Asia-Pacific
Economic Cooperation

Guidelines to Develop Energy Resiliency in APEC Off-Grid Areas

Energy Working Group

February 2017

APEC Project: EWG 09 2015A

Workshop on Improving Energy Resiliency in Off-grid Areas in APEC Member Economies

Produced by

Senior Energy Official

Department of Energy

Rizal Drive corner 34th Street

Bonifacio Global City, Taguig 1632

Philippines

(632) 479-2900

For

Asia-Pacific Economic Cooperation Secretariat

35 Heng Mui Keng Terrace

Singapore 119616

Tel: (65) 68919 600

Fax: (65) 68919 690

Email: info@apec.org

Website: www.apec.org

APEC#217-RE-03.4

CONTENTS

FIGURES

TABLES

ANNEXES

EXECUTIVE SUMMARY

The ***Guidelines to Develop Energy Resiliency in APEC Off-Grid Areas*** aims to provide basic parameters, frameworks, lessons learned, best practices, and case studies in improving energy resiliency among APEC member economies. It takes off from the reality that marginalized and off-grid communities in many areas across the region bear the brunt of the impact of extreme weather events caused by climate change. This vulnerability further aggravates the perennial problems of very limited, unreliable, and costly energy services besetting off-grid communities. Consistent with the Intergovernmental Panel on Climate Change definition, the Guidelines also looks at resilience as "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through preservation, restoration, or improvement of its basic structure and functions".

The guidelines focuses on four major areas of enabling mechanisms and covers two special concerns. The enabling mechanisms include policy and regulations, programs and projects, institutional arrangements, and financing. The special concerns cover water-energy nexus and the role of women in developing energy resiliency.

The following figure summarizes the contents of the guidelines. As illustrated, the guidelines recognizes the dynamism of the different enabling mechanisms and special concerns and takes into account the relationships and overlaps between and among them. Similarly, the guidelines takes cognizance of the different conditions and levels of resiliency in the different APEC member

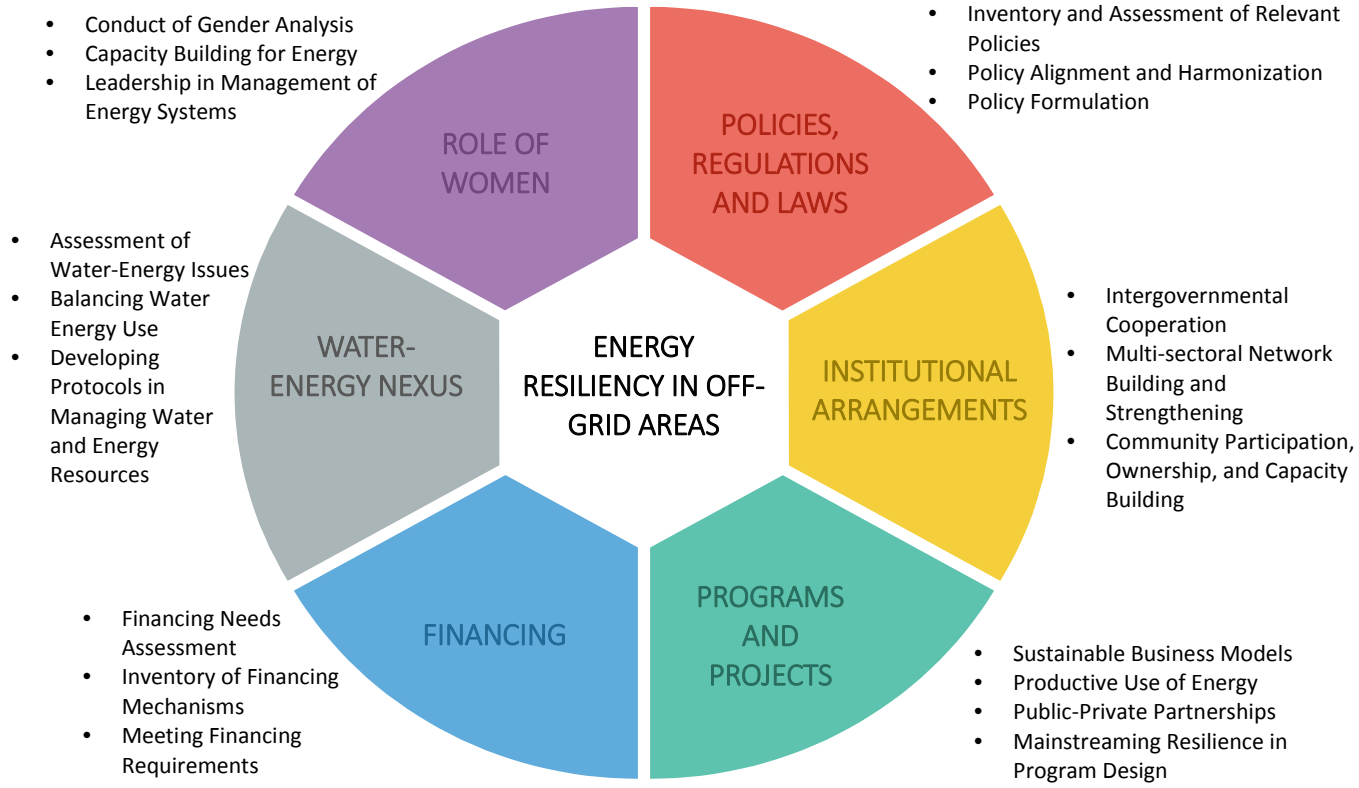


Figure 1. Components of the Guidelines to Develop Energy Resiliency in APEC Off-grid Areas

economies. In view of these considerations, the guidelines, rather than being linear and prescriptive, is geared towards appropriate solutions, practical application, and interfacing. Thus, it is recommended that a specific member economy start with its own situation and needs when using the guidelines and thereafter generate appropriate solutions.

The following section briefly describes each major component of the guidelines:

Policy and Regulations - This section covers policies, regulations, and laws that have been actually enacted and are leading to, have facilitated, or resulted to the implementation of energy resilience measures and projects. The means by which such laws were crafted and put in place, along with challenges encountered and lessons learned, are highlighted. The guidelines focuses on how policies have translated or can actually translate to activities, projects, behaviour change, or investments – mechanisms that can be emulated by other economies planning to formulate policies that will promote energy resilience. It specifically looks into the inventory of existing policies, policy harmonization, and if needed, formulation of new ones.

Programs and Projects - This part features actual programs or projects that exhibit energy resilience and covers examples that are relevant to off-grid areas i.e. island economies or isolated upland communities. It includes initiatives in different parts of the energy supply chain from generation to end user and includes technical but non-infrastructure activities such as preventive or anticipatory maintenance activities. The section puts emphasis on integrating resiliency during the design stage of projects, sustainable business models, productive use applications, and public-private partnerships.

Institutional Arrangements - Discussions under this section focus on arrangements, mechanisms, and coordinative practices established across different organizations or sectors and that have contributed to or resulted to improved energy resilience. These arrangements may be formal or informal, and could be bilateral or multi-sectoral. This section features coordination networks at different levels e.g. from national agencies to local community councils. This part specifically covers intergovernmental cooperation, network strengthening, and community mobilization.

Financing - This section focuses on financing sources and mechanisms that specifically support developing energy resilience. While there is a wide range of financing windows for traditional energy, renewable energy, and energy efficiency development, financing specific energy resilience measures need to be further defined and supported. The discussions cover key points or actual experiences on how energy resilience can be integrated to the financial models or investments flow of energy projects. This part specifically covers financing needs assessment in the context of disasters, inventory of financing windows or facilities, and completion of financing eligibility requirements.

Water-Energy Nexus - This section covers the important relationship of water use and energy production. With the use of tremendous amounts of water in power generation, in the extraction, transport and processing of fuels; and in growing biomass feedstock crops, there is a need to recognize and deal with climate impacts on water resources as well as confront the issue of excessive water extraction for energy. Vice versa, energy is also critical in providing freshwater, as it is necessary for the collection, transportation, distribution, and treatment of freshwater. This section

covers the current state of the water and energy nexus and will highlight broad strokes of strategies being pursued to strike a balance between these two very important and interrelated resources.

Role of Women - Women, especially in developing countries and off-grid areas, are often more exposed to the impacts of climate change. Nevertheless, women are also the ones who lead efforts in relief and recovery as well as initiatives on developing resilience in many dimensions -- including energy -- at the community level. This section puts emphasis on women's vital knowledge of social and natural systems, and their role in making families, communities, and natural resources more resilient to the impacts of climate change. Women also play a key role in developing energy resilience being the dominant workforce in various economic sectors which includes micro-small and medium enterprises, tourism, and agriculture. This section particularly looks into gender analysis and capacity building for the management of energy systems.

These aforementioned sections are expected to interact with each other and as such; certain cross cutting considerations need to be taken into account. In this regard, APEC member economies can take away from this guidelines the following recommendations:

- An inventory and assessment of the current situation and existing energy resiliency policies and measures can be the starting point for each member economy.

- Recognizing climate change impacts and risks and the urgent need for resiliency is vital not just in the energy sector but for all sectors and in the national and local levels. Climate-energy models can be systematically localized to better aid in planning and decision-making.

- Best practices and previous experiences in improving energy resiliency are contained in this document and can be adapted to local conditions. Selected energy resiliency planning and mapping tools are listed in Section 3 of this document as well as specific measures for improving energy resiliency of energy infrastructure.

- Various government agencies, policy-makers, program and project developers, as well as local communities all have a role to play in improving energy resiliency in off-grid areas and cooperation among all players is vital. It is necessary to identify roles and improve coordination among concerned players.

INTRODUCTION

BACKGROUND

Climate change significantly affects the energy sector across many regions and in most cases, off-grid areas are usually at risk and more seriously affected due to their geographic, social, and economic constraints. In recent years, the Asia-Pacific region experienced a series of devastating natural disasters, like the 2010 Chile Earthquake, the 2011 Southeast Asia floods, the Great East Japan Earthquake in 2011, Typhoon Haiyan in 2013, and the China Yunnan Earthquake in 2014. In all of these events, while broader sections of society have been affected, people in off-grid areas are the ones most badly hit and to whom relief and recovery efforts were most difficult to provide. Figure 2 below illustrates average yearly economic losses in the Asia and the Pacific region by the category and type of natural disasters.

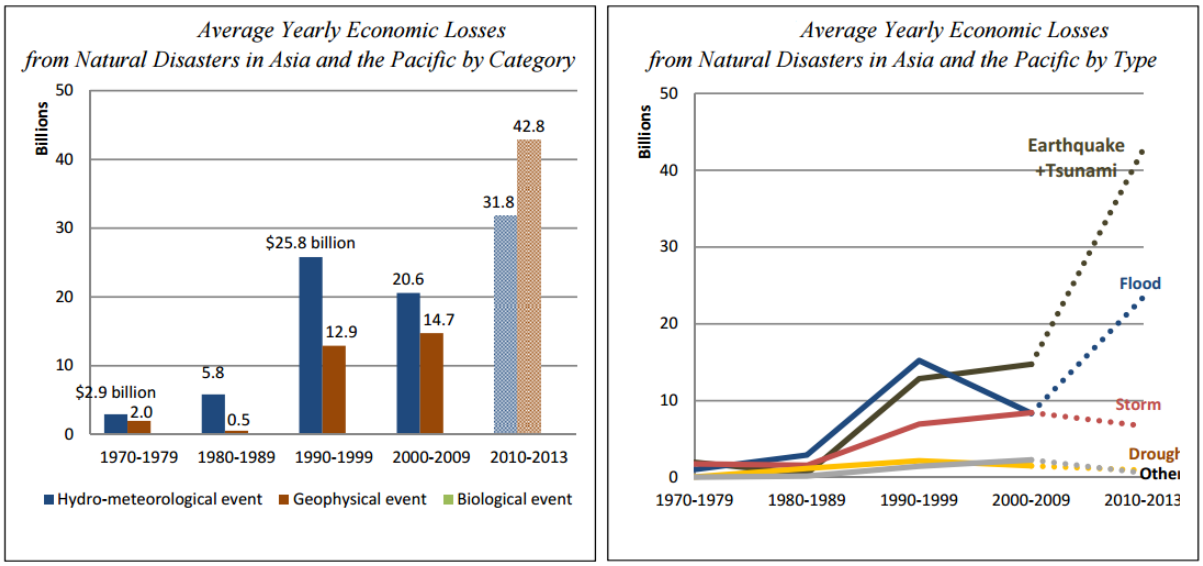


Figure 2. Economic Losses from Natural Disasters in Asia and the Pacific

Source: (UNESCAP, 2015)

The output and efficiency of energy production and supply systems are highly sensitive to climate impacts such as extreme weather events including typhoons, forest fires, landslides, floods, and droughts. Rising sea levels and storm surges are also a concern when it comes to energy facilities. Climate change-induced water stress also affects the energy sector. Decreased availability of water will pose a risk to hydropower, bioenergy, solar and thermal power plants. Energy demand is also affected by increased seasonal temperatures. The ensuing increase in demand for cooling increase peak loads and require additional generation capacities.

The APEC Emergency Preparedness Working Group (EPWG) also reported that that over 70 per cent of the world's natural disasters are being experienced by the 21 APEC Member Economies, causing the disruption of energy supply and destruction of critical energy infrastructure.

Cognizant of the vulnerability of off-grid communities to the impacts of climate change, the APEC energy ministers stated in their Cebu Declaration of 2015 that "A priority goal in developing a resilient APEC community will be to provide energy access to our people, including in remote communities. We note that clean energy technologies and traditional energy sources, including cleaner use of fossil fuels, are important in addressing energy access challenges. We recognize that significant potential exists to provide energy access to rural communities through the up-take of micro grids, energy storage and their integration with renewable energy resources". Along this line, the member economies reiterated the importance of building the resiliency of energy infrastructure and defined resiliency as 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.

APEC's disaster risk reduction framework has four pillars as shown in the figure below. Across the pillars and in most of the sub-components of the framework, energy resiliency would be a consistent critical element.

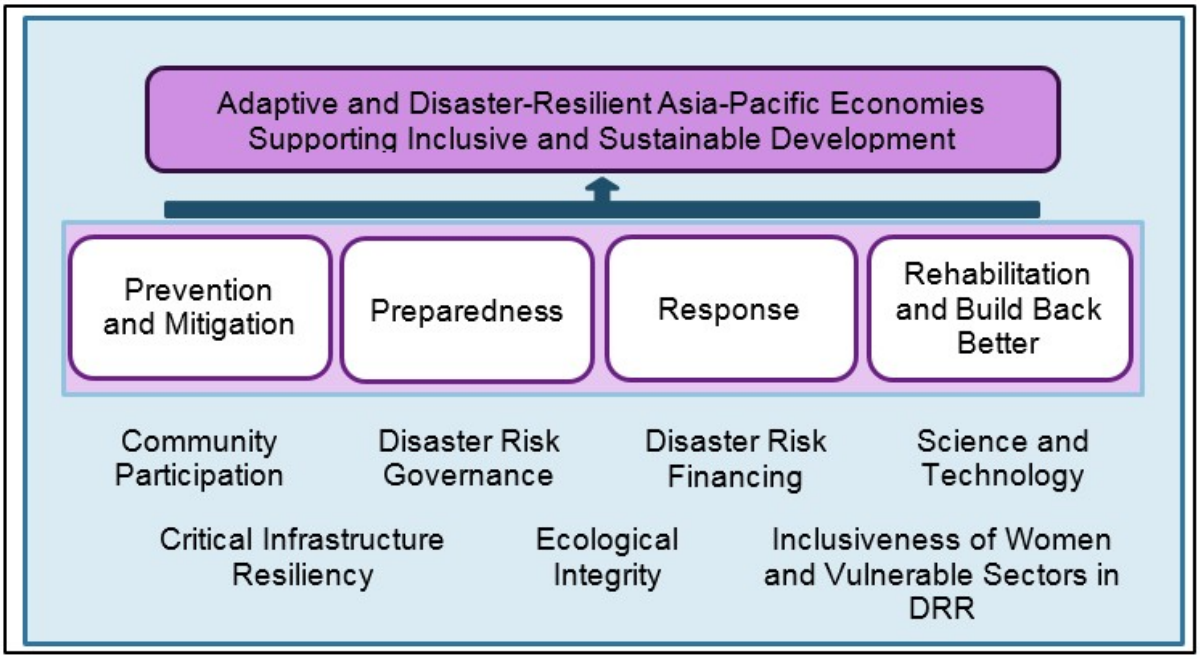


Figure 3. Four Pillars of the APEC Disaster Risk Reduction Framework

Source: (APEC, 2016)

In view of the serious threats of climate change to energy facilities, APEC formed and mobilized its Energy Resiliency Task Force (ERTF) to find, promote, and implement strategies to develop energy resiliency in all sectors of the 21 member economies. The ERTF is starting this important task with a specific focus on off-grid areas.

In late 2015, the Philippines as co-chair of the ERTF with the United States, proposed to the APEC Secretariat to organize a workshop among member economies to address the challenge of building energy resilience in off-grid areas. The APEC Secretariat agreed to support the Philippines and co-funded a project to develop guidelines to improve energy resiliency in APEC off-grid areas. From its conception, the project went through various activities including an online survey among the

member economies, a series of workshops organized by the Philippine's core energy group, and the conduct of the workshop in June 2016.

The *Workshop on Improving Energy Resiliency in Off-grid Areas in APEC Member Economies* was held on June 15-17, 2016 in Boracay Island, Aklan, Philippines. The workshop facilitated and documented the sharing of experiences on various lessons learned and best practices in promoting energy resiliency in off-grid areas. Plenary and breakout sessions covered overarching issues in promoting energy resiliency such as policies, regulations and laws; institutional arrangements and coordination; funding opportunities for energy resiliency; and the role of women in promoting energy resiliency.

The workshop resulted to the drafting of the *Guidelines to Develop Energy Resiliency in APEC Off-Grid Areas.* The guidelines was prepared to provide basic parameters, frameworks, lessons learned, and best practices in improving energy resiliency among APEC member economies. The guidelines promote the building of sustainable and resilient communities (thematic thrust of APEC 2015), which will coalesce with the international call for energy security and a cleaner, safer and more bio-diverse environment. It endeavours to become the take -off point from where APEC member economies can identify, design, and implement energy resiliency measures applicable to their respective conditions and circumstances. It aims to provide a practical framework on improving off-grid energy resiliency for policy-makers, implementers of programs and projects, local government units, private players in the energy sector as well as non-government organizations (NGO's) and local communities.

After the workshop, the draft guidelines was prepared and circulated back to the member economies and workshop speakers for comments. For at least two months, feedback, questions, inputs, and suggestions were solicited and consolidated and eventually incorporated into the guidelines. The guidelines is a result of a long process of consultations and research and will continue to be a living document that the member economies can utilize as well as improve upon.

On a final note on the background, the guidelines took an energy technology and resource-neutral standpoint to allow the consideration of new and innovative technologies applicable to building resiliency in off-grid areas. The guidelines also took into account energy resiliency initiatives both in the demand and the supply side.

IMPORTANCE OF ENERGY RESILIENCY IN OFF-GRID AREAS

Almost one quarter of the world's population -- 1.3 billion people -- lack access to electricity, and at least 620 million of this population are in the Asia Pacific region. People living in these areas are effectively excluded from the developmental gains that electricity brings. This lack of access to modern energy services has significant negative impact to well-being, health, economic growth, and political stability. It is a problem that perpetuates inequitable growth and prohibits building greater resiliency in the face of climate change impacts.

Governments are generally aware of the issue of access and vulnerability and there are many programs being implemented to extend grids to off-grid areas; however, with the daunting number of people that need basic electricity coupled with the recurring damage that extreme weather events cause, a single track government driven grid extension strategy may not be sufficient, if not feasible at all, particularly in remote or low population density areas that are costly to reach. This situation necessitates building appropriate and disaster resilient energy systems.

For the purpose of these guidelines, off-grid areas are regions, provinces, or communities that are geographically isolated, economically marginalized, and disaster prone. This may apply to small island economies, remote upland villages, or inaccessible coastal or desert communities.

Energy infrastructure in off-grid areas are vulnerable given the threats of natural disasters and the impacts of climate change. These areas are so remote that connection to the main grid is not an immediate option. In these areas, kerosene lamps are used for lighting and electricity is mainly sourced from diesel generators; which are in constant risk of fuel supply disruptions and price volatility.

Energy resiliency requires a concerted and sustained effort from all actors. The government needs to provide an enabling framework in which to implement resiliency measures and capacitate actors from all levels.

Collaborative undertakings such as research, development and deployment (RD&D), standards setting, capacity building and other forms of technical assistance are all envisioned to form part of the menu of options and recommendations to promote resiliency of energy facilities in off-grid areas.

> *Energy resiliency is defined in the Cebu Declaration as 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.*

It is also important to emphasize that energy efficiency efforts and proper management of energy consumption contribute to resiliency just as much as building resilient and flexible energy infrastructure does.

KEY CONSIDERATIONS IN IMPROVING ENERGY RESILIENCY IN OFF-GRID AREAS

The following guidelines are not intended to be prescriptive, linear, or compartmentalized. Depending on the situation, needs, and priorities of a member economy particularly for its off-grid communities, the elements and examples presented herein can be considered as starting points or complimentary components of an economy's energy resiliency program. The guidelines intends to assist a member economy design an appropriate and cost effective program by providing examples, cases, and lessons learned from the different member economies. This important aspect of sharing of experiences, technology, and best practices is meant to expedite the strengthening of energy systems in off-grid areas across the region.

SECTION 1: POLICIES, REGULATIONS, AND LAWS

This section identifies ways to integrate climate change risks and resiliency actions in the formulation or enhancement of legal instruments and policies at the national and sectoral levels. National policies are vital in improving energy resiliency in off-grid areas by providing the framework under which the more local levels of governance operate. Policies, regulations and laws can enhance or constrain the ability of other actors to implement resiliency measures and as such, they need to be taken into account carefully. Priorities and budget allocations are also set at the national policy level, further underlining its strategic value.

In aligning policy towards energy resiliency measures, the following approaches are recommended:

- *Recognize climate change impacts in national and sectoral plans and policies*
- *Conduct an inventory and assessment of existing policies*
- *Assess national and local vulnerability to climate change impact*
- *Formulate local ordinances and initiate local action*
- *Formulate and enforce higher design standards*

■ Recognize Climate Change Impacts in National and Sectoral Plans and Policies

At the minimum, climate change risks and energy resiliency need to be included in the text and language of policy. Fundamentally, there is a need to (a) clearly recognize climate change risks and the urgent need for resiliency and (b) consistently apply a climate change lens to policy discussions on energy and resiliency.

The Organisation for Economic Cooperation and Development (OECD) for example, identifies a number of priorities to better incorporate energy resiliency language within development policies, plans, and projects. These include:

- Make climate information more mainstream, relevant, and usable for the development community as a basis for planning and decision-making;
- Develop and apply rapid evaluation tools to help screen and prioritize development activities responding to climate risks;
- Identify and use appropriate entry points for climate information, such as humanitarian aid, poverty reduction, economic development, and natural resource management;
- Shift emphasis to implementation, as opposed to developing new plans; and
- Strengthen meaningful co-ordination and sharing of good practices.

Furthermore, consistently applying a climate lens involves examining

- The extent to which the policy, strategy, regulation, or plan under consideration could be vulnerable to risks arising from climate variability and change;
- The extent to which climate change risks have been taken into consideration in the course of program formulation;
- The extent to which the policy, strategy, regulation, or plan could lead to increased vulnerability, leading to maladaptation or, conversely, to missing important opportunities arising from climate change; and
- For pre-existing policies, strategies, regulations, or plans that are being revised, what amendments might be warranted in order to address climate risks and opportunities

The quick use of a climate lens enables a policy maker to discern whether a policy, plan, or program is at risk from climate change and consequently decide on further work that needs to be done to measure the extent of the risk and identify practical mitigation measures. For more details, refer to these links: https://www.oecd.org/dac/43652123.pdf; www.oecd.org/environment/cc/Adapting-to-the-impacts-of-climate-change-2015-Policy-Perspectives-27.10.15%20WEB.pdf

CASE STUDY: LAW ON ENVIRONMENTAL PROTECTION OF VIET NAM

Viet Nam's Law on Environmental Protection (LEP) requires Strategic Environmental Assessment (SEA) of regional and sectoral plans. These provide a sound potential framework for integrating climate change considerations into sectoral and spatial development planning.

A Strategic Environmental Assessment (SEA) of the Quang Nam province hydropower plan was conducted for the Vu Gia-Thu Bon river basin. A range of important climate change impacts on the hydrology of the basin were identified: increased rainfall intensity and variability; increases in size of extreme flood flows, resulting in large sediment transport and sand excavation; sea-level rise affecting flooding in the seaward parts of the delta; increases in temperature and higher evapotranspiration leading to lower dry season minimal flows with effects on salinity intrusion. Conclusions from the SEA provided vital information namely: (1) that the pace and scale of the proposed hydropower development was at an unsustainable level (2) the need to incorporate climate change parameters in design and management is explicitly mentioned.

Recommendations include enhancement of the sustainability and equity of the hydro sector in the basin; and "safe operations", recommending the implementation of operational regimes and institutional arrangements to reduce droughts and floods and prepare for disasters;

Source: "Strategic Environmental Assessment of the Quang Nam Province Hydropower Plan for the Vu Gia-Thu Bon River Basin", ADB 2008 (For more details, follow the link: https://www.adb.org/sites/default/files/project-document/65209/39536-vie-tacr.pdf)

The APEC Cebu Declaration of 2015 is in itself an example of incorporating energy resiliency into strategic policy, as the member economies signed an instruction which states:

"Consistent with the theme of an energy resilient APEC community, we recognize the need to conduct a vulnerability assessment of existing infrastructure and evaluate current infrastructure standards. 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. Furthermore, we reaffirm that resilience to potential energy supply disruptions can be strengthened through effective, well-targeted market and governance response mechanisms. We also encourage Members to promote energy supply diversity and energy efficiency and to reduce barriers to energy trade and investment in advancing resilience of the energy sector."

■ Conduct an Inventory and Assessment of Existing Policies

A national level assessment of relevant policies is vital in enhancing energy resiliency policy. This enables the harmonization and alignment of policies that can streamline government actions towards energy resiliency. Gaps and inconsistencies can be identified and potentially addressed. Formulation of new and appropriate policies can also be initiated once an assessment is completed.

The following table is an example of a simple list of laws relevant to developing energy resiliency. In this case, laws governing energy sector development in the United States are presented and each law's relevance to developing energy resiliency is quickly identified.

Table 1. Laws in Developing Energy Resiliency in the United States

Year	Title	Relevance to Energy Resiliency
1977	Department of Energy Organization Act	Created federal Department of Energy
1978	National Energy Act, incorporating: -National Energy Conservation Policy Act	Promotes conservation efforts in homes, schools, and other public buildings
1980	Energy Security Act, incorporating: -Biomass Energy and Alcohol Fuels Act -Renewable Energy Resources Act -Solar Energy and Energy Conservation Act -Geothermal Energy Act -Ocean Thermal Energy Conversion Act	Provided loan guarantees for biofuels and alcohol fuels projects
2005	Energy Policy Act	Provided tax incentives for conservation and use of alternative fuels
2007	Energy Independence and Security Act, incorporating: -America COMPETES Act[1]	Increased fuel economy requirements, phased out incandescent light bulbs, encouraged biofuel development
2008	The Energy and Tax Extenders Act of 2008,[2] incorporating: -Food, Conservation, and Energy Act of 2008[3] -Strategic Petroleum Reserve Fill Suspension and Consumer Protection Act -America COMPETES Act -Energy Improvement and Extension Act of 2008	Provides tax incentives for energy conservation initiatives or measures
2009	The American Recovery and Reinvestment Act of 2009	Funding for an electric smart grid Renewable energy tax cuts Weatherizing modest-income homes

At this stage it is important to identify gaps or inconsistencies that need to be addressed. For example, in the US Energy Security Act of 1980, loan guarantees are provided for biofuels and alcohol fuels. While this promoted the growth of the said industries, in the long term it might impinge on the Food, Conservation, and Energy Act when it comes to balancing energy production with food production and water conservation. These kinds of critical balancing points are what this section aims to bring out for policy harmonization.

■ Characterize the Local Energy Market

Understanding the energy market of each member economy especially the local off-grid communities is essential to the formulation of appropriate strategies in improving energy resiliency. National and local energy market studies will benefit energy program managers, regulators, private players and the public and enable them to make informed choices and decisions. Energy market characterization may describe the following: energy demand and consumption pattern, energy supply system and fuel sources, electricity tariff system, grid network and interconnections, as well as areas of vulnerability in the energy infrastructure system; and industry players and regulators.

CASE STUDY: CANADA'S NORTHERN STRATEGY

Natural Resources Canada published in 2015 their Energy Policy Context and Market Characterization for the Development of a Northern Communities Energy Technology Intervention Strategy. The strategy paper speaks about "remote and isolated communities" in the north of Canada. Most of these communities are small, being their comparative factor, but their energy situations are not homogenous. For this reason, the study first explores the local policy context and energy market of each before formulating an intervention strategy. For the full presentation, see Annex 2.

Source: (Natural Resources Canada, 2015)

■ Assess National and Local Vulnerabilities to Climate Change Impact

Considering that resources are usually limited, a process of prioritizing and focusing on critical areas for energy resilience is essential. An ideal starting point for this process is to assess national and local vulnerabilities. This enables policy makers and planners to identify specific risks and corresponding energy resiliency measures. For example, a quick review of national hazard maps such as that of Indonesia (as shown below) immediately defines general areas where priority measures and resources can be allocated. Energy resiliency programs can also be geographically prioritized relative to other key concerns of an economy such as border priority industries, security issues, trafficking, and typhoon frequencies.

Figure 4. Indonesian National Hazard Map

From the national level hazards map, it is important to zoom into the local hazard maps. In this example, focus is on Bali. The following map shows areas that have a very high risk of being totally damaged in the event of a tsunami or even storm surges. This information enables planners to propose location of, for instance, substations and distribution lines in areas safe from inundation and construct cables in water resistant underground lines in areas that are expected to get flooded.

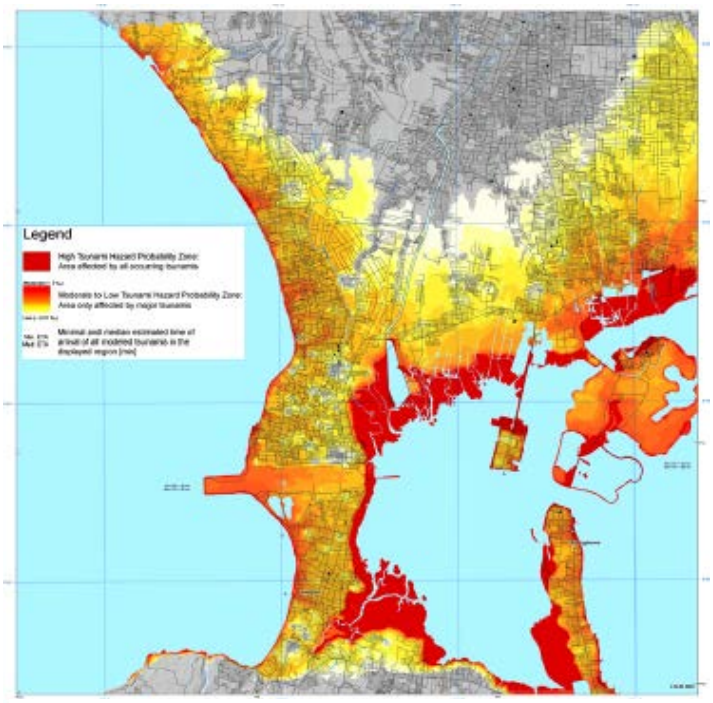


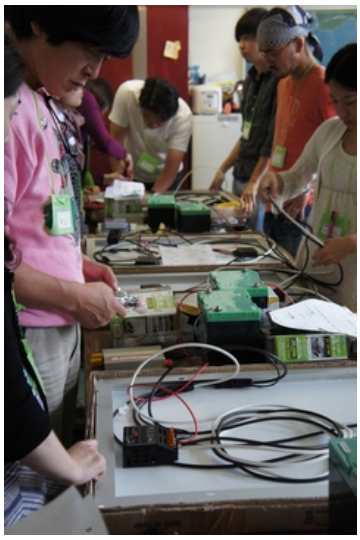
Figure 5. Bali Hazard Map

Source: (European Geosciences Union, 2016)

■ Formulate Local Ordinances and Initiate Local Action

National policies need to be translated into local ordinances and activities in order to enable local players to implement appropriate energy resiliency actions on their own resources and volition. This is particularly important for off-grid areas wherein communities get completely isolated during extreme weather or geologic events and as such, they need to be actively involved in the process of building and maintaining energy resilience.

For example, in Japan, after the Great East Japan Earthquake in March 2011 and the ensuing accident at the Fukushima Daiichi Nuclear Power Plant, many Japanese people started thinking about where their electricity comes from and realized energy issues that they had been ignoring until then. Before the accident, all homes were fully energized, with power very convenient and economical. During the blackout caused by the earthquake, many people suffered since everything in their homes were powered by electricity from big power plants. Many people recognized the importance of energy self- sufficiency and diversity and started to take an interest in systems that can generate electricity at home, such as solar power.



In the wake of the earthquake, local initiatives to develop energy resiliency were encouraged and the initiatives became a civil society action called “Transition Towns” which focused on strengthening local solutions and participation. The working group "Fujino Denryoku" ("denryoku" means "electric power") was formed in 2011 with the aim to help people become independent from traditional power utilities and to make a transition towards self-sufficient, locally-distributed energy. The group's first project was to supply power for lighting and sound systems at a local festival. Eventually, teams also went out to other festivals in the earthquake disaster zones in the Tohoku region, and offered support by supplying power from renewable energy. The working group also holds monthly "Solar Power System Workshops," where participants including beginners can easily assemble a home system by connecting PV panels and batteries, and other components.

Source: http://www.japanfs.org/en/news/archives/news_id032303.html

Additional information on the Fujino experience are available in the following site: https://ourworld.unu.edu/en/transition-town-fujino-goes-for-local-energy-independence

■ Consider Resiliency in Government Subsidies, Grants and Incentives

Energy resiliency should be included as an important eligibility requirement in existing and new government subsidies, grants and incentives schemes for off-grid energy systems. To ensure sustainability of these off-grid systems, they should meet resiliency and technical standards based on local conditions and anticipated environmental stressors.

Specific energy resiliency measures that can be implemented in the project level can be found in Section 3: PROGRAMS AND PROJECTS of this document. They include the preparation of local climate-energy models, hazard maps and energy contingency plans as well as technical standards for energy infrastructure, which can be seen in Table 4. Energy Resiliency Measures in the Power Generation Sector and Table 5. Energy Resiliency Measure in the Power Transmission and Distribution Sectors in the same section.

■ Formulate and Enforce Higher Design Standards

Design and construction standards are useful and practical policy tools that can directly improve energy resiliency. Improved standards for energy infrastructure are necessary to withstand more frequent and unpredictable extreme weather events. This includes improved national standards for generation, transmission and distribution facilities and minimum standards for energy efficiency in buildings. The following examples illustrate how specific measures can be done to respond to specific climate change stresses.

Table 2. Design Standards for Improving Resiliency of Energy Distribution Systems

Distribution System	Effect	Higher Design Standards
High Temperature	Sagging conductors resulting to fires	Higher pole heights Shorter span intervals Higher conductor tension
Floods	Substations and lines submerged Foundation of poles weakened	Increased elevation of substations Reinforced foundations of poles
Storms	Friction of conductors resulting to fires Collapse of poles and towers	Higher conductor tension Use of steel poles instead of wood poles

The photo below is an example of a policy on higher design standards being implemented. In the wake of Hurricane Sandy that hit the US Eastern Seaboard and paralyzed the power system of entire cities, policies on better power designs were pursued such as elevating substations higher than anticipated worse case flood levels.

Figure 6. Higher Elevation Design Standard for Substations

Source: (Johnson, 2016)

SECTION 2: INSTITUTIONAL ARRANGEMENTS

Energy resiliency transcends boundaries of government agencies. It is vital for the energy sector to identify relevant institutions, and define their roles and mandate in relation to climate change resiliency. Implementation of resiliency action will involve different agencies from a wide range of sectors. To effectively implement resiliency actions, roles and responsibilities should be clarified and monitoring and evaluation systems need to be established and enforced. In addition, clear coordination mechanisms and especially communication protocols need to be defined. Concerned agencies also need to be flexible in their respective roles and functions especially during disaster situations.

Institutional arrangements for improving energy resiliency require strengthening by concerned government and private agencies, their cooperation as well as empowering and mobilizing local communities.

■ Review Existing Institutional Arrangements

An initial step involves a review of the existing institutional structure and arrangements that have been established and are relevant to developing energy resiliency. An assessment of the mandates and limitations of the different institutions and the strengths and weaknesses of coordinative set-ups will lay the foundation for more integrative network management. It is important to note though that an institutional structure that has proven to be effective in one economy for promoting energy resiliency may not lead to the same result for another. Solutions, therefore, require a deep understanding of existing structures and cultures and must be adapted to local conditions. The example in Figure 7 features the Australian institutional arrangements under its Critical

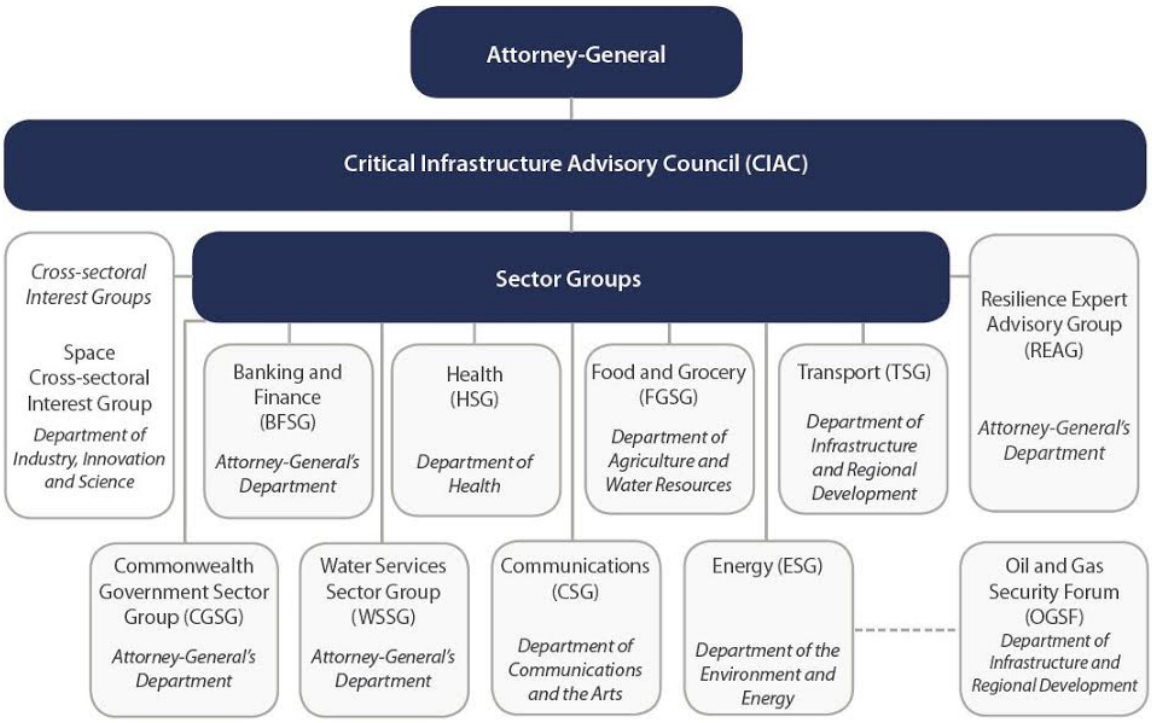


Figure 7. The Australian Government's Trusted Information Sharing Network for Critical Infrastructure Resilience

Infrastructure Resilience Strategy. Under the Strategy, the responsibility for the resiliency of Australian critical infrastructure is shared by the owners and operators, state government and the Australian government. Under the Trusted Information Sharing Network, each of these are represented in the sector groups and at the peak committee, the Critical Instructure Advisory Council.

■ Strengthen Cooperation Among National and Sectoral Government Institutions

There is a need to rethink governance structures in relation to building resiliency to climate change. While a powerful central body of government, such as the office of the President or Prime Minister, can coordinate implementation of resiliency actions, there is a need to involve other agencies and players in consideration of the multi-sectoral and multi-disciplinary nature of building energy resiliency. It is critical that agencies for energy, environment, planning, finance, water, agriculture and trade are engaged in the development of resiliency strategies, and roles and responsibilities are clearly defined.

CASE STUDY: AUSTRALIA'S CRITICAL INFRASTRUCTURE RESILIENCE (CIR) STRATEGY

In 2001 the Australian Government established a national Critical Infrastructure Strategy, providing a strong foundation on which critical infrastructure owners and operators and governments could prepare for, and respond to, a range of significant disruptive events.

Successive Strategies have encompassed over a decade of collaborative effort and achievement by businesses and all levels of government.

The aim of the Australian Government's Critical Infrastructure Resilience Strategy (2015) is the continued operation of critical infrastructure in the face of all hazards. More resilient critical infrastructure will also help to support the continued provision of essential services (provided by critical infrastructure) to businesses, governments and the community, as well as to other critical infrastructure sectors.

Critical infrastructure in Australia is defined as 'those physical facilities, supply chains, information technologies and communication networks which, if destroyed, degraded or rendered unavailable for an extended period, would significantly impact the social or economic wellbeing of the nation or affect Australia's ability to conduct national defence and ensure national security'.

The resilience of Australia's critical infrastructure has been enhanced by the collective work of the States and Territories, the Commonwealth Government and the owners and operators of critical infrastructure.

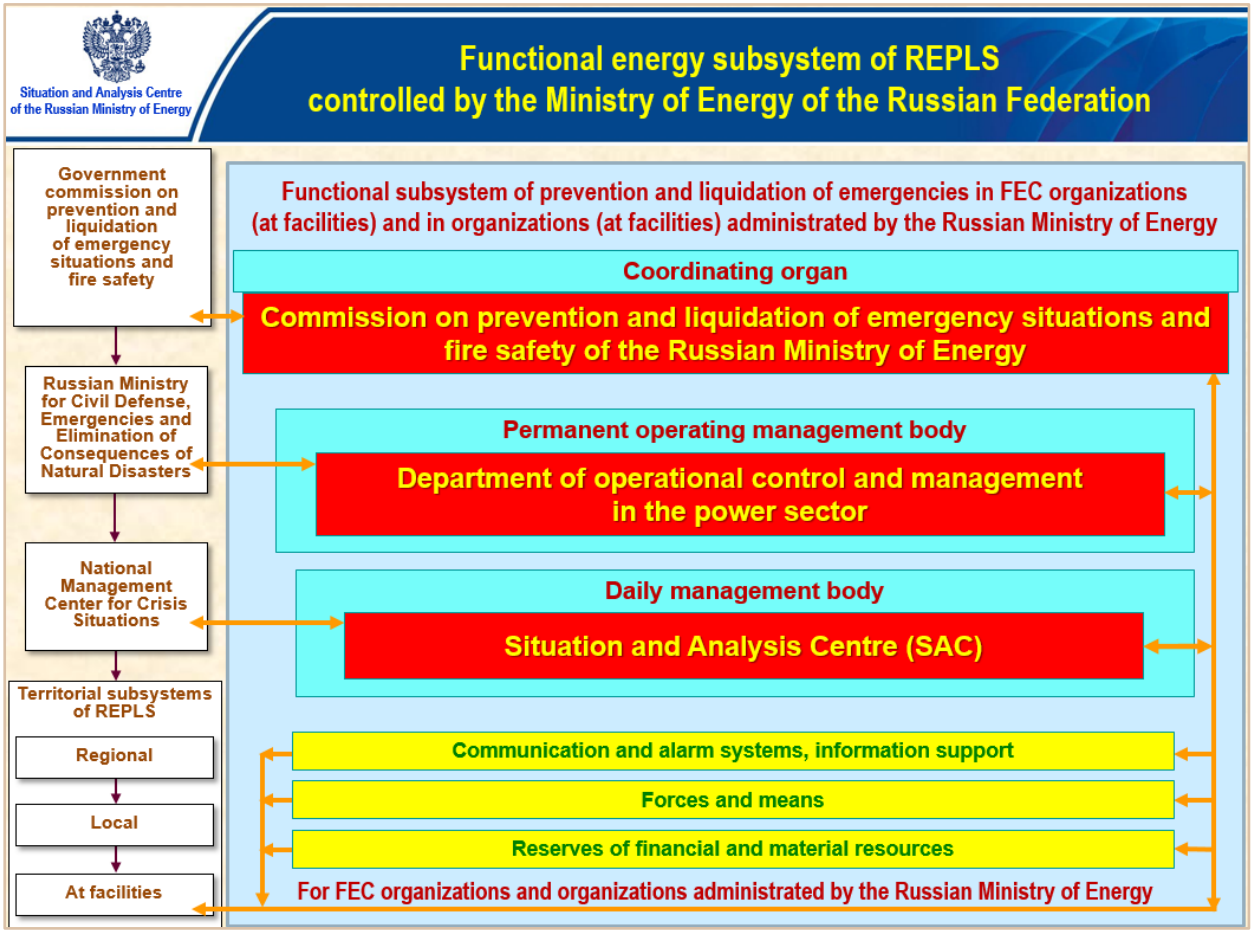
Source: Critical Infrastructure Resilience Strategy of the Australian Government, 2015. For more details, refer to these links:

www.aph.gov.au/DocumentStore.ashx?id=a58ed84e-67fe-42e2-8394-f9344db6d52d&subId=407872

http://www.aph.gov.au/DocumentStore.ashx?id=67a520ca-f666-4538-a360-eda8799ce751&subId=407872

Typical institutional structures include a coordinating national disaster reduction office with responsibilities for both disaster preparedness and response. These agencies often have decentralised branches at the state, province and community levels. At all these levels, planning and formulation of strategies, including contingency plans, risk mapping, and vulnerability assessment, will benefit from taking into account projected climate impacts, with particular focus on their intensity and frequency. (Asian Development Bank, 2012).

Another example of describing institutional coordination and its associated processes is the Russian United State System of Prevention and Liquidation of Emergency Situations (REPLS), as summarized in the following figure. More details of the REPLS are available in the presentation *Energy Emergency Response in Russia: Presentation, 52nd Energy Working Group Meeting, 19 October 2016, Moscow,* details of the presentation are in Annex 3.



■ Empower and Mobilize Local Communities

Building energy resiliency in off-grid areas is inherently community based and requires the active and sustained participation of local communities. For the purpose of these Guidelines, local communities would include local government units, electric cooperatives or associations, civil society organizations, and micro-enterprises. The role of local communities as first responders in the event of disasters and energy disruptions especially in remote areas must be emphasized. Key elements of community empowerment that are necessary for sustained mobilization would include:

- Provision or reinforcement of legal mandate to pursue energy resiliency activities;
- Provision of funds or facilitation of needed financing;
- Exemption from or streamlining of permitting requirements;
- Capacity building on technical skills and business management for key community leaders;
- Facilitation of community consultation and consensus building

There are many other ways to help empower a local community and the above are starting points and by no means all encompassing. As an example, Task Force Kapatid (brother or sister) in the Philippines exemplify cooperation among electric cooperatives and between electric cooperatives and communities (LGUs, households, businesses) in times of crisis. Task Force Kapatid, was launched in 2002 as the electricity sector's solution to the frequently occurring emergency situations. The task force is a volunteer service scheme where electric cooperatives group together to mobilize personnel and logistics to assist other cooperatives that need immediate relief and assistance in the rehabilitation of distribution lines in times of calamities. This is being done to expedite the restoration of power service to member-consumers and alleviate the plight of the rural population that are severely affected by calamities. Through this process, cooperation and solidarity of the 119 electric cooperatives in the economy is strengthened.

When the strongest Typhoon in recorded history hit the Philippines in November 2013, Task Force Kapatid immediately went into motion. In the aftermath of Typhoon Haiyan, the National Electrification Administration (NEA) and 34 electric cooperatives (ECs) in Luzon and Mindanao deployed 9 task force teams composed of 226 engineers and linemen to assist nine cooperatives in the Visayas region affected by the typhoon.

Figure 8. Task Force Kapatid of the Philippines National Electrification Administration at Work

The nine task force teams started to deploy on November 12 to Capiz, Iloilo, Aklan, Leyte, Biliran and Eastern Samar. Dispatched NEA engineers and EC technical staff conducted assessments in all areas. Power restoration and rehabilitation was supervised by NEA. NEA and the ECs rebuilt distribution lines simultaneously with the repair of the transmission lines in order to fast track power restoration. The electric cooperatives voluntarily offered their manpower assistance for the task force. Participating electric cooperatives use their own funds for their personnel and lend their

equipment for free to the affected cooperative. Local governments and national government agencies also mobilized calamity funds to augment the power restoration efforts. Local households helped in the clean-up and the provision of local materials while local civil society organizations facilitated relief goods and coordinated in community coordination and organizing.

SECTION 3: PROGRAMS AND PROJECTS

This section focuses on the physical aspects of energy facilities i.e. infrastructure, technology, civil works, and other associated components. It looks at the local environment of energy facilities covering specific conditions and measures that need to be addressed or implemented to build energy resiliency. Integral to the physical aspects of energy facilities, this section also touches on the functionality and usefulness of energy facilities to local communities.

In streamlining resiliency in energy programs and projects, the following are some of the key actions that can be considered:

- *Localize climate-energy models and hazard maps*
- *Map energy facilities, resources, and other critical structure*
- *Prepare energy contingency plans*
- *Integrate resilience in existing and new energy facilities*

■ Localize Climate-energy Models and Hazard Maps

Climate models, done at the global level, need to be systematically localized to better aid in planning and decision-making. There is a need for global climate models to be downscaled to national and local levels and then integrated with energy models. Directly supporting this process is an exercise in mapping out available climate data and identifying data gaps. It is important that good climate and energy data underpin preparations for energy resilience. Good data is necessary to make accurate climate models.

The following example presents a specific wind hazard assessment of Jeju Island in Korea. In other countries, a map can cover other hazards such as floods, landslides, drought and others, depending on the prevailing conditions of the locality. For more information, refer to the following link: http://www.iawe.org/Proceedings/7APCWE/M2B_6.pdf

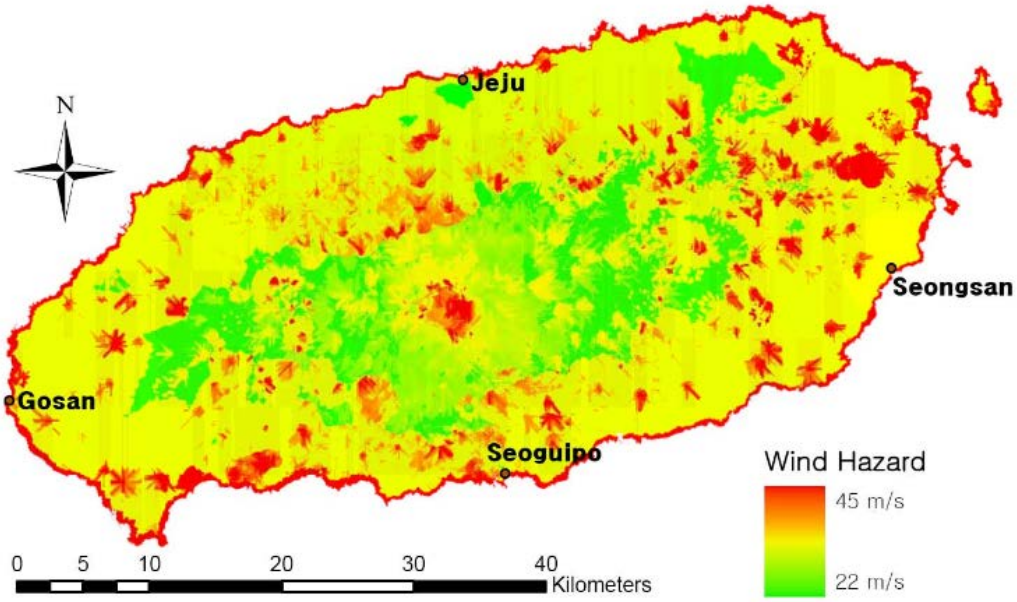


Figure 9. Wind Hazard Map for Jeju Island

Source: Asia Pacific Conference on Wind Engineering

CASE STUDY: QUANTIFYING VULNERABILITY TO CLIMATE CHANGE

This study by David Wheeler published by the Center for Global Development accounts climate change vulnerability by developing risk indicators for three critical problems: Increased weather-related disasters, sea level rise, and loss of agricultural productivity. The study applies these indicators to assessing cost-effective adaptation assistance.

The methodology is applied to assistance for adaptation to sea level rise by the 20 island states that are both small and poor and general assistance to all low-income countries for adaptation to extreme weather changes, sea-level rise, and agricultural productivity loss. For more information, follow this link: https://www.cgdev.org/files/1424759_file_Wheeler_Quantifying_Vulnerability_FINAL.pdf

■ Map Energy Facilities, Resources, and other Critical Structures

An important follow up step to localizing climate models and hazards maps is mapping out energy facilities, resources, and other critical structures such as airports, piers, hospitals, and government centres in relation to the hazards map. By doing this, infrastructure and resources that are most vulnerable to disasters can be identified. Maps showing various aspects of energy infrastructure including energy conversion sites, transmission and distribution pathways, and various energy reserves aim to provide critical and analytical information regarding an area's energy resiliency options and costs.

Resource mapping allows for a better insight on the location and distribution of energy resources and how climate change might affect them. One critical strategy leading to energy resiliency is independence from outside energy or fuel resources. If an area is abundant in wind, hydro or biomass resources – this is already one step in the right direction towards energy resiliency. For example, for hydropower, there is a need to look into hydrologic forecasting, and for biomass, there is a need to look into the availability of feedstock and how climate change events can affect the availability. An example of a biomass resource map for a small island is presented below:

Facility mapping also enables site selection for power facilities taking into account expected changes in wind speeds, storm surges, sea level rise, and flooding. The following illustration shows the proposed location of smart grid facilities in Jeju Island. With the use of both the wind hazards map above and the prospective facilities map, more resilient facility siting and design can be pursued.

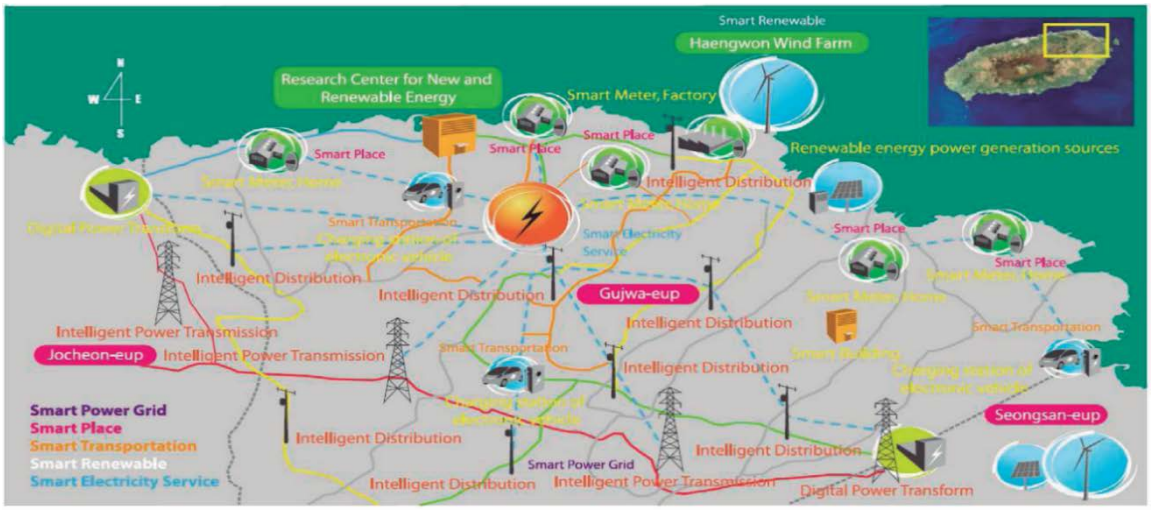


Figure 10. Proposed Location of Smart Grid Facilities in Jeju Island

Source: (Korea's Investment Promotion System, 2016)

SELECTED CLIMATE RESILIENCY PLANNING AND MAPPING TOOLS

Knowledge management in energy resiliency measures: GEF's Adaptation Learning Mechanism http://www.adaptationlearning.net/ - UNDP and USAID

International Institute for Sustainable Development: Community-based Risk Screening Tool—Adaptation and Livelihoods (CRiSTAL). www.iisd.org/pdf/2011/brochure_cristal_en.pdf

World Bank: Climate Change Knowledge portal including ADAPT tool. http://sdwebx.worldbank.org/climateportal

Science-based Risk Analysis: U.S. Climate Resilient Toolkit

Visualize Climate Data in Maps and Graphs: Climate Explorer (https://toolkit.climate.gov/)

Intergovernmental Panel on Climate Change (IPCC) Task Group on Data and Scenario Support for Impact and Climate Assessment. www.ipcc-data.org/guidelines/TGICA_guidance_sdciaa_v2_final.pdf

Opportunities and Risks of Climate Change and Disasters (ORCHID). Institute of Development Studies. www.ids.ac.uk/climatechange

Climate Information Portal (weADAPT). http://wikiadapt.org/index.php?title=The_Climate_Change_Explorer_ToolSERVIR

United States Agency for International Development. www.servir.net World Bank Climate Change Knowledge Portal. http://sdwebx.worldbank.org/climateportal/home.cfm?page=globlemap

The Data Distribution Centre of the IPCC. www.ipcc-data.org

■ Prepare Energy Contingency Plans

To make energy systems in off-grid areas resilient to extreme weather events, a dedicated energy emergency response team is needed at the local level. Ideally, skilled core personnel, materials, transportation, and a clear mandate need to be constantly available. Continuous capacity building for various scenarios and access to climate data and weather forecasts are necessary to enable the emergency team to act effectively. In energy contingency planning, local teams must have clear scenario options and must have the capability to decide whether to restore a minimum level of power for emergency purposes or immediately work on full restoration or in building back better. For example, building sturdier poles for distributions lines can avoid future damage but this will require time and substantial funding. In the meantime, hospitals and government facilities would immediately require power to respond to the emergency.

As an example, CLP Power Hong Kong conducts regular emergency typhoon drills in view of Hong Kong, China's vulnerability to perennial typhoons. Majority of its distribution and transmission lines are carried through overhead lines and are thus vulnerable to strong winds and landslides. It will

take weeks if not months to repair damage poles or transmission towers. Firstly, CLP Power has identified 151 high-risk pylons and 74 slopes needing reinforcement. Then it has introduced an emergency restoration system wherein temporary pylons can be rapidly constructed, allowing power restoration 10 times faster than by repairing the damaged pylons. CLP has also implemented a number of other measures to mitigate the impact of super-typhoons. These include installing smart switchgear on low-voltage overhead lines that can supply electricity directly to customers, installing flood alert systems in substations, and creating a typhoon response protocol and coordinating system. More specifically, CLP further pursues resiliency measures in its power generation as much as it does in its transmission and distribution, as described below:

Table 3. Energy Resiliency Measures Adopted by CLP Power Hong Kong

Power Generation	Transmission and Distribution
• Ability to quickly mobilize a large number of generators • Back-up generation capacity to respond to high peak loads • Distributed energy resources including mobile generators	• Sectional switches to accurately control feeder shutdowns and isolations • Decentralized systems to diversify customer options in case of outages • Back-up equipment such as transformers to achieve swift reconnection (see business case 2) • Distributed storage in buildings to provide emergency power and manage peak loads

For more information on this subject refer to its source at:
www.wbcsd.org/contentwbc/download/1415/18297

Another key example of proactive energy preparedness is the Russian United State System of Prevention and Liquidation of Emergency Situations (REPLS). Highlights of the REPLS are available in the presentation *Energy Emergency Response in Russia: Presentation, 52nd Energy Working Group Meeting, 19 October 2016, Moscow.* For details of the presentation, see Annex 3.

■ Integrate Resilience in Existing and New Energy Facilities

Resiliency has to be mainstreamed or built into energy projects for off-grid areas, from the design phase to implementation. The impacts of climate change and geologic events necessitate more stringent standards for both existing and new energy facilities, from generation to distribution. The following discussions and tables present different options that can be pursued to increase the resiliency of energy facilities in off-grid areas.

Generation facilities. The following table below lists potential resiliency measures in the generation facilities in off-grid areas:

Table 4. Energy Resiliency Measures in the Power Generation Sector

Climate Change Impact	Potential Resiliency Options
Hydropower	
Precipitation (including drought)	• Develop improved hydrological forecasting techniques and adaptive management operating rules • Develop basin-wide management strategies that take into account the full range of downstream environmental and human water uses • Restore and improve the management of upstream land including afforestation to reduce floods, erosion, silting and mudslides • Increase dam height and/or build small dams upstream (if flow is expected to increase) • Construct or augment water storage reservoirs • Modify spillway capacities and install controllable spillway gates to flush silted reservoirs • Modify number and type of turbines more suited o expected water flow rates • Modify canals or tunnels to handle expected changes in water flows • Optimize reservoirs management and improve energy output by adapting to changes in rainfall or river flow patterns
Extreme events (glacier melting, floods)	• Design more robust dams and infrastructure for heavier flooding extreme events • Design for increased flows from glacier melting
Higher air temperature, wind speeds	• Construct or augment water storage reservoirs
Wind Power	
Wind speed	• Design turbines able to operate with and withstand higher wind speeds, gusts, and direction changes • Install taller towers to capture stronger winds at higher altitudes • Choose sites that take into account expected wind speed changes during the lifetime of the turbines • Consider developing and commercializing vertical axis wind turbines (more output per m2 of land area; can operate in wider range of wind speeds)
Air temperature	• Consider effects of extreme temperatures on turbine and blade selection and operation
Storm surges	• Design stronger structures
Extreme events	• Design offshore turbines to withstand expected increases in wind-sea wave forces • Ensure presence of rapid emergency repair teams

Climate Change Impact	Potential Resiliency Options
Solar Photovoltaic Power	
Temperature increases	• Improve airflow beneath mounting structure to reduce heat gain and increase outputs • Specify heat-resistant PV cells and module components designed to withstand short peaks of very high temperature
Precipitation increases	• Select appropriate tilt panel angle to clean dust • Select module surface conducive to self-cleaning • Choose locations with lower probability of dust, grit, snow if practical
Wind speed; Turbidity	• Design structures to withstand higher winds • Assure free space (panel and mounting) so snow can slide off panel • In dry areas, consider panel rinsing system to remove dust and grit
Cloud cover	• Site photovoltaic systems where expected changes in cloud cover are relatively low • Consider micro-inverters for each panel (in place of small numbers of large centralized inverters) to improve stability and increase power output
Extreme events	• Specify stronger mounting structure • Specify cabling and components that can deal with high moisture content and flooding
Biomass Energy and Biofuels	
Floods/ precipitation	• Apply soil and nutrient management techniques • Improve water harvesting and use • Develop resilient ecosystems • Conduct research and development on flood resistant feedstock
Precipitation or temperature changes	• Expand rainwater harvesting, water storage and conservation techniques, water reuse, desalinations, water use and irrigation efficiency, adjustment of planting dates and crop varieties, crop relocation, and improved land management. • Use salt-tolerant plants (halophytes) or robust crops with high biological heat tolerance and water stress tolerance • Improve flood protection • Expand irrigation systems or improve efficiency of irrigation • Where water shortages are expected, consider air cooling • Conduct research and development on drought resistant feedstock
Extreme events	• Increase the robustness of biomass power plants • Use behavioural adaptation measures including early warning systems for rainfall and temperature anomalies, support for emergency harvesting for an imminent extreme event, and provision of crop insurance systems

Transmission and Distribution. Resiliency measures in transmission and distribution (T&D) include specifying redundancy in control systems, multiple T&D routes, relocation, and/or underground distribution for protection against wind, high temperatures, corrosion, and flooding. The following measures for each climate impact may be considered:

Table 5. Energy Resiliency Measure in the Power Transmission and Distribution Sectors

Climate Change Impact	Potential Resiliency Options
Transmission and Distribution	
Temperature increase	• Specify more effective cooling for substations and transformers • Specify certified information and communications technology (ICT) components that are resilient to higher temperatures and humidity
Precipitation and flooding	• Build a resilient high-capacity transmission system • Design flood protection measures for ground mounted equipment in substations • Protect masts, antennae, switch boxes, aerials, overhead wires, and cables from precipitation (water ingress, snow melt); snow (weight); unstable ground conditions (flooding, subsidence); and changes in humidity
High wind speeds	• Reinforce existing transmission and distribution (T&D) structures and build underground distribution systems when practical • Require higher design standards for distribution poles • Construct short spans of distribution lines (reduce pole distance)
Extreme events (flood, typhoons, drought)	• Change routes of overhead lines along roads away from trees, rigorously prune trees, use covered and/or insulated conductors, and use more underground cables, especially in wooded areas • Increase decentralized energy generation (with less grid requirements) • Allow increased rerouting during times of disruption • Include lightning protection (earth wires, spark gaps) in the distribution network • Design redundancy into information and communication technology (ICT) systems • Develop and use “smart transformers” and “smart grids.”

For more information on this topic, refer to the following link:
https://www.adb.org/sites/default/files/publication/29889/climate-risks-adaptation-power-sector.pdf

■ Ensure the Social and Productive Application of Local Energy Facilities

One of the key pillars of resilient energy systems is economic viability. Energy facilities need to be revenue generating, on a sustained basis, for it to sufficiently fund its own operation, maintenance, and repairs. It needs to at least cover its costs and at best generate extra income for upgrades and

expansion. In order to do this, off-grid energy facilities must be designed and implemented in a manner that they have clear and substantial added social or economic value.

Energy facilities that would have social value or services would include:

- School electrification for lighting, ventilation, multi-media educational equipment
- Power for health centres, birthing clinics, and vaccine refrigerators
- Potable water systems, sanitation systems
- Lighting public space, community centres, religious and cultural buildings

Economic or productive application would include:

- Tourism
- Irrigation
- Grain milling
- Fish drying
- Ice production
- Food processing
- Welding / machining

While fees from basic lighting and other household loads remain critical as a base revenue, the element of social and productive value makes energy facilities more critically important to communities since it magnifies the added value of electricity. More than just providing basic lighting or TV for entertainment, it saves lives when used in birthing centres or clinics. Beyond making ice for drinks, it increases household income with improved prices of crops that are milled, processed, or dried. With this higher level of productivity, sustainable business models can be built around local energy facilities. Financing modes that support the said project becomes more diverse as a range of funding mechanisms from grants to subsidies to venture capital become applicable depending on the social or productive nature of the energy facility.

In this regard, it is very important to underscore the role of public-private partnerships. The private sector, both as suppliers of technology i.e. energy producers or customers (specifically small and micro enterprises) i.e. energy consumers offer inherent capabilities that can effectively complement the resources of the government. Such capabilities include but are not limited to capital, technical expertise, technology, and business models. As such, especially in the case of developing energy projects for productive use, it is beneficial to involve the private sector as investors, operators, off-takers, or co-owners of the project.

Figure 11. Example of a Solar Water Pumping System

SECTION 4: FINANCING

Financing energy systems in off-grid areas is already a challenging task. In most cases, such projects are seen by financing institutions as high risk and non-viable, which is inherently true owing to the marginalized nature of such areas. This is aggravated by the general inability of proponents of off-grid energy systems to present a robust project viability case or argue for more patient capital (e.g. lower interest rates, longer tenures) and technical assistance. Due to this, mobilizing capital for off-grid energy projects remain to be very challenging despite the availability of funding from governments, private banks, and multi-lateral donor organizations.

There are various climate funds that can be mobilized to implement energy resiliency measures. The challenge lies in determining specific funding requirements and matching them with the best-fit funding sources, and ultimately accessing such funds.

The challenging nature of funding off-grid energy systems even become more difficulty when the element of resilience is introduced into the equation. Either for existing systems (retrofit) or new facilities (resilient designs), making the case for more capital for more resilient systems is a daunting task considering the nascent approaches to measuring and evaluating resilience and resiliency measures. It is in this regard that these guidelines aim to provide practical pointers in facilitating finance towards and into energy facilities in off-grid areas including its critical resiliency aspects.

■ Assess the Financing Needs of a Specific Energy Facility

The first important step is to determine the precise financing requirements of an off-grid energy facility. This can start with general questions that can screen the requirements and sieve it toward more granular specifications. For example, one can ask these questions:

- In what general area is resiliency being pursued – Policy? Institutional arrangements? Projects?
- If project financing is needed, in what segment of the energy chain is resiliency being strengthened – Generation? Transmission? Distribution? Consumption?
- Are the planned resiliency measures for existing systems? Or for incoming new facilities?
- What is the scale of the project? Will it be done in one implementation period? In phases?

Different responses to these questions and similar ones will yield different possibilities for financing. For policy and institutional arrangements for example, technical assistance funding can be sought from differing development agencies e.g. capacity building for local energy emergency task forces, localizing climate change data etc. For project financing - government funding, commercial loans, angel investments, public-private partnerships, and a host of soft to commercial loans can be explored.

This focusing process can also be done using, for example World Bank's adaptation funding lens wherein a proponent can ask:

- Is the initiative geared towards enhancing system resilience? If yes, is it for planning and operations? Or for system strengthening?
- Is the initiative geared towards rapid response and recover? If yes, is it for emergency response? Or for damage recovery?

Again, different responses would mean different financing instruments. Possibilities of appropriate instruments can include insurance-linked securities, insurance pools, and contingent loans.

For the purpose of making recommended approaches practical and useful, the Guidelines will focus on project financing. In this context, key concerns delve into the specific energy project and resiliency requirements. For example, if an island community aspires to 'underground' its overland micro-grid distribution lines in view of annual typhoons, how does it get funding for such an undertaking? Or if a remote upland community plans to construct a new micro-hydro powered corn milling facility, how does it get funding for the project, inclusive of watershed management activities in anticipation of both flash floods and drought?

At this stage, it is useful to go back to Section 3 (Programs and Projects) specifically in the part of integrating resilience in off-grid energy projects. From this guide, the following steps can be taken:

- Identify the energy facilities to be established or enhanced, defining the specific segments to be improved, installed, or constructed;
- Prepare the project feasibility study including financial analyses and financing requirement estimates;

- With the use of tools in recommended in Section 3 on climate data and hazards, and if available, with the assistance of government or private sector partners, assess and measure the risks being addressed;
- Identify, describe, and compare risk treatment options i.e. resiliency measures and propose the most cost-effective measure;
- Distinguish and estimate the financing needed for the resiliency measures

Again, it is important to note that these steps are recommendatory and serve as starting points only. Different communities will have different conditions and will require different tools and approaches. The critical elements in defining financing requirements for resilient energy systems are (a) a fully developed project feasibility, (b) a technically verifiable and globally accepted method of evaluating risk, and (c) a clear plan of addressing the risk/s backed by the financial resources needed.

■ Search for the Appropriate Financing Product or Modality

Once the specific financing requirements are identified, the next vital step is to find the appropriate financing package and mode. While there is a plethora of climate funding opportunities, they come in different scales, tenures, mechanisms, and priorities. The process of finding a financing product that fits the project being proposed is a distinctly significant undertaking in itself. It important to note that the discount rates i.e. cost of different financing products need to be considered in view of its impact to the overall cost and benefit of the project. An appropriate mix of different modes of financing need to be done to come up with the least cost financing solution. In this regard, a project proponent can consider looking into a number of financing windows, including but not limited to the following:

- Multilateral and bilateral climate funds;
- National funds;
- Loans from private banks and other financing institutions;
- Supplier credit;
- Venture capital and other investment modes;
- Public-private partnerships

The following list and cases serve as useful starting points for this process.

Table 6. List of Multilateral and Bilateral Climate Funds

Fund Name	Website
The Adaptation Fund	http://www.adaptation-fund.org/
The Least Developed Countries Fund	http://www.thegef.org/gef/LDCF
The Special Climate Change Fund	http://www.thegef.org/gef/SCCF
Pilot Program for Climate Resiliency	http://www.climateinvestmentfunds.org/
The Global Climate Change Alliance	http://www.gcca.eu/
Nordic Development Fund	http://www.ndf.fi/
International Climate Initiative	http://www.international-climate-initiative.com/
International Climate Fund	https://www.gov.uk/
The Green Climate Fund	http://news.gcfund.org/

Source: (United StatesAgency for International Development , 2015)

Local governments, private sector and nongovernment organizations can draw from national funds in implementing energy resiliency initiatives. An inventory of available funds nationally can be drawn up to make them more accessible to proponents of energy resiliency actions.

National development and commercial banks also play a fundamental role in financing energy resiliency initiatives. Awareness need to be raised among financial institutions in the risks of climate change, their effects on energy systems and potential resiliency actions, as well as the need for innovative financial approaches, especially given the constraints faced by many remote off-grid communities.

The challenge in financing energy resiliency in off-grid areas remains in managing risks. New financing schemes for energy resiliency include risk transfer and risk reduction, layered risk financing strategy i.e. low impact high frequency can be dealt with by energy utilities while high impact scenarios may use risk transfer instruments, insurance linked securities – World Bank CAT bond, insurance pools and contingent loans that can be accessed and used for recovery and response in a matter of 24 hours after a disaster hits.

Private and public financial institutions especially in the local level must be made aware of climate impacts. Their capacity must also be built in the assessment of resiliency actions in the energy sector.

■ Comply with Financing Requirements

The task of submitting all the requirements of even the simplest financing facility can be very time consuming and tedious. In view of this, it is important to have a clear plan to complete and responsible persons who will attend to compliance requirements. Different financing institutions would require different sets of documents and prerequisites, but it is prudent to prepare the following core documents and reports:

- Proponent's Profile
- Project Feasibility Study
- Risk Assessment

CASE STUDY: PEOPLE'S SURVIVAL FUND OF THE PHILIPPINES

The People's Survival Fund (PSF) is a special fund in the National Treasury of the Philippines that will finance climate change adaptation programs and projects. The fund may be accessed by local government units and community organizations. It will support initiatives such as vulnerability assessment and accounting of natural resources, conduct of planning and management of impacts relating to climate change, setting up of local centres and information networks. The one-billion peso fund in the PSF is programmed annually in the national budget and is administered by a board comprised of government officials as well as representatives from the civil society, academe, and business sector. The Climate Change Office provides secretariat support to the PSF board.

Source: (Climate Change Commission, n.d.)

- Audited Financial Statement
- Agreements with Partners
- Proof of Security or Collateral (if any and if needed)

It is important to coordinate with the financing institution when complying with the prescribed requirements in order to get guidance and insights on how to fulfil all the requirements. There are also development institutions who offer technical assistance and mentoring on how to comply with financing requirements and to make the project and the proponent more 'bankable'. Usually these assistance come as grants and significantly help in building the confidence of financing institutions.

SECTION 5: WATER - ENERGY NEXUS

Globally, the challenge of balancing water and energy is increasingly becoming critical, and this becomes even sharper in off-grid areas where resources are scarce. The use of water to produce energy (e.g. micro-hydro facilities) and the use of energy to extract or convey water (e.g. solar water pumps) are inextricably linked to each other and to a myriad of other activities such as agriculture, sanitation, and small industries. Balancing water and energy use in off-grid areas is essential to making energy facilities resilient and sustainable. It is anticipated that insufficient attention to this aspect of sustainability will eventually lead to project failure and even social conflict (as in the case of upstream water and land use versus downstream micro-hydro power use).

Balancing water and energy use in off-grid areas is essential to making energy facilities resilient and sustainable. Various tools are available to integrate water and energy use such as the Water Evaluation and Planning System discussed in this section.

There is a need to manage water, energy as well as food as a single system. As also discussed in previous sections, climate projections need to be down-scaled to local areas and their impact to hydro and biomass resources studied. Key steps in dealing with this nexus include an assessment of water-energy issues, balancing water and energy use and developing protocols in managing the two resources. For off-grid areas, overlap in these areas includes run-of-river hydro systems, biogas digesters, and agricultural production.

CASE STUDY: SMALL BUSINESS CLIMATE RESILIENCY FINANCING FACILITY

The Small Business Climate Resiliency Financing Facility is a project by the Climate Investment Funds of the World Bank Group in Tajikistan. It is an innovative financing facility to support the uptake of climate-resilient, water-efficient and energy-efficient technologies by small businesses, farmers and households. Specific technologies include small scale off-grid renewable energy generation and energy efficiency improvements in households.

Source: European Bank for Reconstruction and Development Small Business Climate Resiliency Financing Facility Project Document, 2014.

■ Conduct an Inventory of Water Use

First, it is important to define the general categories of water utilization. ***Green water*** refers to water in soil that comes directly from rainfall, and which is available to plants and supporting natural and agricultural ecosystems. ***Blue water*** refers to water in rivers, lakes or aquifers that is available for irrigation, potable water supply, sanitation, industries, and other uses. It is typically managed by means of water infrastructure. ***Grey water*** is refers to fresh water used to assimilate pollutants to meet water quality standards. It is water discharged to a freshwater resource directly through a pipe or indirectly through runoff or leaching from the soil, impervious surfaces, or other diffuse sources. These three general categories of water have different opportunity costs. Green water is only used by plants while blue water can be used by plants but can also be allocated to other uses and can often be re-used.

Consequently, there are different ways to manage the use of blue, green and grey water. In another related lens - ***Consumptive use*** refers to the use of water wherein a part of water withdrawn from a source is not returned but is instead evaporated or changed in state (e.g. pollution). Globally, the largest ecosystem that contributes to consumptive water use is agriculture. ***Non-consumptive water use*** refers to the use of water wherein majority if not all of the water used flows back to the source and there is no substantial change in the state of water. An example of this is the use of flowing water for run-of-river hydro power.

With these categories in view, a quick inventory of water use in an off-grid community can be done. As an example, the following table can serve as a starting point:

Table 7. Water use in off-grid communities

Water Source	Use		
	Domestic	Production	Energy
Rain water	drinking, washing		
Ground water	drinking, washing		
Spring water	drinking, washing	irrigation	
River	washing	irrigation	micro-hydro power

Using maps presented in earlier sections of these Guidelines, it would be useful to locate the sources of water and illustrate their position relative to settlements, farm lands, power facilities, community centres etc. In this manner, areas of water use conflict or complementation can be highlighted.

■ Identify Water and Energy Use Intersections

Taking off from the inventory of water use, the next critical step is to focus on intersections for and energy use. In the example above, it is described that the water from a river in a particular village is used in multiple ways, namely for irrigation, sanitation, and power generation. Depending on the scale of water use, the location and position of facilities, farms, and homes relative to each other, and the frequency and timing of water use, the degree of water use conflict or complementation can be determined. For example, water use conflict is likely to precipitate in a scenario wherein unsustainable farming causing erosion and flash floods is being done upstream of a run-of-river

micro hydro power plant. Enforcing strict land use practices upstream for the sake of sustaining the power plant might not be acceptable or feasible to the farmers upstream.

Other examples of water and energy intersections are:

- Run of river water for micro-hydro power
- Irrigation for biofuel crops
- Harvesting of biomass for bio-gasification
- Water extraction, conveyance, or purification using diesel or renewable energy generators

Focusing on the specific water-energy intersection in a given off-grid community will further define issues that need to be addressed. This leads to the formulation of strategies or even protocols to balance the use of water and energy in a given community.

■ Define Strategies to Balance Water and Energy Use

Finally, it is important to define strategies or protocols to balance water and energy use. At the minimum, this process enables the community to describe and appreciate the water use conflict better and be on the same mind set when confronting the issue. At best, this process can result to effective resource management where all concerned parties continue to benefit sustainably from the local ecosystem. For example, the following strategies can be considered in conflicts arising from the multiple use of water from a river or stream:

Table 8. Strategies in Managing Uses of Water from a River/Stream

Water Source	Intersection or Conflict	Possible Strategies for Balanced Use
River	Unsustainable farming upstream variably causing erosion, floods, and drought consequently reducing the capacity of a micro-hydro power plant downstream	o Conduct community mapping and consultative land use planning o Apply agroforestry and pursue alternative livelihood projects o Enact local ordinances to enforce the land use plan agreed upon
	Diversion of water to irrigate a plantation of wood feedstock for a gasifier reduces water available for washing and irrigating food crops	o Conduct community consultations and build consensus on community priorities o Identify, gather, and process alternative feedstock sources o Enact a local ordinance to enact the priorities and measures agreed upon

This rapid process can also be done to assess water – energy issues affecting other water sources such as ground water and springs. It is important to keep in mind that on the other hand, the use of energy to produce or convey water can also be a point of conflict as the use of energy can also be needed for equally critical purposes (e.g. medical services or telecommunications) which might not have any alternative source of power.

CASE STUDY: WATER-ENERGY NEXUS

Adaptation plans for energy and water are closely linked and should be integrated. Climate change affects the supply of both water and energy. Also, the production and consumption of one resource cannot be achieved without the other. Several efforts exist dealing with this issue. One of them is the Water Evaluation and Planning System developed by the Stockholm Environment Institute's (SEI) U.S. Center. WEAP is a software tool that takes an integrated approach to water resources planning and can be linked to energy models.

WEAP models the demand side of the equation --water use patterns, equipment efficiencies, re-use, prices, hydropower energy demand, and allocation—and the supply side --streamflow, groundwater, reservoirs and water transfers – to assist the planner and policy-maker in examining alternative water development and management strategies.

WEAP takes account of multiple and competing uses of water systems and has the ability to link with SEI's energy and climate mitigation planning software, LEAP or the Long-range Energy Alternatives Planning Software, for an integrated analysis of water-energy trade-offs.

The newly integrated WEAP and LEAP systems were used to explore issues and trade-offs of desalination in California. The study was able to quantify the impact on water imports, electricity demand from the water sector, and greenhouse-gas emissions. The WEAP model shows that desalination could reduce the need for water imports by about 300 million cubic meters per year. However, integration of climate projections shows significant variations between dry and wet years, and LEAP shows desalination increases the water sector's electricity use by about 3 terawatt-hours per year, and emissions, by 1.4 million tonnes of CO_2e per year, by 2049. For more details, refer to this link: http://wef-conference.gwsp.org/fileadmin/documents_news/understanding_the_nexus.pdf

Source: (Stockholm Environment Institute, 2016)

SECTION 6: THE ROLE OF WOMEN IN ENERGY RESILIENCE

Women, especially in developing countries and off-grid areas, are often more exposed to the impacts of climate change and disasters. Nevertheless, women are also the ones who lead efforts in relief and recovery and initiatives on developing resilience in many dimensions -- including energy -- at the community level. Women confront a number of long standing issues that need to be addressed in order to make local energy facilities more sustainable.

■ Recognize Energy Related Issues that Affect Women

It is important to establish the reason why specific attention needs to be given to the situation of women regarding energy development in off-grid areas. In such places that are already marginalized at the outset, women in most cases bear the brunt of poverty, absence of services, and lack of opportunities for gainful employment. The specific issues that confront women in relation to energy poverty are the following:

- *Lack of access to energy services and greater burden shouldered by women and girls*. Persistent gender division of labor, particularly in rural areas, places on women and girls a disproportionate burden of fuel and water collection and their use for cooking. Not only does this take away hours that could have been spent on studies or productive livelihood or seeing to the family welfare; it also exposes women and girls to potential dangers as they trek to and from the fuel and water source;

- *Pollution and health issues*. The use of fuelwood and biomass has been identified as a cause of air pollution in households. Smoke emission can pose health hazards in the form of respiratory ailments, to which women and girls are more prone, since they often do the cooking. In addition, the care of sick family members usually falls on the women;

- *Lack of knowledge or appreciation of the risks involved in available energy products and services*. Fuel products repacked into smaller, affordable portions (sachet) has been extended to gasoline, diesel, kerosene, and other energy products. This practice is dangerous and raises safety and health concerns to the vendors, mostly women and children, and the buyers or users, many of them women who use fuel for cooking. Improper storage of these products can also cause fire and put children's health at risk. Similar safety problems have been noted relative to substandard liquefied petroleum gas (LPG);

- *Gender-differentiated effects of poor and unreliable quality of power supply (prolonged outages or shortages)*. Production and employment effects may differ between women and men, depending on how reliant their factories or workplaces are on commercially distributed electric power. Women's home-based microenterprises are particularly vulnerable to poor quality of power supply. On a different vein, poorly lighted streets and prolonged outages may pose more danger to women and girls in the form of sexual attacks;

- *Invisibility of women, as a group, in public consultations about energy issues*. Levels of energy tariffs affect different households, depending on their level of income. When female-headed households are disproportionately represented in poor communities, tariff levels may not reflect the women's earning capacity. This element and other gender-related energy concerns of women may not be covered when women are excluded from public consultations that are called to assess the communities' willingness to pay or to discuss schemes for making energy more affordable;

- *Possibly limited influence of women on decisions about energy-related investments*. Although women in many households exert considerable influence, studies have indicated that, relative to major expenditures, the decision often rests on the male household head. These expenditures could include "the types of fuels used, the amount of energy purchased, the devices and technology chosen, as well as domestic infrastructure related to ventilation, lighting priorities, energy-based equipment purchased" (ADB 2012, 2). Beyond the household, women's limited representation in energy decision-making processes might mean low priority for issues that affect them, such as clean and efficient cooking energy and street lighting that could improve their safety and mobility;

■ Conduct Pre-Project Design Gender Analysis

It is important to take into account gender concerns even before designing a project or embarking on energy resiliency initiatives, either retrofit or new activities. In this manner, a gender lens can

consistently be observed while shaping the project and bringing it to reality. A proponent of an off-grid project or an energy resiliency strengthening initiative can start with the following questions:

Gender Roles

• How do female/male members in the household or community use a particular energy source or product (electricity, solar, biogas/biomass, gasoline, kerosene, fuelwood)? What risks do women, men, girls, and boys face as they use a particular energy product?

• What problems do women/men or girls/boys encounter in the supply of particular energy products in connection with their household roles, enterprises, or other activities?

• Have women/men availed themselves of services from their electric utility or fuel supplier? Why or why not?

• Is there any troubleshooter (electrician, maintenance service, others) to attend to emergency situations? Are they women or men?

• Who in the household is most concerned with energy conservation? Who implements energy conservation measures in the household? Why them and not others?

• What energy conservation measures do female/male household members know? Practice?
Are there differences in their knowledge or practices? What are these? How did the differences come about?

Access to Resources

• Who usually gets access to information and training opportunities, women or men? Why them? Who decides on who will attend energy-related (energy efficiency and conservation, renewable energy, energy exploration in the area) information dissemination and training activities?

• What access do women/men have to job opportunities available or created in the electricity/oil/coal/renewable energy/other energy subsectors? What factors influence the recruitment/hiring, task assignment, or promotion of women/men in a particular subsector?

• What needs of female/male members of communities can be addressed by information and training in energy conservation, safety, and similar issues?

Participation in Project or Community Activities and Decision Making

• How do female/male household members participate in information, education and communication campaigns, consultations about energy exploration/development in their areas, renewable energy campaigns and installations, and the like?

• What inhibits or prevents female/male household members from participating in specific energy-sector programs or projects at the national/local/community level? What inhibits or

prevents female/male household members from taking on leadership or decision-making roles in energy-sector programs or projects at the national/local/community level?

• What promotes or supports female/male household members' participation in energy-sector program or project activities at the national/local/community level?

■ Conduct Gender Analysis for Energy Resiliency Related Actions

Even for existing or new project that did not go through a gender analysis during or before the design stage, it is very important to do such an analysis during the implementation or operations stage in order to increase the sustainability of the project. Taking into account gender considerations even for existing projects enables project proponents or managers to rethink how energy facilities are being utilized and managed. A number of studies has indicated that, (especially in off-grid areas), the involvement of women in the ownership and management of local energy projects increases community buy-in, financial viability, and technical robustness. In doing gender analysis for existing or new facilities, a proponent can start with the following questions:

Baseline

- What fuels are used for lighting and other power-related activities in the household/ community?
- What livelihood opportunities are present in the area?
- Are women provided with appropriate information on various options and choices of fuel to provide energy services in the household?
- Who decides on fuel choices/electrification options?
- Are women consulted in decision making on fuel choices and possible fuel switching?
- In the choice of electrification option, do women have access to financing support or credit facilities?

Gender Analysis for New Projects

- What are the current livelihood activities of women/men that utilize electricity?
- What are the current activities of girls/boys that require electricity?

Analysis of the Gender Impact of an Ongoing RE Project

- What new enterprises have been created by the introduction of RE sources? Did these include new enterprises for women/men? What are these?
- How have the new enterprises changed the role of women/men in the household? In the community?
- Operation and maintenance of the system: Who has received training? Who has access to the additional income from operation and maintenance activities? Why them?
- Community organizing: Who get to be members of the group organized under the project? Why?
- Who are elected as leaders? What positions do female leaders hold? Male leaders? Why these positions?
- What additional activities do boys have after the introduction of RE sources? What additional activities do girls have? Why the differences?

Assessment of Benefits of Existing Projects

- Who benefits most from the power sector projects? Why them and not others?
- How do these benefits affect women's condition in the area?
- What are the measures/processes employed to quantify these benefits?
- Are there additional benefits derived from the projects that are not included in the projected benefits?
- Are there women involved in the project? What are their roles/responsibilities? What is their level of participation?

The above stated questions have been directly quoted from the Gender Toolkit for the Energy Sector prepared by the Philippine Department of Energy. The said toolkit is a comprehensive guide to gender analysis and programming geared towards the entire energy sector, including oil, gas, coal, and renewable energy. The toolkit, like the many other references and cases studies, is being made available as complementary tools to the Guidelines. For the full copy of the Gender Toolkit, see Annex 8.

CASE STUDY: UNDERTAKING GENDER-SENSITIVE VULNERABILITY ASSESSMENTS

A good practice in engaging communities including women in improving off-grid energy resiliency is a participatory vulnerability assessment of energy resources and use. This involves deduction of availability of energy resources to the community and use of energy by women and men. Climate change impacts, exposure of energy infrastructure and the community's resiliency need to be studied in this assessment. For example, villages where SHS are common and women and men are capable of dismounting them to protect them from rising winds are more resilient to an extreme event than villages where only men can dismount the systems.

Source: Integrating Gender in Climate Change Adaptation Proposals, Asia Pacific Adaptation network.

REFERENCES

APEC. (2016). *APEC Disaster Risk Reduction Framework*. Retrieved 7 August, 2016, from APEC Meeting Papers: http://www.apec.org/Meeting-Papers/Annual-Ministerial-Meetings/Annual/2015/2015_amm/annexa.aspx

Asian Development Bank. (2012). *Climate Risk and Adaptation in the Electric Power Sector.* Mandaluyong: Asian Development Bank.

Climate Change Commission. (n.d.). *Climate Change Commission*. Retrieved from People's Survival Fund: Home: http://www.psf.climate.gov.ph/

Ebinger, J., & Vergara, W. (2011). *Climate Impacts on Energy Systems.* Washington: The World Bank.

European Geosciences Union. (2016). *Natural Hazards and Earth Systems Sciences*. Retrieved 7 August, 2016, from http://www.nat-hazards-earth-syst-sci.net/

International Energy Agency. (2013). The Forum on the Climate Change-Energy Nexus. *The Forum on the Climate Change-Energy Nexus Summary Report.* International Energy Agency.

International Energy Agency. (2014). 5th Forum on the Climate-Energy Security Nexus: Policies and Practices to Enhance Energy. *5th Forum on the Climate-Energy Security Nexus: Policies and Practices to Enhance Energy.* Paris: International Energy Agency.

International Energy Agency. (2015). *Making the Energy Sector More Resilient to Climate Change.* Paris: International Energy Agency.

Johnson, T. (2016). *NJSpotlight*. Retrieved 7 August, 2016, from http://www.njspotlight.com/stories/16/06/14/pseg-power-breaks-ground-on-natural-gas-fired-plant-in-sewaren/

Kenderdine, M. (2 June, 2015). *DOE Launches the "Partnership for Energy Sector Climate Resilience" with 17 Electric Utilities*. Retrieved from United States Department of Energy: http://energy.gov/epsa/articles/doe-launches-partnership-energy-sector-climate-resilience-17-electric-utilities

Korea's Investment Promotion System. (2016). *Invest Korea*. Retrieved 7 August, 2016, from Asia Pacific Conference on Wind Engineering

Natural Resources Canada. (2015). *Energy Policy Context and Market Characterization for the Development of a Northern Communities Energy Technology Intervention Strategy.* Varennes: Natural Resources Canada.

Organisation for Economic Cooperation and Development. (2009). *Integrating Climate Change Adaptation into Development Cooperation.* Organisation for Economic Cooperation and Development.

Powering Agriculture. (2016). Retrieved 7 August, 2016, from http://poweringag.org/

Shtilkind, T. (2016). Energy Emergency Response in Russia: Presentation, 52nd Energy Working Group Meeting, 19 October 2016, Moscow.

Stockholm Environment Institute. (2016). *Water Evaluation and Planning*. Retrieved from http://www.weap21.org/: http://www.weap21.org/

U.S. National Oceanic and Atmospheric Administration. (6 July, 2016). *Building Resilience in Energy Supply and Use*. Retrieved from U.S. Climate Resilience Toolkit: https://toolkit.climate.gov/topics/energy-supply-and-use/building-resilience-energy-supply-and-use

UNESCAP. (2015). *Overview of Natural Disasters and Their Impacts in Asia and the Pacific, 1970-2014.*

United States Agency for International Development . (2015). *A Quick Guide to Climate Change Adaptation Funds.* USAID Adapt Asia-Pacific.

United States Agency for International Development (2016). *Department of Energy Gender Toolkit for the Energy Sector*. USAID COMPETE, Philippines.

Wheeler, D. (2011). *Quantifying Vulnerability to Climate Change: Implications for Adaptation Assistance.* Washington: Center for Global Development.