Asia-Pacific
Economic Cooperation

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APEC Energy Resiliency Guidelines

APEC Energy Working Group

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1 Introduction

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 been an emerging 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 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. Consequently, three separate workshops were held with the support of APEC economies: Chile (January 17, 2022 local time), Chinese Taipei (January 20, 2022 local time), and the Philippines (February 16, 2022 local time).

The guidelines were developed based on best practices and recommendations gathered from participants from each workshop as well as literature research on relevant energy resiliency efforts in the APEC region. The guidelines reflect the perspectives of key stakeholders that play important roles in supporting energy resiliency, including governments, energy supply industries, industry and general energy consumers, and financial institutions to ensure the guidelines promote a holistic approach with the involvement of all key stakeholders to enhance energy resiliency.

APEC Energy Resiliency Guidelines focus on key stakeholders and approaches that were identified in the APEC Energy Resiliency Principle. It is structured in accordance with relevant stakeholders and common approaches among different stakeholders. Section 1 includes an introduction to the guidelines, and Section 2 identifies key terminology and definitions. Section 3 discusses the roles of relevant stakeholders to enhance energy resiliency, focusing on: governments, energy supply industries, industrial and general energy consumers, and financial institutions. Section 4 provides best practices and energy resiliency

approaches for each of the five energy resiliency issues identified in the APEC Energy Resiliency Principle:

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

The Annex provides the original text of the APEC Energy Resiliency Principle, which provides the basis of the guidelines.

Scope

In line with the APEC Energy Resiliency Principle, the guidelines aim to support APEC member economies to build energy systems, which are resilient against both natural and human-induced disasters. The guidelines are intended to provide the general framework and best practices to enhance energy resiliency measures that can be applied to a wide array of disaster types. Natural disasters range from earthquakes to volcano eruptions, to tsunamis, to mass movements, to hurricanes, to tornados, to heavy snows and rain. Human-induced disasters may include cyber-attacks, terrorism, piracy, and other disasters that pose risks and threats to global energy supply chains. It is recommended that each economy tailor its approach in consideration of economy-specific energy resiliency challenges. The guidelines are non-binding in nature. It provides best practices and energy resiliency approaches that may be implemented voluntarily by stakeholders, such as governments, energy supply industries, industrial and general energy consumers, and financial institutions to enhance energy resiliency efforts.

2 Terms and Definitions

- Energy Resiliency: The ability and quality that enables energy systems to withstand extreme natural and human-induced disasters and to recover and return to normal conditions in a timely and efficient manner and to build back better, thereby securing a stable energy supply to society and reducing negative impacts on human lives and economic activities from energy supply disruption.

- Energy Resiliency Plans: An Energy Resiliency Plan is a plan that is developed based on evaluation of the energy-related situation of a stakeholder and provides measures for dealing with disasters. Energy Resiliency Plans may contain guidance on disaster prevention and reduction, restoration, building back better and information sharing.

- Human-induced Disasters: Extreme hazardous events that are caused by human beings, ranging from cyber-attacks, to terrorism, to piracy.

- Natural Disasters: Catastrophic events with atmospheric, geological, and hydrological origins that can damage energy systems and disrupt the energy supply, including earthquakes, volcanic eruptions, tsunamis, mass movements, hurricanes, , tornados, heavy snows, and rain.

3 Relevant stakeholders and their roles to enhance energy resiliency

A multi-stakeholder approach is essential to improve energy resiliency. The Energy Resiliency Principle identifies four types of key stakeholders that play important roles to enhance energy resiliency efforts: 1) Governments, 2) Energy supply industries, 3) Industrial and general energy consumers, and 4) Financial institutions. The following section describes the roles of each stakeholder in building resilient energy systems.

3.1 Governments

Laws, regulations, policies, and standards are essential to enhance energy resiliency measures. Governments play key roles in institutionalizing energy resiliency efforts and engaging relevant stakeholders in the public sector, including local governments, the private sector, and non-governmental organizations (NGOs) to ensure a holistic approach. The key roles of governments include:

- Recognizing the importance of energy resiliency in a policy framework to encourage resiliency efforts in the public and private sectors and relevant NGOs
- Assessing vulnerabilities of the economy's energy systems to identify the gaps and areas for enhancement
- Track the annual costs of natural disasters which can then be utilized in energy resiliency cost-benefit analysis
- Reviewing the existing legal framework from the perspective of energy resiliency in order to avoid overlap with existing requirements
- Developing policies, laws, regulations, standards, and various disaster-related plans, such as contingency plans and disaster response plans for the energy sector, and harmonize existing plans and programs towards an energy resiliency objective.
- Facilitate the formulation of energy resiliency plans in the energy industry
- Engaging with relevant stakeholders during the development laws, regulations, policies, and standards to ensure a holistic approach and identify potential implementation barriers
- Periodically monitoring and evaluating the progress of energy resiliency efforts and revising the approach as needed
- Conducting policy research to identify energy resiliency financing and investment schemes
- Implementing a mechanism to encourage investment in energy resiliency projects through loans, grants, and tax breaks as well as incorporating resiliency specifications in energy infrastructure planning to encourage further investment

Market operators, regulators and advisory boards should develop rules and guidance for the operation of the energy market and make them known to market participants in accordance with the policies, laws, regulations, and standards to enhance system resilience enforced by the government to increase resilience in the energy market.

3.2 Energy Supply Industries

It is important for energy supply industries to develop energy resiliency plans, which include measures to effectively prepare, respond to, and recover from natural and human-induced disasters. Energy supply industries' roles include;

- Conducting disaster impact analysis and vulnerability risk assessments for energy systems and developing and implementing energy resiliency plans, which includes measures to prevent and mitigate the impact of disasters
- Periodically reviewing and amending the plans, taking recent technological advancements and lessons learned from operational practices into consideration
- Establishing an internal and dedicated team or unit responsible for disaster planning, policy development and management and providing periodical training and exercises
- Introducing asset management programs to balance the cost, risk and performance of resilient energy infrastructure
- Diversifying energy resources in order to avoid over-dependence on any single energy resource
- Considering and utilizing cutting-edge energy technologies
- Training staff on disaster and emergency response and recovery, promoting understanding for energy resiliency and knowledge sharing within organizations
- Developing performance metrics on energy resiliency to track and evaluate the progress
- Participating in cross-sectoral efforts to strengthen multi-stakeholder collaboration to improve energy resiliency measures
- Sharing energy resiliency practices with external stakeholders to contribute to improving energy resiliency efforts within APEC economies and beyond

3.3 Industrial and General Energy Consumers

Industrial and general energy consumers can minimize the impact of disasters by planning for contingencies in advance. Industrial and general energy consumers' roles include;

- Identifying types of disasters and risks that operations may face and conducting vulnerability assessment of facilities and equipment
- Developing and implementing energy resiliency plans and periodically reviewing and assessing effectiveness of the plans
- Implementing asset management programs to maintain and monitor the reliability of critical equipment
- Considering and adopting cutting-edge energy technologies to enhance energy resiliency
- Considering and implementing diversification of energy resources
- Securing backup systems, such as emergency generation units and energy reserves
- Training staff to respond and recover from disasters, including drills or exercises to test emergency response capability
- Evaluating lessons learned from disaster response as part of the post-disaster recovery process. An After-Action Review (a formal post-accident assessment of an organization's disaster response capability) is a good practice to extract lessons learned from members of an organization
- Engaging with external stakeholders to share the lessons learned and best practices on energy resiliency efforts

- Contributing to creating financing schemes for energy resiliency projects through facilitating collaboration among key stakeholders and providing business cases to support investment decisions

3.4 Financial Institutions

Financial institutions can contribute to energy resiliency efforts through investing and financing in energy resiliency projects. Financial institutions' roles include;

- Developing and adopting criteria to ensure energy resiliency is considered during investment decision making for energy infrastructure projects
- Evaluating and disclosing the impact of financing energy resiliency projects to facilitate investment decision making
- Collaborating with the public and private sectors, including international organizations as well as multilateral development banks, to offer financing options to invest in energy resiliency projects
- Engaging with external stakeholders to disseminate the importance of considering energy resiliency in infrastructure projects

4 Common approaches among different stakeholders towards energy resiliency

The Guidelines focus on five key approaches identified in the Energy Resiliency Principle to enhance energy resiliency efforts in APEC economies. These include: 1) energy resiliency plans, 2) investment and financing projects towards energy resiliency, 3) proper asset management, 4) emerging technologies adoption, and 5) multi-stakeholder knowledge sharing. Each approach will be further discussed in the following section.

4.1 Energy Resiliency Plans

Energy resiliency planning is key to prepare and protect energy infrastructure from disasters and ensure business continuity. Energy resiliency plans may contain measures for disaster prevention and mitigation, preparedness, response and restoration, building back better as well as means for information sharing. To formulate energy resiliency plans, stakeholders should investigate and evaluate their own energy-related circumstances and energy resiliency challenges and identify appropriate measures. Developing energy resiliency plans starts with recognizing the importance of energy resiliency in a relevant policy and regulatory framework. The framework should encourage stakeholders to develop and implement energy resiliency plans. The following section reviews the approach of promoting energy resiliency planning through the development of an institutional framework, and provides guidance on systematic processes that stakeholders can implement to develop energy resiliency plans.

Develop Institutional Framework to Support Energy Resiliency Planning

Governments play an important role by enshrining the importance of energy resiliency in policy frameworks and implementing mechanisms to properly incentivize the public and private stakeholders to develop energy resiliency plans. Governments may amend and enact policies, laws, regulations, and standards to integrate resiliency planning in the institutional framework. It is important to review the existing legal framework in order to avoid redundancy with existing requirements and harmonize efforts.

Strengthening energy resiliency planning requires a holistic approach with the involvement of all key stakeholders. Thus, the legal framework should be designed to facilitate and harmonize resiliency planning across different stakeholders. The framework should also incorporate mechanisms to periodically review the resiliency efforts and identify areas of improvement to incorporate it into future policy planning.

For example, the Philippine government has developed the Energy Resiliency Policy framework, which recognizes the importance of energy resiliency and establishes an overall framework to facilitate energy resiliency planning, including the following elements:

- Strengthen the existing energy infrastructure
- Implement the “Build Back Better” principle in terms of reconstruction and rehabilitation of damaged infrastructure
- Improve existing operational, maintenance, and practices to ensure continuous operations and energy supply
- Develop resiliency standards that will be used as a basis for future construction of energy facilities

Under this framework, all stakeholders in the energy industry are required submit a Resiliency Compliance Plan (RCP), which covers prevention, response, and recovery measures for energy infrastructure. The Philippine government conducts initial and periodic reviews of RCPs to ensure consistency with the Energy Resiliency Policy and continuous improvement. The results of these reviews are used to identify gaps and challenges related to energy resiliency planning and incorporate lessons learned into future policy planning to align and strengthen industry energy resiliency efforts.

Table 1: The Philippines' Resiliency Compliance Plan

In 2018, the Philippine Department of Energy (PDOE) issued Department Circular No. 2018-01-0001, "Adoption of Energy Resiliency in the Planning and Programming of the Energy Sector to Mitigate Potential Impacts of Disasters", also called The Energy Resiliency Policy. It requires all energy industry players in the Philippines to submit Resiliency Compliance Plans (RCP), which contain structural and non-structural measures to gauge infrastructure and human resource preparedness during and after disruptive events.

The RCP categorizes the energy resiliency programs and activities into four pillars:

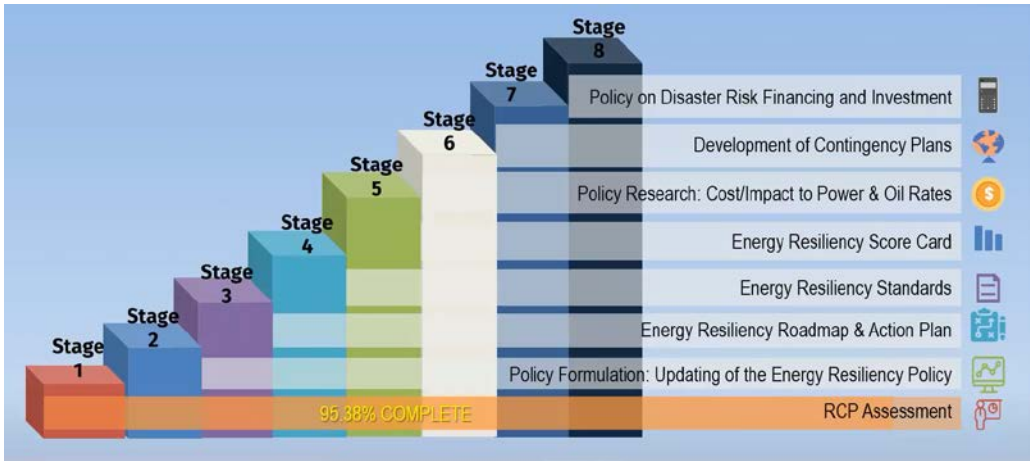
- Strengthening infrastructure
- Stockpiling
- Systems development
- Response and recovery

Following the announcement of the RCP requirement, industry participants were given six months to submit their RCPs. Electric cooperatives submit RCPs through the National Electrification Administration (NEA), which reviews and consolidates their RCPs before submitting them to the PDOE. The RCPs must be reviewed every 3 years.

In 2021, the Task Force on Energy Resiliency (TFER) secretariat partnered with the US Agency for International Development (USAID) to assess the RCP submissions. The team confirmed a total of 161 RCPs were submitted from power generation and transmission companies, distribution utilities, and electric cooperatives. The RCP submissions from the oil industry will be assessed as the next step.

The results of the RCP assessment provide baseline data on the existing resilience efforts of the energy industry. Based on the results, PDOE will proceed with the following steps per Figure 1 below: Update the existing Energy Resiliency Policy; formulate the Energy Resiliency Roadmap and Action Plan to address the identified gaps and challenges; formulate the Energy Resiliency Standards; formulate the Energy Resiliency Score Card; conduct the cost/impact assessment of energy resiliency to power and oil rates; develop the Contingency Plans; and formulate a Policy on Disaster Risk Financing and Investment.

Figure 1: Philippine Department of Energy's Post-RCP Assessment Roadmap



Source: Philippine Department of Energy

In another example, Chinese Taipei implemented a relevant Critical Infrastructure Protection Act for protection of the economy's critical infrastructure. It requires that critical infrastructure facilities implement risk assessment, prepare protection plans, and conduct regular drills. As an operator of one of critical energy infrastructure in Chinese Taipei,

government-owned electric power company Taipower implements risk assessment and develops safety protection plans for its energy systems.

Implement Systematic Process of Resiliency Planning

Energy resiliency plans should be developed through engagement with internal and external stakeholders to ensure a holistic approach. It is recommended to implement a systematic process to develop and implement energy resiliency plans and review the effectiveness of related measures. The following provides a step-by-step process for developing energy resiliency plans.

Figure 2: Systematic Process for Resiliency Planning

STEP 1 Stakeholder Engagement

Energy resiliency plans should be developed by stakeholders in both the public and private sectors as well as NGOs and adopted by all levels within each organization. It is important to engage all key stakeholders in energy resiliency planning, particularly in the early stages of the planning phase to seek areas for collaboration and identify potential barriers to implementation.

Governments play a key role in identifying relevant stakeholders and facilitating stakeholder engagement. Governments may form a coordinating body to promote public-private sector collaboration. Task forces could be formed consisting of key stakeholders, including government, energy supply industries, energy consumers, and financial institutions, to ensure a holistic approach.

For example, the Philippine government has partnered with the Philippine Disaster Resilience Foundation (PDRF) to develop the National Energy Contingency Plan (NECP) to develop greater coordination between the private sector and the government of the Philippines. PDRF is a private sector-led disaster management non-government organization that includes major business groups in the Philippines. PDRF and the government conduct joint planning, simulations, and drills to practice and enhance the NECP.

STEP 2 Risk Assessment

The most essential component of energy resiliency planning is the assessment of vulnerabilities in energy systems. The first step is gathering relevant data on potential hazards and threats and available energy resources; and reviewing mitigation measures currently in place. After gathering data, impact is evaluated by considering the risks and exposure posed by potential disasters on the energy system infrastructure. Each stakeholder should assess the vulnerabilities of energy systems to identify gaps in energy resiliency efforts, taking into account its own unique energy challenges and situation.

Table 2: Chilean National Energy Commission's Resiliency Assessment Methodology

As a regulatory body, Chile's National Energy Commission (CNE) conducts a study every year, as part of the transmission planning process, to promote new transmission assets in the electrical system. The Transmission Planning Regulation of 2017 defines a resiliency assessment stage in the methodology of the transmission planning process. This stage requires CNE to assess and evaluate the following four types of events every year: (1) Tsunamis; (2) Gas price shocks; (3) Power plant delays; and (4) Extreme hydrology.

The Planning and Transmission Regulation of 2021 was implemented to authorize broader action to annually define the kinds of threats and/or events that Chile needs to address. CNE defines them in a technical study for the Transmission Expansion Plan.

CNE has developed a methodology for resiliency assessment, consisting of four main steps.

- (1) Set Scope: Set a scope and define the types of threat to address
- (2) Define Impact: Analyze the potential impact of threats and collect data for measurement of the likelihood and the severity of the threat
- (3) Define Risk: Assess risks using collected data, based on a Risk Matrix, and prioritize the risks to address
- (4) Define Solution: Identify most cost-effective project options

The Resiliency Assessment evaluates natural disaster events. It is important to secure data on historical events from the Chilean ISO, Superintendency of Electricity and Fuels (SEC), and other institutions. It is also important to develop a model to project the future likelihood and impact of natural hazards due to climate change, as the frequency and impact of those events on electrical systems will be very different in the future.

STEP 3 Strategy Development

After conducting vulnerability risk assessment, stakeholders can use the results to identify solutions to improve energy resiliency. Common objectives and performance goals are developed to measure the effectiveness of the plan. The development of strategy should be based on consideration of resource availability and cost-benefit analysis. The prior impact assessment can be used to navigate prioritization of resource allocation. Criteria or indicators can be effective tools to identify the areas of improvement and guide the resource allocation and prioritization.

The key elements of energy resiliency plans may include:

- Identification of disaster risks
- Designation of roles and responsibilities of organizations
- Preparedness measures, including hazard mitigation planning process, vulnerability risk assessment, strategy development and plan implementation
- Response measures, including basic planning for emergency response with specific measures to mitigate the impact of disasters
- Rehabilitation and recovery measures to rapidly restore energy supply based on the "Build Back Better" principle

Preparedness measures are a set of actions that are taken to reduce the impact of potential disasters on energy systems. They may include the establishment of institutional arrangements to reduce and prepare for disasters, including an office or a unit responsible for disaster preparedness. They may also include the implementation of risk mapping; implementation of preventative measures, such as infrastructure hardening; implementation of redundancy; as well as training emergency responders. Energy resiliency plans should consider the need to diversify energy supply in terms of fuel types, supplier types, geography, and distribution in order to avoid risks from overdependence on a single energy source.

Response measures are a set of actions that are taken to mitigate and minimize the impact of disasters on energy systems. A dedicated energy emergency response team may be formed, with skilled personnel, equipment, logistics and, where relevant, disaster-specific response protocols to facilitate the implementation of response measures.

Rehabilitation and recovery measures are a set of actions that are taken to restore energy infrastructure from the impact of disasters, to return to normal conditions as soon as possible. Measures included in energy resiliency plans should adhere to the "Build Back Better" principle, under which stakeholders keep strengthening existing energy infrastructure based on energy resiliency standards to endure a greater scale of disaster than the previous one. Rehabilitation and recovery measures may include clean-up of the disaster site, repairing damaged infrastructure, deployment of personnel or equipment assistance, and mobilization of disaster recovery funds. On the other hand, rehabilitation measures may include retrofitting and other engineering solutions to strengthen the energy facilities. As climate patterns evolve and technological innovations progress, the elements of energy resiliency plans should be continuously updated in accordance with these changes.

Most APEC economies experience various types of hazards. Thus, it is important for energy resiliency plans to be inclusive in nature and be applicable to multiple disaster types. This all-hazard approach enables sharing resources and expertise as well as providing flexibility in responding to different situations. APEC member economies should consider supplementing energy resiliency plans with disaster specific measures that take economy specific hazards into account.

STEP 4 Implementation

Each stakeholder organization should identify roles and responsibilities for its staff to oversee the implementation process. Integrating energy resiliency planning into existing practices may require collaboration with internal and external stakeholders. Building consensus on the importance of energy resiliency within an organization can increase integrated coordination and ensure investment is properly allocated to address energy

resiliency issues. External stakeholder support is important to supplement technical capabilities and to secure additional funding. Financial institutions play an important facilitation role for the implementation of energy resiliency efforts through providing financial support. Finally, specific timelines should be developed to evaluate the progress of the implementation.

STEP 5 Monitoring and Evaluation

The effectiveness of energy resiliency plans should be evaluated regularly. The review should incorporate any new technological advancements as well as lessons learned from the operational practices and past incident management. Any gaps and challenges identified during this process should be incorporated into energy resiliency planning as well as provide insights for future policy making.

Governments may evaluate the energy resiliency plans developed by energy supply industries and industrial and general energy consumers to inform future planning and policymaking to further enhance energy resiliency practices. A coordinating body including public and private sector stakeholders may be formed to encourage sharing of best practices and lessons learned to improve energy resiliency planning.

4.2 Investment and Financing to Projects towards Energy Resiliency

In order to make energy systems resilient against disasters, stakeholders should actively invest and finance projects that contribute to enhancing energy resiliency in each economy. Energy resiliency might not always be considered as priority in the decision-making process for energy infrastructure projects. This can prevent sufficient funding for energy resiliency projects. Increasing recognition of the importance of energy resiliency is essential. Implementing mechanisms, such as criteria or tools to properly assess energy resiliency needs can encourage investment in energy resiliency projects.

Establish Criteria to Facilitate Investment in Energy Resiliency

Facilitating investment and financing for energy resiliency projects starts with identifying investment priorities. This process involves reviewing disaster vulnerabilities and potential impact assessment for energy facilities, resources, and other critical infrastructure to identify weaknesses that may compromise a stable energy supply. This process will help prioritize the areas where investments are the most necessary, selecting amongst potentially many stakeholders that have insufficient capital for investments in energy resiliency. In the case of private sector energy consumers, calculating expected financial losses associated with natural disasters and future climate impacts may help build consensus within each organization to make investments in energy resiliency.

Governments may develop toolkits to help stakeholders identify gaps in energy resiliency and inform financing decisions. For example, the Philippine Department of Energy (PDOE) is developing an Energy Resilience Scorecard to provide an evidence-based guide to financing investments in energy resiliency. Potential applications of energy resiliency scorecard in innovative financing will continue to be explored in the future.

Table 3: The Philippines' Energy Resilience Scorecard

The PDOE and the US Agency for International Development (USAID) are now working together to create the Energy Resilience Scorecard. The scorecard will depict broader risk modeling and help capture the actual readiness of the government and utilities. The scorecard will provide evidence-based information that guides decision-making and resource allocation, including financing for readiness and resilience strengthening.

The scorecard is useful as it enables governments, businesses, and utilities to measure performance against domestic and global resilience benchmarks. It also facilitates the institutionalization of standards and facilitates data visualization, gathering, use, and sharing. This tool is also effective in conducting targeted training to strengthen resiliency and can serve as a valuable guide for policy formulation.

Innovative funding and financing could be a component of the Energy Resilience Scorecard. PDOE and USAID will continue to explore potential applications of the scorecard in designing incentives for innovative finance in the future.

Financial institutions can also contribute to energy resiliency by developing criteria and evaluation tools for financing decisions. Criteria and evaluation tools should be developed based on the impact of investment on reducing disaster risks. The specification should both identify eligible projects and indicate which project parameters will be used to measure risk reduction. Energy supply industries and energy consumers may record and report on the impact of energy resiliency projects on risk reduction to further refine the financing criteria. In addition, governments may establish a mechanism for private companies to disclose relevant information to financial institutions.

For example, insurance provider AXA Climate conducts a series of vulnerability and risk assessments to help companies understand how climate may impact their business. It advises them how to adapt their asset and value chain to climate change, including process revision, technology adjustment, and even decisions for decommissioning or recommissioning of assets. AXA Climate also offers climate insurance. In order to enable a sufficient level of investments in energy resiliency, risks involved in the long-term investments should be mitigated and addressed. For instance, when it comes to a long-term investment project over 20 or 30 years, investors may require understanding of the future outlook for the impact of climate change to make investment decisions. In such situations, parametric insurance can incentivize investing in long-term energy resiliency projects by mitigating future risks and uncertainty. Availability of insurance services differs depending on the maturity of economies. Therefore, capacity building and knowledge transfer is needed to ensure affordable insurance solutions can be adopted by developing economies.

Table 4: AXA Climate's Parametric Insurance

AXA Climate helps companies in the energy sector to ensure resiliency against natural disasters and catastrophes. Insurance mitigate volatility risks and makes sure that financial compensation is given. However, insurance for traditional issues has not been adequate to ensure fast recovery from extreme climate disasters. Normally, in insurance, business interruption is only insured if a company suffers direct damage. Cases where business interruption is caused by a company losing access to energy sources due to climate disasters are not generally covered. To address such circumstances, AXA introduced parametric insurance based on climate indexes, which provides coverage for business interruption due to climate disaster even when there is no direct physical damage to the business. AXA's parametric insurance calculates the correlation between climate risks and business losses based on the financial data of its clients. This insurance enables a

company or project owner to ensure that the company will be able to pay back the loan independently of the weather conditions.

Implement a Financing Mechanism to Incentivize Resiliency Investments

Governments and financial institutions may support resiliency investments through grants, subsidies, loans, and tax breaks, among others, to support resiliency projects. For example, the Philippines has introduced various funding sources for resiliency investment. As tax breaks for renewables opened a new market for those technologies in the past, new tax credits for resiliency technologies are expected to incentivize private companies to move toward mainstreaming of energy resiliency. In addition, energy tariffs may be used to incentivize the implementation of certain resiliency measures, such as back-up generation.

For example, in case of Japanese real estate company Mitsui Fudosan's Nihonbashi Smart City Project, the initial investment was provided by financial institutions, and supported by partial subsidies from the central and city governments as the project was considered to contribute to Japan's resiliency enhancement efforts. In addition, Mitsui Fudosan recovered its investments in back-up power generation equipment and other resiliency features installed for the project through an energy tariff over 20 years – the useful life of the infrastructure. The Nihonbashi Smart Energy Project is a regional thermal energy center with a large-scale co-generation system fueled by pipeline gas that aims to help cope with power outages and strengthen urban disaster prevention capabilities (see Section 4.4 for more details about Nihonbashi Smart City Project).

Governments may consider enacting and amending laws, regulations or grid codes to encourage stakeholders to make resiliency investments in preparedness. For example, the Philippines has recently enacted a law establishing an Electrical Cooperative Emergency and Resiliency Fund, with authorization of approximately $15 million for restoration and rehabilitation of electric cooperatives damaged by a disaster. Also, a new law was passed to promote development of microgrids, furthering the total electrification of the Philippines. Now, the Philippine government is seeking to introduce a new financing mechanism for resiliency investment, the "Policy on Disaster Risk Financing and Investment", by the end of 2022.

Governments can also encourage investment in energy resiliency by clearly defining that resiliency is an important element in the bidding process for government procurement. If energy resiliency is not part of the technical specifications for the infrastructure bidding process, a contract might be awarded solely based on the lowest price. Governments can encourage consideration of energy resiliency by making it one of the evaluation criteria in selecting infrastructure projects.

Promote Public and Private Partnerships to Fund Energy Resiliency Projects

There should be continued dialogues among stakeholders in the energy sector about harnessing existing and new innovative funding and financing mechanisms to strengthen resiliency measures. Partnerships between public and private sector entities may be formed to design innovative financing schemes for energy resiliency projects. For example, government and financial institutions can partner to offer climate resiliency bond to facilitate investment in resiliency projects.

International Cooperation for Financing Resiliency Projects For developing economies, where budgets for investing in energy systems are limited, necessary funding for energy resiliency may be provided by international aid from advanced economies, international organizations and/or multilateral development banks. For example, USAID has partnered with PDOE in the Philippines for a $34 million (or 1.7 billion peso) energy resiliency initiative called “Energy Secure Philippines” to ensure investment in energy resiliency projects.

Table 5: The Philippines-USAID Initiative “Energy Secure Philippines”

In 2020, USAID, in a partnership with PDOE, initiated a key resiliency initiative called “Energy Secure Philippines” (ESP), to support energy resilience in the energy sector of the Philippines. The project is designed to help the Philippines enhance energy accessibility, reliability, and security given the nature of the unified power system in the economy.

ESP aims to mobilize more than $750 million (or 38 billion pesos) of private resources and secure finances for new renewable or clean energy projects amounting to 500 megawatts of new generation capacity. The project will achieve its goals by pursuing three objectives: (1) improve the performance and therefore resilience of electric utilities and service providers, (2) increase the deployment of advanced energy sources and energy technologies, and (3) support competitiveness within the energy sector.

4.3 Proper Asset Management

Proper asset management can prevent and mitigate the impact of disasters on energy systems, as well as facilitate disaster recovery. Asset management includes proper installation, management and replacement of assets in order to sustain a stable energy supply. It also includes stockpiling assets for disaster recovery. Taking a systematic approach to asset management helps to balance the costs, risks and performance of resilient energy infrastructure and enables stakeholders to tailor their measures to their own resiliency needs and risks.

Incorporate Systematic Approaches for Asset Management

Effective asset management should incorporate systematic approaches to build resilient energy infrastructure. The process includes:

- Identify risk and conduct vulnerability assessment
- Review existing asset management practices to evaluate the current level of preparedness, gaps, and opportunities for enhancing energy resiliency
- Develop policy and strategy to enhance asset management. This includes formalizing the organization’s commitment to integrating energy resiliency issues in asset management policy and identifying approaches to enhance energy resiliency measures based on the impact assessment and cost relative to risk reduction benefits. A long-term financial plan should be considered to support energy resiliency measures.
- Implement asset management practices by integrating energy resiliency measures
- Monitor and evaluate the progress

Tailor Asset Management Measures to Resiliency Needs and Risks

Asset management measures should be adopted based on each organization's needs and energy resiliency risk. Examples of such measures include:

- Diversify resources of energy supply
- Increase ratio of self-sufficient energy sources, technologies and facilities
- Modernize the existing infrastructure
- Implement solutions to manage energy supply and demand
- Secure sufficient energy reserves and energy production facilities
- Address redundancy in energy systems
- Stockpiling assets for disaster recovery

Based on the resiliency risks identified in their organizations, energy supply industries may implement various schemes to ensure stable and reliable system operations. Energy supply industries may use cutting-edge energy management systems that help forecast energy demand and control energy equipment for proper asset management and high efficiency operation.

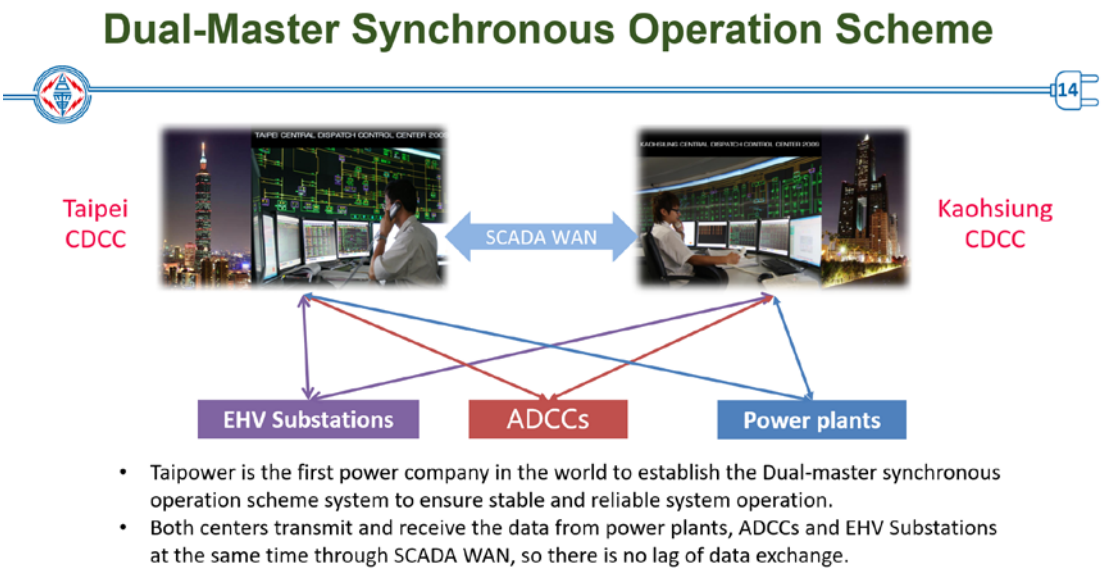
For example, in Chinese Taipei, to maintain business continuity of its energy system network, Taipower introduced a synchronous operation system with multiple control centers. The company also introduced an electricity trading platform to better manage energy supply and demand by bringing in private-sector decentralized resources into its electricity network.

Table 6: Taipower's Measures to Ensure Stable Power Supply

Climate change is contributing to a rising number of natural disasters and corresponding increase in the scale of damage to power systems. Taipower has implemented various countermeasures to strengthen Chinese Taipei's power grid, including:
(1) strengthening utility poles (e.g., upgrading the materials used for the poles, increase the engineering strength depending on the construction site environment, etc.);
(2) improving grid resilience (e.g., increasing the number of automated feeders, expanding the construction of smart substations, upgrading substations and distribution lines, etc.); and
(3) laying underground power lines (especially in areas easily affected by typhoons and large power outages).

Taipower is also the first power company in the world to establish a Dual-Master Synchronous Operation Scheme System to ensure reliable system operation. As seen in Figure 3, If any problem occurs in either one of the economy's two largest cities – Kaohsiung or Taipei, 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 data from power plants, Area Dispatch Control Centers (ADCCs) and Extra High Voltage (EHV) substations at the same time through Supervision Control and Data Acquisition Wide Area Networks (SCADA WAN), so there are no data latency problems.

Figure 3: Dual-Master Synchronous Operation Scheme



Sources: Taipower

In addition, Taipower has partnered with private sector entities to implement decentralized energy resources to ensure a stable energy supply. In November 2021, Taipower launched an electricity trading platform to incentivize external energy suppliers to actively supply power to Taipower, particularly supporting its seasonal operation. Qualified traders can participate in this trading platform with self-use or commissioned resources such as a self-use generator, renewable energy, basic power generation equipment, interconnected battery energy storage system, and demand response. This trading platform will bring in private decentralized resources to stabilize the power grid. Figure 4 below illustrates the structure of the trading platform.

Figure 4: Electricity Trading Platform

Sources: Taipower

Energy consumers can take also take actions to enhance resiliency through proper asset management. For example, BHP, an international natural resources company, which operates has three copper mines in Chile, has implemented various measures to improve the availability of energy supply and mitigate the impact on mineral production during natural disasters.

Table 7: BHP's Measures for Business Continuity

BHP operates three copper mines in Chile – including Escondida, the world's largest copper mine. These three mines represent 23 percent of all copper production in Chile. BHP's assets were vulnerable to any disruptions to Chile's electricity supply, as its extraction sites were connected to and relied on the electricity supply systems. In fact, Escondida requires large amount of electricity, and the three BHP mines represented 8.7 percent of Chile's annual energy demand. On November 14, 2007, a 7.7-magnitude earthquake occurred and affected the transmission systems connected to the BHP mines, with no electricity available for about 35 hours. While there was no loss of human lives at the BHP sites, the economic loss from the suspension of copper production amounted to $34 million in total. This event made BHP and other industries in Chile more aware of the importance of energy resiliency in their industrial assets.

Since 2007, BHP has taken various measures to improve the availability of energy supply and mitigate the impact on mineral production during natural disasters. The company has installed back-up generation plants, which has become a common practice among all medium and large companies in energy-intensive industries in Chile, such as forestryand mining. Those companies sell back reductant electricity to the power grid. Additionally, as Chile has frequent natural disasters such as earthquakes, tsunamis and volcanic eruptions, in the event of any such disruptions to the power supply Chile's energy consumers voluntarily reduce their electricity consumption to avoid a total blackout. Thanks to the post-2007 improvements, BHP can now restore normal operations of its mines within one to two hours of a major disruption on average.

Establish Disaster Response Teams

Energy supply industries and energy consumers may establish organizations to monitor, respond and recover from disasters. As a way to monitor and evaluate asset management as well as speed up post-disaster recovery, stakeholders may establish emergency operation centers (EOCs). For example, in Chinese Taipei, Taipower operates an EOC with a Disaster Prevention Management System (DPMS) that aggregates information on power outages, equipment status, and available support manpower to help shorten the power recovery time during a disaster. In the Philippines, there are several EOCs both in the public and private sector that monitor and respond to disasters. For the government, the Office of Civil Defense under the National Defense has established an EOC used by the National Disaster Risk and Reduction Council. The EOCs are further mainstreamed in other alerting agencies including the local government units. On the other hand, private sector led EOCs include PDRF, which is a redundant scheme for resiliency. In addition to this, the Philippines' transmission asset operator, National Grid Corporation of the Philippines (NGCP) has its own control and command center, which is activated during disasters to monitor the power situation.

Table 8: PDRF Operations Center

PDRF is an alliance of businesses dedicated to enhancing the disaster management capabilities of the private sector in the Philippines. PDRF's EOC - the PDRF Operations Center - is based in Clark, two hours outside of the capital Manila, in order to be prepared for a major earthquake hitting metro Manila. From the Operations Center, PDRF can monitor disasters, including storms, earthquakes and volcanic eruptions anywhere in the Philippines and in the world.

Stakeholders in the energy industry can join forces to deploy manpower and resources to support and accelerate the recovery of energy supply industries affected by natural disasters. For example, private sector utilities may form a collective partnership to share their personnel and equipment with disaster-stricken utilities in order to enable quick restoration of energy infrastructure from natural and other hazards. In the Philippines, the National Electric Administration (NEA), agency supervising the Electric Cooperatives, has formed a task force called *'Kapatid'* or Brotherhood that facilitates disaster recovery cooperation through the deployment of linemen and logistics to affected distribution utilities in the aftermath of a disaster. The PDRF on the other hand provides assistance to the Task Force Kapatid during disaster response through logistic support, specifically, providing sea vessels to ferry the Task Force to disaster-stricken islands.

Table 9: The Philippines' Task Force Kapatid

NEA formed Task Force Kapatid (which means "brotherhood" in the Filipino language) to facilitate collaborative industry disaster recovery efforts. When a disaster disrupts the power supply in a certain area, Task Force Kapatid and distribution utilities provide manpower support to the affected distribution utilities so that they can immediately restore the electricity supply. Aside from manpower sharing, distribution utilities also share equipment and materials, among other things.

When a disaster strikes, thousands of linemen from several private companies and electric cooperatives will go to the disaster-stricken areas with the permission of the local electric utility. They can spend months helping restore power in the different islands. As part of Task Force Kapatid, PDRF used barges and ships from its member companies to transport vehicles and

equipment of the PDOE and private sector energy companies to distant islands to help restore power.

4.4 Emerging Technologies Adoption

Where possible, stakeholders should fully consider and adopt cutting-edge energy technologies that help disaster prevention and reduction, restoration, building back better and information sharing in order to improve energy resiliency. It is important for energy supply industries and energy consumers to evaluate the availability of cutting-edge energy technologies to optimize the planning, operation, and maintenance of energy systems. Examples of energy resiliency technology solutions include:

- Advanced weather and disaster forecasts – Support decision making through accurately predicting potential hazards, which enables faster response and recovery
- Real-time alerting system – alert energy system operators regarding different hazards through different channels
- Big data – inform investment or insurance decisions using various data, such as electricity consumption, insurance data, as well as scientific modeling on climate change scenarios
- Simulation – conduct multi-variable simulations to analyze energy resiliency-related scenarios such as possible outages
- Artificial Intelligence (AI) – optimize the planning, operation, and maintenance of energy systems
- Internet of Things (IoT) – enable advanced energy infrastructure management as well as optimize energy supply and consumption, such as applications for smart grids, energy and water conservation, predictive maintenance, etc.
- Augmented Reality (AR) – improve operation and maintenance of energy infrastructure through applications such as smart glasses, support training of emergency responders
- Robots and drones – enable more effective operations and maintenance of energy infrastructure, such as pipeline management and remote inspection

Governments and financial institutions should support the implementation of such technology solutions through providing financing options and incentives. It is also critical to assess cyber security risk from integrating new technology options with existing systems. Appropriate mitigation measures should be implemented to minimize the risk.

The following section provides examples of key technologies, which can be used to enhance energy resiliency.

Hazard Mapping

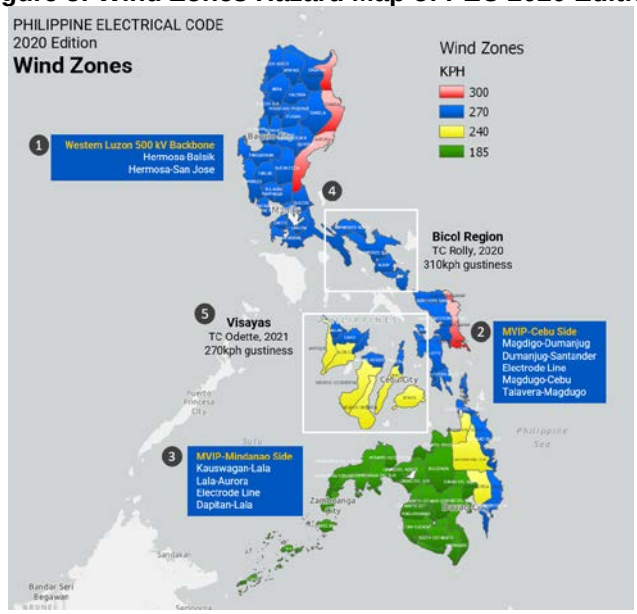
Hazard mapping can be a useful tool to enhance energy resiliency. Governments and energy supply industries may create a map to monitor and display the location of, for example, natural disasters, energy infrastructure, and populations without energy supply, across different political jurisdictions. In some cases, an online platform has been created to enable the private sector and individuals to access the hazard maps.

Table 10: National Grid Corporation of the Philippines' Use of Hazard Maps in Transmission Planning

The National Grid Corporation of the Philippines (NGCP), the sole transmission services provider in the Philippines, uses hazard maps in its grid planning. These maps cover flooding hazards, landslide hazards, lightning strikes, and also communication facilities located within the tropical cyclone risk and wind intensity zone. Such hazard maps provide important information to help NGCP understand the risks of natural hazards to its transmission facilities. Hazard maps indicate the extent of expected risk areas and enable NGCP to develop its resiliency plan.

NGCP selects the sites of its substations and transmission line routes using criteria based on updated hazard maps from government agencies. One example is NGCP's upgrade of transmission line wind speed design, based on wind speed levels by region provided by the 2020 Philippine Electric Code (PEC) Wind Zones map. NGCP considered PEC Wind Zones as minimum values and designed transmission lines to endure higher wind speeds than the PEC levels. NGCP also considered the recent typhoons that hit the economy for consideration in future design of power transmission lines.

Figure 5: Wind Zones Hazard Map of PEC 2020 Edition



Source: NGCP

Hazard maps also help NGCP make the most informed decision in the management of transmission assets. Hazard maps enable technology-based asset component hardening, for example, providing guidance on where to build board pile foundations and slope protection for transmission facilities.

Use of Advanced Energy Technologies

Energy supply industries, including the generation, transmission, and distribution sectors, may introduce and adopt advanced energy systems in order to enhance performance of energy infrastructure as well as its resiliency against disruptions. Investing in advanced energy technologies is key to realizing a more robust energy system. A notable example among APEC economies is the Nihonbashi Smart Energy Project in Japan, which uses co-generation systems fueled by pipeline gas for emergency generation in preparedness for earthquake, tsunami, flooding and other disasters.

Table 11: Nihonbashi Smart Energy Project

The Nihonbashi Smart Energy Project is a regional thermal energy center with a large-scale co-generation system fueled by pipeline gas that aims to help cope with power outages and strengthen urban disaster prevention capabilities. The project was initiated as a result of the Great East Japan Earthquake in 2011. Due to the shutdown of power plants, the supply and demand of electricity became tight in Tokyo, and rolling blackouts were implemented to prevent unforeseen major power outages. After the experience, Mitsui Fudosan began considering the need to build a strong energy system to ensure uninterrupted energy supply.

As other buildings in the community are faced with a risk of power supply interruptions, Mitsui Fudosan decided to utilize medium-pressure gas lines, which use piping with superior strength and provide highly reliable energy with a proven track record of no gas leaks. A gas co-generation system that uses medium-pressure gas as fuel can generate electricity using a gas engine. So, even in the event of a widespread power outage, backup power can be generated.

As a result, a power plant was built on the basement level third floor, using three gas engines that generate a maximum of 23,000 kilowatts of electricity. The generated electricity is sent to a substation on the basement level fourth floor and mixed with electricity from grid power. The system can convert voltages into the three levels of 60,000, 20,000 and 6,000 volts, based on the customer's need, without any additional equipment installation. The plant's total supply capacity is 43,000 kilowatts, which is enough electricity to power 14,000 households.

In addition, when the gas engines produce electricity, exhaust heat is created in the form of exhaust gas and hot water. Steam and chilled water are created from the exhaust gas. The steam, together with hot water, is sent to buildings to be used for hot water supply and heating. Also, thermal storage tanks store chilled water at night, for use in air conditioning.

The plant was constructed underground where the impact of earthquakes is minimized. Concrete walls reaching up to the second floor in a pot-like structure were also constructed to ensure protection from flooding and other water damage. The plant is also sealed by a 30cm-thick waterproof door at its opening to prevent flood waters from entering. The plant is also located in a safe underground network that connects each area.

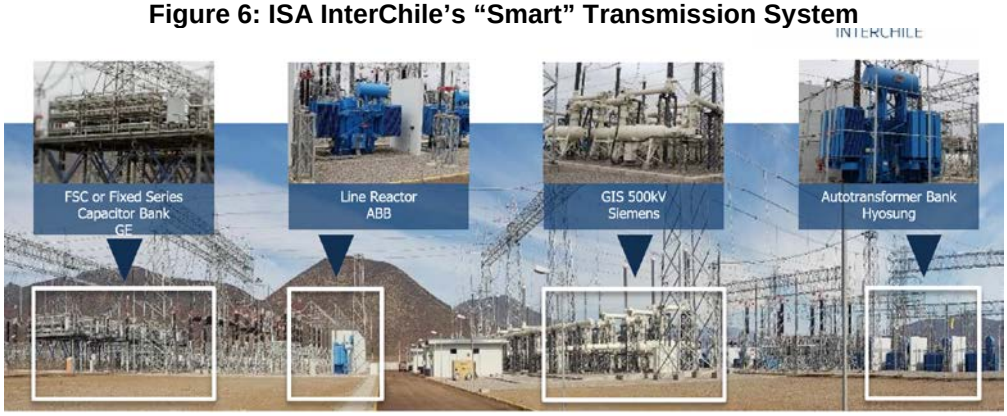
ISA Group, the largest electric energy transporter in Chile and Latin America, provides another example of the use of innovative transmission system solutions, including new substations and smart transmission systems.

Table 12: ISA InterChile's Innovative Solutions in Transmission System

ISA Group works in Columbia, Brazil, Chile, Peru, Bolivia, Argentina, and Central America. InterChile, ISA's Chile affiliate, was created in 2012 after it 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.

In order to realize a more robust transmission system, it is important to incorporate intelligence and make the energy network smarter and more responsive so that the network can adapt, respond and recover more quickly. For example, ISA introduced a new 500 kV substation, which incorporates advances in the use of protection and measurement systems with fiber optics that improve response times. The substation's dynamic reactive compensation makes the operation more flexible via automatic absorption of reactive energy during hours of low demand, to maintain a 500 kV regulated value without the need to remove circuits from the interconnection. It also uses gas-insulated technologies that allow reduction of the space required for construction and minimize maintenance needs. It is also built to withstand aggressive climate events that are common in the region.
Furthermore, ISA has introduced "smart", flexible transmission systems in Chile to increase protection of the transmission line under certain climate conditions.

Figure 6: ISA InterChile's "Smart" Transmission System



Source: ISA Group

Internet of Things (IoT) for Energy Infrastructure Management

Use of Internet of Things (IoT) – sensors embedded with communication technology that transfer data – can enable advanced management of energy infrastructure by providing a higher level of situation awareness. Energy supply industries may adopt IoT technologies to build a smart grid, promote demand-side management, and/or optimize energy supply and consumption. Integrated with machine learning and other technologies, IoT can help obtain real-time demand and supply information that energy supply industries may use in tackling the intermittent nature of renewable energy generation. IoT technologies can also be adapted by industrial and general energy consumers. IoT has been already widely utilized in advanced energy management systems for demand forecasting and optimal operation control in normal times, as well as for energy supply control in times of disasters. With further improvement of computational speed, industrial and general energy consumers may be able to achieve more precise control.

4.5 Multi-stakeholder Knowledge Sharing

As energy systems are increasingly interconnected with new and renewable energy as well as distributed resources being increasingly introduced, building energy resiliency is becoming an effort that requires collaboration among various stakeholders. Not only governments and energy supply industries, but also industrial and general energy consumers and financial institutions now need to be aware of the importance of resilient energy infrastructure. Knowledge sharing is key to enable all stakeholders to share a common understanding and knowledge to effectively cooperate with each other to implement necessary actions to enhance energy resiliency.

Every stakeholder in the energy industry may facilitate understanding for energy resiliency issues and contribute to knowledge sharing with stakeholders both within economies as well as globally. Stakeholders can better identify the most effective measures and approaches in line with the situations in each economy by sharing their experiences and best practices.

Assess Resilience Knowledge Gaps and Capacity Building Needs

Assessment of resilience knowledge gaps and capacity building needs may be conducted to facilitate knowledge sharing. As mentioned, the Philippines is currently developing an Energy Resilience Scorecard, which is a useful tool that can enable governments, businesses, and utilities to measure resilience performance against the economy's and international resilience benchmarks. This tool could be effective in conducting targeted training for a certain stakeholder to strengthen its energy resiliency.

Cross-Sectoral Collaboration

Cross-sectoral collaboration is essential to facilitate the involvement of all stakeholders to enhance energy resiliency. Cross-sectoral knowledge sharing can promote best practices and innovative technologies driven by both the public and private sectors. To facilitate cross-sectoral collaboration, a shared platform or coalition may be formed to increase engagement of governments, energy supply industries, energy users, financial institutions, and other knowledge partners. For example, in the Philippines, major business groups joined forces to form the PDRF to strengthen collaboration for capacity building between the government and the private sector. Notably, PDRF operates through a cluster system that groups member companies into eight clusters, including water and sanitation, infrastructure, logistics, finance and insurance, information communication technologies (ICT), search and rescue/medical, food and non-food, and power, fuel and energy. Through the cluster system, member companies can effectively cooperate for capacity building activities tailored to a specific cluster as well as those requiring cross-cluster collaboration, where necessary.

Cross-sectoral efforts also include strengthening the capacity of host communities. Industrial and general energy consumers may support resiliency planning in host communities where their operation complexes are located, improving the ability of the communities and their businesses to adapt alike. Support for host communities may include provision of disaster risk reduction trainings and community mapping activities, as well as taking into account host communities for multi-stakeholder engagement, in order to better understand the communities' actual needs.

International Collaboration for Capacity Building

Capacity building support may be provided through cross-economy learning, transdisciplinary working groups, and exchanges through conferences and seminars. Governments may partner with other economies or international organizations for research and capacity building in energy resiliency. For example, the Chilean Energy Ministry's Resiliency and Risk Management Unit is working with the Coalition for Disaster Resilient Infrastructure (CDRI), an international coalition of governments, international organizations, multilateral development banks, private sector and academic institutions to promote disaster-resilient infrastructure. CDRI helps the Unit to consider how to improve the resiliency of the generation, transmission, and distribution sectors. The Unit is also engaged in technical cooperation with the Inter-American Development Bank (IDB) and the Latin American Energy Organization (OLADE) to develop a regional toolbox that guides the management of energy information.

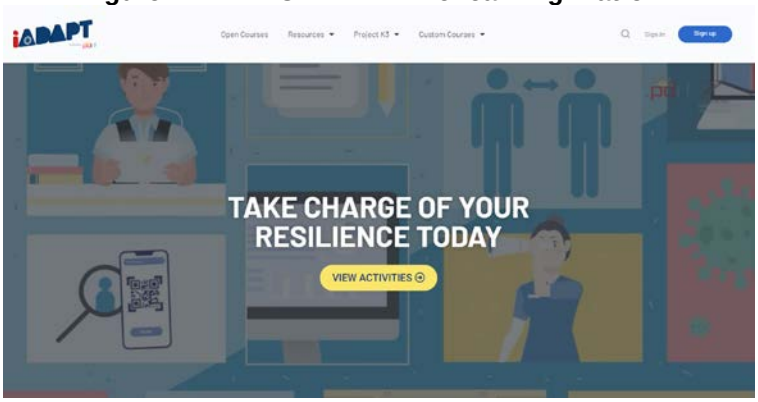
Use of Online Platforms and Tools for Knowledge Sharing

Online training platforms and online repositories may be established to make resiliency best practice knowledge accessible to a wider range of stakeholders. For example, AXA Climate has launched an online platform to help companies execute training and upskill their employees to succeed in sustainable transition. The platform offers regular courses and microlearning chapters comprised of educational videos and quizzes on the science behind climate and sustainability as well as action-based roadmaps that are customized for each job role. PDRF also provides an e-learning platform to raise awareness of energy resiliency in communities.

Table 13: PDRF's Resiliency Training Platform

The PDRF provides training to help energy sector stakeholders be prepared for future catastrophes. It offers courses on tropical weather, earthquakes, household preparedness, and business continuity, the last of which is one of the most popular courses. Other courses cover the incident command system and operating emergency operations centers. PDRF has also worked closely with the Philippine Department of National Defense's Office of Civil Defense in preparing courses for various government agencies to help prepare them to continue operation during a crisis. Since the COVID-19 pandemic, PDRF has shifted to online forums, creating an eLearning platform called "iADAPT" (Innovations Academy for Disaster Awareness, Preparedness, and Training).

Figure 7: PDRF's "iADAPT" eLearning Platform



Source: PDRF

5 Annex: Energy Resiliency Principle

The following sections provides the original texts from the APEC Energy Resiliency Principle, which provides the basis for the guidelines.

APEC Energy Resiliency Principle

I. Background and Purpose of the principle

1. Energy, ranging from oil, coal, natural gas to electricity, provides a basis for various social and economic activities. Stable energy supply is essential to achieve sustainable development of all economies and regions.

2. In the Cebu Declaration, the Energy Ministers of Member Economies of the Asia-Pacific Economic Cooperation (APEC) affirmed the importance of energy resilience to promote energy security and achieve sustainable development in 2015 APEC Energy Ministerial Meeting with the theme of “Towards and Energy Resilient APEC community” held in Cebu, Philippines. Besides the Energy Ministers recognize importance of quality energy infrastructure, energy supply diversity, energy efficiency and energy access to promote energy resilience of the region.

3. 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. Cyber-attack, terrorism and piracy and other human-induced disasters besides pose risks and threats to global energy supply chains.

4. Energy resilience is the ability to secure stable energy supply by effectively dealing with disasters (both natural and human-induced disasters). APEC member economies have shared and discussed the experiences and knowledge of each economy in its Energy Working Group (EWG) and Energy Resiliency Task Force (ERTF).

5. 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 need to investigate economy-specific circumstances and to consider tailored countermeasures in a holistic manner with all stakeholders involved.

6. In the Cebu Declaration, energy resiliency support APEC members to achieve energy security and sustainable development, which contains economic prosperity and environmental sustainability. Originated from the Cebu Declaration, EWG activities aim to promote the three E’s (economic growth, energy security and the environmental sustainability) and safety as a prerequisite (3E+S). Thus, activities to promote energy resiliency should be sufficiently in line with the 3E+S.

7. Other global disaster risk reduction initiatives including the Sendai Cooperation Initiative for Disaster Risk Reduction provide important insights perspectives to improve energy

resiliency effectively. In addition to the EWG/ERTF discussions, the principle also refers to the other existing interregional initiatives.

II. Definition of energy resiliency

8. Energy resiliency, an important concept to promoting energy security and sustainable development and providing access, is the ability and quality that enables for energy systems to withstand extreme natural and human-induced disasters and to recover and return to normal conditions in a timely and efficient manner and to build back better, thereby securing a stable energy supply to society and reducing negative impacts on human lives and economic activities from energy supply disruption.

III. Respect for diversity among economies, holistic approaches and multi-stakeholder processes

9. Member economies and related organizations should respect the diversity of efforts among member economies, holistic approaches from the supply-side to the demand-side, and multi-stakeholder processes with all relevant sectors including energy industries, industrial and general consumers, financial institutions, governments and other related organizations.

10. The principle covers a whole framework and a comprehensive set of factors and initiatives that contribute to improving energy resiliency to disasters. APEC member economies may select and implement the initiatives relevant to each economy's situation.

IV. Relevant stakeholders and their roles to enhance energy resiliency

11. **Governments** should implement initiatives including enacting, amending and abolishing energy-related regulations to support private actors in enhancing energy resiliency. Governments should besides stablish standards and guidance so that energy supply industries and industrial energy consumers can formulate energy resiliency plans that may contain disaster prevention and reduction, restoration, building back better and information sharing.

12. **Energy supply industries** should implement initiatives including formulating and implementing energy resiliency plans, diversifying sources of energy supply in terms of fuel types, supplier types, geography and distribution. Energy supply industries should besides increase ratio of self-sufficient energy sources, technologies and facilities, introduce grid system integration technologies of variable renewable energy (VRE), secure and store sufficient energy reserves and power generation equipment/facilities in case of disasters. Energy supply industries should further increase efficiency of water use in energy supply and utilization processes, ensure electric redundancy through flexible transmission and distribution systems with wide-area power interchanges, interconnections, loop-systems, multiple connections, double-tracking and power-grid stabilizers, and introduce demand response (DR) system to manage and control energy demand, and thereby well preparing and responding to disasters with all initiatives above.

13. **Industrial and general energy consumers** should implement initiatives including formulating and implementing energy resiliency plans, securing and storing additional energy

reserves, and deploying distributed energy resource (DER) systems and technologies including in-house power generation, cogeneration, and micro-grid systems.

14. **Financial institutions** should implement initiatives including positively evaluating, investing and financing both public and private projects that contribute to enhancement of energy resiliency of member economies.

V. Common approaches among different stakeholders towards energy resiliency

(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.

(Investment and financing to projects towards energy resiliency)

16. Stakeholders should actively invest and finance projects that contribute to enhancing energy resiliency in each economy. In addition to post-disaster response and recovery, prior investment to address underlying risk factors is essential in enhancing energy resiliency, as noted in the “Sendai Framework for Disaster Risk Reduction 2015-2030” adopted at the 3rd United Nations world conference on disaster risk reduction in 2015.

17. Stakeholders should appropriately evaluate contribution of invested and financed projects to energy resiliency in addition to projects’ profitability. From that perspective, indices and matrices to properly measure levels of contribution to energy resiliency should be established as well as building mechanisms for private companies to disclose relevant information to financial institutions.

(Proper asset management)

18. Stakeholders should introduce asset management systems to balance cost, risk and performance of energy resilient infrastructure. As the ISO 55000 explains, proper installation, management and renewable cycles of assets are critical in sustaining a stable energy supply and to attract various finance sources, thereby enhancing the energy resiliency of each economy.

(Emerging technologies adoption)

19. Stakeholders should fully consider and adopt cutting-edge energy technologies including more accurate weather and disaster forecasts and other base technologies including Artificial Intelligence (AI) and Internet of Things (IoT).

20. Stakeholders should collaborate to advance new technologies and to secure public and private investment and loans to those technologies towards developing a more resilient energy system.

21. Stakeholders should fully consider and take actions to maintain cyber security for energy systems when adopting new information communication technologies.

(Multi-stakeholder knowledge sharing)

22. Stakeholders should take voluntary measures at all levels. Effective efforts are encouraged to be shared among stakeholders both within economies as well as globally.

VI. Follow-up actions based on the principle in EWG/ERTF

23. Establish detailed guidelines to support formulation of energy resiliency enhancement plans in APEC member economies. The guidelines would be different depending on stakeholder types, would include a set of indices to evaluate what kind of initiatives could better improve energy resiliency, and would include a set of existing best practices as references for member economies.

24. Develop tools to better evaluate risk and vulnerability to disasters. Mutually share experiences related to investment, plans and concrete measures on disaster prevention, response and recovery.

25. Offer training programs to support implementation of the principle, the guidelines and tools in member economies.