a resilient energy sector due to the economy's vulnerability to natural and human-induced hazards, which have disrupted the delivery of energy goods and services, affecting the Philippines' economy and people's daily lives.

He emphasized the importance of the private sector, civil society, development partners, and multilateral development partners to invest in improving resiliency through technical assistance and funding. Further, he suggested that APEC economies should consider a policy mechanism that provides funding support for rehabilitation programs. The Philippines' energy sector also collaborates with international partners to develop science- and evidence-based frameworks and strategies in order to enhance its resilience system and infrastructure and disaster response capabilities.

He recalled the establishment of the APEC Energy Resiliency Task Force during the 2015 APEC Energy Ministers meeting held in Cebu, Philippines, which also led to the adoption of energy resiliency in the plans and programs of the Department. He noted the creation of the Philippine DOE's Task Force on Energy Resiliency (TFER) and the requirement that the energy industry submit a Resiliency Compliance Plan which will determine the best practices for building better infrastructure and more efficient systems. He mentioned several initiatives that promote energy resiliency in the Philippines, including the APEC workshop on improving energy resiliency in off-grid areas in APEC member economies, an energy consumer and stakeholders conference with the theme "strengthening governance and resiliency in the energy sector," and the E-Power Mo, a strategy to enhance energy resiliency in the Philippines. The Philippines will work

together with other APEC member economies to adopt existing protocols and guidance in energy resiliency.

Finally, he encouraged the participants to work together to encourage the development and adoption of guidelines that account for the varying conditions of economies.

5.3.2. Session 2. Presentation of Energy Resiliency Efforts

Background and Purpose of the Energy Resiliency Principle

Mr Yuya Uno, Deputy Director of Energy Supply and Demand Policy Office, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan

Mr Uno provided the background and purpose of the APEC Energy Resiliency Principle. He explained that energy is the most essential service which provides a basis for various social and economic activities. While the recent agreement among APEC economies urges investing in energy resilience, energy resilience could be a new criterion of socially sustainable activity in the context of sustainable finance.

Development of APEC Energy Resiliency Guidelines

Ms Nanako Hisamichi, Project Manager, Washington CORE

Ms Hisamichi presented the draft outline of APEC Energy Resiliency Guidelines to solicit input from the workshop participants. She covered the guidelines' background and objectives, development timelines, and the roles of stakeholder including governments, energy supply industries, energy consumers, and financial institutions. She also discussed five key approaches to energy resiliency, including:

1. Energy resiliency plan;
2. Investment and financing for energy resiliency projects;
3. Proper asset management;
4. Emerging technologies adoption; and
5. Multi-stakeholder knowledge sharing.

5.3.3. Session 3. Panel Presentations

Panel Presentation #1 – NGCP's Energy Resilience Challenges and Measures

Mr Giovanni Randolfo A. Galang, Assistant Vice President and Head of the Technical Management Department, National Grid Corporation of the Philippines

Mr Galang introduced the National Grid Corporation of the Philippines (NGCP), the sole transmission services provider in the Philippines. He presented the NGCP's preparation measures to mitigate the impact of disasters on its transmission facilities, and shared NGCP's resilience measures and its ability to recover from and reduce the magnitude of power disruption. NGCP highlighted its proactive approach to disaster risk reduction and management.

- NGCP's disaster management measures

The Philippines was ranked fourth in the world among the economies most affected by extreme weather events, according to the Global Climate Risk Index from 1998 to 2017, by Germanwatch, a Bonn, Germany-

based nonprofit public policy organization. On average, the Philippines is hit by 26 earthquakes and typhoons per year.

In this context, NGCP has implemented various disaster management measures, such as provision of sufficient backups for emergency. This includes emergency restoration systems, steel poles, spare transformers, and mobile transformers. Also, NGCP is empowering its partner communities through disaster risk reduction trainings. NGCP ensures that its command centers are fully equipped and have well-trained personnel.

- NGCP's Integrated Disaster Action Plan

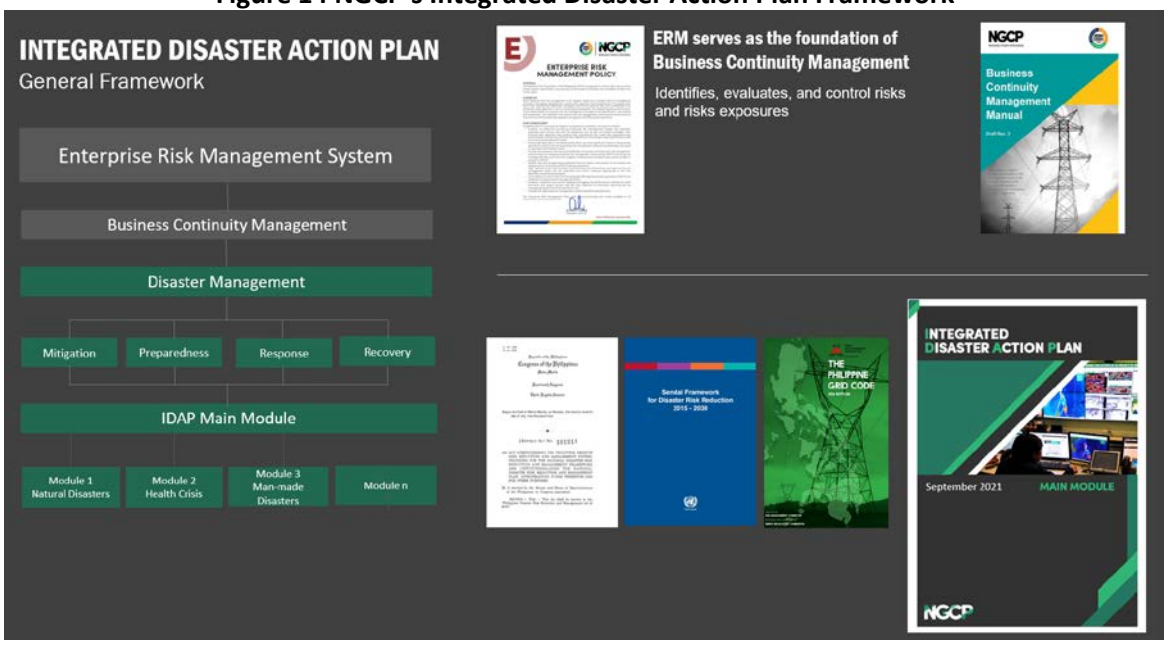
NGCP's Integrated Disaster Action Plan (IDAP) serves as the general framework that prescribes end-to-end emergency and rehabilitation procedures to ensure the readiness of all its transmission facilities. The IDAP considers the use of internationally accepted principles and adoption of a holistic disaster risk management approach as contained in Republic Act No. 10121. It involves the four thematic areas of mitigation, preparedness, response, and recovery.

The IDAP consists of a main module - which is based on the Sendai Framework for Disaster Reduction and the Philippine Grid Code - and disaster specific modules, which include Natural Disasters, Health Crises, and Man-made Disasters. Under the IDAP framework, the following plans and guidelines relevant to resiliency planning have been developed:

- Integrated Disaster Action Plan: Main Module
- Integrated Disaster Action Plan: Module 1 – Natural Disasters
- Transmission Development Plan 2020-2040
- Business Continuity in the Time of Health Crisis Guidelines
- National Grid Corporation of the Philippines-Computer Emergency Response Team Manual

The figure below illustrates NGCP's Integrated Disaster Action Plan framework.

Figure 14 NGCP's Integrated Disaster Action Plan Framework



Source: National Grid Corporation of the Philippines

- Overall Command Center

NGCP has a four-tiered Disaster Management structure, including corporate, region, district, and individual facility tiers. Its Overall Command Center serves as its communication arm with regional counterparts. It is the focal station to monitor weather disturbances and other contingencies and the nerve center for drills, coordinating responses, resource mobilization, and information management during disaster operations and other events. It has links to the Philippines' weather bureau and satellite images from the Joint Typhoon Warning Center (JTWC) in Hawaii and Japan Meteorological Agency (JMA).

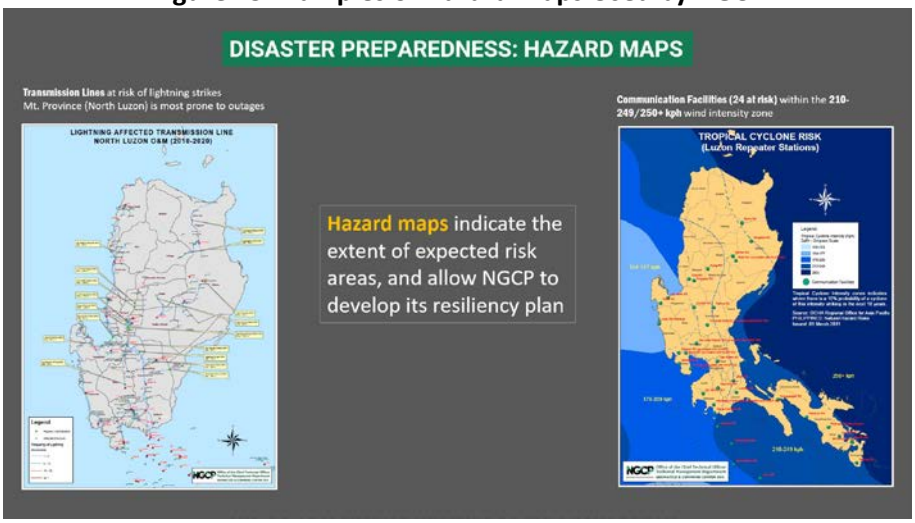
- Grid resiliency measures

In the alignment with the Philippines' Energy Resiliency Policy (DOE Department Circular No. DC2018-01-001), NGCP has developed the Grid Resiliency Plan. The key elements of the Grid Resiliency Plan include:

1. Adherence to "Build Back Better" principle;
2. Resilient and robust grid configuration;
3. Technology-based planning and decisions;
4. Enhanced asset management;
5. Adoption of emerging technologies; and
6. Covering all disruptive event domains (human, physical, cyber).

NGCP's grid planning is based on risk assessment. NGCP selects sites for its substations and transmission line routes using criteria based on updated hazard maps from government agencies. NGCP also enhances its asset management by adapting international best practices, such as use of a database for asset management and prioritization for allocation of resources based on asset conditions.

Figure 15 Examples of Hazard Maps Used by NGCP



Source: National Grid Corporation of the Philippines

NGCP's disaster preparedness involves the use of maps for hazards including floods, landslides, lightning strikes, and wind intensity zones. Such hazard maps provide important information to help NGCP understand the risks of natural hazards to its transmission facilities and develop its resiliency plan accordingly. Hazard maps enable asset management based on risk assessment. For example, determining where to build bored pile foundations and slope protection for transmission facilities.

NGCP is also adapting emerging technologies, such as energy storage systems and smart grid. NGCP has an ongoing initiative to support the integration of increasing amounts of renewable energy into the grid. Lastly, NGCP's Integrated Disaster Action Plan calls for the creation of an Electricity Resilience Model (ERM) team whose roles include development and deployment of a modeling system for grid planning and real-time resiliency analysis. The ERM team will conduct annual needs assessment activities to ensure the organization can effectively perform highly specialized activities, such as data analytics, extreme event grid planning, big data management, data visualization, and cybersecurity to enhance energy resiliency.

Panel Presentation #2 – Powering Progress for the Future: Energy Resiliency at Pilipinas Shell

Lorelie Quiambao Osial, President and CEO, Pilipinas Shell Petroleum Corporation

Ms Osial highlighted Pilipinas Shell's energy resiliency initiatives in the Philippines.

- Strategies for energy security

The unprecedented crisis of the COVID-19 pandemic disrupted the oil and gas value chain. Pilipinas Shell has an effective business continuity plan and a disaster response plan that can facilitate response for a single or multiple different crises. The company conducts an after-action review for disasters, such as super typhoons, and incorporates the lessons learned into its business continuity and disaster response plans to ensure continuous improvement.

Pilipinas Shell has been working to improve its supply chain to achieve a more affordable and reliable energy supply. For example, the transformation of the Tabangao Refinery to Shell Import Facility Tabangao (SHIFT) is pivotal to strengthening the energy supply chain with a capacity of 263 million liters (ML). SHIFT is well positioned to meet the demand of Metro Manila, South Luzon, and Northern Visayas. Shell also established an outside supply point in Subic. These developments, together with Shell's North Mindanao import facility in Cagayan De Oro (CDO), complement the supply chain triangle that Pilipinas Shell has created. By 2025, Pilipinas Shell aspires to increase its number of medium range terminals from 3 to 5.

Shell PLC also invests in diversification of energy sources, including renewables and new energies. The Tabangao import terminal is 100% powered by a combination of solar, geothermal, and hydro energies. Additionally, the solar farm onsite, which has over 5,200 solar panels and seven inverters, can generate up to 300-megawatt hours of power.

- Strategies for decarbonization

Shell Plc has a target to become a net zero emissions energy business by 2050 by reducing emissions from its operations and from the energy product it sells, and by capturing and storing any remaining emissions using technology or balancing them with offsets.

Shell PLC continues to manage the environmental impact of its terminals and depots, by complying with environmental regulations and standards for its emissions and effluence. The move to transform the Tabangao refinery resulted in a 50% reduction in the company's direct GHG emissions. In the coming years, Pilipinas Shell aims to transform its business, providing more low carbon energy options such as biofuels, hydrogen, electric vehicles charging, and electricity generated by solar and wind power.

Panel Presentation #3 – The Role of the Private Sector in Energy Resiliency

Mr Rene Jose Sayoc Meily, President, Philippine Disaster Resilience Foundation

Mr Meily presented the Philippine Disaster Resilience Foundation's (PDRF) role in private sector-led energy resiliency efforts in the Philippines.

- Private sector-led emergency operations system

PDRF is a private sector-led disaster management organization that includes many of the major business groups in the Philippines. PDRF operates through a cluster system, which has eight industries, including: (1) water & sanitation; (2) infrastructure; (3) logistics; (4) finance & insurance; (5) ICT; (6) search & rescue/medical; (7) food & non-food; and (8) power, fuel & energy.

PDRF operates the first private sector-led Emergency Operations Center (EOC) in the region, based in the Clark Freeport and Special Economic Zone. The hub operates 24/7 using advanced communications software and technology to monitor climate related and natural hazards in close coordination with deployed resources in the field. It also serves as a training center for disaster preparedness and for the coordination of relief and response efforts during major disasters.

- Energy sector contingency plan

In 2018, the Philippine Department of Energy, in partnership with the PDRF, initiated the updating of the 2002 National Energy Contingency Plan. This calls for greater coordination among the private sector and the government of the Philippines. Based on the plan, PDRF and the government conduct joint planning, simulations, and drills in preparation for large scale earthquakes in Metro Manila.

Figure 16 Energy Resiliency Collaboration between PDRF and the Philippine Government

Source: Philippine Disaster Resilience Foundation

- Task Force Kapatid

PDRF supports building the disaster response capabilities of the Task Force Kapatid (which means "brotherhood" in the Filipino language). When a disaster strikes, thousands of linemen from several private companies get dispatched to the disaster-stricken areas to support the local utility companies. PDRF plays a vital role in coordinating resources among its member companies during crises. During disaster response for

Typhoon ODETTE (International Name RAI), the PDRF was able to coordinate the availability of barges and ships with the member companies of its logistics cluster to transport vehicles and equipment to distant islands to help restore power.

- Disaster risk training & financing options

PDRF also provides support for capacity building. PDRF offers training to help energy sector stakeholders be prepared for future catastrophes. It offers courses in tropical weather, earthquakes, household preparedness, and business continuity. Among its courses are courses on the incident command system and operating emergency operations centers. Since the COVID-19 pandemic, PDRF has shifted to online forums, creating its own online platform called "I Adapt".

PDRF is also promoting several disaster risk financing options. First, PDRF met with the UN Development Programme (UNDP) and BPI Capital to discuss producing a climate resiliency bond. In one example of this financial model, the Department of Energy acts as a bond issuer. The money raised from the sale of the bonds to social investors in the Philippines and throughout the world can be used to build energy resilient facilities. Another major tool is insurance, which can cover much of disaster-related damage and help accelerate the restoration of power facilities after disasters.

Panel Presentation #4 – DOE Philippines' Energy Resiliency Efforts and Best Practices

Mr Michael O. Sinocruz, OIC-Director of Energy Policy and Planning Bureau, Department of Energy of the Philippines

Mr Sinocruz introduced the Philippine Department of Energy's (PDOE) various policy measures to enhance the economy's energy resiliency.

- Energy Resiliency Policy

PDOE issued the Department Circular No. DC2018-01-0001, "Adoption of Energy Resiliency in the Planning and Programming of the Energy Sector to Mitigate Potential Impacts of Disasters", which is also called Energy Resiliency Policy (ERP) to increase the reliability of the economy's energy systems against the effects of natural calamities. The ERP provides the legal basis for energy resiliency efforts in the Philippines. It aims to promote disaster risk reduction measures in the existing infrastructure as well as future investment, for example, by developing resiliency standards that will be used as the basis for future construction of energy facilities.

To ensure continuous policies, plans and programs, the energy resiliency is integrated in the "Philippine Energy Plan" that covers the period of 2020 to 2040. The plan highlights the strategic focal points on the following two aspects.

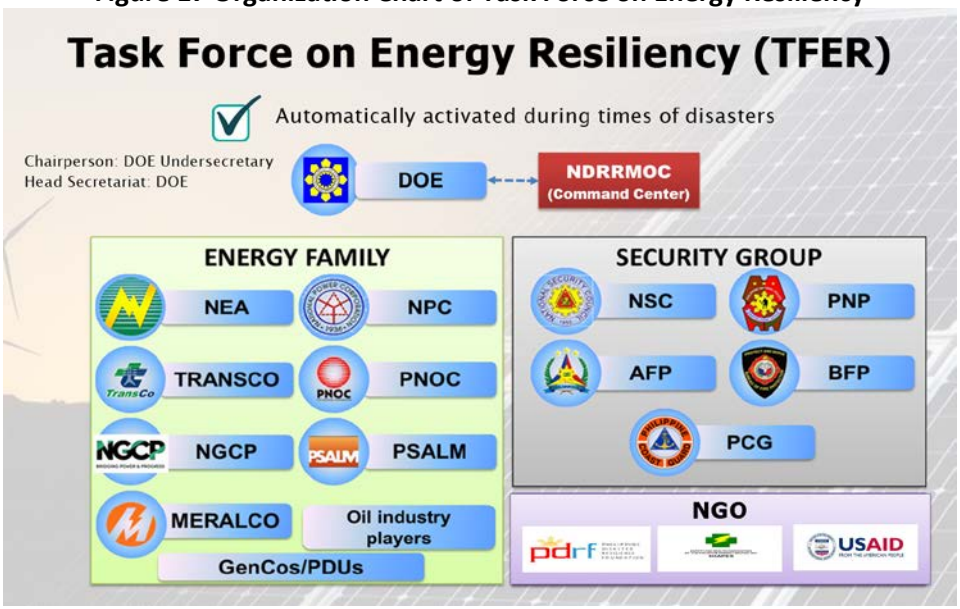
(1) Energy Resiliency: Assessment of Resiliency Compliance Plan (RCP), energy sector preparedness measures, energy sector disaster response during the COVID-19 pandemic, preparedness and management for compound disasters, rehabilitation of damaged facilities through the "Build Back Better" principle, and development of disaster risk financing and insurance.
(2) Energy Security: Oil and gas security (e.g., external oil supply disruption, oil and gas exploration, smuggling of oil products, etc.), and power system security (e.g., cybersecurity threat, bombing of transmission facilities, insurgency in rural electrification areas, etc.).

- Task Force on Energy Resiliency

The DOE Department Circular No. DC2018-01-0001 created the Task Force on Energy Resiliency (TFER), which is chaired by the Senior Undersecretary of the Department of Energy. It is composed of various energy companies, security groups, and non-governmental agencies. TFER addresses resiliency challenges and is currently focused on the electricity sector and oil sector.

For the electricity sector, TFER coordinates with different stakeholders, such as the National Disaster Risk Reduction Management Council (NDRRMC) for power restoration activities, and the PDRF for logistic and response concerns. For the oil sector, TFER ensures stable oil supply in ports for timely delivery of petroleum products. For example, the DOE implements and monitors a price freeze for LPG and kerosene in areas that have declared a state of calamity. The TFER ensures reasonable oil prices for disaster areas with an oil price hike, and creation of a centralized directory of contact people for all oil companies for response activities.

Figure 17 Organization Chart of Task Force on Energy Resiliency



Source: Department of Energy of the Philippines

When an emergency or a natural disaster occurs, or even prior to it, the PDOE automatically activates TFER, which convenes a meeting to look at preparedness, stockpiling, systems, and related issues. TFER also conducts regular meetings during the event, and a post-event evaluation after the event.

During calamities, once the power supply is affected in certain areas, Task Force Kapatid and other distribution utilities provide manpower support to the affected distribution utilities so that they can immediately restore the electricity supply. Aside from manpower, distribution utilities also share equipment, materials, among others.

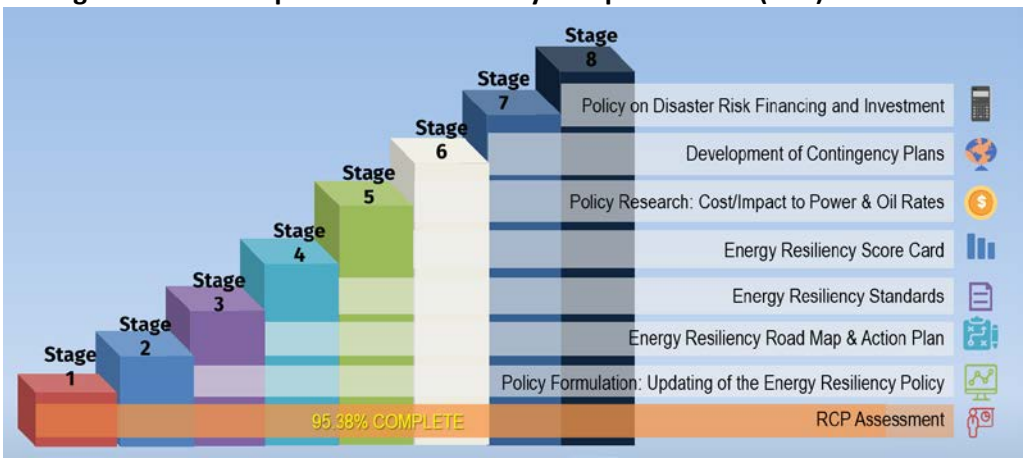
- Resiliency Compliance Plan

The ERP requires all energy industry stakeholders, including electric cooperatives and distribution utilities, to submit a “Resiliency Compliance Plan (RCP)” that contains structural and non-structural measures to

strengthen energy resiliency – which are categorized into the following four pillars: (1) strengthening infrastructure; (2) stockpiling; (3) systems development; and (4) response and recovery. The energy industry stakeholders were given six months to submit their RCPs, which would be reviewed at least once every three years.

In 2021, the TFER Secretariat partnered with the U.S. Agency for International Development (USAID) Energy Secure Philippines (ESP) Team to conduct an evaluation of 161 RCPs submitted by generation, transmission, and distribution companies and electric cooperatives. In addition, TFER and USAID ESP are planning to evaluate RCPs submitted by the oil industry. Based on the results of RCP evaluation, PDOE will update the existing ERP to address any gaps and challenges in energy resiliency policy. Part of the ERP update will be formulating the Energy Resiliency Standards and the Energy Resiliency Scorecard.

Figure 18 Next Steps after the Resiliency Compliance Plan (RCP) Assessment



Source: Department of Energy of the Philippines

- Challenges and lessons learned during disaster response and early recovery

During the recent disaster response and early recovery activities for Super Typhoon Odette in December 2021, PDOE identified several challenges to the economy's energy resiliency, such as weather disruptions of marine transportation of repair equipment; disaster response operations cancelled due to personnel testing COVID-19 positive; insufficiency of fuel supply for diesel power plants; and spikes in prices of petroleum products in disaster-stricken areas.

As a result, PDOE is proposing the following policy recommendations:

(1) Introduce provision to promote solar energy in the residential sector in remote areas,
(2) Introduce provision to encourage installation of mobile generators for critical infrastructure,
(3) Review the existing resiliency standards for transmission and distribution sectors,
(4) Review the existing policy on stockpiling
(5) Develop pre-arrangements for the logistics cluster's disaster response (e.g., inventory and transportation of logistics) with the NDRRMC and NGOs (e.g., PDRF),
(6) Institutionalize Task Force Kapatid membership and management,
(7) Conduct research on disaster risk financing and investment,
(8) Formulate a protocol on emergency oil rationing during disasters,
(9) Review and enhance the oil price monitoring to prevent oil price hikes,

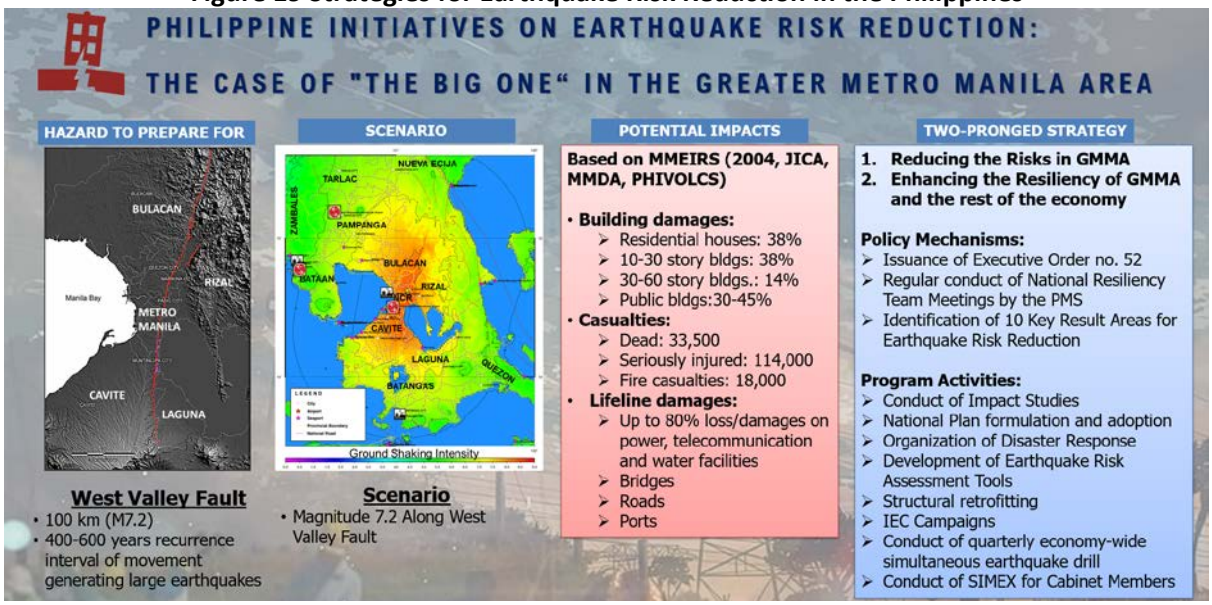
(10)Enhance disaster reporting and database.

- Initiative to update the National Energy Contingency Plan

The PDOE is currently updating the National Energy Contingency Plan (NECP) in preparation for a large-scale earthquake (i.e., magnitude 7.2) in the greater Metro Manila area. The update aims to harmonize the energy sector's system response with pre-identified disaster scenarios and to strengthen coordination, communication, and interoperability of the concerned energy industry participants. The update is expected to be completed by May 2022.

The update incorporates two strategies: (1) reducing risks in the greater Metro Manilla area; and (2) enhancing resiliency of this area and the rest of the economy. The policy mechanisms and program activities associated with the strategies are detailed in the following figure.

Figure 19 Strategies for Earthquake Risk Reduction in the Philippines



Source: Department of Energy of the Philippines

Panel Presentation #5 – Tools to Enhance Energy Resilience Financing

Mr John Aaron Edgar, Office Director for Environment, United States Agency for International Development-Philippines

Mr Edgar introduced the tools that U.S. Agency for International Development (USAID) has proposed to use in enhancing energy resiliency financing in the Philippines.

- Energy Secure Philippines

Strengthening resiliency is one of USAID's key priorities, as embodied in the agency's draft Climate Strategy Framework. The framework was announced at the 2021 United Nations Climate Change Conference (COP26) in Glasgow to engage the private sector to increase equitable access to finances to support resiliency adaptation and mitigation actions.

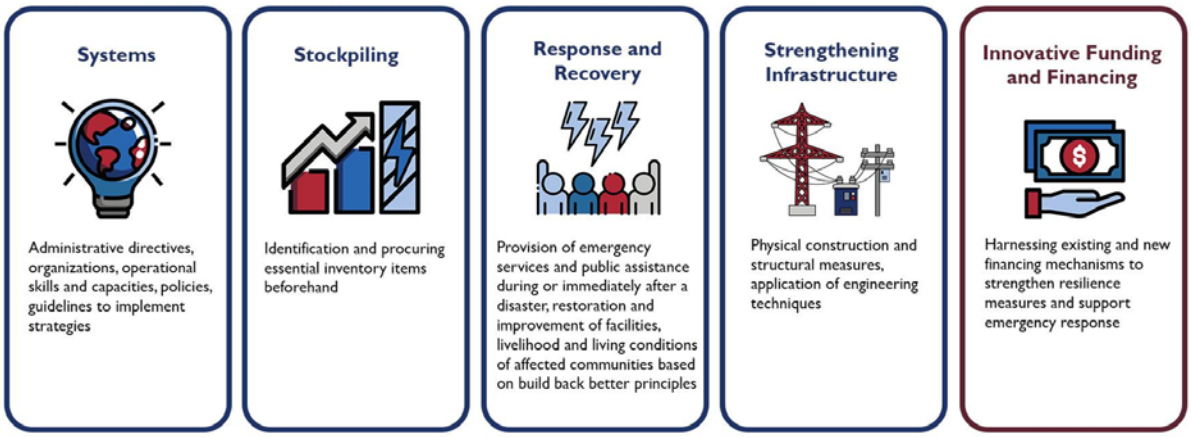
In 2020, USAID, in partnership with PDOE, launched a key resilience initiative in the Philippines' energy sector, called Energy Secure Philippines (ESP). The project is designed to help the economy enhance energy reliability and security given the nature of its unified power system. The project has invested 1.7 billion pesos ($34 million). Ultimately, ESP aims to mobilize more than 38 billion pesos, or $750 million, of private resources for, among others, new renewable or clean energy projects amounting to 500 megawatts of generation capacity. Under the ESP, USAID is also implementing several energy resiliency activities including: a grant center contract to offer $7.5 million in grants to the private sector, NGOs, and civil society to promote energy resiliency; and a review of RCPs submitted from over 230 facilities – both power and oil/gas sectors.

- Energy Resilience Scorecard

USAID is now supporting PDOE to create an "Energy Resilience Scorecard", which depicts broader risk modeling and measures resiliency performance against the Philippines' and international resiliency benchmarks. The scorecard is expected to serve as a valuable guide for policy formulation as well as targeted training on energy resiliency.

As illustrated in the figure below, innovative funding and financing is a critical component of the Energy Resilience Scorecard, as it can allow for evidence-based decision making on resource allocations. USAID and PDOE will have a continuous dialogue on innovative funding and financing schemes, along with potential applications of the resilience scorecard.

Figure 20 Five Pillars of Resilience Scorecard



Source: United States Agency for International Development

5.3.4. Session 4. Moderated Panel Discussion and Q&A

Q1. What factors help secure funding for energy resiliency internally and externally? What concerns and challenges are associated with securing financing?

Mr Galang (NGCP) mentioned that the vulnerability of transmissions infrastructure can increase the long-term cost of investments in transmission facilities. An enhanced resiliency standard, which ensures transmission facilities are "climate proof", can serve to justify and encourage the investments.

In addition to the importance of a resiliency standard, **Mr Meily** (PDRF) said that government tax breaks for the private sector can help secure financing for resilience investments, as illustrated by past cases in which

tax breaks successfully encouraged the deployment of renewable energy projects. **Mr Sinocruz** (PDOE) emphasized that the PDOE is providing energy resiliency-related funding for affected electric cooperatives from the $15 million Electrical Cooperative Emergency and Resiliency Fund, and it now seeks to come up with a new financing framework for energy resiliency by the end of 2022, through an initiative supported by USAID.

Mr Edgar (USAID) echoed that the private sector in the Philippines can play an important role in financing energy resiliency measures – particularly prevention measures, which have long-term benefits and hopefully provide a return on investments. **Ms Osial** (Pilipinas Shell) added that a robust government policy can incentivize not only energy companies but also consumers to change their behavior toward more sustainable energy usage as well as investment in energy resiliency.

Q2. What are the areas that mostly urgently require capacity building for energy resiliency? What are the ways we can foster grassroots community engagement in such efforts?

Mr Edgar suggested that a government policy framework should be enhanced to better encourage the private sector to invest in energy resiliency. For example, a new law passed in the Philippine legislature aims to promote community microgrid development, presenting a robust opportunity for private companies to play an important role in improving energy access through microgrids. Similar policy approaches can be introduced for energy resiliency. **Ms Osial** said needs assessment is important for stakeholders to understand the actual needs of the surrounding community. In this sense, partnerships with local governments and other grassroots organizations should be strengthened to better understand current and future risks and come up with an integrated solution tailored to the specific case. **Mr Meily** added that PDRF is cooperating with local communities through "community mapping" activities, in which members of the communities provide PDRF with information about hazard risks specific to the local area as well as planning details, such as evacuation routes. Using input from the community, a 3D map is developed to help member companies identify any issues or hazards that could lead to disasters like wildfires.

Q3. What are some examples of resiliency measures targeting oil pipeline infrastructure?

Ms Osial answered that Shell looks at resiliency of oil pipeline infrastructure from a life cycle perspective, which includes financing, design, operation, and maintenance. The environmental and geographical landscape changes over time, so it should be considered whether such changes would have any implications for current/future risks of human-induced or natural disasters.

5.3.5. Session 5. Closing Session

Closing Remarks

Dr Kazumoto Irie, President of the Asia Pacific Energy Research Centre (APERC)

Mr Michael O. Sinocruz, OIC Director of Energy Policy and Planning Bureau, Department of Energy of the Philippines

Dr Irie and Mr Sinocruz thanked everyone for their participation. Dr Irie stated that the insightful presentations and discussions during the workshop will make a great contribution to the development of the APEC Energy Resiliency Guidelines. Dr Irie added that the Japanese government and the APERC will continue

to promote energy resiliency issues in APEC through the “Energy Resiliency Enhancement Project.”

Mr Sinocruz pointed out that energy resiliency is critical, particularly for developing economies, and emphasized the importance of investment, subsidies, and financial assistance to support energy resiliency to adapt to climate change. He also asserted the importance of collaborative efforts among public, private, and non-governmental organizations to develop an energy sector that is resilient to both natural disasters and other emergencies. He said that he hopes valuable insights provided by the event will bring APEC economies one step closer to the realization of resilient and sustainable energy systems, which is especially vital in light of current global energy supply chain disruptions.

Appendix 1: Workshop Analysis

Participants Overview

A total of 342 individuals registered for the three workshops, and a total of 293 individuals participated. The participants were from 12 economies including: Chile, Chinese Taipei, India, Indonesia, Japan, Malaysia, Peru, Republic of Korea, Singapore, Thailand, the Philippines, and the United States.

Survey response

62 attendees completed the project evaluation surveys; they were asked to rate a number of aspects of the workshop using the agreement levels of 'Strongly Agree', 'Agree', and 'Disagree'.

Table 3 Workshop Evaluation Results

	n = 62	Strongly agree	Agree	Disagree
1	The objectives of the workshop were clearly defined.	37 (60%)	25 (40%)	0 (0%)
2	The workshop achieved its intended objectives.	34 (55%)	28 (45%)	0 (0%)
3	The agenda items and topics covered were relevant.	37 (60%)	25 (40%)	0 (0%)
4	The content was well organized and easy to follow.	33 (53%)	29 (47%)	0 (0%)
5	The time allocated for the workshop was sufficient.	20 (32%)	31 (50%)	11 (18%)
6	The workshop included diverse viewpoints across economies and professions (government, private sector, academia).	36 (58%)	23 (37%)	3 (5%)
7	The workshop was effective in sharing successful expertise, best practices, and knowledge.	35 (56%)	26 (42%)	1 (2%)
8	The workshop was a good foundation for future international cooperation and discussion among APEC economies regarding energy resiliency.	36 (58%)	25 (40%)	1 (2%)
9	The workshop was a good opportunity to provide you with new insights and awareness about energy resilience-related activities.	40 (65%)	22 (35%)	0 (0%)
10	The workshop improved your understanding of the APEC Energy Resiliency Principles.	40 (65%)	21 (33%)	1 (2%)

According to the evaluation survey results in the above table, all survey respondents answered that workshop objectives were clearly defined, and the objectives were met based on the workshop contents. All respondents agree the workshops were well organized and easy to follow. The majority of respondents answered the workshops provided them a good opportunity to consider broad aspects of energy resilience-related activities as well facilitated sharing of expertise, best practices and knowledge related to energy resiliency. The respondents thought the workshops helped them understand the APEC Energy Resiliency Principle and the workshop provided a good foundation for future international cooperation and discussion among APEC economies toward improving energy resiliency.

Suggestions for improvements included lengthening the event to allow more discussion, and including viewpoints from a broader range of economies and professions, such as government, private sector, academia, and civil society. Some respondents also mentioned that the virtual setting limited interaction and

requested in person events in the future.

Regarding takeaways from the workshops, many respondents answered that the workshops facilitated understanding of the roles that various stakeholders play in supporting energy resiliency and the importance of stakeholder engagement. Respondents also mentioned that they learned the importance of encouraging financing and use of technologies, such as AI, IoT, and distributed energy resources to further enhance energy resiliency efforts, particularly in developing economies.

The survey respondents raised the importance of a holistic approach with the involvement of all stakeholders to strengthen energy resiliency, including not only the government and industries, but also energy consumers. They also mentioned that proper assessment of energy resiliency is essential and encouraged government and industries to work on benchmarking and standardization efforts on energy resiliency. The survey respondents also mentioned it is essential to consider the impact of human-induced disasters in resiliency planning, particularly cyberattacks, and to periodically review resiliency efforts to identify new threats and integrate them into resiliency planning for continuous improvement. Other key issues raised by the respondents include the importance of diversification of energy resources, developing business continuity plans in advance and properly training people to build disaster response capabilities.

In terms of balancing decarbonization and energy resiliency efforts, many survey respondents mentioned that these can be achieved simultaneously with the use of technologies, such as batteries. Many responded that the green transition needs to ensure energy resiliency in planning processes and that there is sufficient funding available to secure a stable energy supply.

Regarding suggestions for future APEC capacity building activities, the respondents called for development of sector specific and disaster specific guidance, as well as knowledge sharing and trainings through further similar workshops and webinars to share best practices, data, and information related to energy resiliency.

Appendix 2: Workshop Agenda

Workshop AGENDA (Hosted by Chile)
9:00 AM-11:30 AM (Chile time)
Monday, 17 January 2022

Start	End	Session		Focus	Main Speaker
09:00	09:10	Opening Session	Introductory Remarks from Project Overseer and Host Economy Overview of workshop agenda	An overview of workshop agenda and goals, an overview of the importance of energy resiliency in Chile and the APEC region.	Mr Tetsurou Ito (Director of International Affairs Division, Ministry of Economy, Trade and Industry of Japan) Under Secretary Francisco Lopez (Undersecretary of Energy, Energy Ministry of Chile)
09:10	09:30	Presentation of Energy Resiliency Efforts	"Background and Purpose of the Energy Resiliency Principle"	This session will present the background and purpose of the APEC Energy Resiliency Principle.	Mr Shintaro Fujimori (Chief for Energy Supply and Demand Policy Office, Ministry of Economy, Trade and Industry of Japan)
			"Development of APEC Energy Resiliency Guidelines"	This session will present the draft outline of APEC Energy Resiliency Guidelines to solicit inputs from the workshop participants.	Ms Nanako Hisamichi (Project Manager, Washington CORE)
09:30	09:45	Technical Session	"Resilience and Risk Management"	This session will present Chile's policy making and implementation for energy resiliency and natural disaster risk management.	Mr Daniel Charlín (Head of Resiliency and Risk Management, Energy Ministry of Chile)
09:45	10:00		"Resilience Assessment Methodology in the Chilean Transmission System"	This session will present a resiliency assessment methodology that is used for the transmission system planning in Chile.	Ms Johanna Monteiro Zuniga (Electrical Engineer for Planning Department, National Energy Commission of Chile)

Start	End	Session		Focus	Main Speaker
10:00	10:30		"Multi-Stakeholder Approach for Energy Resilience against Earthquakes and Other Disasters in Chile – Mining View"	This session will present a mining company's efforts to enhance energy resiliency against earthquakes and other natural disasters in Chile.	Mr Carlos Salamanca (Principal ISO of Interconnections and PAAs, BHP Chile)
			"Challenge of Resilience in the Energy Transition"	This session will present an energy transmission company's effort to strengthen energy resiliency of the transmission system in Chile.	Mr Oscar Álamos (Regulatory Specialist, ISA InterChile)
10:30	10:45		"How the Energy Sector Can Build Resiliency by Adapting to Climate Change?"	This session will present an insurance company's approaches to help the energy sector in Chile build resiliency against climate challenges.	Mr Stéphane Godier (Head of Americas, AXA Climate)
10:45	11:25	Panel Discussion/Q&A		Based on the prepared questions and questions received from the audience, moderator will facilitate panel discussion.	Moderator: Ms Nanako Hisamichi (Washington CORE) Panellists: Mr Daniel Charlin, Ms Johanna Monteiro Zuniga, Mr Carlos Salamanca, Mr Oscar Alamos, Mr Stéphane Godier
11:25	11:30	Closing Remarks		Closing Remarks from Project Overseer and Host Economy	Mr Tetsurou Ito (Director of International Affairs Division, Ministry of Economy, Trade and Industry of Japan) Mr Daniel Charlin (Head of Resiliency and Risk Management, Energy Ministry of Chile)

Workshop AGENDA (Hosted by Chinese Taipei)
9:00 AM-10:55 AM (Chinese Taipei time)
Thursday, 20 January 2022

Start	End	Session		Focus	Main Speaker
09:00	09:10	Opening Session	Introductory Remarks from Project Overseer and Host Economy Overview of workshop agenda	An overview of workshop agenda and goals, an overview of the importance of energy resiliency in Chinese Taipei and the APEC region.	Mr Tetsurou Ito (Director of International Affairs Division, Ministry of Economy, Trade and Industry of Japan) Mr Ming-Chih Chuang (Director, Bureau of Energy, Chinese Taipei)
09:10	09:30	Presentation of Energy Resiliency Efforts	"Background and Purpose of the Energy Resiliency Principle"	This session will present the background and purpose of the APEC Energy Resiliency Principle.	Mr Shintaro Fujimori (Chief for Energy Supply and Demand Policy Office, Ministry of Economy, Trade and Industry of Japan)
			"Development of APEC Energy Resiliency Guidelines"	This session will present the draft outline of APEC Energy Resiliency Guidelines to solicit inputs from the workshop participants.	Ms Nanako Hisamichi (Project Manager, Washington CORE)
09:30	09:45	Technical Session	"Chinese Taipei: Power System Infrastructure Resilience"	This session will present an energy company's efforts to strengthen its power system infrastructure resilience in Chinese Taipei.	Dr Chin-Chung Wu (Director of the Department of System Operations, Taipower)
09:45	10:00		"Japan: Nihonbashi Smart City Project"	This session will present discussed approaches an energy consumer in Japan implemented to strengthen energy resiliency.	Mr Yukikazu Kawahigashi (Executive Manager of the Project Planning Division of the Environment and Energy Service Department, Mitsui Fudosan)

Start	End	Session		Focus	Main Speaker
10:00	10:15		"Republic of Korea: New Resilience Strategies based on Cascading Outage Analysis to Enhance Power Grid Security"	This session will present a cascading outage analysis and new energy resilience strategies proposed by a partnership between academia and a power company in Korea.	Professor Hur Jin (Professor of the Department of Climate and Energy Systems Engineering, Ewha Womans University)
10:15	10:50	Panel Discussion/ Q&A		Based on the prepared questions and questions received from the moderator and audience, moderator will facilitate panel discussion.	Moderator: Ms Nanako Hisamichi (Washington CORE) Panelists: Dr Chin-Chung Wu, Mr Yukikazu Kawahigashi, Professor Hur Jin
10:50	10:55	Closing Session		Closing Remarks from Project Overseer and Host Economy	Mr Tetsurou Ito (Director of International Affairs Division, Ministry of Economy, Trade and Industry of Japan) Mr Ming-Chih Chuang (Director, Bureau of Energy, Chinese Taipei)

Workshop AGENDA (Hosted by the Philippines)
9:00 AM-11:30 AM (The Philippines time)
Wednesday, 16 February 2022

Start	End	Session		Focus	Main Speaker
9:00AM	9:10AM	Opening Session	Introductory Remarks from Project Overseer and Host Economy Overview of workshop agenda	An overview of workshop agenda and goals, an overview of the importance of energy resiliency in the Philippines and the APEC region	Mr Tetsurou Ito (Director of International Affairs Division, Ministry of Economy, Trade and Industry of Japan) Senior Undersecretary Felix William B. Fuentebella (Undersecretary of Energy, Department of Energy of the Philippines)
9:10AM	9:30AM	Presentation of Energy Resiliency Efforts	"Background and Purpose of the Energy Resiliency Principle"	This session will present the background and purpose of the APEC Energy Resiliency Principle.	Mr Yuya Uno (Deputy Director of Energy Supply and Demand Policy Office, Ministry of Economy, Trade and Industry of Japan)
			"Development of APEC Energy Resiliency Guidelines"	This session will present the draft outline of APEC Energy Resiliency Guidelines to solicit inputs from the workshop participants.	Ms Nanako Hisamichi (Project Manager, Washington CORE)
9:30AM	10:45AM	Technical Session	"NGCP's Energy Resilience Challenges and Measures"	This session will present measures that the Philippines' sole grid operator has taken to address energy resiliency challenges in the economy.	Mr Giovanni Randolfo A. Galang (Assistant Vice President and Head of the Technical Management Department, National Grid Corporation of the Philippines)
			"Powering Progress for the Future: Energy Resiliency at Pilipinas Shell"	This session will present Shell's energy resiliency initiatives in the Philippines.	Ms Lorelie Q. Osial (President and CEO, Pilipinas Shell Petroleum Corporation)

Start	End	Session		Focus	Main Speaker
			"The Role of the Private Sector in Energy Resiliency"	This session will present the private sector-led disaster organization's role in energy resiliency efforts in the Philippines	Mr Rene Jose Sayoc Meily (President, Philippine Disaster Resilience Foundation)
			"DOE Philippines' Energy Resiliency Efforts and Best Practices"	This session will focus on policy measures and frameworks designed to enhance energy resiliency in the Philippines.	Mr Michael O. Sinocruz (OIC Director of Energy Policy and Planning Bureau, Department of Energy of the Philippines))
			"Tools to Enhance Energy Resilience Financing"	This session will present USAID's Energy Secure Philippines initiative and tools proposed to evaluate energy resiliency efforts	Mr John Aaron Edgar (U.S. Agency for International Development)
10:45AM	11:25AM	Panel Discussion/ Q&A		Based on the prepared questions and questions received from the audience, moderator will facilitate panel discussion.	Moderator: Ms Nanako Hisamichi (Washington CORE) Panellists: Mr Michael O. Sinocruz, Mr Giovanni Randolfo A. Galang, Ms Lorelie Q. Osial, Mr Rene Jose Sayoc Meily, Mr John Aaron Edgar
11:25AM	11:30AM	Closing Session		Closing Remarks from Project Overseer and Host Economy	Dr Kazumoto Irie (President, Asia Pacific Energy Research Centre) Mr Michael O. Sinocruz (OIC Director of Energy Policy and Planning Bureau, Department of Energy of the Philippines)

Appendix 3: Workshop Presentations

List of Workshop Presentations

1. APEC Energy Resiliency Principle and Guidelines Background

1.1. Presentation 1: Background and Purpose of the Energy Resiliency Principle

by Mr Shintaro Fujimori, Mr Shintaro Fujimori, Chief for Energy Supply and Demand Policy Office, Agency for Natural Resources and Energy, the Ministry of Economy, Trade and Industry of Japan (Chile and Chinese Taipei workshops)

and

Mr Yuya Uno, Deputy Director of Energy Supply and Demand Policy Office, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan (The Philippines workshop)

経済産業省

APEC EWG 07 2020A
Workshop on Energy Resiliency Principle

Background and Purpose of the Energy Resiliency Principle

January 2022
METI (Japan)

0

Why energy resilience?

- Disasters have caused disruptions of energy supply which provided the basis for various economic and social activities, and thus threatened an achievement of socially sustainable objectives.
- Investing in energy resilience is the priority, as APEC is the region most affected by many types of natural disaster.

The Great East Japan Earthquake (2011)

Typhoon No.15 &16 in Chiba Prefecture (2019)

2

Energy resilience in inter-governmental discussions

- At the APEC Energy Ministers' Meeting held in October 2015 in Cebu, the Philippines, the theme of the meeting was "Toward the Realization of an Energy-resilient APEC Region".
- As a result of the meeting, "Cebu Declaration on East Asian Energy Security" was adopted.

(Excerpt from "Cebu Declaration")

- 2nd We affirm the importance of energy resiliency in promoting energy security and sustainable development and providing access to the people. This includes in particular, the ability and quality of energy infrastructure to withstand extreme natural and man-made disasters, to recover and return to normal conditions in a timely and efficient manner and to build back better.
- 7th We encourage members to improve the robustness of their energy infrastructure and policy, through capacity building, sharing of information, and promoting best-practices as appropriate.

https://policy.asiapacificenergy.org/sites/default/files/Cebu Declaration and Instructions_APEC FINAL.pdf

2

Definition of "APEC Energy Resiliency Principle"

- At the APEC EWG59 held in August 2020, principles were formulated to encourage voluntary efforts to contribute to energy resilience ("APEC Energy Resiliency Principle").

(Excerpt from "APEC Energy Resiliency Principle")

- 5th Since each economy is diverse in terms of geographical, environmental, economic, social and other situations, the impacts of disasters significantly differ among economies.
  Each economies needs to investigate economy-specific circumstances and to consider tailored countermeasures in a holistic manner with all stakeholders involved.
- 16th Stakeholders should actively invest in and finance projects that contribute to enhancing energy resiliency in each economy.
- 17th Stakeholders should appropriately evaluate contribution of the projects, which they invested in and financed, to energy resiliency in addition to projects' profitability.

3

Energy resilience as a new criteria for socially sustainable activity

- Energy is the most essential service which provides a basis for various social and economic activities. Investing in energy resilience should be regarded as a socially sustainable activity in the context of SF.
- Investing in energy resilience is also contribute to the achievement of the UN Sustainable Development Goals (SDG 9 & 11).
- Recent agreement among APEC economies urges investing in energy resilience.
- Energy resilience could be a new criteria of socially sustainable activity in the context of sustainable finance.

What is energy resilience?

Energy resilience is the ability to secure stable energy supply by effectively dealing with disasters (both natural and manmade disasters).

(APEC Energy Resiliency Principle)

Relevant SDGs

4

1.2. Presentation 2: Development of APEC Energy Resiliency Guidelines

by Ms Nanako Hisamichi, Project Manager, Washington CORE

Asia-Pacific Economic Cooperation

Workshop on Energy Resiliency Principle EWG 07 2020A

Development of APEC Energy Resiliency Guideline

WASHINGTON | CORE

Objectives and Scope

Objectives

- Clarify the roles of key stakeholders identified in ERP to enhance energy resiliency
- Share measures and best practices on energy resiliency to support the APEC member economies build resilient energy infrastructure
- Provide guidance on multi-stakeholder approach in enhancing energy resiliency measures and developing energy resiliency plans

Scope

- Provides general guidance and best practices to enhance energy resiliency measures
  - Applicable to the wide variety of disasters including both natural disasters and man-made disasters
  - Each economy is recommended to tailor approaches considering the economy-specific energy resiliency challenges

Guideline Development Process

- December 2021: developed outline for Energy Resiliency Guideline
- January – February 2022: Three Workshop will be hosted to gather inputs on various stakeholders to develop Energy Resiliency Guideline

Sub- region	Date and Time	Host Economy
South America	Monday, 17 January 2022 9:00 AM-11:30 AM (Chile time)	Chile
Northeast Asia	Thursday, 20 January 2022 9:00 AM-11:00 AM (Chinese Taipei time)	Chinese Taipei
Southeast Asia	Wednesday, 16 February 2022 9:00 AM-11:30 AM (the Philippines time)	The Philippines

- April 2022: Planned completion date for the Energy Resiliency Guideline

Structure of the Guidelines

1. Introduction
   - Background
   - Objective
   - Scope
2. Terms and Definition
3. Energy Resiliency Principle (ERP)
4. Relevant stakeholders and their roles to enhance energy resiliency
   - Governments
   - Energy supply industries
   - Energy consumers
   - Financial institutions
5. Common approaches among different stakeholders towards energy resiliency
   - Energy Resiliency Plans
   - Investment and Financing to Projects towards Energy Resiliency
   - Proper Asset Management
   - Emerging Technologies Adoption
   - Multi-stakeholder Knowledge Sharing

Roles of Key Stakeholders

Holistic approach with the involvement of all key stakeholders is critical to enhance energy resiliency

Common Roles

- Recognize the importance of energy resiliency
- Conduct vulnerability assessment of energy systems
- Develop energy resiliency measures
- Engage with internal and external stakeholders to share the lessons learned and best practices
- Periodically review and assess the effectiveness of the energy resiliency plans

Stakeholder-Specific Roles

Government	Energy Supply Industries	Energy Consumers	Financial Institutions
• Review the existing legal framework and develop policies, laws, regulations, and standards to facilitate the formulation of energy resiliency plans • Implement mechanisms to incentivize energy resiliency efforts • Establish an organization that is responsible for coordinating energy resiliency initiatives across internal and external stakeholders	• Implement contingency measures, including diversification of energy resources and securing sufficient energy reserves, backup systems • Introduce asset management programs to balance cost, risk and performance of energy resilient infrastructure • Consider and adopt utilization of cutting-edge energy technologies • Train staff on emergency response and recovery	• Implement asset management programs to maintain and monitor the reliability of critical equipment • Consider and adopt cutting-edge energy technologies • Secure backup systems, such as emergency generation units and energy reserves • Train staff to respond and recover from disasters	• Develop and adopt criteria to ensure the aspect of energy resiliency is considered during investment decision making for energy infrastructure projects • Collaborate with the public and private sector and offer financing options to invest in energy resiliency projects

Energy Resiliency Approaches

Energy resiliency plans	• Energy resiliency plans evaluate the energy-related situation of a stakeholder and provides measures on how to deal with disasters. Energy resiliency plans may contain disaster prevention and reduction, restoration, building back better and information sharing • Review and develop legal framework to facilitate development of energy resiliency plans • Implement systematic process to develop and maintain effective energy resiliency plans, including stakeholder engagement, risk assessment, strategy &prioritization, implementation, and periodic review
Investment and financing to projects towards energy resiliency	• Identify key areas of investment • Contribute to energy resiliency by developing mechanisms, such as criteria and evaluations tools to ensure energy resiliency is considered during the investment decision making for energy infrastructure projects
Proper Asset Management	• Asset management includes proper installation, management and renewable cycles of assets in order to sustain a stable energy supply • Assess each organization's energy resiliency needs risk and implement appropriate measures, including diversification of energy resources, increase ratio of self-sufficient energy sources, modernize infrastructure, etc. • Incorporate systematics approaches to build resilient energy infrastructure
Emerging Technologies Adoption	• Evaluate the availability of cutting-edge energy technologies to optimize the planning, operation, and maintenance of energy systems in order to improve energy resiliency • Support the implementation of such technology solutions through providing financing options and incentives • Assess cyber security risk from integrating new technology options to the existing systems. Appropriate mitigation measures should be implemented to minimize the risk
Multi-stakeholder Knowledge Sharing	• Stakeholders should facilitate understanding for energy resiliency issues and contribute to knowledge sharing with internal and external stakeholders • Assessment of resilience knowledge gaps and capacity building needs may be conducted to facilitate knowledge sharing • Cross-sectoral collaboration is encouraged to facilitate peer-to-peer learning, networking and capacity building.

Key Questions

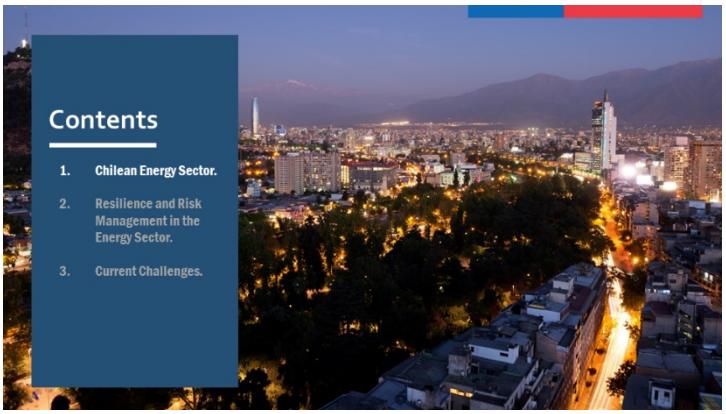
Thank you

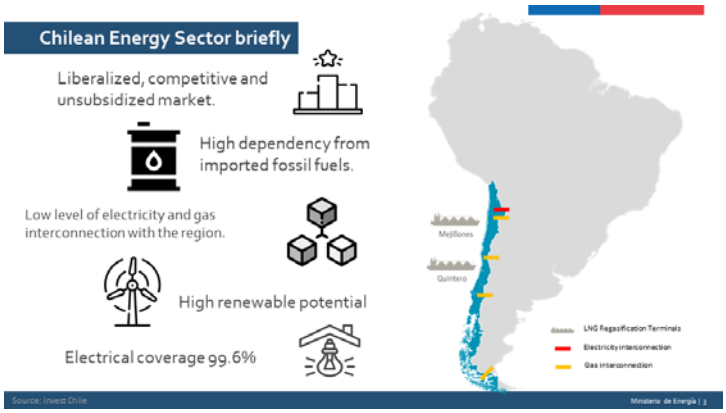
Contact information
Nanako Hisamichi, Project Manager
Washington CORE
Email: nanako@wcore.com

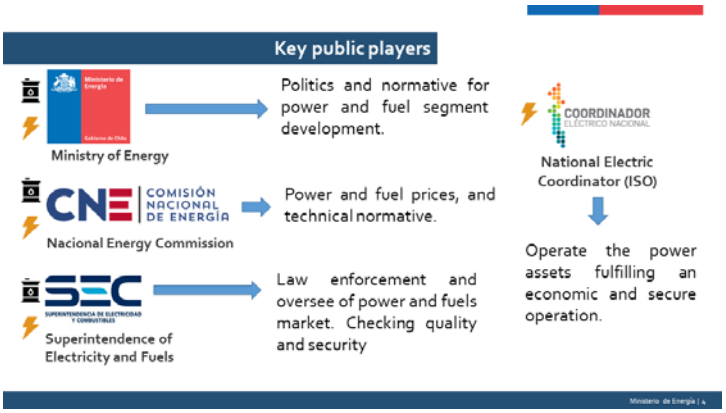
2. Chile workshop January 17, 2022

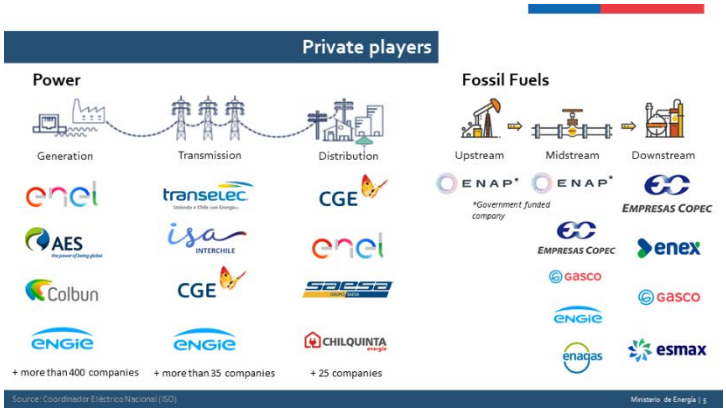
2.1. Presentation 3: Resilience and Risk Management

by Mr Daniel Charlin, Head of Resiliency and Risk Management, Ministry of Energy of Chile









Context of the Energy system

1-Long (4.270 km) and narrow economy (90 - 200 km)

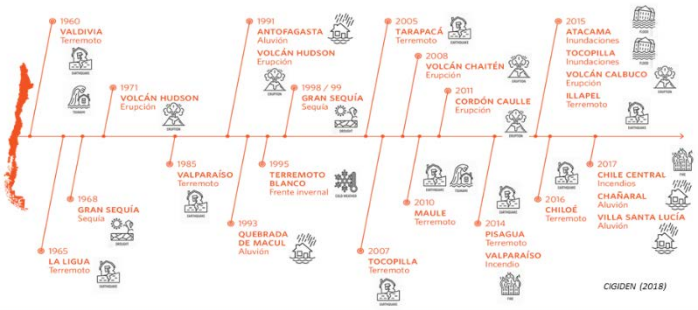
2-Power and fuel offer, diverse but concentrate

3-Energy consumers also concentrated and not close to energy production/importation places

Contents

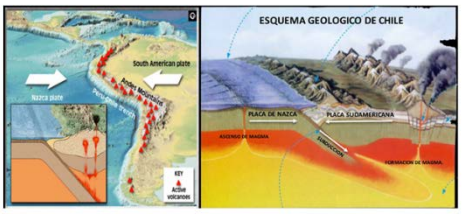
Frequent threats

Earthquakes Eruptions Extreme weather Others



CIGIDEN (2018)

Chile is an earthquake zone



8.8-degree earthquake on February 27th, 2010, in Chile

Earthquake on February 27th, 2010

Common damages seen in 27-F earthquake

- Insufficient looseness in high voltage connections
- Collapse of high voltage circuit breakers
- Damages to transformer and power reactor bushings
- Damages to disconnectors
- Damages to power transformers

Earthquake on February 27th, 2010

Lessons learned and implemented:

- Increase looseness among interconnections of electrical equipment.
- Update the seismic technical specification.
- Recommendations for Seismic verification/design of foundations, support structures, and equipment.
- Emergency spare parts stock.
- Measures to deal with emergencies.
  - Update system safety standards.
  - Reinforcing ISO´s attributions and autonomy.
  - Set economy-wide policies to face disasters which affects the energy sector.

Source: CIGRE

Who manage the threats in the energy sector?

Resilience and risk management unit

We articulate in the energy sector the risk management

- Incorporate risk management on the energy market policies.
- Advise authorities on the energy contingencies
- Develop dynamic and easy tools to help the decision-making process on emergency cases
- Create and monitor risk maps

Objectives

Resilience and risk management unit

Ensures the incorporation of the concept of resilience and the monitoring, prevention and management of emergencies.

URGR

Emergency Coordination	Risk Management	Resilience and Adaptation
Alert **Answer** **Recovery**	**Mitigation** **Preparation** **Alert**	**Prevention** **Mitigation** **Preparation**

Energy Sector Support

- SEREMIs

Disaster Risk Reduction Support

What we do?

Tools – Risk management map viewer

This platform:

- It is used by energy companies
- It is used by the ISO and other institutions
- It is recognized in the January/February 2022 edition of the IEEE Power & energy magazine

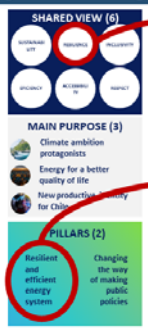
What we do?

Tools – Online viewer of customers without supply

What we do? – We use external data

Risk management in energy policies

The Current Economy-wide Energy Policy



Resilience:

"A shared view across all the participants in the policy update process".

First Pillar:

Resilient and efficient energy system

*"A quality and **reliable** power supply".*

Energy and Disaster Risk Reduction policies

3° axis: energy development of energy systems

- Monitor security
- Incorporate resilience into development
- Promote energy sufficiency

5 Priority axes

- Understand disaster risk
- Strengthen the governance of disaster risk management
- Plan and invest in disaster risk reduction for resilience
- Provide an efficient and effective response
- Promote a sustainable recovery

Current work in progress

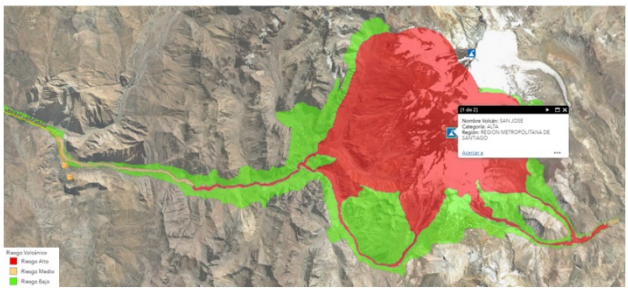
CDRI
Coalition for Disaster Resilient Infrastructure

IDB

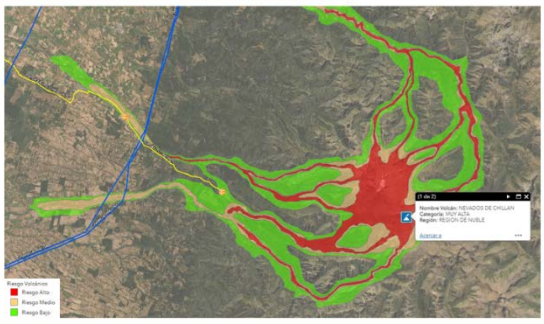
olade

- Plan to reduce supply interruptions due to last-mile connectivity problems in distribution, framed in the program "Enhancing the Resilience of Power Infrastructure" – CDRI.
- Technical cooperation with other economies in the region in the development of a regional toolbox that guides the provision of public services (water, energy and basic sanitation) in the POST-COVID 19 recovery process, from the perspective of growing resilience – IDB – OLADE.

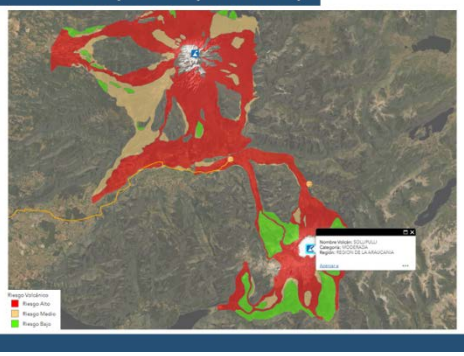
Examples of eruption risk maps



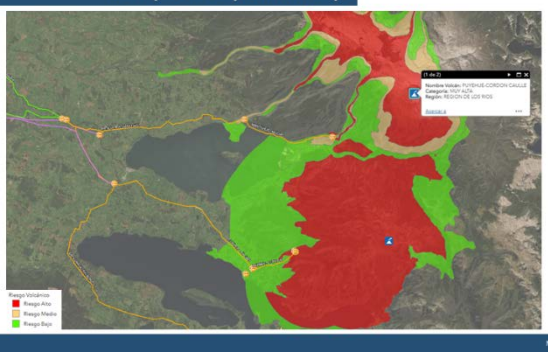
Examples of eruption risk maps



Examples of eruption risk maps



Examples of eruption risk maps

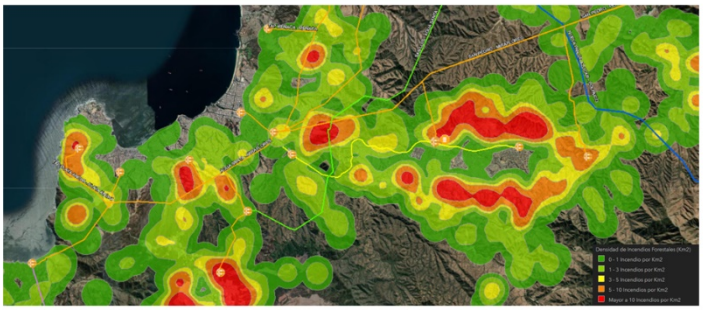


Examples of tsunami risk maps

Examples of tsunami risk maps

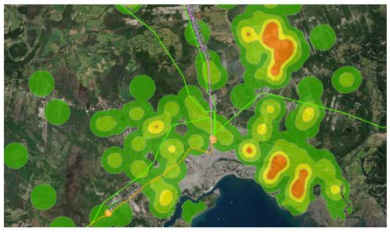
Examples of tsunami risk maps

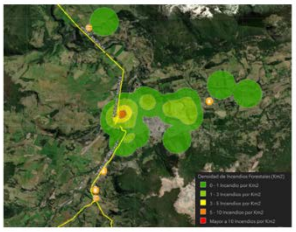
Examples of forest fire risk maps



Examples of forest fire risk maps

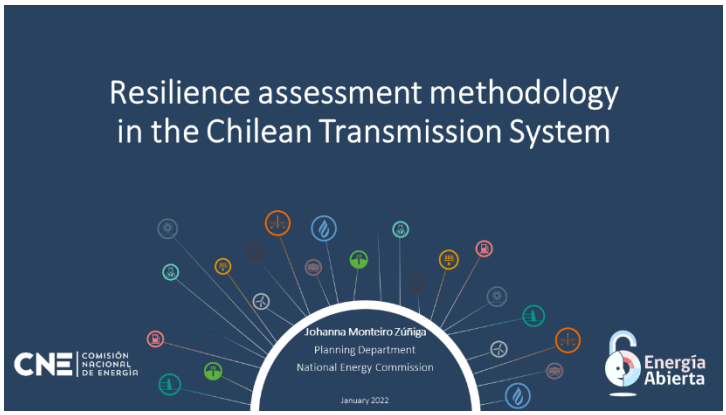
Examples of forest fire risk maps

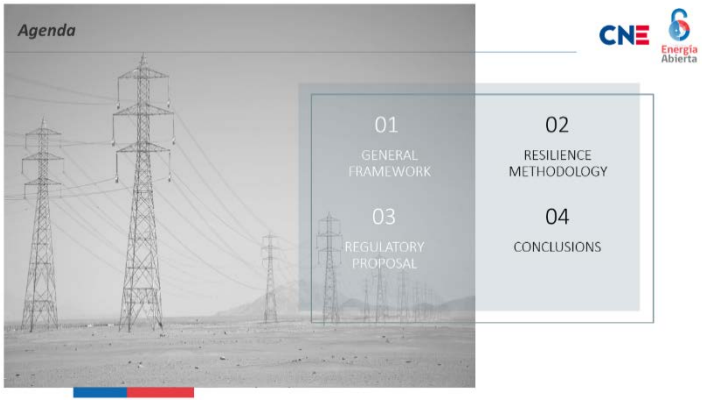


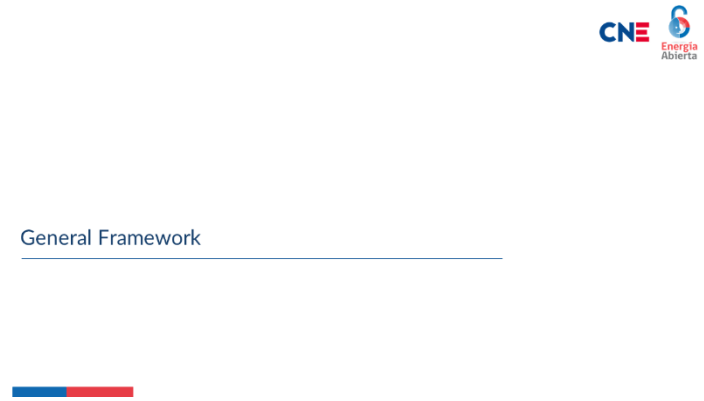


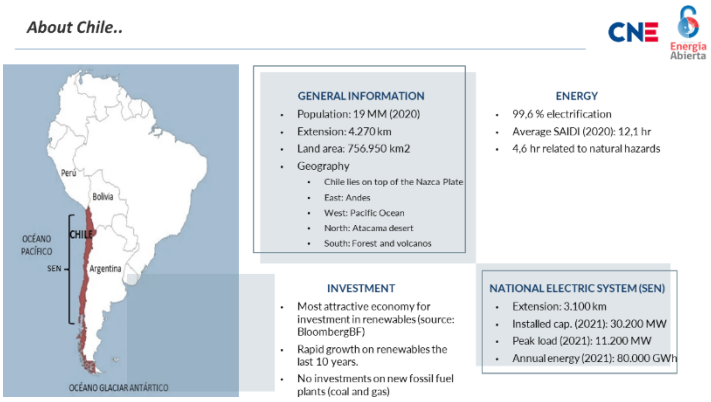
2.2. Presentation 4: Resilience Assessment Methodology in the Chilean Transmission System

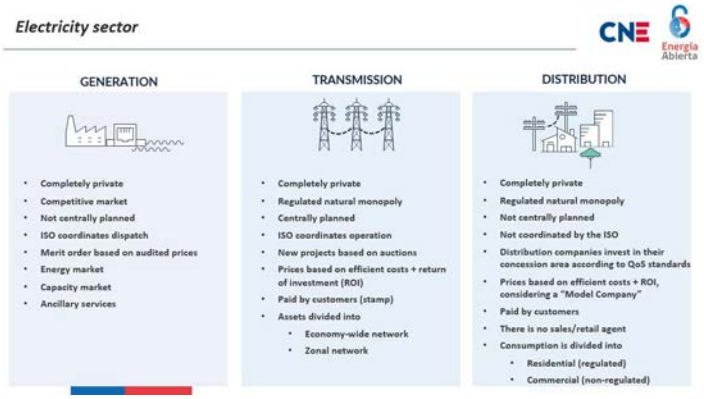
by Ms Johanna Monteiro Zuniga, Electrical Engineer for Planning Department, National Energy Commission of Chile

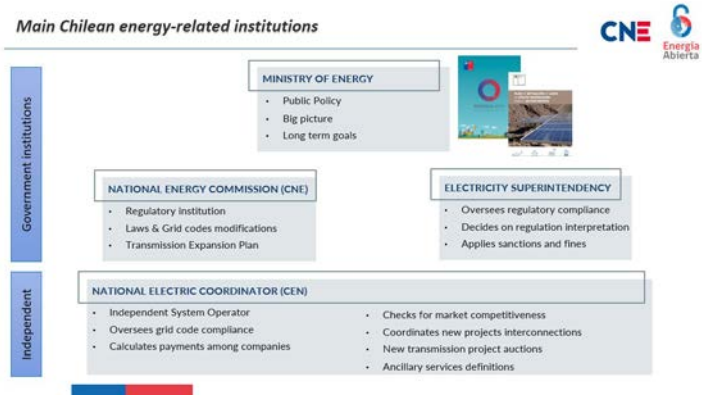




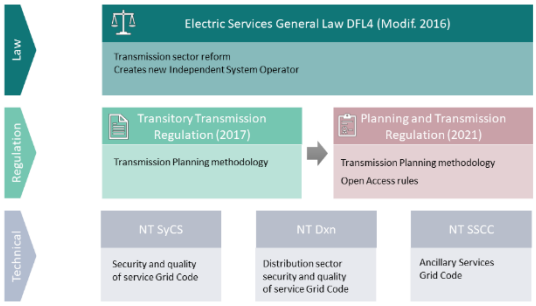








Legal Framework Resiliency related

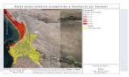


Regulatory Framework

2016	2017	2021
LEY 20.936 – Art. 87° a)	RE 711 – Art. 19° b)	DS 37 – Art. 92°
*"**The Transmission Planning process** must consider: a) supply-risk minimization, considering events, for instance, price shocks or shortage of fuels, delay or unavailability of electric assets, **natural disasters or extreme hydrological conditions**".*	*"Resiliency Assessment:* *The new grid expansions (economy-wide and zonal) will enable suitable SEN performance when extreme situations occur, in order to be able to supply customers and not diminish the normal technical and economic standards of the electrical system.* ***In particular, this stage will assess the following events: (i) tsunamis, (ii) fuel price shocks, (iii) delay on a new generator, and (iv) extreme hydrology"***	*"Resiliency Assessment:* *...* *In particular, ... it will be assessed ... the performance of the electrical system, based on **events defined in the Technical Study from the Transmission Expansion Plan**, considering at least, natural disasters such as earthquakes, tsunamis and landslides."*

Context
Current situation

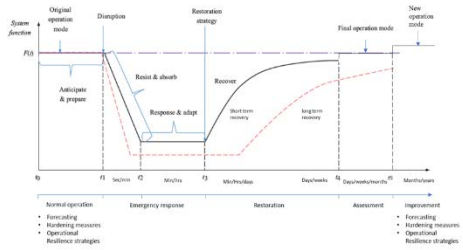
EXPANSION PLAN 2020

Tsunami	Unaveilability of a group of power plants placed on the coast	
	Change in the merit order between coal and gas power plants	**Gas prices´ Shock**
Delay on power plant	Delay of Alto Maipo power plant commissioning (530 MW) by 5 years	
	Considers the top 5 most extreme hydrologies (dry and wet)	**Extreme hydrology**

Resilience Methodology

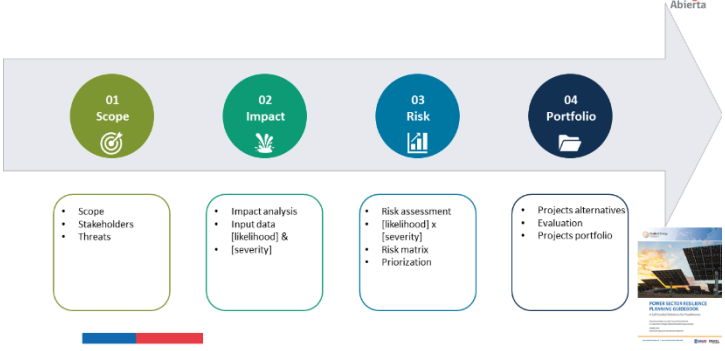
Resilience:

"the hability to anticipate, resist, absorb, respond to, adapt to, and recover from a disturbance"



Source: Y. Lin, Z. Bie y A. Qu, «A review of key strategies in realizing power system resilience,» Global Energy Interconnection, vol. 1, nº 1, Enero 2018.

Methodology



Methodology
Scope

Data

Historical Events
Data collected from ISO and SEC

Climate Projections
Requires a model to project the future likelihood and impact of natural hazards due to climate change

Threats / Events

Natural
- tsunami
- wildfires
- earthquake
- landslide

Human-caused
- accidents
- terrorism
- cyberattcks

Technological
- infrastructure
- equipment
- IT

Analysis

Based on metrics
- Stakeholders' professional judgment
- Scores matrix
- Evaluation customized project

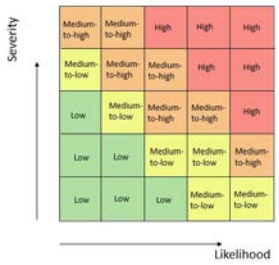
Probabilistic
- Probabilistic assessment
- Simulation based model
- Statistic analysis

Methodology
Assessment – Impact & Risk

Threat:
Events likelihood
Score [1-10]

Impact:
How the threat has an impact over the electric system assets.

Vulnerability:
Events severity (impact magnitude)
Score [1-10]

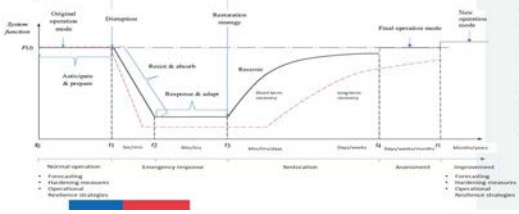


Methodology
Resiliency projects

Hardening measures

Operational measures

Quick recovery measures



Hardening measures:
Investment related to building new assets, or hardening existing ones.

Operational measures:
Investment related to grid automatic schemes, in order to get through the event in an better performance.

Quick recovery measures:
Elements that help to a quick load reconnection, for instance, distributed generation.

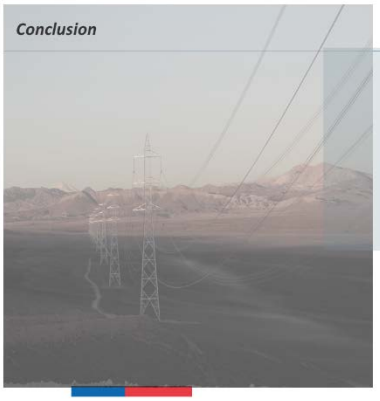
How to invest in the distribution sector?

DISTRIBUTION LAW
- There is a developing reform; however, the first drafts did not consider resiliency as a topic.
- Beyond control circumstances events are not part of utilities' duty (force majeure)
- "Model Company"
- The reform was paused

DISTRIBUTION GRID CODE
- Not straightforward to define a standard
- The Distribution Grid Code has included recently an important change related to Quality of Service.
- "Model Company"

ANCILLARY SERVICE
- Similar to a "local" System Recovery Plan
- Process has a structure to determine the asset "qualification"
- Process has a structure to measure the performance
- It wouldn't require any law or regulatory modification

Conclusion



Conclusion

- The resiliency assessment exists in the context of the Expansion Transmission Plan, according to the Law. However, this approach has some limitations.
- The methodology suggests to make an evaluation of the most efficient projects whether they belong to the transmission or the distribution sector.
- In order to develop a new project on the distribution sector, it is suggested that the ancillary services market could promote it.


Thank you
Johanna Monteiro Zúñiga
Planning Department
National Energy Commission
January 2022
CNE
COMISIÓN NACIONAL DE ENERGÍA
Energía Abierta

2.3. Presentation 5: Multi-Stakeholder Approach for Energy Resilience against Earthquakes and Other Disasters in Chile - Mining View

by Mr Carlos Salamanca, Principal ISO of Interconnections and PPAs, BHP

Multi-stakeholder approach for energy resilience against earthquakes and other disasters in Chile – Mining View

BHP

Carlos Salamanca
Principal ISO, Interconnections and PPAs – (Chile)

Agenda

BHP

Mining approach to Energy Resilience – Earthquakes and other associated phenomena	Energy Issues	Building Resilience
• Context • Chilean BHP Assets • Learned Lessons	• Science deep dive • Issue review • Impacts review and identification • Impact Prioritisation	• Approaches to Energy resilience and adaptation • Problem solving framework • Identifying resilience options and adaptation pathways

Slide 2

Context
BHP Assets in Chile

BHP

- **Minera Escondida (MEL)**
  - Escondida is the world's largest producer of copper concentrates and cathodes.
  - Located 170 km from Antofagasta, 3100 meters above sea level and 1,1 Mt fine copper production for FY2021
    - › Energy consumption aprox 5,0 TWh per year , Max Power consumption 700 MW.
- **Pampa Norte**
  - Minera Spence: located 68 km from Calama, 1750 meters above sea level and 149 Kt fine cooper production for FY2021.
    - › Energy consumption aprox 1,0 TWh per year, Max Power consumption 100 MW.
  - Compañía Minera Cerro Colorado (CMCC): located 120 km from Iquique, 2600 meters above sea level and 69 Kt fine cooper production for FY2021.
    - › Energy consumption aprox 0,2 TWh per year , Max Power consumption 27 MW.

In terms of copper production - for CY2020 - **MEL + Spence + CMCC** represented aprox 23% Chile production and aprox 6% worldwide. **In terms of energy consumption** - for CY2020 - **MEL + Spence + CMCC** represented aprox 8,7% Chile annual Energy Demand and near to 10% economy's peak demand.

Learned Lessons:
Some Earthquakes Events and Impacts

BHP

Escondida, Spence and Compañía Minera Cerro Colorado
14-Nov-2007 / 18-Dec-2077 (replica)
Epicenter: Tocopilla
Magnitude: 7,7 / 6,7 Richter (replica)
Effects: Landslides and dust clouds. Power and communications outage and clogged roads.
Operation stoppage: aprox 35 hours / 35 hours (replica)
Economic Impact: 34 MMUSD / 13 MMUSD (replica) - @2,8 USD/pound (copper average price Nov-2007)

"Las enormes minas de cobre Escondida y Chuquicamata, próximas al lugar donde se sintió con más fuerza el terremoto, interrumpieron ***sus operaciones debido a un corte de energía,*** *lo que hizo disparar los precios internacionales del metal del cual Chile es el mayor productor del mundo.* ***Los precios del cobre para entrega en diciembre subían un 6 por ciento a 3,29 USD".***
Source: www.reuters.com (15-Nov-2007)

"Escondida produce más de 1,3 millón de cobre fino anuales por lo que por cada hora de producción equivale a más de US$ 960 mil, considerando un precio del cobre de ***US$ 2,8 por libra*** *mientras que para calcular medio día las pérdidas implicará para la firma menores productivos estimados en unos US$ 113 millones. BHP también es dueña de Spence y Cerro Colorado, fuera donde el suministro eléctrico se vio suspendido por casi 15 horas y 17 horas respectivamente. Cotella, indicó* ***las mineras ligadas a BHP habrían dejado de producir el equivalente a unos US$ 13 millones durante las más de doce horas*** *en las que no contaron con energía el domingo, hasta el completo restablecimiento del suministro.*
Para el terremoto de noviembre BHP reportó que sólo en Escondida dejó de producir ***5.300 toneladas en los días*** *que le tomó restablecer totalmente el abastecimiento eléctrico,* ***lo que implicó mermas por unos US$ 34 millones".***
Source: www.revistaei.cl/2007/12/18

Slide 4

Some Earthquakes Events and Impacts

Compañía Minera Cerro Colorado
14-June-2005
Epicenter: 80 km Bolivia border
Magnitude: 7,9 Richter
Effects: Landslides and dust clouds. Power Outage and clogged roads,
Operation stoppage: aprox 24 hours

Minera Escondida y Minera Spence
17-May-2014
Epicenter: 88 km North MEL
Magnitude: 5,5 Richter
Effects: landslides and dust clouds. Power Outage and clogged roads.
Operation stoppage: 2 hours

Compañía Minera Cerro Colorado
02-April-2014
Epicenter: 36 km from Iquique
Magnitude: 8,2 Richter
Effects: landslides and dust clouds.
Operation stoppage: 0 hours

Minera Escondida y Minera Spence
12-July-2010
Epicenter: 79 km from Calama
Magnitude: 6,2 Richter
Effects: landslides and dust clouds.
Operation stoppage: 0 hour

Minera Escondida y Minera Spence
03-June-2020
Epicenter: 48 km from San Pedro de Atacama
Magnitude: 6,8 Richter
Effects: landslides and dust clouds.
Operation stoppage: 1 hour

Electrical System Availability Improvements against earthquakes since 2005/2007

Other risks due to Earthquakes at critical infrastructure

- **Shipping Ports and Desalination Plants**
  - Potential damages due to Tsunamis: currently Escondida and Spence consume 100% desalinated water provided from Desalination Plants located at Antofagasta and Mejillones bays.
  - In addition Escondida and Spence use shipping ports located Antofagasta and Mejillones bays too.
- **Access Roads and Communications**
  - Risks over workers and provision of critical supplies transport and communications lines due to huge landslides caused by earthquakes.
- **Water and Concentrate pipelines**
  - Long pipelines pipelines laid over hundreds of km from sites until ports

Approach to Energy Resilience

Energy Resilience take in account World Climate Change, therefore include actions by focusing on:

- reducing our emissions through accelerating the development and deployment of low emissions technologies;
- working with others, including our industry and governments, to enhance the global response to climate change**.
- increasing our preparedness for climate change impacts in order to improve our energy resilience responses.

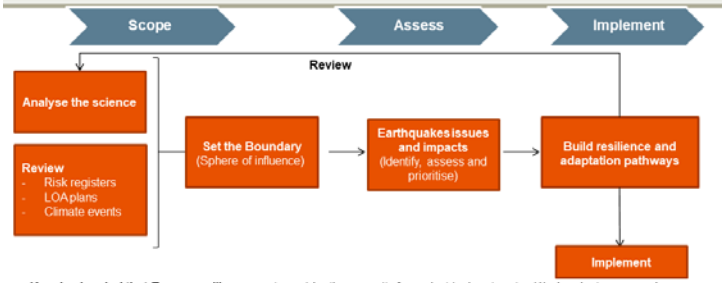
**. In September 2021, BHP published its Climate Transition Action Plan 2021, which sets out our strategic approach to our goal to reduce operational GHG emissions (Scope 1 and Scope 2 from our operated assets) to net zero(2) by 2050, and our enhanced Scope 3 position for GHG emissions in our value chain. The Plan, together with more information on our climate commitments, actions and performance, including our Climate Change Report 2020. Available at bhp.com/climate

Why Energy resilience is required?

- BHP corporate strategy is based on **long-life** assets
- We recognize sustainability is integral to the work we do at BHP. We believe it leads to higher performance by making us more productive and safe.
- Building energy resilience to the physical impacts of earthquakes among others phenomena is **essential to long-term business success with sustainability.**

Eclectic approaches to Energy Resilience

Energy Resilience Planning Process

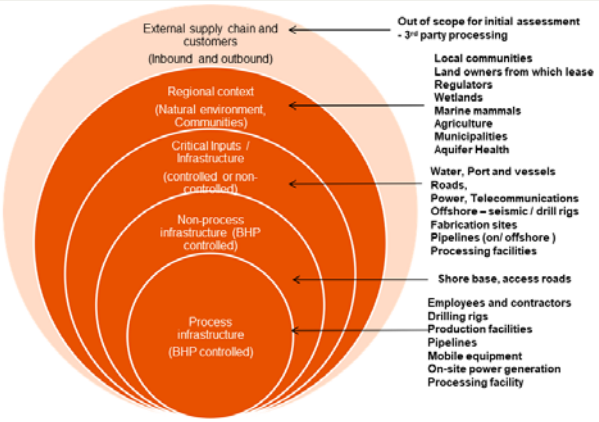


Keeping in mind that Energy resilience must consider the capacity for a electrical system to: (1) absorb stresses and maintain function or minimize unavailability installations under critical events and (2) adapt reorganize, and evolve to be better prepared for future impacts, the planning process should include:

- **Is an Earthquake issue** a potential event that can be acute (e.g. Hurricane), chronic (e.g. increasing temperatures) or cumulative (e.g. increasing drought conditions)?
- **Sphere of influence** like a boundary used to assess earthquake impacts to our business. It includes aspects both within and outside our operational control.

Sphere of influence

BHP



Out of scope for initial assessment
- 3rd party processing

Local communities
Land owners from which lease
Regulators
Wetlands
Marine mammals
Agriculture
Municipalities
Aquifer Health

Water, Port and vessels
Roads,
Power, Telecommunications
Offshore – seismic / drill rigs
Fabrication sites
Pipelines (on/ offshore)
Processing facilities

Shore base, access roads

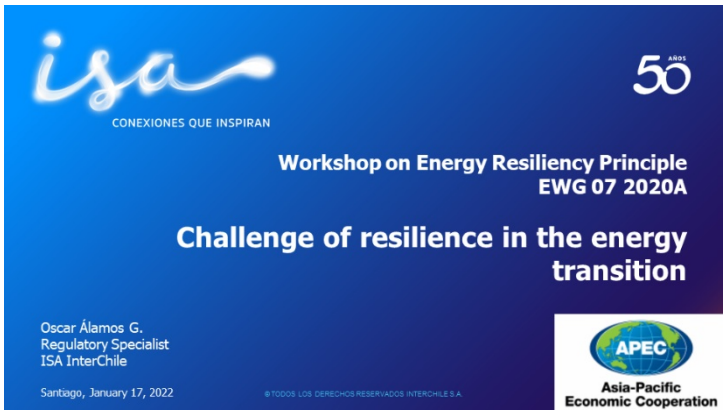
Employees and contractors
Drilling rigs
Production facilities
Pipelines
Mobile equipment
On-site power generation
Processing facility

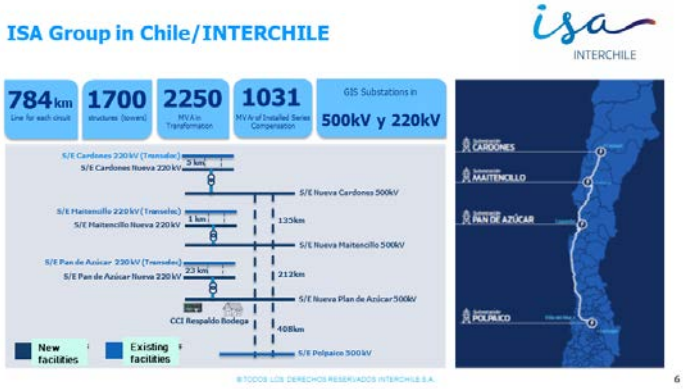
Thank you

BHP

2.4. Presentation 6: Challenge of Resilience in the Energy Transition

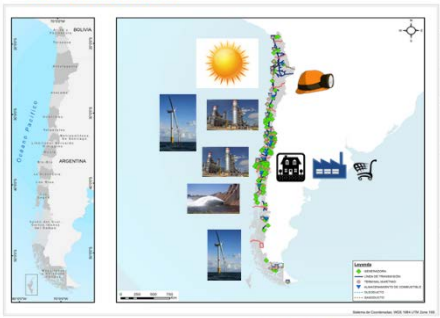
by Mr Oscar Alamos, Regulatory Specialist, ISA InterChile





Chilean Electric System: Exposure and vulnerabilities

isa INTERCHILE



- Chile long and narrow economy
- Electrical system of similar nature.
- Varied supply, but spatially concentrated.
- Mining, residential, commercial, and industrial demands are concentrated and not necessarily close to generation poles.
- Without interconnections with neighbors.
- Importer of fuels & gas.

Chile: Economy facing multiple threats

isa INTERCHILE

Energy Transition

isa RCHILE

The role of transmission system: the vehicle for the energy transition

isa INTERCHILE

no transmission, no transition

- Like the highways, the transmission system is part of the basic infrastructure that the economy requires to interconnect producers and consumers, creating the electricity market.
- A reliable transmission system allows the use of renewable energy potentials, avoids congestion and curtailments, and provides the necessary service security to provide electrical service.
- Transport capacity and flexibility will be key in the energy systems of tomorrow.

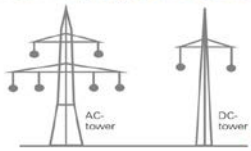
The new paradigm: resilient, beyond reliability

M. Panteli and P. Mancarella, The Grid: Stronger, Bigger, Smarter? Presenting a conceptual framework of power system resilience, IEEE Power and Energy Magazine, May/June 2015, Invited Paper

A "bigger" transmission system

Our compromise: Provide the country with the experience of the most relevant group in Latin American transmission lines

A "stronger" transmission system



Our compromise: Incorporate innovative solutions that allow us to get the best out of our facilities

A "smart" transmission system

Our commitment: Incorporate cutting-edge technology and contribute from the frontier of knowledge

A "smart" transmission system

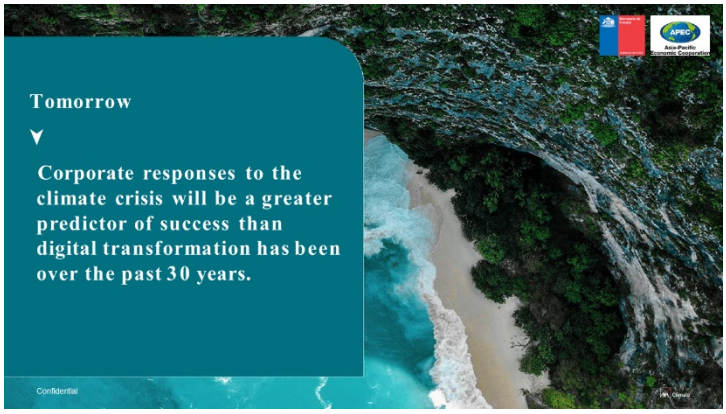
Our commitment: Incorporate cutting-edge technology and contribute from the frontier of knowledge

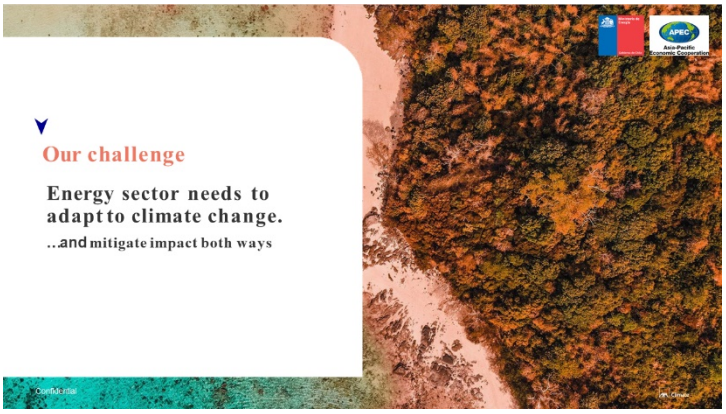
Thank you
Contact: oalamos@interchilesa.com

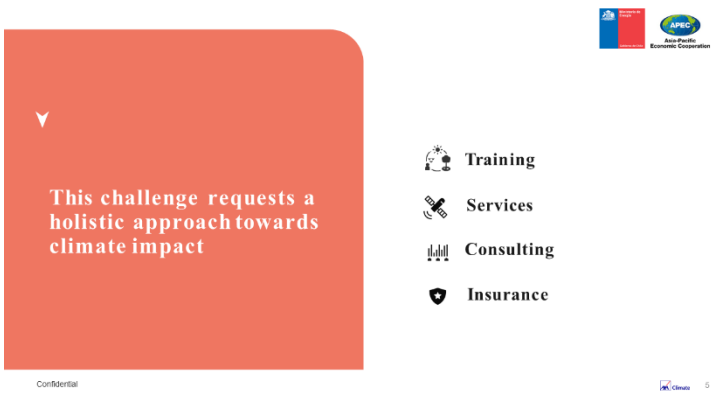
INTERCHILE
RUT: 76.257.379-2 | Cerro El Plomo 5630, Oficina 1801, Santiago de Chile
Tel: +5622945950 | www.interchilesa.com

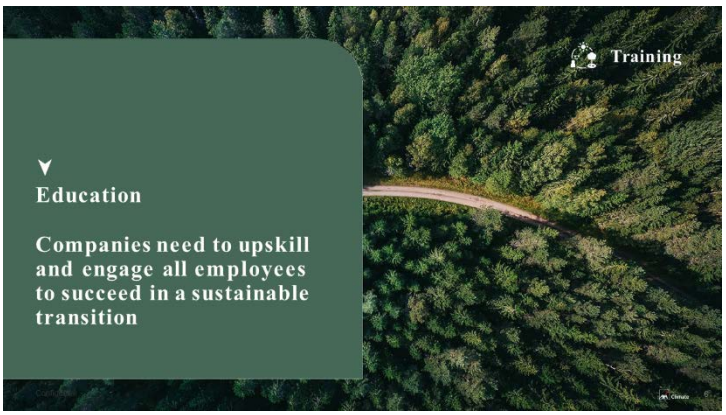
2.5. Presentation 7: How the Energy Sector Can Build Resiliency by Adapting to Climate Change

by Mr Stéphane Godier, Head of Americas, AXA Climate





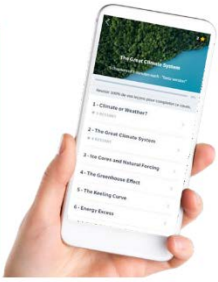




How to do it?

Training

An online learning experience, made of 150+ microlearning chapters, 100% customisable, to engage and upskill your employees in your sustainable transition.



On line courses

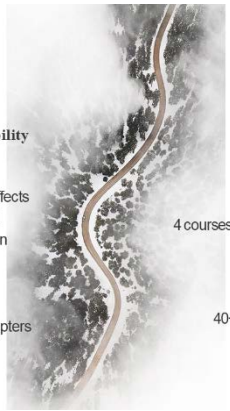
Training

UNDERSTAND

The science behind sustainability

Intrinsic mechanism and ripple effects between climate change, natural resources, biodiversity and human societies.

6 courses - 50+ microlearning chapters (videos and quizzes)



ACT

Action-based roadmap customised for each job role

4 courses on collective sustainable challenges

4 courses covering 4 job roles

40+ microlearning chapters (videos and quizzes)

This challenge requests a holistic approach towards climate impact

Training

Services

Consulting

Insurance

Services

Companies need to monitor the occurrence of Nat Cat risks *ex ante*…

CYMO

CYMO is the first standardized multi-peril alerting system at global scale, based on risk and personalised to the company sites.

- 3 communication channels (Email, phone call &SMS)
- 5 level of alerts & 5 perils covered Flood, Storm, Earthquake, Wildfire and Tsunamis
- Human climate risk expertise
- Site location-specific
- Possibility to attach BCP within alerts
- 2 levels of accuracy for 24/7 alerting

…so that they can react and resume operations *ex post*.

Energy resiliency plans
15. Stakeholders should investigate and evaluate their energy-related situation, and formulate plans to deal with disasters. Stakeholders should review and amend the plans continuously taking recent technological advancement into consideration.

CYMO ALERT

«Never miss any extreme natural threat»

Risk Management benefits

- Provide with an efficient alerting system
- Ensure that everyone one knows
- Increase climate risk awareness

Mail | Phone | SMS

Adapted and personalized to each actor

Services

operational teams

- Gradual alerting system
- Based on risk : never miss a climate threat
- Personalized to site location
- Customized communication channel

This challenge requests a holistic approach towards climate impact

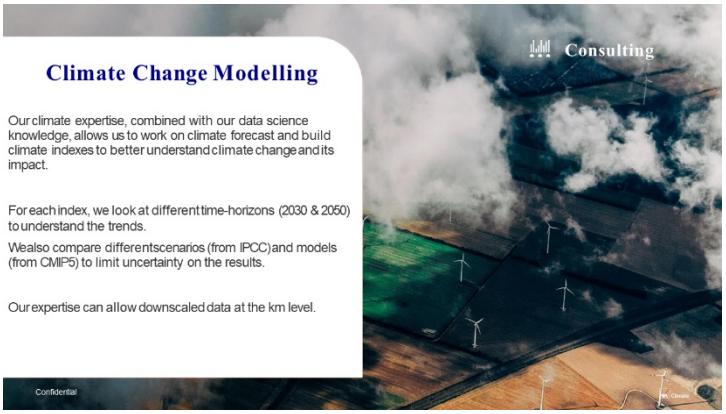
Training

Services

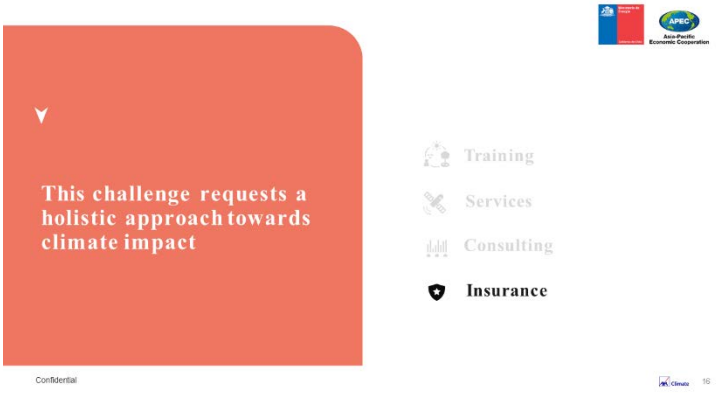
Consulting

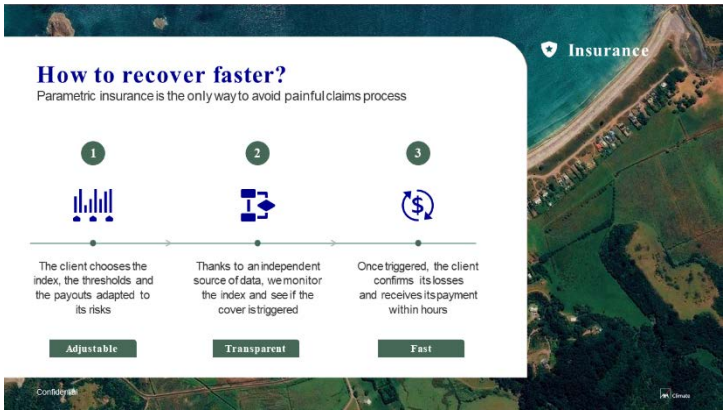
Insurance

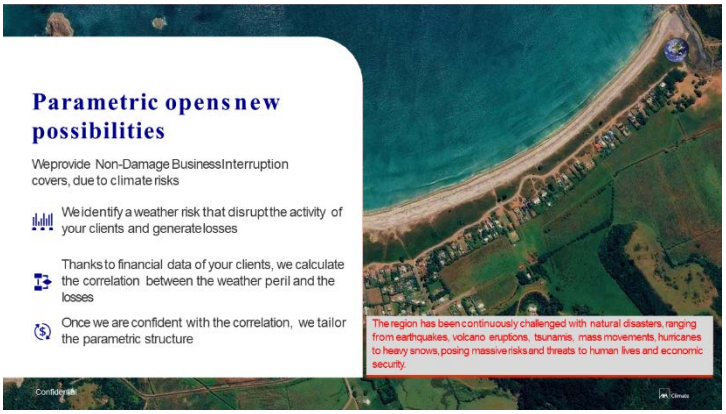

Consulting
How to adapt your assets & value chain to climate change?
We guide you trough your climate adaptation journey by sharing data and knowledge to make you smarter
Global Risk Assessment to identify at-risk assets from your portfolio or for acquisitions
Local Vulnerability Assessment and adaptation level score for your most at-risk assets
Local Adaptation Plan to build resilience and take opportunities
Investment and Financing to Projects towards Energy Resiliency
Facilitating the investment and financing for energy resiliency projects starts with identifying the area of investment.
The process involves disaster vulnerabilities and impact assessment on energy facilities, resources, and other critical structure to identify the gap in providing stable energy supply
Confidential


Consulting
Climate Change Modelling
Our climate expertise, combined with our data science knowledge, allows us to work on climate forecast and build climate indexes to better understand climate change and its impact.
For each index, we look at different time-horizons (2030 & 2050) to understand the trends.
We also compare different scenarios (from IPCC) and models (from CMIP5) to limit uncertainty on the results.
Our expertise can allow downscaled data at the km level.
Confidential


Consulting
Climate Adaptation Advisory
Advisory services, relying on insurance data and scientific modeling, to integrate climate risks into your prevention / insurance decisions or to comply with climate-related disclosure objectives.
Tailor-made Climate Consulting: We address all climate-related challenges that you may face, whether local or global
We can help to start your climate journey and to prioritize:
Climate Risk Screening: Climate risks now, and tomorrow (2030/2050), prioritization of most-at-risk sites, presentation of key climate risks among 50+ indicators at the site level, highlight of key vulnerabilities to investigate
Adaptation Scoring: Deep-dive vulnerability assessment at a site level with 3 axis: #1 Awareness & Governance #2 Physical Vulnerability #3 Insurability
Snapshots of our data and modeling
Confidential


This challenge requests a holistic approach towards climate impact
Training
Services
Consulting
Insurance
Confidential
16


Insurance
How to recover faster?
Parametric insurance is the only way to avoid painful claims process
1
The client chooses the index, the thresholds and the payouts adapted to its risks
Adjustable
2
Thanks to an independent source of data, we monitor the index and see if the cover is triggered
Transparent
3
Once triggered, the client confirms its losses and receives its payment within hours
Fast
Confidential


Parametric opens new possibilities
We provide Non-Damage Business Interruption covers, due to climate risks
We identify a weather risk that disrupt the activity of your clients and generate losses
Thanks to financial data of your clients, we calculate the correlation between the weather peril and the losses
Once we are confident with the correlation, we tailor the parametric structure
The region has been continuously challenged with natural disasters, ranging from earthquakes, volcano eruptions, tsunamis, mass movements, hurricanes to heavy snows, posing massive risks and threats to human lives and economic security.
Confidential

Earthquake Protection - Acceleration index

Insurance

Case study: Airports in Dominican Republic

Client Need

A client owns serveral airports in Dominican Republic with significant earthquake exposure and wants to protect them against earthquake damages and business interruption.

Client Pain Points

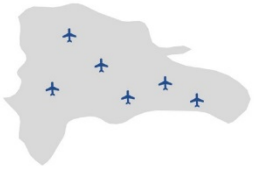
In the traditional property market, the client faces:

- High level of deductibles
- NDBI exclusions
- Exclusions in terms of perils and goods

Our solution

The earthquake parametric protection can be an innovative complement to the client's existing PDBI contract, protecting also against financial losses due to Non-physical damage business interruption. AXA Climate predefines the coverage based on the airports' characteristics and agree upon the Payout structure. AXA Climate uses Spectral Acceleration index that reflects the most damaging shaking produced by an earthquake.

Index	Spectral Acceleration 0.3s	
Payout structure	SA 0.3s	Payout [%] of insured value per site
	0.45 g	10%
	0.60 g	25%
	0.75 g	50%
	0.90 g	75%
	1.15 g	100%



Confidential

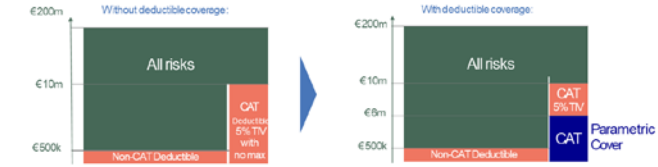
Focus on Deductible Buy-back

Insurance

CAT deductible is high in a PDBI or CAR/EAR program ?
→ We can protect the self-insured retentions with a complementary parametric insurance

Benefits:
We protect client's retention with a parametric deductible buy-back, to bring client retention in the problematic economy/peril down to the same level as for the rest of the program for CAT

Example:
The General Property Program Deductible is € 500k for FLEXA and 5% of insured values without maximum



Confidential

Focus on Parametric Carve Out

Insurance

Exposed locations?
→ It is possible to "carve out" some specific locations from a traditional insurance program (PDBI, Cargo or CAR/EAR)
→ Assets are fully covered by a specific parametric cover while selected perils are removed from the traditional program

Benefits:

- Facilitates the insurance placement for the client by increasing traditional players' risk appetite
- Keeps the client covered, preserving its NatCat limits

Confidential

Lack of wind Protection

Insurance

Case study: Offshore Wind farm in Denmark

Client Need

The client is looking for a solution to manage the uncertainty of wind availability – lack or excess of wind – and thus reduce the overall risk exposure of the wind farm.

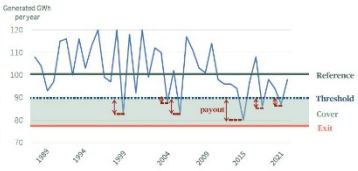
Client Pain Points

Non-physical damage business interruption exclusions in the traditional insurance coverage.

Our solution

Lack of Wind Protection financially protects wind farms against natural fluctuations. With our partners we model the hourly energy produced according to wind speed to secure the financial equivalent of reliable wind production.

Index	Modelled energy production through hourly winds
Threshold	Yearly production decrease 10% below average
Payout structure	EUR 26,666 per % below the threshold
Max payout limit	EUR 400,000
Payout simulation 2018	EUR 120,000



Confidential

Lack of rain Protection

Insurance

Case study: Hydropower plant in Colombia

Client Need

The client is looking for a solution to be covered in case of lack of rain, which may highly reduce the energy production of the plant.

Client Pain Points

Non-physical damage business interruption exclusions in the traditional insurance coverage.

Our solution

The index proposed is an estimation of the energy production of the plant in Gwh, with respect to yearly rainfall measured by weather stations located in the area of the dam. A formula is obtained to give a very good approximation of this energy production based on rainfall.

Index	Modelled energy production
Threshold	Yearly energy production below 12000 Gwh
Payout structure	$50 per MWh below the threshold
Max payout limit	$ 100m
Exit	11000 Gwh

Confidential

Water Level Protection

Case study: Transport routes on the Rhine river

Insurance

Client Need

During prolonged droughts or floods, main transport routes can become impassable, leading to delays or additional costs when loading onto smaller boats and/or using alternative freight solutions (rail/road).

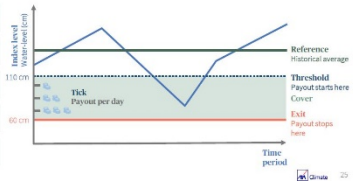
Client Pain Points

Partial and not adapted coverage in the traditional insurance offer.

Our solution

WATER LEVEL Protection is customized to your water level exposure: the payout is defined to cover your loss of revenue due to business interruption, your increased operating costs – to mitigate the situation / find alternative solutions, and other potential expenses. Once the threshold is met – water above and / or under a certain level -, you receive the payout.

Index	Cumulated cm below a critical threshold over a risk period
Threshold	110 cm
Payout Structure	Max € 8k / day
Exit	60 cm
Limit	€ 2 000 000



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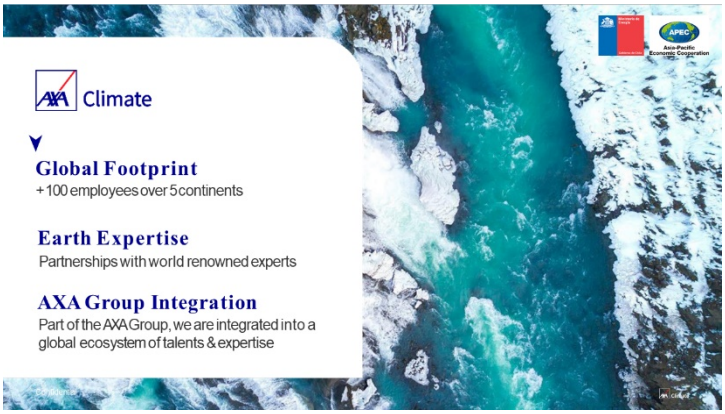
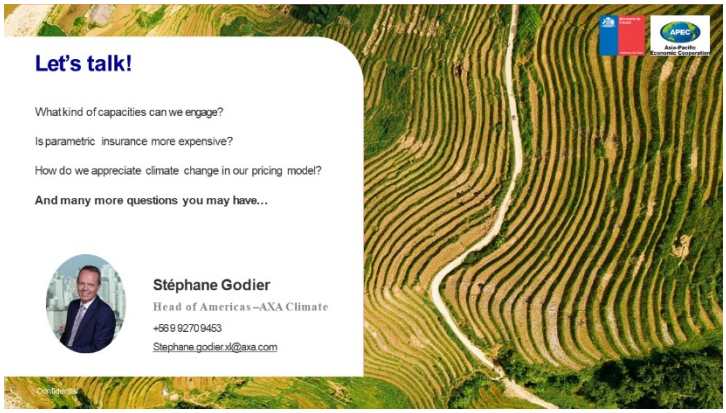
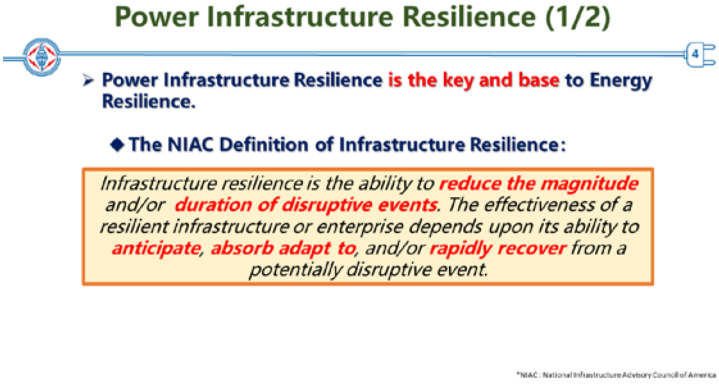


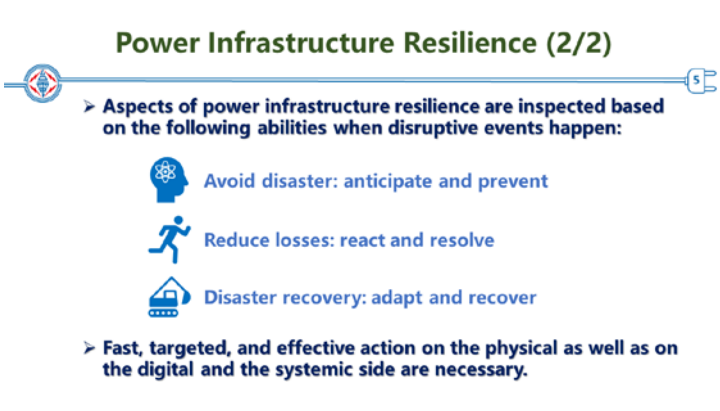


3. Chinese Taipei workshop (Jan. 20, 2022)

3.1. Presentation 8: Chinese Taipei: Power System Infrastructure Resilience

by Dr Chin-Chung Wu, Director of the Department of System Operations, Taipower





Types of Risks on Power Supply

7

Natural Disaster (Earthquake, Hurricane)	Extreme Climate (Drought, Snowstorm)	Carbon Reduction (Emission reduction, Transformation)	Human Factors (Information Security, Terrorism)

• Sep 21, 1999 earthquake
  • outages: 6.5 million households
  • transmission system damaged and outages for 20 days.
• Sep 25-28, 2016 Typhoon Meiji : outages 4 million households
	Very little rainfall from the end of 2020 to June 2021, which affects the power generation of the pumped-storage unit, resulting in 513 and 517 blackout events	Green energy has affected the stability of the power system (such as night peaks, intermittent, inertia). California ISO ordered rolling outages affecting at least 200,000 customers during August 15-19, 2020.	The Internet of Things is accompanied by information security risks. In 2021, the power grids of India and Puerto Rico were attacked causing power outages. Several companies in Chinese Taipei were also attacked by ransomware.




Strategies to Sustain Power Supply Stability

8

Ways to Improve Power System Resilience

9

Recovery

- Speed up post-disaster recovery
- Repair equipment and manpower preparation

Tolerance

- Avoid disaster and reduce losses
- Action plan for preventive measures

https://www.seinsights.asia/specialfeature/5065/5109

Disaster Recovery: Emergency Operation Center + Repair Equipment & Manpower

10


High-level contingency decision-making

Central EOC | EOC of MOE | City Government


Taipower Emergency Operation Center


Integrated logistics support


Weather Information


Grid Information


Nuclear Power Safety Information


Power Plant Information

During a disaster, Taipower's DPMS (Disaster Prevention Management System) can aggregate power outage information, equipment status, and support manpower to help shorten the power recovery time. It can also publicize the power outage and recovery situation.

Critical Infrastructure Protection Act

11

Chinese Taipei government has established protection guidelines for critical infrastructure.

What a critical infrastructure shall do:
1. implement risk assessment
2. prepare a protection plan
3. conduct regular drills

Taipower is one of critical infrastructure facilities!

Avoiding Disasters: Risk Assessment and Preparatory Exercises

12

War Chess Deduction

International Seminar

Discuss energy security issues such as disaster prevention, counter-terrorism, emergency repairs, and smart grids with economies around the world, and conduct regular drills with various risk scenarios to improve regional energy security.

Avoiding Disasters: Strengthening the Power Grid

13

With the influence of the global extreme climate, the scale of damage to the power system from multiple disasters has continued to increase. Taipower has analyzed the causes of various accidents and proposed countermeasures to strengthen the power grid.

Strengthen the pole	Improve grid resilience	Underground power lines
		
Upgrade the materials used for the poles and increase the engineering strength according to the construction site environment	1. Increase the number of automated feeders 2. Expand the construction of smart substations 3. Upgrade substations/lines	Underground power grid projects have been extensively implemented in those areas easily affected by typhoons and large power outages.

Dual-Master Synchronous Operation Scheme

14

Taipei CDCC

SCADA WAN

Kaohsiung CDCC

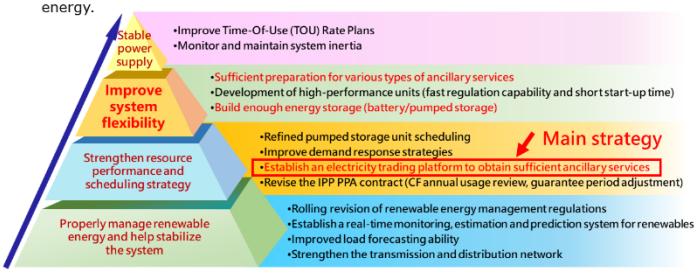
EHV Substations | ADCCs | Power plants

- Taipower is the first power company in the world to establish the Dual-master synchronous operation scheme system to ensure stable and reliable system operation.
- Both centers transmit and receive the data from power plants, ADCCs and EHV Substations at the same time through SCADA WAN, so there is no lag of data exchange.

Supporting Measures for Energy Transition

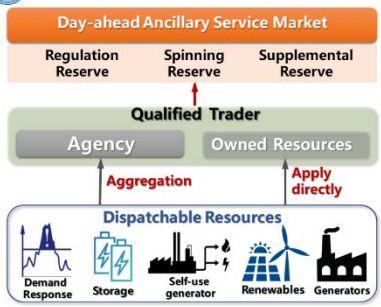
15

Taipower has planned multiple supporting measures to reduce the impact of renewable energy.

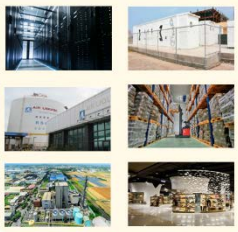


Electricity Trading Platform

16



Bring in private decentralized resources to stabilize the power grid



Conclusion

17

Conclusion

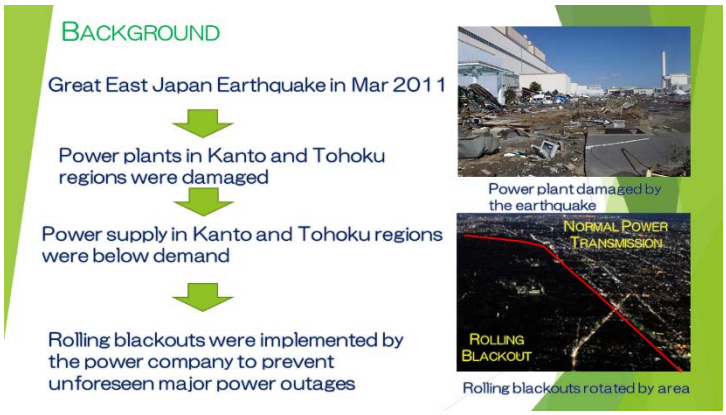
18

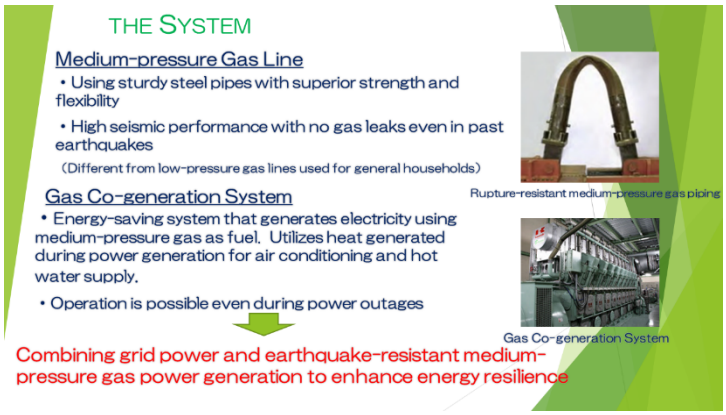
1. Electricity supply is an economy-level security issue, and there should be a comprehensive crisis awareness and preparation in advance to improve the tolerance and resilience of the power system.
2. In response to challenges such as extreme climate and energy transition, Taipower has prepared various measures and an electricity trading platform to maintain a stable supply of electricity.

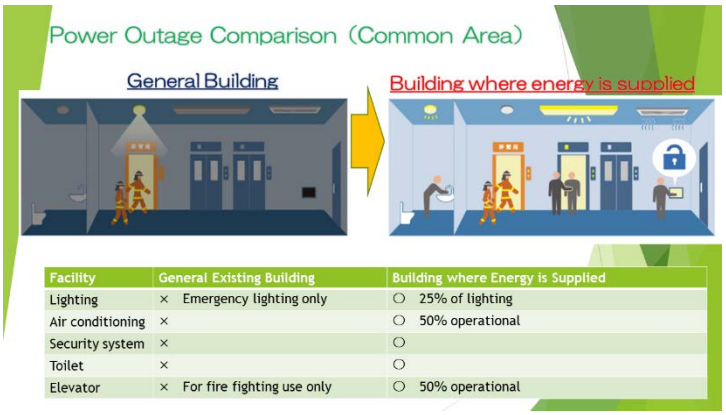

THANKS
FOR YOUR ATTENTION

3.2. Presentation 9: Japan: Nihonbashi Smart City Project

by Mr Yukikazu Kawahigashi, Executive Manager of the Project Planning Division of the Environment and Energy Service Department, Mitsui Fudosan







Power Outage Comparison (Exclusive Area)

General Building

Building where energy is supplied

Facility	General Building	Building where energy is supplied
Lighting	× Emergency lighting only	○ 25% of lighting
Electrical outlet	×	○
Air conditioning	×	○ Approx. 28℃ in summer

Enhances disaster prevention performance and improves business continuity for tenants

Expanding to Other Areas

Large-scale development project in other areas is also underway

TOYOSU

YAESU

NIHONBASHI

Thank you very much for your kind attention

3.3. Presentation 10: Republic of Korea: New Resilience Strategies based on Cascading Outage Analysis

by Dr Jin Hur, Professor of the Department of Climate and Energy Systems Engineering, Ewha Womans University

New Resilience Strategies based on Cascading Outage Analysis to Enhance Power Grid Security

2022 ASIA PACIFIC ENERGY RESEARCH CENTRE (APERC) WORKSHOP ON ENERGY RESILIENCY PRINCIPLE

2022. 1. 20

Jin Hur
Department of Climate and Energy Systems Engineering
Ewha Womans University (Republic of KOREA)

Outline

1 Introduction: Natural Disasters Building for Resiliency

2 Cascading Outage Analysis & Modeling

3 Case Study and Discussion

4 Future Work and Recommendation

EWHA WOMANS UNIVERSITY

Natural Disasters Building for Resiliency (1/2)

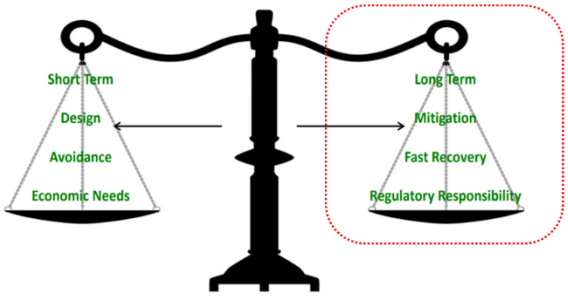
- Extreme weather and natural disasters devastate power generation, transmission, and distribution systems.
- These extreme events are likely to become more frequent or more intense due to climate change.
  - In February 2021, an extreme winter storm event caused a massive electricity generation failure in the state of Texas, which resulted in a loss of power for more than 4.5 million homes.
- In this work, we propose new resilience strategies implementing the cascading outage mitigation and fast restoration using variable generating resources to enhance power grid security.

We present the impact analysis for natural disaster from the earthquake scenarios based on the empirical data using the proposed cascading outage.

Cascading outages based on sequential power facility trips due to initial disturbances were applied to evaluate the power system impact caused by earthquakes.

Natural Disasters Building for Resiliency (2/2)

- Operations and Design Philosophy



(References: Practices on Natural Disaster Mitigation, IEEE PES GM 2019)

Cascading Outages in NERC Requirement

- **Definition in NERC's Glossary of Terms**

  "The uncontrolled **successive loss of system elements** triggered by an incident at any location. Cascading results in widespread electric service interruption that cannot be restrained from sequentially spreading beyond an area predetermined by studies."

- **Requirements in NERC TPL-001-4 (**Transmission System Planning Performance Requirement**)**
  - Requires evaluation of possible actions for **potential cascading caused by extreme events**

- **Tools Used for Cascading Analysis (Korean Power Grids)**
  - **Python:** Initial Disturbance Screening
  - **PSS/E (Siemens PTI)**: Detailed analysis of the select contingencies

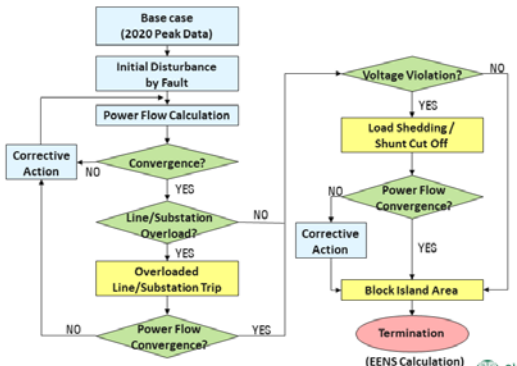
Cascading Outage: Algorithms

- **The proposed simulation procedures based on Python-PSS/E interface tool for cascading outages caused by large-scale earthquakes are as follows:**

STEP 1 Set-up Base case	• Calculate the initial power flow after setting the Base case • Start system simulation after checking overload and voltage violations
STEP 2 Initial Disturbance Simulation	• Select the initial disturbance after the initial earthquake • Review factor: line, generator, substation
STEP 3 Check Convergence	• **When converge**: check violations • **When diverge**: corrective action for convergence – Re-dispatch of generator, reactive power control, load shedding
STEP 4 Cascading Tripping Simulation	• Check divergence, power balance, overload, voltage violation • **When diverge**: corrective action for convergence • **When overload occurs**: 150% or more overload facility → Trip • Solve the voltage problem
STEP 5 Calculate EENS	• Calculate EENS according to load trip for system convergence

Cascading Outage: Algorithms

Cascading outage algorithm



Cascading Outage: Detailed Procedures (1/5)

Selection of initial disturbance event (IDE)

- **IDE was selected to evaluate the systemic effects of a fault earthquake.**

Sequential trip of generator, substation, or generator-substation is applied
(Consider the occurrence time of the earthquake and damage scale (DS))

* Damage scale (DS)
- If it exceeds 1, it means that the probability of occurrence exceeds 50%
- If it exceeds 1.5, then the probability of occurrence is very high

Trip with divergent power flow is defined as the IDE

Sequential cascading outages are performed

Cascading Outage: Detailed Procedures (2/5)

Initial disturbance simulation

- **A cascading outage simulation was performed for the selected initial disturbance.**
- **Depending on the selected IDE,**
  - Trip the line or transformer with an initial disturbance
  - Check whether it converges through the power flow calculation

Cascading Outage: Detailed Procedures (3/5)

Corrective action

- **If the initial disturbance simulation converges,**
  - voltage violations and slack bus generation ranges are checked before acting on a 150% overload
- **For the system stabilization,**
  - If undervoltage occurs -> load shedding
  - If overvoltage occurs -> shunt block
- **Here, corrective actions are performed, targeting the load and shunt of the bus, in the area where the disturbance is being simulated.**
  - When the load is cut off, 50 MW is gradually eliminated to solve the violations
  - When the shunt is cut off, 50 MVar is gradually eliminated to solve the violations
  - Subsequently, it is examined whether the generation range of the slack bus is exceeded

Cascading Outage: Detailed Procedures (4/5)

Criteria of facility trip

- **If the system converges after all corrective actions have been taken, the overload is reviewed to examine whether the overload factor of facility exceeds 150%.**
  - If there are multiple facilities with an overload factor exceeding 150%, the facility with the highest overload factor is tripped, and then the previous steps are repeated.
  - This process is repeated until no additional facilities exceed the 150% overload factor.

Divergence test

- **After power flow divergence, if the system cannot converge even after corrective actions are taken, it is considered as divergence, and the simulation is terminated.**
  - When the power generation in the system is less than the load
  - When the amount of load shedding due to corrective action exceeds 4,000 MW

Cascading Outage: Detailed Procedures (5/5)

Termination of simulation and calculation of EENS

- **The cascading outage simulation is terminated**
  - when there are no more facilities with overload exceeding 150% or
  - when the expected energy not served (EENS) was calculated by identifying the change in load capacity based on the basecase and the divergence condition is reached.

Data

Input data

- **Base case: 2020 peak data (load factor 100%)**
- **Cascading outage scenario:**
  - Generate contingency events due to the large-scale earthquake in the area A in Korea that trip nearby generators

Generator	Time (sec)
Thermal	9.98
Combined A	11
Thermal	11
Nuclear A	14.47
Cogeneration	15.24
Nuclear B	15.62
Pumped Storage A	15.74
Pumped Storage B	16.7
Combined B	17.32
Pumped Storage C	18.03
Combined C	22.6

▲ Fault of Power Plant in Area A in Korea

Fault of Substation in Area A in Korea ▶

Substation	Class	Time (sec)	DS
1	154kV	1.48	1.46
2	154kV	1.87	1.48
3	154kV	2.19	1.4
4	154kV	2.51	1.51
5	154kV	2.6	1.47
6	345kV	2.97	1.21
7	154kV	3.14	1.39
8	154kV	3.39	1.36
9	154kV	3.94	1.33
10	154kV	4.12	1.47
11	154kV	4.19	1.45
12	154kV	4.78	1.43
13	345kV	4.86	1.48
14	154kV	5.26	1.22
15	154kV	5.27	1.41
16	345kV	5.61	1.46
17	154kV	5.66	1.29
18	345kV	5.82	1.29
19	345kV	6.36	1.4
20	154kV	7.06	0.37
21	154kV	7.09	1.36
22	154kV	7.1	1.33
23	154kV	8.07	0.65
24	154kV	8.13	1.16
25	154kV	8.47	0.57
26	154kV	8.59	1.11
27	154kV	8.82	1.09
28	154kV	9.27	0.32
29	154kV	9.45	1.14

Simulation Method (1/2)

- **The cascading outage was analyzed as a fault earthquake occurred in the region A caused a contingency that tripped a nearby generator.**
- **The cascading outages procedure due to the generator trip caused by the earthquake in the area A is mainly performed in the following five steps.**

STEP 1 — Set-up Basecase
- After setting the basecase for the cascading path following the earthquake in area A, power flow calculation was performed.

STEP 2 — Initial Disturbance Simulation
- When generators (CC plant ⇨ GT#7 plant ⇨ GT#8 plant ⇨ ST#4 plant ⇨ Nuclear A plant) tripped in sequence, the power flow diverged.
- Nuclear A plant is defined as an initial disturbance for cascading outage simulation analysis.

✓ **Initial disturbance definition:**
- The system converges stably in the sequential trip of CC plant ⇨ GT#7 plant ⇨ GT#8 plant ⇨ ST#4 plant.
- The divergence in a sequential generator trip is defined as the initial disturbance of the cascading outage, and cascading outage algorithm is applied.

Simulation Method (2/2)

- **The cascading outage was analyzed as a fault earthquake occurred in the region A caused a contingency that tripped a nearby generator.**
- **The cascading outages procedure due to the generator trip caused by the earthquake in the area A is mainly performed in the following five steps.**

STEP 3 — Check Convergence
- To converge the unstable system, remedial action was implemented through load shedding.

STEP 4 — Cascading Tripping Simulation
- The power flow was converged by blocking the load at the neighboring area, but overvoltage and undervoltage occurred.
- The voltage violation was eliminated by adjusting the shunt and tap as a corrective action.

STEP 5 — Calculate EENS
- The EENS capacity was 1,502.3 MW.

Results

Sequential generator trip and EENS in area A in Korea

- **The table summarizes the cascading outages based on the nearby generator trip by the fault earthquake occurred in area A.**

Sequence of disturbance	Generator near area A in Korea					EENS [MW]
	1st	2nd	3rd	4th	5th	
Initial Disturbance Event (IDE)	CC plant	GT#7 plant	GT#8 plant	ST#4 plant	Nuclear A plant	1,502.3
					Power flow divergence	

➢ When a total of five units were tripped from the CC generation plant to nuclear power plant, the power flow diverged.

➢ According to the sequential generator trip, it can be confirmed that the system converges when the surrounding load is tripped by 1,502.3 MW, facilitating a stable system operation.

Discussion on Case Study (1/3)

- **The large-scale blackouts in Europe and North America were caused by the broken power balance based on the sequential accidents from the initial disturbance.**
- **In this case study,**
  - ✓ the possibility of outages and impact on the system were analyzed by applying the cascading outages algorithm based on the fault earthquake.
  - ✓ the cascading path of the disturbance was reviewed in advance analyzing the outage path based on the trip of the power facility.
  - ✓ methods to minimize damage on power facilities (e.g., system stabilization through load shedding) were examined.

Discussion on Case Study (2/3)

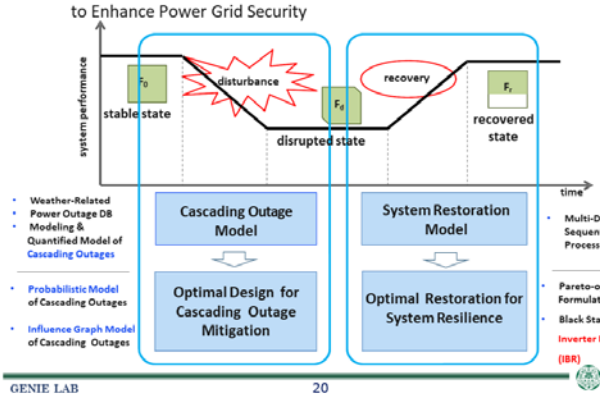
- **When a fault earthquake occurred in area A, a combination of generator, substation, and generator and substation trips, including DS, were considered.**
  - ✓ When the system converges stably, a sequential power facility trip is continuously performed.
  - ✓ However, when the system diverges, the event is defined as the IDE for cascading outages, and the cascading outages algorithm is applied.
  - ✓ The simulation of cascading outages was terminated, and the EENS of area A in Korea was 1,502.3 MW.

Discussion on Case Study (3/3)

- **When an earthquake occurs, a blackout may occur in the power system, which may spread to adjacent areas.**
  - The power system is gradually restored, and the period of system restoration depends on factors such as earthquake intensity and damage level.
  - Even after the power is restored, a rolling blackout may occur because of an aftershock.
- **In future, additional research is required on**
  - ✓ **Scenario models and database construction for possible earthquakes**, along with disturbance spread and resilience models to analyze the system impact due to the earthquake.
  - ✓ **A dynamic security analysis** that reflects the dynamic characteristics of power facilities.
    - In this case study, the analysis focused on the static security of the system based on the initial disturbance

Future Work and Recommendation

- New Resilience Strategies based on **Variable Generating Resources (VRE)** to Enhance Power Grid Security



Thank you

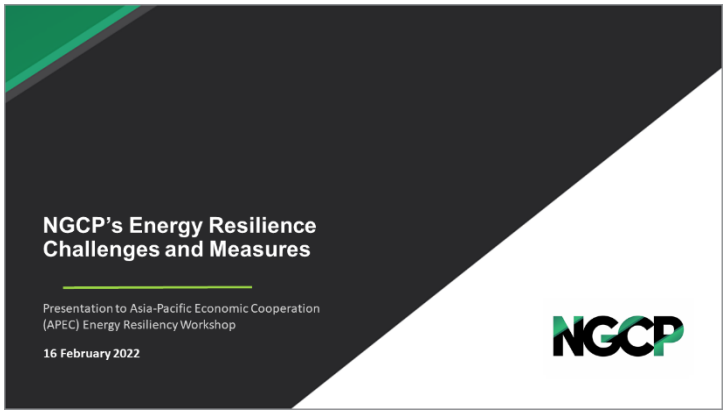
Jin Hur
Ewha Womans University

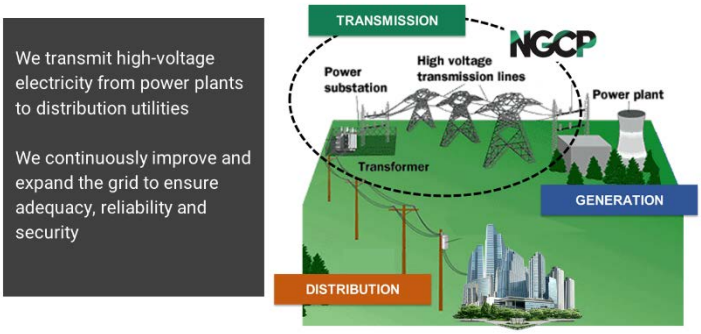
EWHA WOMANS UNIVERSITY

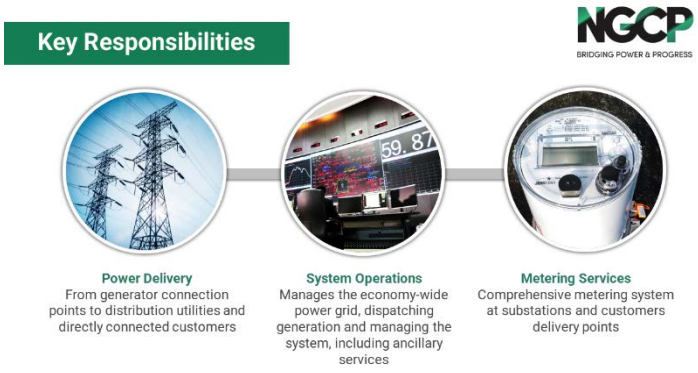
4. The Philippines workshop (Feb. 16, 2022)

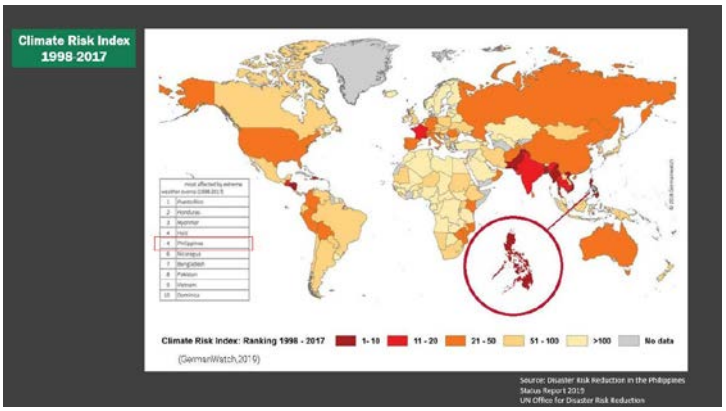
4.1. Presentation 11: NGCP's Energy Resilience Challenges and Measures

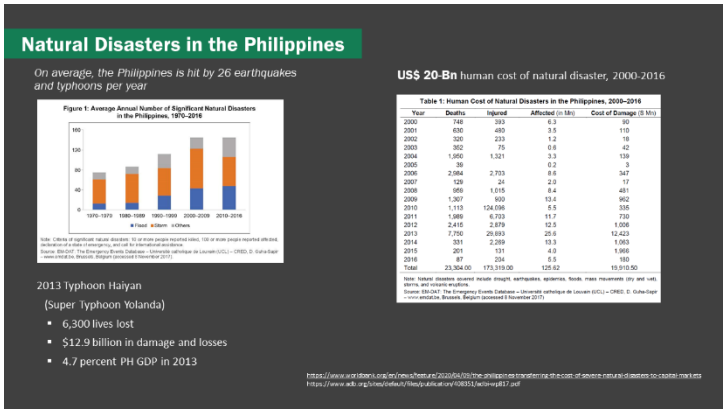
by Mr Giovanni Randolfo A. Galang, Assistant Vice President and Head of the Technical Management Department, National Grid Corporation of the Philippines











DISASTER PREPAREDNESS

Measures taken to prepare for and reduce the effects of disasters

IFRC

Pre-disaster actions
- Organizing
- Training
- Planning
- Equipping
- Stockpiling
- Hazard mapping
- Public information/education

Also includes development/enhancement of:
- overall preparedness strategy
- policy
- institutional structure
- warning and forecasting capabilities
- plans to safeguard lives and assets

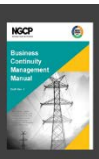
Republic Act No. 10121
"Philippine Disaster Risk Reduction & Management Act of 2010"

INTEGRATED DISASTER ACTION PLAN

General Framework

ERM serves as the foundation of Business Continuity Management

Identifies, evaluates, and control risks and risks exposures



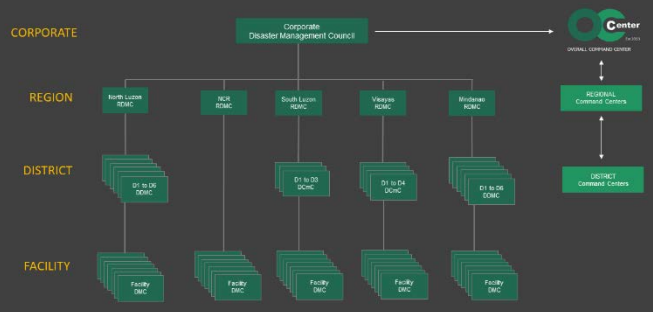
INTEGRATED DISASTER ACTION PLAN

General Framework

ERM serves as the foundation of Business Continuity Management

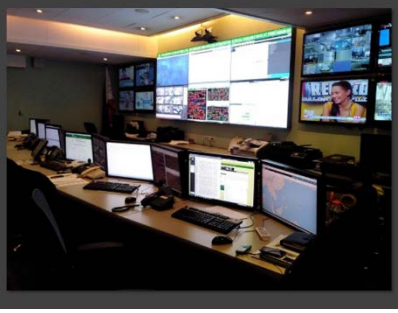
Identifies, evaluates, and control risks and risks exposures

FOUR-TIERED DISASTER MANAGEMENT



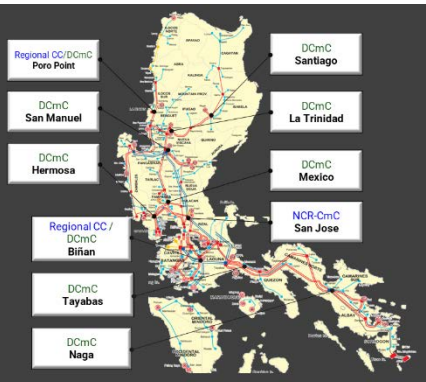
OC Center
Est 2013
OVERALL COMMAND CENTER

- Focal station to monitor weather disturbances and other contingencies
- Nerve center for drills, coordinating response, resource mobilization, and information management during disaster operations and other events
- With links to PH weather bureau and satellite images from JTWC and JMA
- Consolidation of situation reports from the regional and district command centers

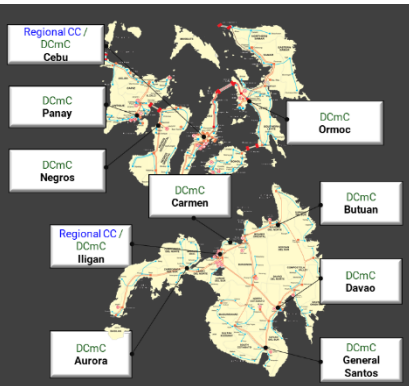


LUZON

Command Centers

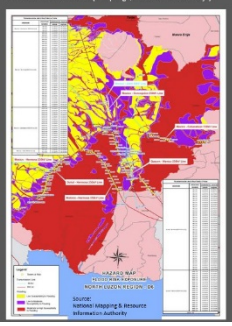


VISAYAS MINDANAO
Command Centers



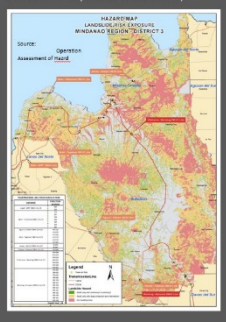
DISASTER PREPAREDNESS: HAZARD MAPS

Transmission Structures at risk of flooding
District 6 – Central Luzon (Pampanga, Bulacan & Nueva Ecija)



Hazard maps provide important information to help NGCP understand the risks of natural hazards to its transmission facilities

Transmission Structures at risk of landslides
District 3– Mindanao (Bukidnon & Misamis Oriental)



DISASTER PREPAREDNESS: HAZARD MAPS

Transmission Lines at risk of lightning strikes
Mt. Province (North Luzon) is most prone to outages

Hazard maps indicate the extent of expected risk areas, and allow NGCP to develop its resiliency plan

Communication Facilities (24 at risk) within the **210-249/230+ kph** wind intensity zone

DISASTER PREPAREDNESS

NGCP has a set of **pre-identified measures** it undertakes to better respond to and cope with tropical cyclones

Before Typhoon Season
Remember to GAS AFF

Good housekeeping	• check space heaters, sealing of equipment cabinets & marshalling boxes • check station batteries & chargers • store all spare insulating oil inside warehouse including supply for on-going P&E projects • check all RCCs & ACCs communication facilities • check standby & portable generators, emergency lights, fuels & communication equipment
Aerial Patrol Slope protection	• patrol on TL structures not easily accessible to linemen • IR scanning & UV inspection of TL • fast track completion of slope protection projects • install storm guys where necessary • replace defective/missing parts of tower • retighten telecom antennas • analyze design & recommend structural reinforcement and/or reconfigure the lines
Anti-flooding Measure	• finish anti-flooding projects • readiness of submersible pumps • check & clean drainage system, cable trenches & water catch basins, transformers oil & water separator • prepare sand bags for use to prevent flooding inside substation
Facility inspection	• re-inspect TL structures near river banks, lakes, cliff & mountainous locations • check condition of existing slope protections, critical vegetations & safety clearance of conductors • inspect the substation access roads that experienced flooding & identify alternate routes • ensure availability of design drawings of structures that maybe affected by disaster • inspect microwave radio structures prone to landslides
Facility reinforcement	• water-proof roof tops & clean downspouts of all control buildings, warehouses, & other storage facilities • cover with tarpaulin critical HV equipment stored outdoor

DISASTER PREPAREDNESS

Sufficient spares for emergency:
ERS, steel poles, mobile transformers

ERS and Steel Pole Spares | Spare and Mobile Transformers

DISASTER PREPAREDNESS

- Empowering partner communities through disaster risk reduction trainings
- Fully-equipped command centers
- Well-trained personnel

RESILIENCE

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

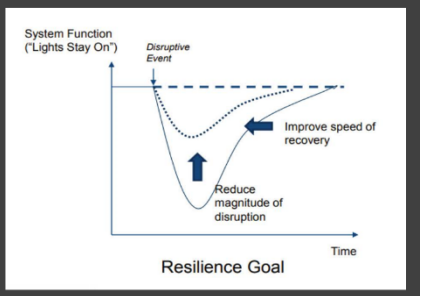
Republic Act No. 10121
"Philippine Disaster Risk Reduction & Management Act of 2010"

Power Sector

In the context of power systems:

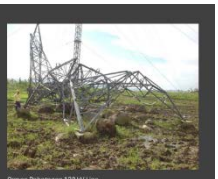
Resilience means the ability to – **resist, adapt to**, and **timely recover** from disruptions

Resilience is a vital consideration for business continuity



Department of Energy Circular 2018-01-001
"Adoption of Energy Resiliency in the Planning and Programming of the Energy Sector to Mitigate the Potential Impacts of Disasters"

1. Strengthen existing infrastructure facilities
2. Incorporate mitigation improvements – "Build Back Better" principle
3. Improve operational and maintenance standards and practices
4. Develop resiliency standards


Ormoc-Babatngon 138 kV Line
Tropical Cyclone "YOLANDA" 2013


Ubay-Corella 138 kV Line
Tropical Cyclone "ODETTE" 2021


Naga–Tiwi–Daraga 230 kV Line
Tropical Cyclone "NINA" 2016


Taal Volcano Eruption
January 2020

GRID RESILIENCY
Energy Resiliency Plan

1. Adherence to "Build Back Better" principle
2. Resilient and robust grid configuration
3. Technology-based planning and decisions
4. Enhanced asset management
5. Adoption of emerging technologies
6. Covers all disruptive event domains (human, physical, cyber)

NGCP TDP 2020-2040
"NGCP is also implementing resiliency planning to improve the ability of the power system to withstand the effects of adverse environmental conditions, man-made power interruptions, and other system disturbances."

"...Provides guidance on how to prepare the workplace to ensure that the critical functions continue to operate amid the existence of a health crisis."

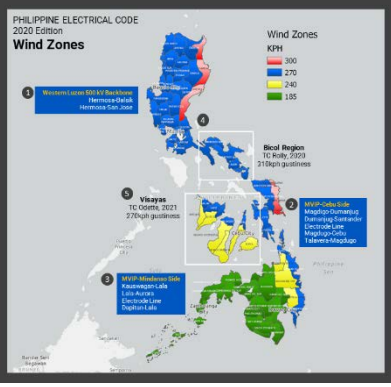
NGCP 2021 IDAP
"...disaster management is further aligned with the company's ERM Policy and business continuity management system. In addition, the scope of the IDAP considers the use of internationally-accepted principles and adoption of holistic disaster risk management approach as contained in Republic Act No. 10121 - otherwise known as "Philippine Disaster Reduction and Management Act of 2010."

"...provides guidelines and procedures on natural disasters, covering four thematic areas: mitigation, preparedness, response, and recovery."

Computer Emergency Response Team's step-by-step prevention of, response to and recovery from any cyber attack

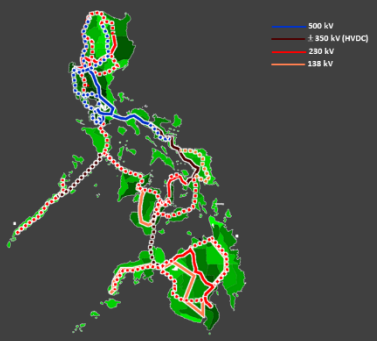
GRID RESILIENCY
Build Back Better

Upgraded wind speed design
Adoption of 2020 PEC Wind Zones



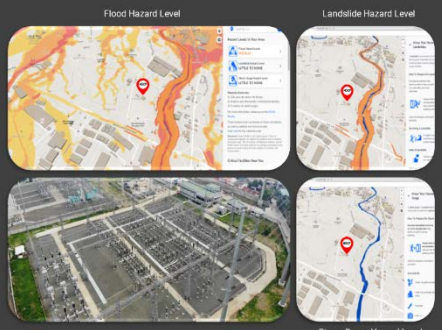
GRID RESILIENCY
Robust Grid Configuration

- ✓ New transmission backbone to support generation developments
- ✓ Stage-by-stage establishment of redundancy and transmission backbone loop configuration for resiliency
- ✓ Grid interconnection upgrades and new island interconnections



GRID RESILIENCY
Technology-Based Planning

Substation site and transmission line route selection criteria based on hazards maps



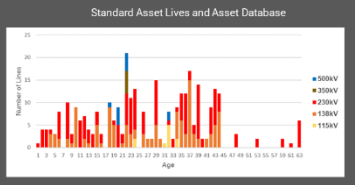
Calamba 230kV Substation Project

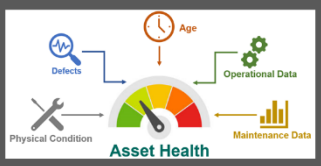
Source: NOAH Website

GRID RESILIENCY
Enhanced Asset Management

Asset Replacement Program

- adopts international best practices in the assessment of assets
- provides the most informed decision in the management of transmission assets





Asset Condition & Prioritization

GRID RESILIENCY
Enhanced Asset Management

Hazard maps
Provide technology-based asset component hardening

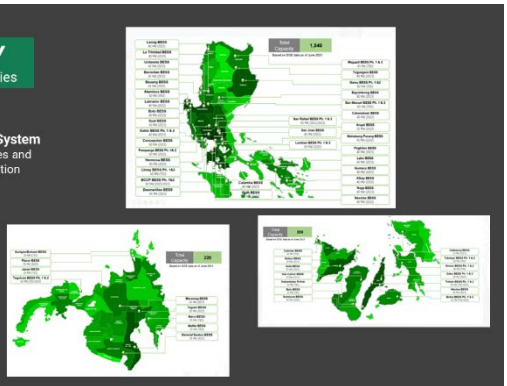
Bored Pile Foundation
San Esteban–Bantay 115 kV TL

Bored Pile Foundation
La Trinidad–Bauang 230 kVTL

Slope Protection–Rockwall
EB Magalona Substation

GRID RESILIENCY
Adoption of Emerging Technologies

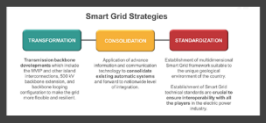
Battery Energy Storage System
Can provide ancillary services and relieve transmission congestion



GRID RESILIENCY
Adoption of Emerging Technologies

SMART GRID

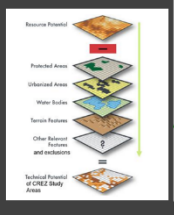
To enhance power system manageability in spite of grid complexity

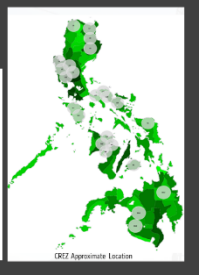


RENEWABLE ENERGY INTEGRATION

Green Energy Corridors. Ongoing initiative to enable the integration of large-scale renewable energy into the grid

Available indigenous RE resources could significantly contribute to the economy's vision to ensure sustainable, secure, sufficient, and affordable energy.





CREZ Approximate Location

GRID RESILIENCY
Capacity Building on ERM

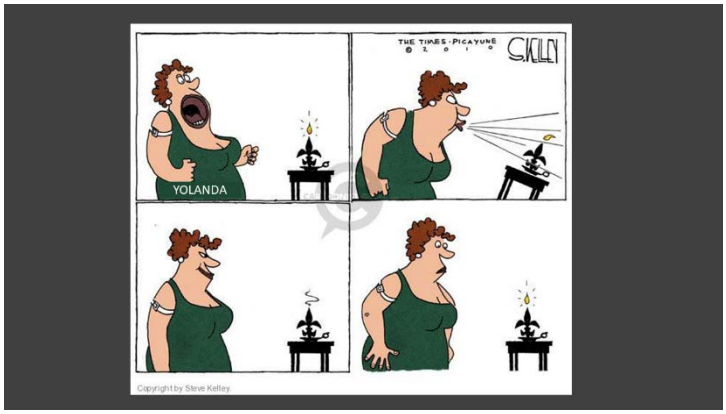
IDAP Clause 5.1.3
Electricity Resilience Model

An ERM Team is working to develop and deploy engineering class modeling system for grid planning and real-time resilience analysis

The ERMT shall build its capacity to operate and understand relevant application software on:

- Domain Simulators
- Geographical Information Systems
- Economic Models
- Visualization tools
- Threat models
- Data Processing Models
- AI/Machine Learning

Conduct annual needs assessment activities to ensure that the organization can effectively operate and conduct these highly specialized activities and responsibilities. (e.g., data analytics, extreme event grid planning, GIS operation, data gathering, big data management, data visualization, cybersecurity, etc.)

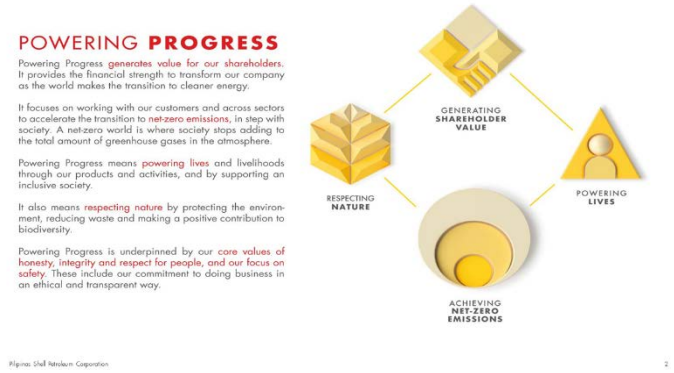


NGCP

BRIDGING POWER & PROGRESS

4.2. Presentation 12: Powering Progress for the Future Energy Resiliency at Pilipinas Shell

by Ms Lorelie Quiambao Osial, President and CEO, Pilipinas Shell Petroleum Corporation

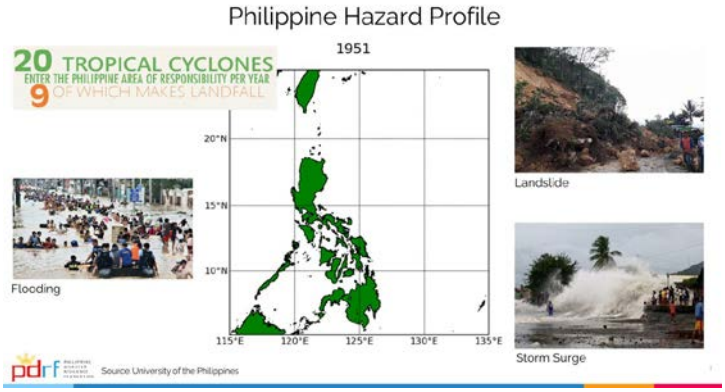



A fully powered
and progressive
Philippines

4.3. Presentation 13: The Role of the Private Sector in Energy Resiliency

by Mr Rene Jose Sayoc Meily, President, Philippine Disaster Resilience Foundation

The Philippines' major private sector vehicle and coordinator for disaster risk reduction and management



SUPER TYPHOON RAI (ODETTE)

	Yolanda (Haiyan, 2013)	Odette (Rai, 2021) *Ongoing assessment*
Affected Persons	16.1 Million	8.34 Million
Damaged Houses	1.14 Million	1.37 Million
Total Amount of Damages	Php 95.5 Billion	Php 33.3 Billion
Power	25 Days 100% Restored	33 Days 97% Restored
Water	Limited water supply 5 months after Yolanda	27 Municipalities Affected 26% Restored
Telecom	419 Municipalities 71% Restored 10 days after	247 Municipalities Affected 73% Restored

*Data as of January 26, 2021

TASK FORCE KAPATID

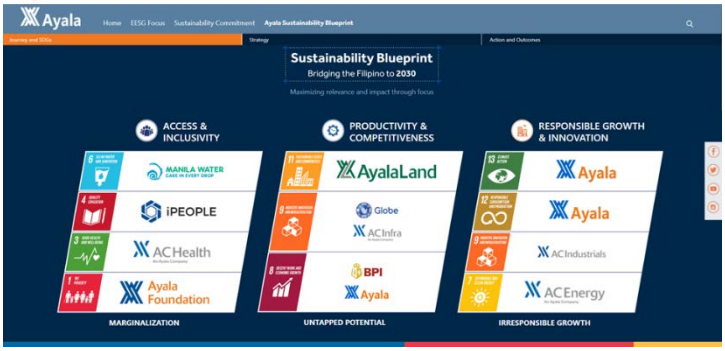
TASK FORCE KAPATID

PDRF RESILIENCE TRAINING & EDUCATION CURRICULUM

TRAINING

ENERGY DEVELOPMENT CORP.

AYALA CORPORATION



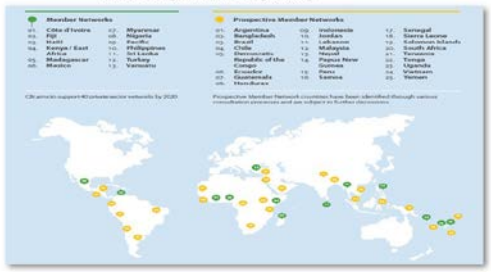
BONIFACIO GLOBAL CITY

WAYS FORWARD

- Multi-stakeholder planning
  - Emergency response
  - Preventive measures
- Disaster Risk Financing
  - Green Bonds
  - Insurance

CONNECTING BUSINESS INITIATIVE

Connecting businesses globally



THANK YOU!

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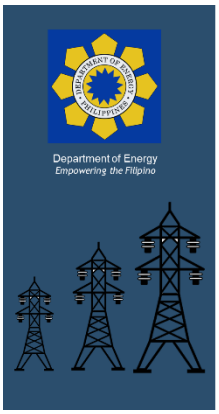
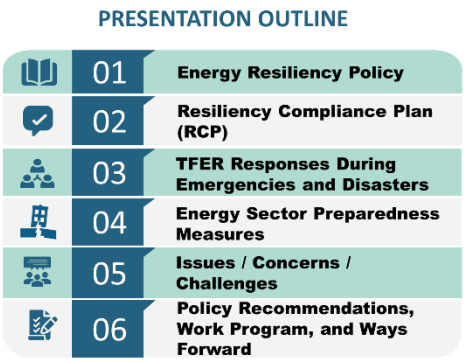
TWITTER @thepdrf
INSTAGRAM @thepdrf

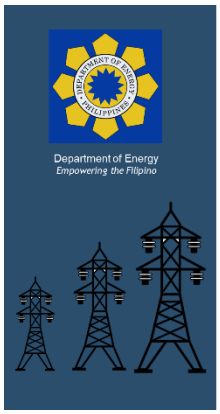
www.pdrf.org

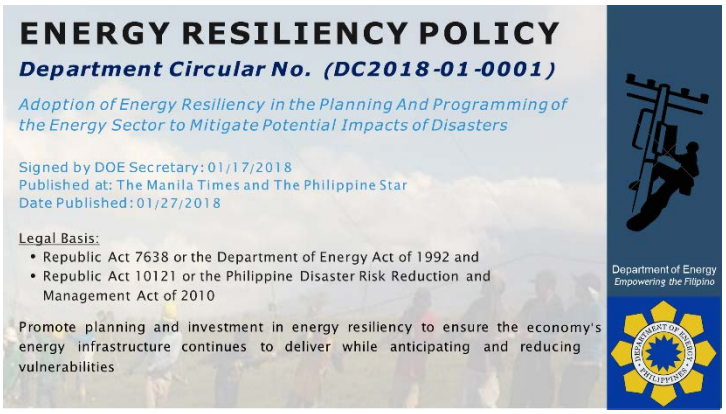
4.4. Presentation 14: DOE Philippines' Energy Resiliency Efforts and Best Practices

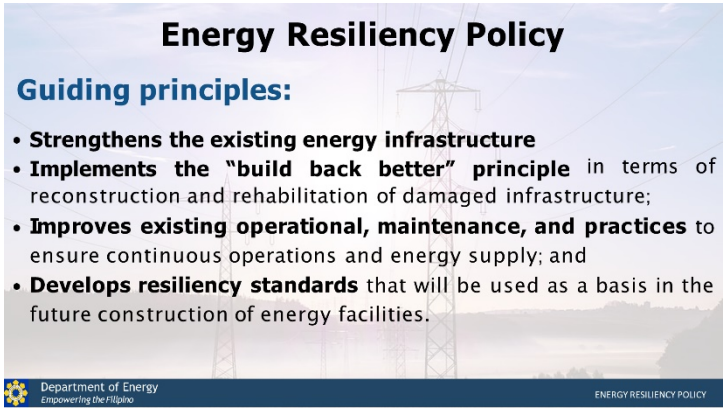
by Mr Michael O. Sinocruz, OIC Director of Energy Policy and Planning Bureau, Department of Energy of the Philippines

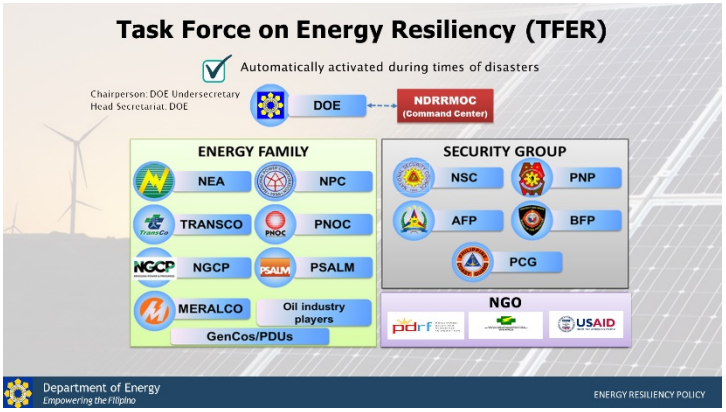












SCOPE AND APPLICATION

Energy Resource | Renewable | Power | Oil | Utilization

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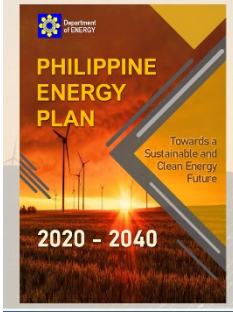
ENERGY RESILIENCY POLICY

INTEGRATION OF ENERGY RESILIENCY IN THE PHILIPPINE ENERGY PLAN 2020 - 2040



STRATEGIC FOCUS:

RESILIENCY AND SECURITY OF ENERGY SYSTEM

- Objective 1: Strengthening Energy System Resiliency
  - Assessment of RCP
  - Energy Sector Preparedness Measures
  - Energy Sector Disaster Response during the COVID-19 pandemic
  - Preparedness and Management for Compound Disasters
  - Rehabilitation of Damaged Facilities through the "Build Back Better" Principle
  - Development of Disaster Risk Financing and Insurance
- Objective 2: Strengthening Energy Security
  - Alignment to the "National Security Policy"
  - Addressing energy security challenges such as:
    - Oil and Gas Security (*external oil supply disruption, oil and gas exploration, smuggling of oil products, etc.*)
    - Power System Security (*Cybersecurity threat, bombing of transmission facilities, insurgency in rural electrification areas*)

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ENERGY RESILIENCY POLICY

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02 **Resiliency Compliance Plan (RCP)**

RESILIENCY COMPLIANCE PLAN

The ERP requires the energy industry participants to submit a Resiliency Compliance Plan (RCP) which shall contain structural and non-structural measures options, to gauge infrastructure and human resource preparedness during and in the aftermath of disruptive events.

Strengthening Infrastructure | **Stockpiling** | **Systems** | **Response and Recovery**

RESILIENCY COMPLIANCE PLAN

Strengthening Infrastructure

Strengthen existing infrastructure facilities to adapt to and withstand adverse conditions and disruptive events.

Example activities are:

- Retrofitting
- Reconstruction
- Repairs
- Other Mitigation Projects

RESILIENCY COMPLIANCE PLAN

Stockpiling

This refers to the disaster mitigation process of identification and procuring essential inventory items beforehand.

Example activities are:

- Fuel Stocking
- Warehousing
- Procurement of Spare Materials

RESILIENCY COMPLIANCE PLAN

Systems

This refers to administrative directives, organizations, operational skills and capacities, policies, guidelines, plans to implement strategies and improved coping capacities to lessen the adverse impacts of hazards.

Example activities are:

- Inspections
- Risk Assessments
- Audits
- Capacity Development and Enhancement

RESILIENCY COMPLIANCE PLAN

Response and Recovery

Incorporate mitigation improvements into the reconstruction and rehabilitation of infrastructure damaged in accordance with the Build Back Better principles.

Example activities are:

- Establishment of Response Protocols
- Development of Business Continuity Plan

RESILIENCY COMPLIANCE PLAN

6 months - submission

Energy Industry Participants →

Electric Cooperatives →

updated every 3 years

Compliance, Monitoring, Enforcement & Post-evaluation

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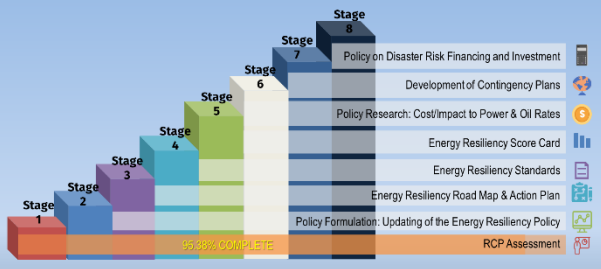
Database Summary	BATCH 1	BATCH 2
Total Energy Companies	GENCOS, DUs, Upstream, and Transmission (130)	Distribution Utilities (102)
Total RCP Submissions	130	31
Compliant Region	Central Luzon	CAR and Region 8
Pillar with Highest No. of Activities	Systems 716	Systems 145
Bulk of Investments	Strengthening Infrastructure and Stockpiling	Strengthening Infrastructure and Systems
Submission rate vs. Universe	GenCos: 45% DUs: 60% Upstream: 11%	2018: 5% 2019: 9% 2020: 6%

Next Steps after the RCP Assessment



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17

Funding Sources

Private companies are encouraged to allocate funds

Government agencies , Government-Owned or Controlled Corporations shall allocate funds in their annual plans and budget

National Disaster Risk Reduction and Management Fund, Peoples' Survival Fund

Small Power Utilities Group shall source capital expense for rehabilitation and facilities for new areas of development based on the approved MEDP

Electric Cooperatives may source development programs and/or capital expenditure

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DC 2018-01-0001 Section 6 Funding Sources for the Implementation of Resiliency Compliance Plan (RCP)

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03 TFER Responses During Emergencies and Disasters

2020 ENERGY SECTOR RESPONSE DURING EMERGENCIES AND DISASTERS

2020 Taal Volcano Eruption
- Conducted initial assessment of energy facilities and initiated restoration activities by the respective energy stakeholders;
- Organized, together with other energy stakeholders, a humanitarian assistance to the affected areas of the eruption; and,
- Activated the Task Force Disaster Preparedness for Power Restoration and CSR/Rescue operation.

Typhoon "Quinta" Molave
- Emergency restoration commenced immediately after passage of typhoon in affected transmission and distribution lines, and facilities of the National Power Corporation-Small Power Utilities Group (NPC-SPUG).
- Power restoration teams composed of line crews from North Luzon, National Capital Region (NCR) and Visayas were organized for the quick restoration of transmission and distribution lines in the affected areas.

Super Typhoon "Rolly" Goni
- The TFER Chairperson visited Catanduanes to assess the energy situation and address pressing concerns
- Task Force Kapatid organized by the NEA in cooperation with the PHILRECA assisted in the power restoration works in Catanduanes, Camarines Sur, Albay, Marinduque, and Mindoro.
- A total of 70 teams with 404 linemen from the different ECs in Regions I, II, III, IV-A, V, CAR, VI, and VIII were mobilized.

Typhoon "Ulysses" Vamco
- Deployment of Task Force Kapatid organized by NEA in cooperation with PHILRECA to assist in the power restoration works in Bicol Region.
- The NPC-SPUG Task Force with 15 linemen deployed for the power restoration works in Catanduanes.
- The NPC provided two (2) generator sets for the energization of Baras and Gigmoto in Catanduanes.
- The NPC energized the NDRRMC's Water Filtration Equipment at Brgy. Marinawa, Bato, Catanduanes.

2021 ENERGY SECTOR RESPONSE DURING EMERGENCIES AND DISASTERS

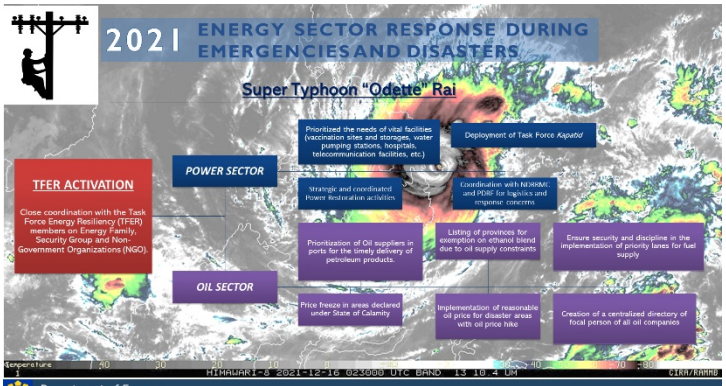
Typhoon "Kiko" Chantu
- Emergency restoration commenced immediately after passage of typhoon in affected transmission and distribution lines, and facilities of the National Power Corporation-Small Power Utilities Group (NPC-SPUG).
- Power restoration teams composed of line crews from North Luzon were organized for the quick restoration of transmission and distribution lines in the affected areas.

Situational Reports on Earthquake Incidents
- Situational reports were issued after the earthquake incidents happened during 2021.
- The department monitored the intensity and status of nearby plants to assess the situation at hand.

Typhoon "Jolina" Conson
- Emergency restoration commenced immediately after passage of typhoon in affected transmission and distribution lines, and facilities of the National Power Corporation-Small Power Utilities Group (NPC-SPUG).
- Power restoration teams composed of line crews from North Luzon, National Capital Region (NCR) and Visayas were organized for the quick restoration of transmission and distribution lines in the affected areas.

2021 ENERGY SECTOR RESPONSE DURING EMERGENCIES AND DISASTERS

Super Typhoon "Odette" Rai



2021 ENERGY SECTOR RESPONSE DURING EMERGENCIES AND DISASTERS

The **Task Force Kapatid** was activated, and the following were the breakdown of activities done through this.

For **Electric Cooperatives** the following number of teams, contigents, and vehicle were sent to assist damages ECs.
- 143 Teams
- 1307 Contingents
- 214 Vehicles

For **PIOUs** the following number of teams, contigents, and vehicle were sent to assist damages ECs.
- 12 Teams
- 99 Contingents
- 28 Vehicles

2021 ENERGY SECTOR RESPONSE DURING EMERGENCIES AND DISASTERS

Task Force Kapatid

ISSUES/ CONCERNS/ CHALLENGES

CHALLENGES DURING DISASTER RESPONSE AND EARLY RECOVERY ACTIVITIES FOR TYPHOON ODETTE

- ❑ **Local weather disturbances – causing delay in transportation (sea vessel) and power restoration**
- ❑ **Health and Safety (COVID-19) for Manpower (testing positive) – Refunding of operational expenses (*transportation expenses from airlines and shipping*)**
- ❑ **Intermittency of communication signal in disaster-stricken areas**
- ❑ **Sufficiency of Fuel Supply for Diesel Power Plants**
- ❑ **Spike in prices of petroleum products in disaster-stricken areas due to hoarding and demand escalation**
- ❑ **Accessibility of sites**
  - ➢ Right-of-Way Issue
  - ➢ Clearing of debris
- ❑ **Logistics and Transportation**
  - ➢ Manpower Augmentation from other DUs/ECs
  - ➢ Availability of materials/equipment
  - ➢ Delivery/transportation of materials/equipment (Port issues – long queue, availability of vessels)
  - ➢ Limited flights for TFK Contingents
- ❑ **Financial aid for the damage incurred that will be used for payment of procured materials and equipment of Electric Cooperatives *(RA No. 11039 EC Emergency and Resiliency fund (ECERF)***

POLICY RECOMMENDATIONS

PROPOSED POLICIES

1) Provision of solar electrification/light in every household; and provision of mobile generator sets and/or solar power systems in critical facilities/lifelines such as evacuation centers, hospitals, telecommunication facilities, government buildings, water pumping stations, etc.

2) Review and enhance resiliency standards of transmission and distribution facilities to strengthen infrastructures against natural calamities based on the *Build Back Better* Principle

3) Review the policy on stockpiling and prepositioning of Electric Cooperatives (ECs) for disaster response

4) Review RA No. 11039 EC Emergency and Resiliency Fund (ECERF) and other sources of funds (Quick Response Fund) for disaster operations

5) Develop pre-arrangements for the logistics cluster disaster responses (inventory and transportation of logistics) with NDRRMC and NGOs (PDRF)

6) Institutionalize Task Force *Kapatid* membership and management

7) Conduct policy research on Disaster Risk Financing and Investment

8) Oil sector to formulate a protocol on supply rationing during disasters

9) DOE-OIMB to review and enhance oil price monitoring and implementation to avoid local oil price hike during disasters/calamities

10) Database development and enhancement of Disaster Reporting (Power and Oil)

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04 Energy Sector Preparedness Measures

ENERGY SECTOR'S PREPAREDNESS MEASURES

NATIONAL ENERGY CONTINGENCY PLAN

Guiding Principles:

- ❑ Priority in the RESTORATION OF ELECTRIC SERVICE shall be given to installations vital to economy-wide security
- ❑ Priority in the ALLOCATION OF PETROLEUM PRODUCTS shall be given to vital and strategic activities
- ❑ Associated effects on DOMESTIC SOCIO-POLITICAL STABILITY SHALL BE ADDRESSED IMMEDIATELY by agency concerned

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PHILIPPINE INITIATIVES ON EARTHQUAKE RISK REDUCTION: THE CASE OF "THE BIG ONE" IN THE GREATER METRO MANILA AREA

HAZARD TO PREPARE FOR

West Valley Fault
- 100 km (M7.2)
- 400-600 years recurrence interval of movement generating large earthquakes

SCENARIO

Scenario
- Magnitude 7.2 Along West Valley Fault

POTENTIAL IMPACTS

Based on MMEIRS (2004, JICA, MMDA, PHIVOLCS)

- **Building damages:**
  - ➢ Residential houses: 38%
  - ➢ 10-30 story bldgs: 38%
  - ➢ 30-60 story bldgs.: 14%
  - ➢ Public bldgs:30-45%
- **Casualties:**
  - ➢ Dead: 33,500
  - ➢ Seriously injured: 114,000
  - ➢ Fire casualties: 18,000
- **Lifeline damages:**
  - ➢ Up to 80% loss/damages on power, telecommunication and water facilities
  - ➢ Bridges
  - ➢ Roads
  - ➢ Ports

TWO-PRONGED STRATEGY

1. **Reducing the Risks in GMMA**
2. **Enhancing the Resiliency of GMMA and the rest of the economy**

Policy Mechanisms:
- ➢ Issuance of Executive Order no. 52
- ➢ Regular conduct of National Resiliency Team Meetings by the PMS
- ➢ Identification of 10 Key Result Areas for Earthquake Risk Reduction

Program Activities:
- ➢ Conduct of Impact Studies
- ➢ National Plan formulation and adoption
- ➢ Organization of Disaster Response
- ➢ Development of Earthquake Risk Assessment Tools
- ➢ Structural retrofitting
- ➢ IEC Campaigns
- ➢ Conduct of quarterly economy-wide simultaneous earthquake drill
- ➢ Conduct of SIMEX for Cabinet Members

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Source: DOST-PHIVOLCS

Way Forward

ENERGY RESILIENCY

01 — 2018- 3RD Semester 2022
RCP Evaluation
Based on sectoral submission of the RCPs
Present the results of RCP evaluation
Determine the next Step based on the evaluation

02 — January 2019-May 2022
Updating of the Nat'l Energy Contingency Plan for The Big One
Updating of NECP for Power & Oil SIMEX/TTEs with energy Stakeholders

03 — April-June 2020
Covid 19 Response Protocol
Formulate a response protocol for the energy sector to mitigate the Covid-19 pandemic

04 — June-July 2020
Public Service Continuity Plan
Formulate a DOE Public Service continuity plan for Covid-19

05 — 1st Semester 2022
Energy Resiliency Roadmap
Formulate a roadmap with specific action plans per sector

06 — 2022 Onwards
Energy Resiliency Standards
Development of Energy Resiliency Standards for power and oil sector

07 — 2022 Onwards
Policy Evaluation and Formulation
Determined after RCP Evaluation


END OF PRESENTATION
THANK YOU!
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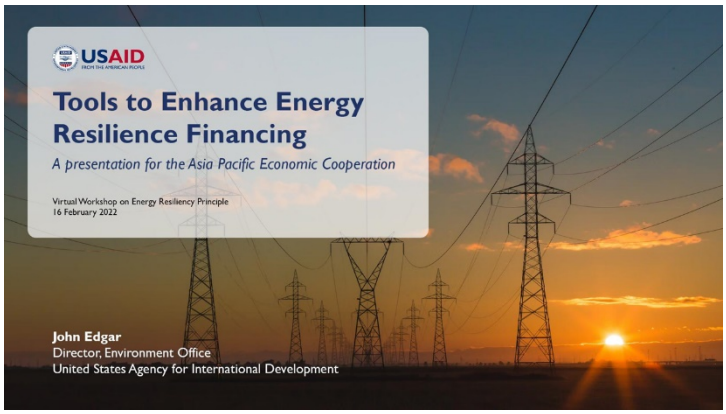
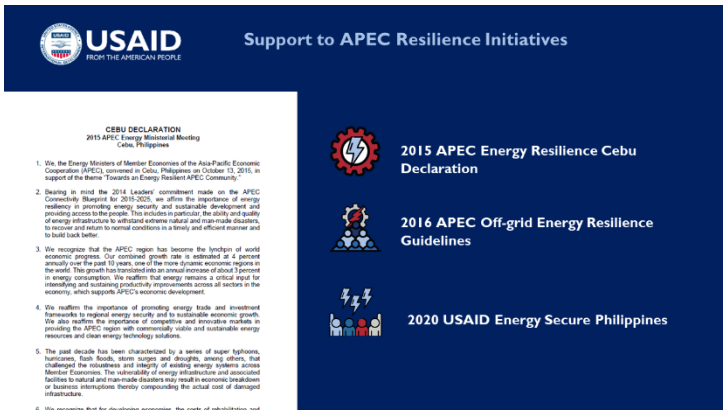
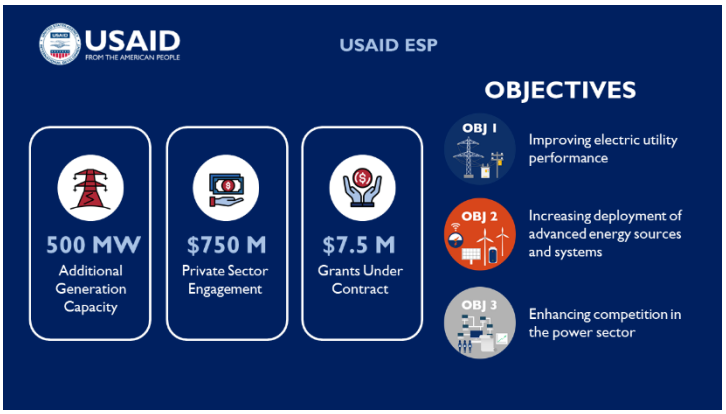
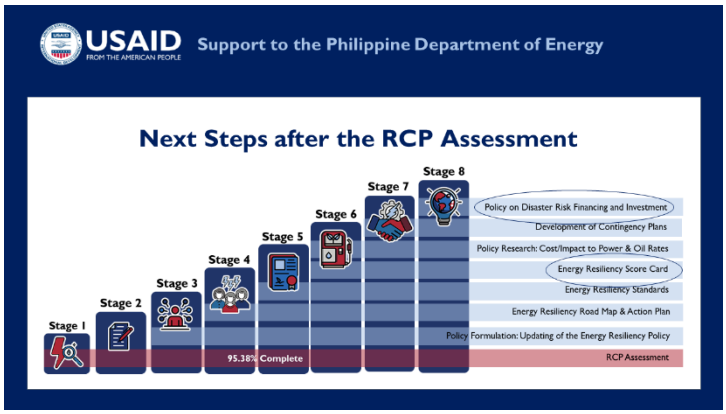
4.5. Presentation 15: Tools to Enhance Energy Resilience Financing

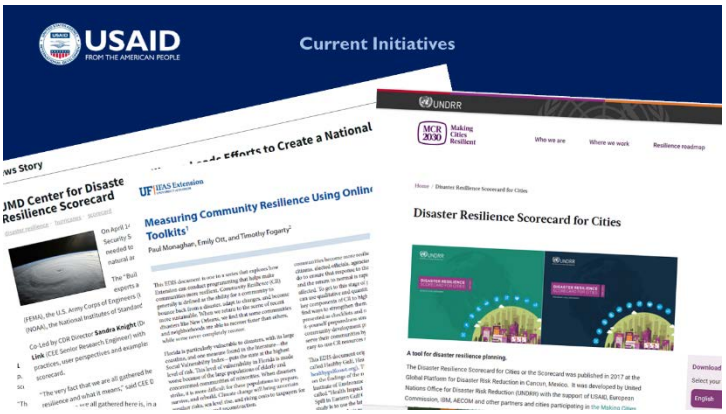
by Mr John Aaron Edgar, Office Director for Environment, United States Agency for International Development-Philippines

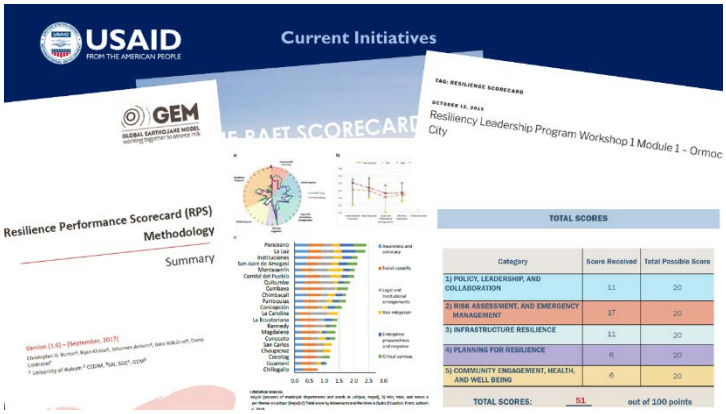


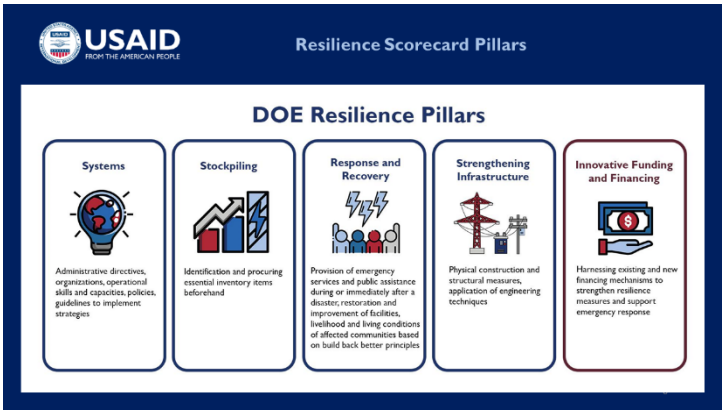









USAID
FROM THE AMERICAN PEOPLE
Current Initiatives
GEM
Resilience Performance Scorecard (RPS) Methodology
Summary
TAG: RESILIENCE SCORECARD
OCTOBER 12, 2015
Resiliency Leadership Program Workshop 1 Module 1 – Ormoc City
TOTAL SCORES
Category
Score Received
Total Possible Score
1) POLICY, LEADERSHIP, AND COLLABORATION
11
20
2) RISK ASSESSMENT, AND EMERGENCY MANAGEMENT
17
20
3) INFRASTRUCTURE RESILIENCE
11
20
4) PLANNING FOR RESILIENCE
6
20
5) COMMUNITY ENGAGEMENT, HEALTH, AND WELL BEING
6
20
TOTAL SCORES:
51
out of 100 points


USAID
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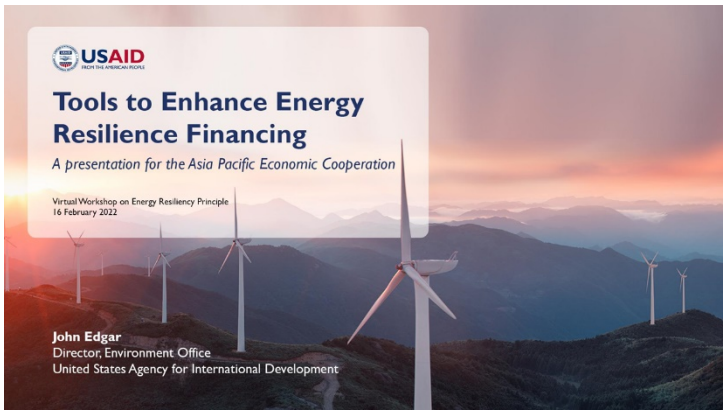
Resilience Scorecard Pillars
DOE Resilience Pillars
Systems
Administrative directives, organizations, operational skills and capacities, policies, guidelines to implement strategies
Stockpiling
Identification and procuring essential inventory items beforehand
Response and Recovery
Provision of emergency services and public assistance during or immediately after a disaster; restoration and improvement of facilities, livelihood and living conditions of affected communities based on build back better principles
Strengthening Infrastructure
Physical construction and structural measures, application of engineering techniques
Innovative Funding and Financing
Harnessing existing and new financing mechanisms to strengthen resilience measures and support emergency response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FROM THE AMERICAN PEOPLE
Tools to Enhance Energy Resilience Financing
A presentation for the Asia Pacific Economic Cooperation
Virtual Workshop on Energy Resiliency Principle
16 February 2022
John Edgar
Director, Environment Office
United States Agency for International Development