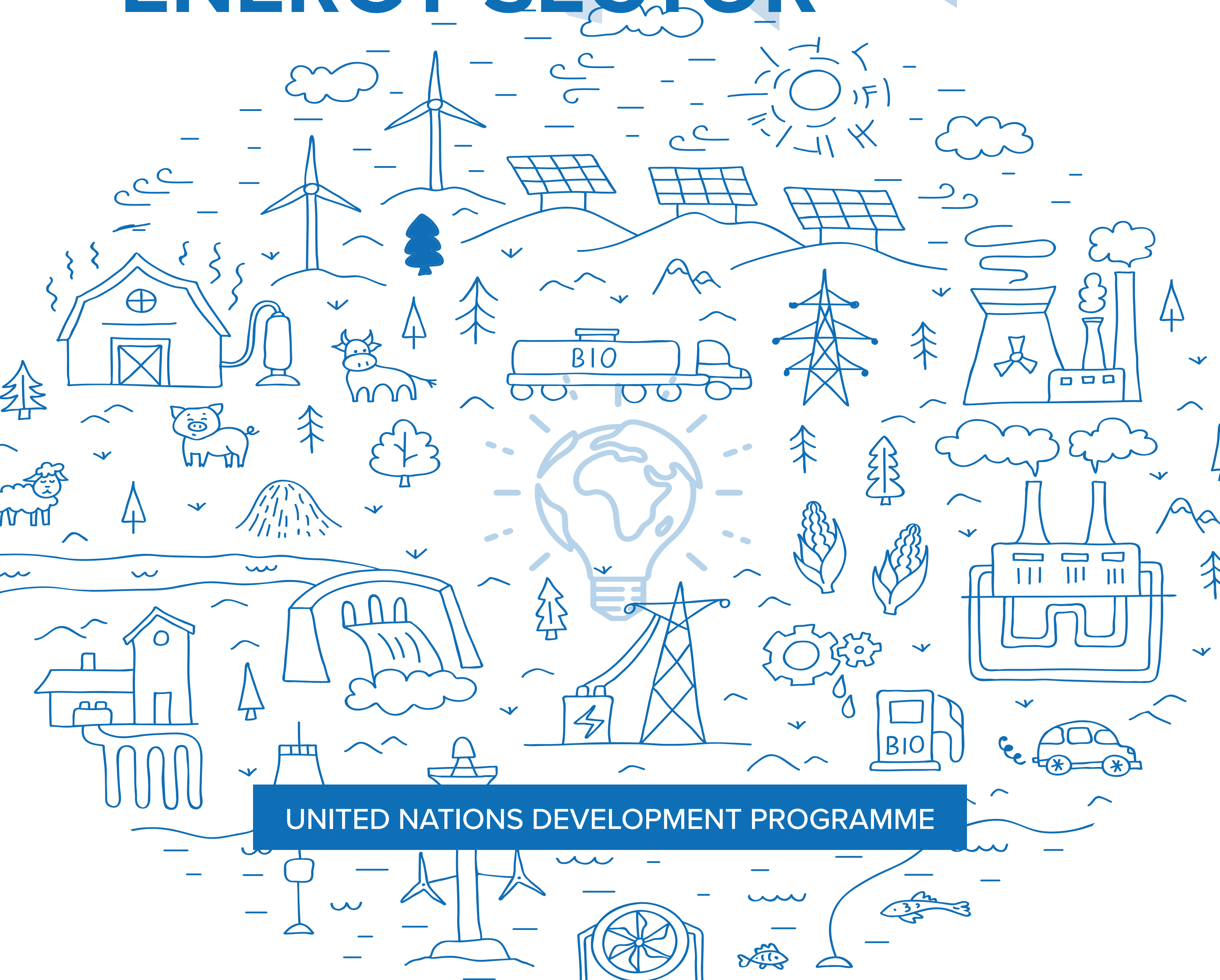
DISASTER RECOVERY FRAMEWORK GUIDE FOR THE ENERGY SECTOR



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Acknowledgements

The Energy Disaster Recovery Framework Guide was commissioned by the United Nations Development Programme (UNDP) in partnership with the UNDP Sustainable Energy Hub. It is intended to assist senior national and local government advisors/senior-level planners, relevant private sector leaders, intergovernmental organizations and implementing partners to execute effective and efficient energy-focused recovery programmes.

The Guide emphasizes that recovery programming focusing on the energy sector can play a critical role in poverty reduction and achieving the Sustainable Development Goals, and ensuring that affected people maintain their living standards, working conditions, environment and health during and after disasters, and build resilience over time. Mitigating risk exposure and strengthening the resilience of energy systems is the best way to protect the most vulnerable, beat back poverty, and promote shared and sustained growth.

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UNDP would like to thank the European Union for supporting the publication of this document through the "Strengthening Capacities for Post-Disaster Needs Assessment and Recovery Planning PDNA Roll Out III Project".

Design & Layout:

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1.1 Context

1.1.1 Increased frequency and impact of disaster events

Between 2000 and 2019, 7,348 natural-hazard related disaster events were recorded worldwide by EM-DAT.[1] In total, these disasters claimed approximately 1.23 million lives, an average of 60,000 per year, and affected over 4 billion people (individuals affected by more than one disaster, who are particularly vulnerable, can be counted more than once). In addition, disasters led to approximately US$ 2.97 trillion in economic losses[2] worldwide in the same period. These numbers represent a sharp increase of the number of recorded disaster events compared to the previous twenty years. Between 1980 and 1999, EM-DAT recorded 4,212 disasters linked to natural hazards worldwide, which claimed approximately 1.19 million lives and affected over 3 billion people. Economic losses totalled $1.63 trillion. While better recording and reporting may partly explain some of the increase in events, much of it is due to a significant rise in the number of climate-related disasters.[3]

The increasing frequency of climate-related disasters can also be seen in the number of disaster events in 2021, as compared to the average number of annual disaster events for the period 2001-2020.

1.1.2 Impacts of disasters on the energy sector

The cost of power infrastructure disruptions is complex, including the impact on consumers (both households and firms), and damage to power infrastructure caused by disasters. The proportion of the power outages in one territory caused by natural hazards can vary anywhere between 0 and 100 percent, though most country-level estimates fall in a range between 10 and 70 percent. Between 2000 and 2017, 74 and 37 percent of the total recorded outage duration of power outages in the United States and the European countries under consideration, respectively were attributed to natural hazards.

Evidence shows that natural hazards, particularly storms, are the most frequent cause of electricity supply disruptions in the United States, and a major cause in Europe. In developing countries, fragile energy systems are vulnerable to various shocks, not only natural hazards. For example, in Bangladesh, natural hazards account for a smaller proportion of power outages, as system failures due to other factors are so frequent that energy users experience daily outages. In Chittagong, a major coastal city in Bangladesh, storms cause only 4 percent of all outages. In Dhaka, an average of two outages due to non-natural hazard reasons are reported per day throughout the year.[4]

Electricity outages in developing countries cause capacity utilization annual losses to firms of $32 billion, and annual sales losses of $82 billion. In addition, firms in developing countries are forced to spend an additional $65 billion a year on self-generation of electricity to cope with outages.[5]

For households, the impact of power outages is significant: they can affect cooling and heating (which may have health implications), economic activity and income generation, children's educational, social and leisure activities,

1 EM-DAT | The international disasters database (emdat.be).
2 All economic figures are adjusted to inflation for US$ 2019.
3 Climate-related disasters include disasters categorized as meteorological, climatological, or hydrological.
4 Stronger Power: Improving Power Sector Resilience to Natural Hazards, Lifelines: the Resilient Infrastructure Opportunity, World Bank, 2019, World Bank Document.
5 Stronger Power.

and regular household tasks, such as cooking and cleaning. The cost of power outages to households in low- and middle-income countries could be anywhere between $2.3 billion and $190 billion a year.[6]

In addition to the impact on consumers, disaster damages to power infrastructure and the resulting losses can weigh heavily on government balance sheets. For example, after Hurricane Irma restoring the grid in Florida took weeks, required more than 16,000 workers, and cost around $1.3 billion. despite the $3 billion that had been invested over the previous 10 years to improve the resilience of the Floridian electricity grid.[7] In countries with less advanced power systems, power grid and generation facilities are often even more vulnerable.

In the context of developing countries, the availability of accessible, renewable and affordable energy is a pre-requisite to achieving many of the Sustainable Development Goals (SDGs).[8] Furthermore, in fragile countries the lack of electricity services reflects the inability of the state to provide basic services in an inclusive and reliable manner, according to transparent criteria. In turn, this reduces trust between the state and society, and tears away at the social contract between citizens and communities on the one hand and the state on the other hand. All of this increases state fragility, increases the potential for conflict and contributes to the drivers of violent extremism.[9]

1.2 Purpose of this Guide

In this context of increasing disaster events and impacts, UNDP and other United Nations agencies, the World Bank, and the European Union (EU) have been developing a set of guidelines to help countries assess the impact of disasters and recover from their effects. In particular, the following seminal guides have already been developed:

- Post Disaster Needs Assessments (PDNA), Volume A Guidelines,[10] which sets out the detailed methodology for the assessment.
- Post Disaster Needs Assessments, Volume B Guidelines,[11] which sets out the detailed methodology for sectoral assessments.
- Disaster Recovery Framework Guide,[12] which sets out the detailed methodology for implementing a recovery strategy.

The main purpose of this document is to provide an action-oriented guide to assist national and local governments, relevant private sector partners, inter-governmental organizations and implementing partners to develop a Disaster Risk Framework (DRF) for the Energy Sector comprising sector-focused effective and efficient recovery programmes.

The scope of the energy sector in these guidelines is very wide, covering energy from fossil fuels and renewable energy sources (such as solar energy, wind power, hydroelectric power, thermal energy and bioenergy), and including all other aspects of energy for heating, pumping water, cooling, cooking, and so on. Only nuclear power

6 Stronger Power.
7 Stronger Power.
8 Prolonged and widespread power outages have major consequences for people's health and well-being: they impede access to refrigeration for food and medicine, as well as the ability of firms to provide people with goods, services, jobs, and incomes. [Stronger Power]
9 Impact of the Oil Crisis and COVID-19 on Iraq's Fragility, UNDP Iraq, 2020.
10 Post Disaster Needs Assessments, Volume A Guidelines, European Union, United Nations and World Bank, 2013, https://www.gfdrr.org/recovery-hub.
11 Post Disaster Needs Assessments, Volume B Guidelines, European Union, United Nations and World Bank,2013, https://www.gfdrr.org/recovery-hub.
12 Disaster Recovery Framework Guide, Revised Version, European Union, United Nations and World Bank, March 2020, Disaster Recovery Framework Guide | GFDRR.

plants are excluded, as assessing damage to a nuclear plant itself maybe the domain of a specialized agency and a government may have security restrictions.

1.3 Energy sector within the PDNA and links with this Sectoral DRF Guide

The energy sector is addressed by the infrastructure PDNA,[13] where reference is made to energy generation, distribution, and supply lines. Furthermore, the guidance calls for the identification of the short-, medium- and long-term recovery needs required for the various dimensions of recovery. as summarized in Table 1.

Table 1 *Main recovery needs for the energy sector*

	Short Term	Medium Term	Long Term
Reconstruction of infrastructure and physical assets			
Resumption of service delivery and access to goods and services			
Restoration of governance and social processes			
Risk reduction and building back better			
Restoration of human development (e.g. as measured by indicators of the Human Development Index)			

Source: Human Cost of Disasters: An overview of the last 20 years, 2000-2019, Centre for Research on the Epidemiology of Disasters (CRED), United Nations Office for Disaster Risk Reduction (UNDRR), 2020, The human cost of disasters: an overview of the last 20 years (2000-2019) | UNDRR.

The Energy Sector PDNA[14] provides sector-specific examples and discussions on the disaster impacts on the above five dimensions of recovery. Furthermore, it identifies important gender considerations in the recovery needs for the energy sector, including the need for a gender breakdown of the labour force – whether skilled or not – as essential components of the baseline information to be gathered at the start of the assessment, together with information on wages and salaries. Once the estimated production losses for the energy sector have been calculated, separate estimates are to be made of the number of jobs temporarily or permanently lost due to the disaster for both men and women, together with how their personal incomes may have declined.

This Guide provides a discussion and recommendations on recovery policy, institutional arrangements, financial mechanisms and implementation details necessary for each of the above five recovery dimensions.

13 Post Disaster Needs Assessments, Volume A Guidelines.
14 Post Disaster Needs Assessments, Volume B Guidelines.

1.4 Relationship between the energy sector disaster recovery framework and energy sector resilience building programmes

Resilience is defined as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.[15] The energy sector is considered part of the national critical infrastructure, defined as the physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society.

In most countries, the power system is designed to cope with high-frequency but relatively low-impact events. Low-frequency, high-impact events – such as most natural hazards – are rarely considered fully, and the implementation of planned management measures is often patchy. As climate change is likely to increase the frequency and intensity of this type of events, improving the resilience of the power sector to natural hazards is becoming essential for economic well-being and quality of life. This is particularly the case for developing countries with a lack of disaster risk management capacities, ageing and poorly maintained assets, and poorly designed networks without adequate levels of redundancy.[16]

For many developing countries, spending on power makes up a high share of gross domestic product (GDP). Between 2018 and 2030, it is estimated that developing countries are spending between $45 billion and $58 billion a year on new power infrastructure. With maintenance and variable costs, total spending could reach approximately $88 billion to $118 billion per year. Hence, natural hazards and climate change are critical factors that must be accounted for, given the large investments that will take place in the power sector in the next decades.[17]

In this context, recovery should thus be seen as one aspect of building resilience for the energy sector, and this should be complemented by other aspects, as discussed in Section 2 on Preparedness.

1.5 Vulnerability of components of the energy sector

1.5.1 Vulnerability of components of the energy sector to various hazards

The main components of the energy sector can be summarized as follows:[18]

- **Thermal generation** (oil, coal, gas, and diesel generators): these are generally quite robust, yet they can sustain damages during cyclones and earthquakes if not designed to sufficiently high standards.
- **Hydropower generation:** this is mostly vulnerable to droughts, as the streamflow it requires to function cannot be maintained with low water availability. While droughts can affect service continuity, they usually do not have lasting impacts on infrastructure. Earthquakes and floods are the two hazards that do threaten the plant integrity.

15 Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction, United Nations General Assembly, Seventy First Session, Agenda Item 19 (c), A/71/644, 2016, Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology relating to Disaster Risk Reduction : (un.org).

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- **Solar photovoltaic** (PV) generation facilities: these can operate at almost any size, from a single panel to large utility-scale plants, and are mainly vulnerable to high winds that can damage the panels and to hailstorms. Earthquakes can also affect solar farms, particularly if the attachment of the PV panels to the support structure is not properly designed.

- **Wind turbines:** these are vulnerable to earthquakes and cyclones. In the case of earthquakes, wind turbines are particularly vulnerable to the vertical, rather than horizontal, component of ground motion acceleration.

- **Power grid:** transmission and distribution infrastructure, where network failures are responsible for most outages. Transmission infrastructure is usually more robust than distribution infrastructure, and hence more resilient to natural hazards (therefore underground distribution is recommended). Tower-based transmission systems typically consist of truss or lattice designs that support the conductors, while distribution systems are based on poles, often wooden ones. Transmission lines are vulnerable to many natural hazards, including wildfires, high winds, freezing rain, heavy snow, earth movement (liquefaction, earthquakes and landslides) or even extreme heat. In very high temperatures, sagging of the lines has also been observed, sometimes leading to failures.

- **Power grid:** substations are highly vulnerable to floods, earthquakes, and cyclones. If their components are not properly anchored, earthquakes can cause substantial damage to substations. Tall components of electrical substations (such as disconnect switches) are susceptible to damage from wind, while floods can damage expensive components and lead to extensive service interruption. Extreme heat events can affect transformer performance, but they do not cause long-lasting damage.

Figure 1 presents a summary of the above vulnerabilities, and emphasizes the importance of multi-hazard design for assets to avoid physical damage or service interruptions. Transmission infrastructure is also dependent on other infrastructure for its recovery; for instance transportation is necessary as equipment, materials, and repair crews must be brought to each site for repair. As a result, the time required to restore the lines is usually the main reason for the lag in recovery time.

Figure 1 *Summary of the vulnerability of the energy sector components*

Type	Earthquake	Cyclone	Flood	Tsunami	Wildfire	Drought	Extreme Heat
Thermal plants	High	High	Medium	High		High	Medium
Hydropower plants	High	Low	Medium	Low		High	Medium
Solar (PV)	Low	High	Medium	Medium		Medium	Very low
Wind	High	Medium	Low	Medium		Very low	Very low
T&D lines	Medium	High	Low	Medium	High	Medium	Medium
Substations	High	High	High	Medium	High	Low	Medium

Source: Stronger Power: Improving Power Sector Resilience to Natural Hazards, Lifelines: the Resilient Infrastructure Opportunity, World Bank, 2019, World Bank Document.

Ageing equipment, lack of maintenance, rapid expansion of the grid, and insufficient generation capacity are all factors that reduce the reliability of services under normal operating conditions, and increase the system's vulnerability to natural hazards. The higher vulnerability of power systems in developing countries means that low-intensity high-frequency events have large, disruptive impacts, disproportionately affecting more vulnerable population groups including female-headed households and those living in remote rural areas, informal settlements and internal displacement camps.

1.5.2 Impacts of climate change on the exposure and vulnerability of the energy sector

Several climate change–induced phenomena are likely to increase power sector vulnerability. With increased drought frequency and higher temperatures, the efficiency of thermal power plants is likely to decrease. Extreme weather events could disrupt infrastructure, affecting the delivery of electricity; higher temperatures may also result in greater transmission losses because of the increased resistance of power lines.

Climate change will also affect flood frequency and hydrological outputs by changing not only river flow and evaporation, but also the frequency of erratic river flow, which affects dam safety.

Climate change is likely to increase temperatures but decrease solar radiation, which in turn will decrease the potential of solar energy, with the efficiency of photovoltaic modules potentially dropping by about 0.5 percent for every 1°C increase in temperature.

Finally, climate change–induced sea level rises may necessitate power plant relocation, and lead to increased flooding of coastal assets, combined with higher wind speeds and greater corrosion of these assets due to saltwater sprays.[19]

1.5.3 Effects of climate change on stranded assets

Stranded assets are defined as assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities.[20] Environment-related risks that can cause asset stranding include:[21]

- Environmental challenges (such as climate change and natural capital degradation).
- Changing resource landscapes (such as shale gas abundance or phosphate scarcity).
- New government regulations (such as carbon pricing and air pollution regulation).
- Falling costs of clean technology (such as solar PV, onshore wind and electric vehicles).
- Evolving social norms (such as fossil fuel divestment campaigns) and consumer behaviour (such as certification schemes)
- Litigation (such as carbon liability) and changing statutory interpretations (such as fiduciary duty and disclosure requirements)

Falling clean technology costs and physical environmental change are identified as the factors most likely to strand assets in the future.[22]

19 Stronger Power.
20 Stranded Assets in Agriculture: Protecting Value from Environment-Related Risks, Caldecott, B., N. Howarth, and P. McSharry, Smith School of Enterprise and the Environment University of Oxford, 2013.
21 Stranded Assets: A Climate Risk Challenge, Inter-American Development Bank, 2016.
22 Stranded Assets: A Climate Risk Challenge.

2. Preparedness

2.1 Introduction to sectoral resilience building programmes and principles

Although the main focus of this Guide is to guide the reader to develop an Energy Sector DRF after a disaster has occurred and a needs assessment has been conducted, this section emphasizes the need for preparedness before a disaster occurs, because it will greatly facilitate the development of recovery frameworks and resilient recovery. The practical steps for developing an energy sector DRF begin in section 3, but this section helps the reader to assess the needs and modalities of preparedness. Having these elements set in place will help both the PDNA and the DRF tasks. A set of Principles for Resilient Infrastructure have been developed to assist with raising awareness and creating a common understanding for building infrastructure resilience.[23] These principles are summarized in Table 2, together with key activities to achieve each principle and the envisaged resilience capability arising from implementing the key activities. As part of the preparedness efforts, the degree to which each of these principles is adhered to should be assessed, and plans should be developed to implement key resilience building activities prior to any disaster.

Table 2 *Principles for resilient infrastructure*

Principle	Key activities	Resilience capability
Adaptive transformation	P1.1 Design safe-to-fail infrastructure	Absorb failures
	P1.2 Create adaptive capacity	Resist and absorb failures; Adapt to failures; Enhance recovery process
	P1.3 Develop dynamic structures	Adapt to failures; Enhance recovery process
	P 1.4 Enable extensibility	Adapt to failures; Absorb failures
	P 1.5 Allow for human discretion	Resist failures; Adapt to failures; Enhance recovery process
	P 1.6 Adopt appropriate level of complexity	Adapt, transform, and recover more easily
Environmental integration	P2.1 Use nature-based solutions	Resist in the face of risk of disasters with a natural hazard origin; Absorb effects of disasters with a natural hazard origin; Accommodate the natural environment
	P2.2 Integrate ecosystem information	Prevent the risk of disasters with a natural hazard origin; Adapt to natural environment conditions
	P2.3 Minimize environmental harm	Prevent the risk of disasters with a natural hazard origin
	P2.4 Maintain the natural environment	Prevent disruptions caused by disasters with a natural hazard origin

23 Principles for Resilient Infrastructure, UNDRR, 2022, Principles for resilient infrastructure | UNDRR.

Principle	Key activities	Resilience capability
Protection by design	P3.1 Raise essential safety requirements	Prevent disruption from all disasters
	P3.2 Exceed component level requirements	Prevent disruption from all disasters
	P3.3 Consider complex interdependencies of connected networks	Absorb failures
	P3.4 Embed emergency management	Resist and absorb failures
	P3.5 Use local sustainable resources	Resist failures
	P3.6 Design for multiple scales	Enhance recovery process
	P3.7 Commit to maintenance	Adapt to all disasters
Social engagement	P4.1 Inform people about disruptions	Prevent unmanageable loads of usage; Avoid risks associated with lower supplies in emergency situations
	P4.2 Raise resilience literacy	Support transformation to apply more technical advancements necessary for being more resilient
	P4.3 Incentivize demand behaviour	Prevent unabsorbable high loads of usage; Resist abrupt failures by manageable level of usage
	P4.4 Aid community participation	Prevent man-made interruptions; Enhance recovery process through public participation
Shared responsibility	P5.1 Harmonize open standards	Resilience for whole lifecycle
	P5.2 Cultivate collaborative management	Prevent failure; Enhance recovery process
	P5.3 Establish shared responsibilities	Support transformation to data-based approaches to be more resilient; Prevent failure; Enhance recovery process
	P5.4 Enhance connectivity for information sharing	
	P5.5 Assure data safety to develop trust	Support transformation to data-based approaches to be more resilient
	P5.6 Share risk and return information	Prevent failure
Continuous learning	P6.1 Expose and validate assump-tions	Prevent all risks
	P6.2 Monitor and intervene appro-priately	
	P6.3 Analyse, learn, and formulate improvements	
	P6.4 Stress test	

Source: Principles for Resilient Infrastructure, UNDRR, 2022, Principles for resilient infrastructure | UNDRR.

2.1.2 Compliance with minimum standards and best practices

Increasing the resilience of infrastructure networks requires direction of efforts towards enhancing the resistance and reliability of each of the components of the network. National codes for the design of lifelines (such as the US American Society of Civil Engineers (ASCE) Code on Design[24]) traditionally focus on component strength considerations against different hazards. More recently, standards now also include considerations for building the redundancy of the network as a whole. These standards also require preparedness efforts to ensure effective and efficient response and recovery frameworks and plans. One such example is the United States Federal Emergency Management Agency (FEMA) National Infrastructure Protection Plan (NIPP).[25] Other important standards also exist at regional level (such as the Association of South-East Asian Nations (ASEAN), the EU, and Latin America and the Caribbean), national level (in, for example, Japanese, New Zealand and Chile) and through international agencies (such as the World Bank, the Global Facility for Disaster Reduction and Recovery (GFDRR) and the United Nations Office for Disaster Risk Reduction (UNDRR)). When referring to Table 2 above, it should be recognized that most of these would fall under the third principle: "Protection by design".

In addition to adhering to the above minimum standards, it is also important to be informed by best practices and guidelines that help to promote the remaining five principles of infrastructure resilience referred to in Table 2. These best practices are referred to throughout the body of the document as applicable, while a succinct list is provided in Section 7.

2.2 Introduction to energy sector resilience building programmes and principles

In addition to abiding by the above principles for building resilience in critical national infrastructure, strategies for building resilience in the energy sector should also include the following steps (which are preferably carried out before a disaster to expedite and facilitate feeding into them as part of the recovery process):[26]

- Enhance data and information generation and sharing.
- Enhance demand-side energy efficiency.
- Enhance the robustness of the components of the infrastructure by hardening it and improving its design.
- Enhance network flexibility and adaptability to ensure that the system will be able to react as smoothly as possible when disasters strike.
- Enhance emergency preparedness to minimize the consequences of natural hazards.
- Comply with international and national standards and best practice guidelines for building the resilience of the energy sector.

24 Minimum Design Loads and Other Criteria for Buildings and Other Structures, 2022, Minimum Design Loads and Associated Criteria for Buildings and Other Structures (7-22) (asce.org)

25 NIPP, FEMA, 2013, National Infrastructure Protection Plan (NIPP) 2013: Partnering for Critical Infrastructure Security and Resilience (cisa.gov)

26 Stronger Power. World Bank Document. The enhancement of resilience to disasters and climate change in the Caribbean through the modernization of the energy sector, Studies and Enhancement Series No. 84, United Nations ECLAC Sub-regional headquarters for the Caribbean, 2020.

2.2.1 Enhancing data and information collation for renewable energy

Data and quality information are required to guide decision making, to monitor and verify future scenarios and to carry out resilience building programmes that can then inform and link to recovery efforts. Inadequate or insufficient baseline data could hinder efforts to make reliable assessments, identify and reduce risks, build resilience, and assess the effects and impacts of disasters on energy infrastructure, ecosystems and populations. Data and information gaps in energy, climate change and disaster risk management (DRM) are a challenge in many countries in the world. Specific energy-related data gaps include:[27]

- Lack of widespread understanding, awareness and communication on renewable energy (RE) cost-effectiveness, posing a significant barrier to their adoption.
- Lack of availability of RE assessments and technology feasibility studies, where although various countries have conducted initial assessments of resource potential for several technologies, detailed resource studies are required for implementing specific projects. Where detailed resource assessments have not been conducted, they should be carried out, and where assessments have been conducted they should be made publicly available and easily accessible. Compiling all completed assessments in a central location, open to all energy stakeholders, would facilitate knowledge sharing and avoid duplication of efforts.
- Higher-resolution assessments for priority geographic locations are not conducted and/or shared. National-level assessments provide a valuable overview of available resources and indicate promising areas for deployment of specific technologies. However, for project development, assessments must be conducted with higher specificity. Priority areas for more detailed assessments include those with the best resources, near population centres.
- Analysis is not conducted and/or communicated of opportunities for resource complementarity in integrated energy planning. Many opportunities exist to deploy certain RE technologies in tandem, taking advantage of seasonal and diurnal variations to overcome some of the challenges typically posed by the variability of renewable resources. Assessments of complementary potential will facilitate smarter and more integrated energy planning and will indicate opportunities for the most efficient and cost-effective RE deployment.

The above energy-sector data gaps are exacerbated by gaps in: i) maps with geo-referenced infrastructure; ii) energy sector statistics (see Section on baseline data); and iii) sufficiently refined hazard, exposure and vulnerability maps.

2.2.2 Improving the proportion of renewables in the energy mix portfolio

Decision makers should carry out the following critical actions to increase the deployment of RE: i) strengthen the policy commitment to RE and mobilize funding; ii) build institutional, technical, and human capacity to support RE deployment across institutions and actors; and iii) harness the crosscutting impact of RE on sustainable development by encouraging local and regional engagement, and international cooperation on RE capacity development and deployment. A climate-change-responsive energy policy, and energy roadmap, that incorporates use of RE and incentivises energy efficiency would: i) reduce risk in isolated communities; ii) reduce national expenditure on fossil fuels and greenhouse gas emissions; iii) increase resilience in health, water, and production; and iv) enhance energy access and economic development.[28]

27 The enhancement of resilience.

28 The enhancement of resilience.

Main actions to encourage the deployment of renewables

- De-monopolize grid access and encourage generation by independent power producers (IPPs) through i) facilitating dialogue among key stakeholders (such as policymakers, utilities and users) to identify an action plan for enacting reform; ii) establishing consistent and clear guidelines and rules of engagement to allow full incorporation of IPPs; and iii) establishing independent regulatory bodies to design and enforce priority initiatives, policies, projects, and activities.
- Incentivize renewable generation through regulatory reform by: i) developing policy mixes according to international and regional best practices; ii) developing model legislation; iii) identifying and implementing support policies (such as feed-in tariffs, adopting production tax credit, establishing net metering/net billing, utilizing auctions/tendering, and developing dedicated rural electrification programmes focused on renewable power); iv) identifying and implementing policy mechanisms specifically targeting areas and populations with limited access to electricity; v) creating renewable portfolio standards (RPS) to promote RE resources by mandating electricity supply companies to source a proportion of supplied energy from renewable energy; and vi) developing an evolutionary approach to regulation for changing the generation landscape from existing assets to more intelligent and distributed approaches.
- **More specifically in developing countries**, the key challenge of funding the transition towards a low carbon energy system is to address existing investor risks that affect the financing costs and competitiveness of renewable energy. The task of addressing these investor risks led to the development of two groups of public de-risking measures:[29]
  - Policy de-risking instruments seeking to remove the underlying barriers that are the root causes of risks. These instruments include, for example, support for renewable energy policy design, institutional capacity building, resource assessments, grid connection and management, and skills development for local operations and maintenance (O&M).
  - Financial de-risking instruments that seek to transfer the risks that investors face to public actors, such as development banks. These instruments can include, for example, loan guarantees, political risk insurance (PRI) and public equity co-investments.

2.2.3 Enhancing demand-side energy efficiency

Recovery efforts based on infrastructure resilience principles, and build back better (BBB) principles, cannot rely exclusively on the incorporation of RE. Demand-side energy efficiency (EE) and other energy saving measures are crucial, as they are the most cost-effective and fastest way to lessen the environmental and socioeconomic costs associated with energy systems. Demand-side EE is achieved when less energy is used to deliver the same service, or when the same amount of energy delivers more services. This concept is relevant in the context of climate change challenges in two ways: (i) the less energy used, the fewer emissions produced; and (ii) cost-effective EE achieves environmental benefits at low cost, and thus could reduce the economic costs of achieving climate change policy goals. Unlike incorporating RE technologies or modernizing the grid, EE improvements are convenient because they are often the cheapest and fastest ways to reduce the costs associated with energy systems. The merit of demand-side EE also resides in its compounding effect.[30]

29 Derisking Renewable Energy Investment, UNDP, 2013 Derisking Renewable Energy Investment | United Nations Development Programme.

30 When a user demands one less unit of energy because of EE measures, the system saves much more than that unit of energy because related losses during generation, transmission and distribution are avoided. [The enhancement of resilience.]

Saving $36 billion worth of electricity without turning the lights off[31]

According to the Inter-American Development Bank (IADB), there were two ways for Latin America and the Caribbean to generate the required 143,000 GWh of electricity in 2018: one option that included investments in energy efficiency, would cost around $16 billion; the other, without reliance on improved EE, would cost $53 billion. The study emphasized the concept of energy intensity[32] as a measure of the EE of a nation's economy. The factors identified that can influence an economy's overall energy intensity include: i) climate; ii) structure of sectoral energy consumption; and ii) the technology used by predominant industries.

Country	Energy Intensity index	Estimated Savings (kWh of electricity/ year for 10% EE improvement by 2018)	EE investment required (by 2018)	Construction of a 250 MW gas fired open cycle power plant
Barbados	1.08	130 GWh	US$ 15 million	US$ 49 million = 0.3 of a power plant
Guyana	8.7	105 GWh	US$ 12 million	US$ 39 million = 0.2 of a power plant
Jamaica	3.55	1000 GWh	US$ 116 million	US$ 373 million = 2 power plants
Trinidad and Tobago	5.73	980 GWh	US$ 116 million	US$ 373 million = 2 power plants

2.2.4 Enhancing the robustness of energy sector components (hardening)

Years of underinvestment and poor maintenance are exacerbating the vulnerability of the energy infrastructure to natural hazards. It is better to assess – and where necessary improve – the robustness of the components before a natural hazard occurs in order to reduce outage times and the impact on other sectors in society.

Maintenance is equally important. For generation plants, maintenance encompasses inspecting the state of the asset visually, cleaning debris and obstructions, periodically servicing standby generators, painting metal surfaces to prevent corrosion and replacing rotting wooden distribution poles. For the power grid, tree contact with power lines is a leading cause of outages, including the August 2003 blackout that affected 50 million people in the northeast United States and parts of Canada.[33]

Building the resilience of the Puerto Rico energy infrastructure[34]

Hurricane Irma, a Category 5 storm, made landfall in Puerto Rico on 6 September 2017. It was followed by Hurricane Maria on 20 September, a Category 4 storm with wind speeds of over 250 km/h. The consecutive storms caused catastrophic damage to the electrical grid, with power outages to 90 percent of the island. Much of Puerto Rico's electricity is generated at power plants on the southern coast, while the largest population centres are in the north, with 2,400 miles of transmission and 30,000 miles of distribution lines in the island's forested, central mountain range. Poor maintenance and vegetation management, coupled with high winds, led to severe damage, and approximately 101 transmission line segments, 636 poles, and 673 conductors/ insulators were damaged by the storm.

31 The enhancement of resilience.
32 Energy intensity is mostly calculated as units of energy per unit of GDP.
33 Stronger Power.
34 Stronger Power.

Generating facilities were promptly repaired; however, none of these facilities were able to connect to the grid for several months because of the state of the grid and because the operator feared that the grid would not be able to deal with renewable energy variability. Small amounts of solar and hydropower were able to reconnect to the transmission system in late 2017, but the first wind farm did not reconnect until February 2018. Puerto Rico's second largest solar and wind farms, both badly damaged, did not come back in service until 2019.

Results show that the cost of BBB, when compared to baseline estimates, can vary widely. For example, hardening the transmission grid (lines, poles, circuits) has relatively low incremental costs (around 10 percent) while hardening the distribution system (replacing wood poles with tubular steel poles) has much higher incremental costs (around 100 percent). In Puerto Rico, upgrading transmission and distribution infrastructure to withstand Category 3 hurricanes would increase costs by 3-40 percent, while upgrading to withstand Category 4 hurricanes (210-250 km/h sustained wind speeds) would increase costs by 24–70 percent.

As part of the recovery process and Building Back Better, Puerto Rico committed to meeting its electricity needs with 100 percent renewable energy by 2050 – while realizing interim goals of 40 percent by 2025 and 60 percent by 2040 – phasing out coal-fired generation by 2028, and improving energy efficiency by 30 percent by 2040, as established in Puerto Rico Energy Public Policy Act (Act 17).[35] To meet these goals and support widespread end-use electrification, Puerto Rico is exploring renewable energy and other generation technologies for energy storage, distributed generation, distribution control, electric vehicles, and energy efficient and responsive loads that can be deployed in each of Puerto Rico's cities and communities.

Pre-disaster and post-disaster investments to enhance resilience[36]

Measures to harden infrastructure depend on the type of hazard that most threatens a country's grid.

For instance, Tonga, which is highly exposed to cyclones, began to upgrade its grid by replacing its low-voltage overhead network with aerial-bundled conductors (ABCs), installing underground service cables to customer premises, and installing new smart meters. The project was undertaken for its technical benefits (to reduce losses and outages) as well as to improve resilience to hazards. An estimated 54 percent of the network had been upgraded when Tropical Cyclone Gita made landfall in Tongatapu in February 2018. The cyclone damaged 45.9 percent of the parts of the power grid that had not been upgraded, compared to only 4.7 percent of the upgraded segments of the grid.

One straightforward way to improve power system performance during floods is to elevate solar panels, or to locate plants or substations in an elevated area that will not be flooded – and, when possible, far enough from the coastline to avoid coastal flooding. For existing plants that cannot be moved, elevating critical components is an option (particularly for substations), as is building dykes or flood protection walls. In the Tonga Ha'apai Islands, for example, following Tropical Cyclone Ian in 2014, the government decided to move transformers above the maximum possible sea-flood level. Similarly, following Hurricane Sandy in 2012, operators installed flood walls and flood doors, and raised one substation control room above storm-surge levels. Installing flood monitoring devices to notify operators during a flood event can also help mitigate the inundation. Finally, diesel generators are particularly vulnerable to floods, so the primary recommendation to make them more resilient is to avoid the usual practice of storing them in basements. Keeping the fuel stored next to generators should also mitigate the second vulnerability of these generators: the supply chain issue.

35 Puerto Rico Energy Public Policy Act, 2019.

36 Stronger Power.

Building the resilience of the power sector to cyclones – the case of Odisha[37]

Bhubaneswar, the million-resident capital city of Odisha state in India, is prone to cyclones, which result in severe damage to critical infrastructure. Both Cyclone Phailin (2013), and Cyclone Fani (2019) damaged critical infrastructure including the power supply in the capital city, thereby interrupting the functioning of government offices, the state legislative offices, the airport, police stations, hospitals and education services.

The power supply to Bhubaneswar and its adjacent region was reliant on two stations, 26 km away from the city, with 400kV and 220kV air insulated substations (AIS). Two overhead double circuit lines connecting the two grids were the only supply lines to the city. In response to the cyclones' damage, the state government embarked on a process to set up a more resilient network through various schemes.

The government of Odisha strengthened the transmission and distribution (T&D) system through various schemes at a cost of almost $700 million over a period of five years. These schemes included the ODSSP (Odisha Distribution System Strengthening Project), SCRIPS (State Capital Region Improvement of Power System), and DRPS (Disaster Resilient Power System). Bhubaneswar now has two 400kV sources which feed into different 220kV grids in a ring system down the line. Three 132kV circuits have been converted from aluminium conductor steel reinforced (ACSR) panther conductors to high-tension low sag (HTLS) conductors.

The debilitating impact of cyclones proved beyond doubt the importance of building the resilience of power systems. The estimated annual cost to India between 2011 and 2030 of achieving universal access to power by 2030 is $3 billion, with a cumulative cost of $62 billion. With such large sums at stake, it is crucial that the power infrastructure be made resilient to disaster and climate risk. Odisha has taken crucial steps to make the power sector resilient, demonstrating that political will, combined with strong technical capacities and resources, make it possible to safeguard and build disaster resilient infrastructure.

The ODSSP scheme was introduced to improve the distribution system by augmenting the existing network with new 33/11kV substations and lines. In this scheme, twelve 33/11kV gas insulated substations (GIS) have been constructed exclusively in Bhubaneswar city, along with 33kV and 11kV connectivity in underground (UG) cable line and overhead lines in H-type poles. Additionally, seven 33/11kV GIS substations are under construction in SCRIPS scheme in Bhubaneswar city. These GIS substations with UG cable connectivity are completely cyclone proof and more resilient than an AIS substation. The T&D system has also been designed and constructed in a ring network at different voltage levels and connected with multiple supplies using a SCRIPS Transmission Scheme. Bulk consumers are given power supply through an UG cabling system. Alternate power supply has been provided for critical establishments such as the main hospital, key government offices, the airport, the railway station, the water pumping station and so on. A dedicated source has been arranged with multiple supplies for all critical services.

With all these improvements, the power supply in Bhubaneswar city is more resilient to future cyclones. Furthermore, the restoration process has become much easier due to implementation of a Supervisory Control and Data Acquisition (SCADA) system. All stakeholders also follow the standard operating procedures (SOPs) during pre-cyclone preparedness, response and post-cyclone restoration and recovery. In addition to these improvements, the state government has a plan in place to increase transition from its current 14 percent reliance on renewable energy to a holistic energy transition plan which will encompass almost all forms of energy consumption, including energy consuming sectors like agriculture, transport and industry, as well as the power sector. Going forward, Odisha aims to meet 43 percent of its total electricity requirements by 2030 through renewable energy, and to have 4 percent storage capacity to manage grid stability and intermittency issues.

37 Power Sector Resilience Study, Coalition for Resilient Infrastructure, 2021.

The government of Odisha is also working in partnership with the Coalition of Disaster Resilient Infrastructure (CDRI) to enhance the resilience of power infrastructure in the state under the three main components: 1) "Disaster preparedness and management"; 2) "Risk mapping and improvement of infrastructure"; and 3) "Institutional capacity and financing for resilience". These components provide a framework to "build back better" and will upgrade the power infrastructure to make it cyclone resilient.

Using the above type of classical criticality analysis, the impact of a large shock that would affect more than two elements of the network is not accounted for. Furthermore, data on the full distribution of possible events is not available. Therefore, more robust investment is needed in changes to improve the resilience of the network to a wide range of random events.

2.2.5 Enhancing the network flexibility and diversification (system effects)

Criticality analysis can highlight opportunities to increase resilience through redundancy. However, this does not necessarily mean doubling or tripling key components of the network or undergrounding the lines. A more effective approach is usually to create meshed networks that provide multiple supply points to various nodes in the grid. A meshed network reduces exposure to outages along corridors and provides the ability to quickly switch loads between feeders or supply points. This approach is increasingly being used for traditionally star shaped distribution networks that are now becoming as meshed as most transmission networks.[38]

Distributed energy resources (DERs) are another option to diversify and increase the grid flexibility. DERs increase resilience through embedded generation, microgrids, and mobile generating units by supporting load without the grid.

Role of distributed energy resources during Hurricane Sandy[39]

The 2010–2011 earthquakes in New Zealand highlighted the value of targeted pre-emptive investment in infrastructure. Estimates show that the $6 million spent to harden transmission and distribution infrastructure resulted in a $30-50 million reduction in direct asset replacement costs.

The Co-Op City microgrid in New York is one of the largest residential end-use customer microgrids in the world (40 MW serving 50,000 inhabitants and businesses on 330 acres). Though the configuration within the Co-op City complex makes it a campus/institutional microgrid, it offers resilience to its host residents, businesses, and beyond. It successfully isolated during Superstorm Sandy throughout local power outages using SCADA-based microgrid controls platform, and was able to export 10,700 MWh to the grid. Distributed generation enables more islanding mechanisms, as generation is located closer to the load, feeding directly into the distribution network and often bypassing the transmission grid.

DERs usually include renewable generation, diesel generators, back-up power sources (such as small natural gas turbines) and batteries. Until recently, DER installation, and particularly renewable installation, has been driven by consumers and by environmental concerns; only recently has resilience become another driver of its development. If well planned, DERs can help the network operator not only increase system resilience, but also in some cases relieve congestion and avoid the construction of additional transmission infrastructure.

2.2.6 Smart grids and innovations

New technologies that improve power sector resilience are continuing to emerge. Smart grids, advanced metering infrastructure, automation, drones, and remote sensing are all being employed to help improve reliability and

38 Stronger Power.

39 Beyond the Buzzwords: Making the Specific Case for Community Resilience Microgrids, Strahl J., Bebrin M., Paris E. and Jones D., 2016.

mitigate the risks of natural hazards. For example, smart grids and advanced metering infrastructure improve situational awareness; facilitate rapid restoration of service; and enable the operationalization of meshed distribution networks, DERs, and adaptive islanding.[40]

Modular system design is another innovation that entails standardized approaches to initial sizing of the electricity generation, storage, distribution, and control components, while already planning for step-by-step system enlargements. This can reduce initial investment costs, particularly across a portfolio of mini-grid sites, and also facilitates easily enlargement of the system size over time as demand grows (productive use), which is key to a virtuous cycle of achieving financial viability. It also introduces redundancy and independence, thereby enhancing network resilience.[41]

A private sector long-term approach to building resilience[42]

Orion is one of the largest electricity distribution companies in New Zealand, providing power in remote rural areas, regional towns, and the city of Christchurch. In 2011, approximately two-thirds of its consumers lost power after the Christchurch earthquake. By the end of the following day, Orion had restored power to 50 percent of the affected consumers; by the end of the week, to 86 percent; and within 10 days, to 95 percent. The prompt recovery was mainly due to the long-term planning approach Orion had adopted. Indeed, Orion embarked on a seismic strengthening programme designed to improve network resilience and minimize the economic impacts resulting from outages, based on the 1997 Christchurch Lifelines report, Risks and Realities.[43] The portfolio of resilience building measures include:

- All new structural assets – together with existing strategic structural assets like sub-transmission lines and zone substations – were designed to withstand a 500-year seismic event with little or no service disruption.
- Improvements at bridges, including strengthening the connections between superstructures and substructures, increasing column strength and ductility, strengthening or renewing retaining and approach structures, and strengthening lateral/longitudinal restraint mechanisms.
- Maintaining a meshed electricity distribution system. This spider-web approach to the network greatly increased the company's ability to restore power promptly after the 2010 and 2011 earthquakes. It meant that power stayed on unless all the multiple links into an area failed. If all the links were indeed damaged, the company could fix the link that was the easiest and quickest to repair.

2.2.7 Enhancing emergency preparedness

Enhancing the emergency preparedness of the energy sector can reduce losses and damages, thereby reducing interruption times and allowing for a more focused targeting of resources for prompt recovery based on BBB. Furthermore, emergency preparedness measures form an integral part of a holistic resilience building approach. Typical emergency preparedness measures include:[44]

- Developing, implementing and testing emergency operations plans. These plans should account for climate change and be updated as gaps are identified.
- Stockpiling spare items to expedite the repair or replacement of key assets and equipment, as often this makes the difference between a speedy and a prolonged recovery.

40 Stronger Power.
41 Derisking Renewable Energy Investment
42 Resilience Lessons.
43 Risk and Realities: A Multi-Disciplinary Approach to the Vulnerability of Lifelines to Natural Hazards, based on the work of the Christchurch Engineering Lifeline Group, Centre for Advanced Engineering, University of Canterbury, Christchurch, New Zealand, 1997.
44 Power Grid Recovery after Natural Hazard Impact, JRC Science for Policy Report, European Commission, 2017.

- Ensuring interoperability among and between neighbouring transmission and distribution systems operators.

interoperability among neighbouring transmission and distribution systems[45]

In the aftermath of Hurricane Katrina, power companies in the affected areas brought in repair crews and materials from 23 of the United States and Canada. This speedy mobilization was possible because power companies: i) received early warning about the hurricane; ii) had developed and exercised internal emergency plans; and iii) had established mutual aid agreements with neighbouring companies beforehand.

Mutual aid agreements have been an invaluable instrument of resource surge in several emergency response mission areas (including rescue and medical care), and can arguably help system operators to rapidly expand their repair capabilities to respond to the added requirements of major emergencies. However, the rapid surge of capabilities often generates an entirely new set of demands. After Hurricane Katrina, Mississippi Power had to operate 18 temporary shelters for 11,000 staff, and 12 logistics sites to manage the extra material.

However, interoperability will pose specific challenges. For example, when freezing rain battered Slovenia in January 2014, over 250,000 people were left without power, some for more than 10 days. At the peak of the response, more than 1,500 people worked to restore power, including, among others, foreign expert workers. Language was an obstacle to effective operations, and foreign workers needed to be led by local personnel. This case highlights the need for operators to work with neighbouring companies to ensure interoperability with mutual aid resources before disaster strikes.[46]

- Ensure interoperability between neighbouring transmission and distribution systems operators and emergency management organizations.

Operators' interoperability with emergency management organizations

Operators need to maintain interoperability with the emergency management community in their area of operation. Ideally, system operators should participate in emergency management committees at least at national level. By maintaining interoperability with the emergency management organization, operators can: i) streamline their risk assessments and preparedness efforts; ii) receive early warning; and iii) rapidly access surge capabilities that would not be available otherwise.

For example, because Powerlink Queensland sat in the State Disaster Coordination Committee, it had access to daily meteorological briefings, aerial resources and boats in the aftermath of the 2011 Queensland, Australia floods.[47]

In another example, when the Vasilikos Power Plant was destroyed by an explosion in the adjacent Evangelos Florakis Naval Base in Cyprus, the Government of Cyprus requested generators through the then European Union Civil Protection Mechanism. Among other items, generators with a total capacity of 71 MW were shipped from Greece. Although the generators were sent by the Greek authorities to their Cypriot counterparts, the logistical and administrative part of the operation was handled by the respective national civil protection authorities, and the operation was co-funded by the Civil Protection Financial Instrument of the European Commission.[48]

- Prioritize repairs to critical energy users, who should be identified before a disaster, as part of a concerted effort involving the emergency management community, the operators and critical clients themselves. Critical energy

45 Power Grid Recovery after Natural Hazard Impact
46 Protecting Electricity Networks from Natural Hazards, Organisation for Security and Cooperation in Europe (OSCE), 2016.
47 Planning for stronger, more resilient electrical infrastructure - Improving the resilience of electrical infrastructure during flooding and cyclones, Queensland Reconstruction Authority, 2011.
48 Power Grid Recovery after Natural Hazard Impact

users should be identified, ideally during the development of emergency operations plans. Critical users usually include oil and gas refineries, water-treatment plants, telecommunication networks, service stations, hospitals, pharmacies and other facilities. Emergency operations plans should include lists of critical users, locations, an indication of the potential consequences of the outage, the minimum power required to maintain functionality, the transmission and distribution operators, the capabilities of the users (such as backup generators), as well as their needs. Planning uncertainty will likely make it impossible to prioritize the needs of all users; however, the list should as a minimum indicate which users need to be prioritized during the response and which during the recovery phase. Figure 2 is an example of how such a list could be built at local or regional level.[49]

Figure 2 *Example of critical customer table, to be used at local or regional level*

Customer					Grid			
Designation	Type	Location	Outage consequences	Minimum power requested	TSO/DSO	Consequences	Capabilities	Needs

Source: Guide ORSEC Départemental et Zonal : Mode d’action rétablissement et approvisionnement d’urgence des réseaux électricité, communications électroniques, eau, gaz hydrocarbures, Direction Générale de la Sécurité Civile et de la Gestion des Crises, Paris, DGSCGC, 2015.

2.3 Role of sectoral resilience plans

In the wake of the 2007 floods in the United Kingdom, an in-depth review was carried out focussing on flood risk management, the resilience and vulnerability of critical infrastructure, the emergency response, emergency planning and the recovery phase.[50] A main recommendation of the review was that sectoral resilience plans should be developed for all critical national infrastructure sectors, including the energy sector. As a minimum sectoral resilience plans should aim to:

- Develop a picture of risk and vulnerability for the entire sector on a periodic basis, through bottom-up aggregation of risk and vulnerability analysis.
- Define the levels of resilience required across critical infrastructure (based on standards of resilience and protection, economic incentives and business continuity planning for all risks);
- Develop a programme of measures (actions) for achieving the appropriate level of resilience, along with timescales for delivery, guided by the key activities and the principles in section 2.1; and
- A mechanism for reporting progress on implementation of the programme of measures and updating the plan on an annual basis.

49 Guide ORSEC Départemental et Zonal: Mode d’action rétablissement et approvisionnement d’urgence des réseaux électricité, communications électroniques, eau, gaz hydrocarbures, Direction Générale de la Sécurité Civile et de la Gestion des Crises, Paris, DGSCGC, 2015.

50 The Pitt Review, Learning Lessons from the 2007 floods, July 2008, [ARCHIVED CONTENT] Final Report (nationalarchives.gov.uk).

The presence of such a resilience building plan: i) enhances recovery preparedness prior to the disaster; and ii) identifies key activities that can be implemented as part of the recovery process after the disaster.

2.4 Pre-disaster status of the energy sector

The preparedness effort may include updating data on the status of the energy sector on an annual basis before any disaster. This data can then be used as a basis for estimating damage and production flow changes. Indeed, the PDNA for the Energy Sector[51] calls for collation of the following information:

- Geographical location and generation capacities of each power generation system, including renewable energy systems and decentralized options that may have been affected (grid system and off-grid system, from source including coal, gas, hydro power, solar and wind) and the corresponding transmission infrastructure including pipelines and powerlines;
- Geographical location and typical stocking levels of warehouses;
- Historical information on the typical monthly provision of services, including demand by type of user, range of charges depending on type of user, and historic monthly revenues and operational costs;
- Annual reports to shareholders in private and public enterprises in the sector, including financial statements of revenues and costs of operations, and insurance coverage.
- Transmission and distribution network data;
- Pipeline and pumping station routing;
- Fuel storage facilities;
- Stand-by and back-up systems to assist with recovery;
- Availability of long-lead items (such as power transformers);
- Information on employment, production, and revenue of related enterprises/industries, such as coal mining or oil/gas extraction.
- Overview of government policies on energy sector development plans; sustainable energy goals; capacities of government departments; locations of offices and staff; skilled labour; and standby procurement processes.

2.5 Wider enabling environment for building the resilience of the energy sector

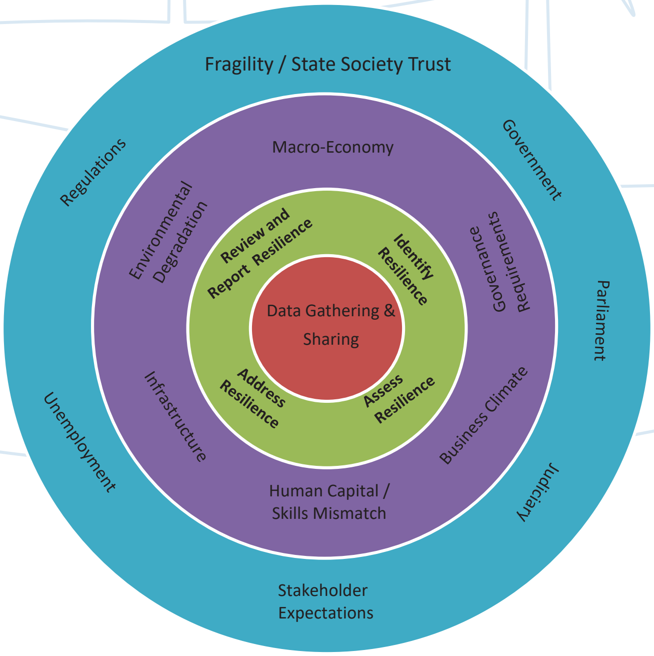
Resilience building is not a linear process; rather it is the balancing act of several interwoven elements that interact with each other, and that have to be in balance with each other if resilience building is to be effective. Furthermore, resilience cannot be built against specific risks in isolation; as the management of one risk may have an effect on another, and management actions could be implemented that control more than one risk simultaneously.

Figure 3 shows the elements of resilience building for illustrative purposes; however, in reality these elements blend together. In addition, the particular stage in the process that one may be at for any particular risk will not necessarily be the same for all risks.

51 Post Disaster Needs Assessments, Volume B Guidelines.

Figure 3 shows that the resilience building process takes place in a context; and certain key inputs (such as those related to financing, legislation, institutions and capacities) have to be given to the overall process in order to generate the outputs that will be desired from a resilience building perspective. These key inputs, and challenges to their effectiveness, should be identified and assessed prior to any disaster.

Figure 3 *Wider enabling environment for resilience building*



2.5.1 Wider enabling environment for promoting renewable energies

For the purposes of establishing a legal regime governing and encouraging private-sector investment in renewable resources and technologies, both political and legal definitions factor into a policy definition of which resources deserve to be specifically treated as renewable resources:[52]

- **From a political perspective**, renewable energy resources can be divided into numerous categories depending on the political goals under consideration. Thus, renewable resources may be distinguished by i) categorizing those which are well established and those which are underdeveloped; ii) those that have immediate development potential versus those that do not; and iii) those with potential rural customer bases and those with urban customer bases.
- **From a legal perspective**, existing laws such as land use, water, mining, and hydrocarbon laws need to be scrutinized to determine their potential jurisdiction over and applicability to renewable resources. It is important to define which technologies are to be considered "renewable" for the purposes of any piece of legislation. Such legislation can define renewable resources as appropriate, given the state of development of natural resources in that country.

52 The Renewable Energy Policy Manual, United States Export Council for Renewable Energy, 2000, http://solstice.crest.org/renewable/usecre/manual.html

2.6 Importance of policy harmonization

From a policy perspective, a major challenge is harmonization of the multiple policy areas that affect the safety and security of a country's electricity supply.[53] Jurisdiction over management of the risks to the electric power grid from natural hazards is often spread over several administrative levels. Furthermore, at each administrative level, electricity supply involves a multitude of public and private stakeholders, and authority over risk management is spread horizontally over many actors.

At country level, protection of electricity from natural hazards is addressed in energy, civil protection (or disaster management) and critical infrastructure policies. Energy-related regulations focus on maintaining generation-demand balance. Risk assessments are geared towards ensuring security of supply and only implicitly address natural hazards. Civil protection regulations require comprehensive national risk assessments, and several countries include disruption to the electricity subsector in their national risk assessments. However, in many countries, current disaster risk assessment guidance documentation focuses on human and economic losses, and has not reinforced the need for sector-specific and industry preparedness against natural hazards. Critical infrastructure protection policies require security plans that address the risk of disruption from major threat scenarios, usually prioritizing manmade threats over natural hazards.

Each of these existing policies tend to focus on one aspect of power grid resilience. Without a complete picture of the natural hazards facing the electricity grid, energy-related regulations may be protecting the power grid against the wrong hazards. Without proper understanding of the capabilities and resilience of the power grid, civil protection plans (alternatively termed disaster management plans) may be calling for the wrong mitigation and response measures. In addition, each of these policies establishes another set of regulatory requirements and places an additional burden on regulatory authorities and operators. Furthermore, this poses a risk of confusion stemming from each of these strategic documents addressing different hazards. For example, the National Risk Assessment may be based on a 100-year flood and the Crisis Risk Assessment on a 50-year flood, while the Operator Security Plan may not include floods at all. Moreover, each document may suggest different flood protection measures for the utility's facilities, and add to the economic burden of maintaining a reliable electricity supply. Acting independently, each of these prevention and mitigation measures may be counter-productive against other measures, even for the same hazard, let alone for different hazards. Finally, the emergency plans produced based on each strategic document may be built on a different set of assumptions and dictate a different set of measures.

Therefore, harmonization efforts should aim to align individual policy requirements:

- **Using a consistent set of scenarios in the risk assessments** required by each policy would support the development of collaborative thinking about strategic needs across all risk management phases. It would also help public and private organizations involved in the energy sector at all administrative levels to share a common understanding of threats and risks facing the power grid.
- **Integrating risk management efforts** by using the same set of scenarios across all risk assessments. For example, a national risk assessment, developed by the country's civil protection authority, could identify an earthquake scenario. Based on this scenario, the national civil protection authority would develop a risk mitigation strategy, eventually supported by an action plan. An energy operator could use that earthquake scenario to develop its operator security plan (OSP). The OSP would likely describe the impact of that scenario on the security of electricity supply in more detail than in the NRA. It could also suggest a strategy and action plan for the operator to reduce the risk of disruption of its system. The measures stipulated in the OSP should

53 Power Grid Recovery after Natural Hazard Impact

be integrated with the national risk mitigation strategy, to maximize the benefit/cost ratio of the interventions and reduce the risk stemming from prolonged power outages to a minimum.

Finally, it should be recognized that in many developing countries weak governance hampers effective and prompt modification to legislation, and enforcement of any such legislation. Having draft legislation ready prior to a disaster will enable relevant stakeholders, and the international donor community, to lobby and take advantage of the momentum and the public demand for public services based on BBB principles.

2.7 Assessing and monitoring resilience building in the energy sector

Building the resilience of the energy sector requires monitoring and verification to determine and evaluate the real reach of the main steps discussed in this section. Each type and phase of intervention requires a set of indicators that enable evaluators to measure performance in relation to a baseline scenario. Monitoring and verification mechanisms must include allocation of financial and technical resources, periodicity and accountability measures. Information should be shared, with other institutions and with the public, and be readily available for decision makers. It should also be used for policy learning, guiding changes or modifications based on progress or changes in conditions.

In some cases, linkages may be made with the Sustainable Development Goal indicators, including:

7.1.1 Proportion of population with access to electricity

7.1.2 Proportion of population with primary reliance on clean fuels and technology

7.2.1 Renewable energy share in the total final energy consumption

7.3.1 Energy intensity measured in terms of primary energy and GDP

3 Recovery policy

3.1 Guiding principles for the formulation of a recovery vision and recovery policy for the energy sector

The section above provided detailed elements of preparedness measures to select and implement prior to disasters. The following sections of this document guide the reader to develop the chapters that make up a disaster recovery framework for the energy sector. These chapters will be integrated with chapters for the other sectors to make up the general DRF for the country. There are intersectoral linkages; therefore, sectoral teams are advised to communicate during the process of elaboration. The core elements to consider when developing a recovery vision, and associated programmes and policies, for the energy sector are:

- **Commitment from executive authorities at national and sectoral levels,** ensuring that the vision is developed at the highest level of government. Such a commitment will be easy to secure provided a similar commitment has already been obtained for the implementation of the energy sector resilience building plan that the recovery strategy and vision links to.
- **Conducting stakeholder consultations for a common recovery vision.** The government can invite groups of internal stakeholders (the ministry of energy, the regulatory authority, and other ministries whose sectors are main energy users) and external stakeholders (aid agencies, professional bodies, non-governmental organizations (NGOs), civil society organizations (CSOs) and the private sector) to sessions in which it communicates and seeks inputs for a vision of recovery. Such a consultation process, and its associated mechanisms for seeking and collating feedback, should already be in place as part of the process of developing an energy sector resilience building plan.
- **Ensuring alignment with development programmes.** The recovery vision must be coherent with the government's broader, longer term development goals for the energy sector, with linkages to Sustainable Development Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all. In particular, linkages should be established with government plans in terms of: i) proportion of population with access to electricity; ii) proportion of population with primary reliance on clean fuels and technology; iii) renewable energy share in the total final energy consumption; and iv) energy intensity measured in terms of primary energy and GDP.
- **Incorporating the principles of infrastructure resilience** (which includes BBB) – i) adaptive transformation; ii) environmental integration; iii) protection by design; iv) social engagement; v) shared responsibility; and vi) continuous learning – in the recovery vision for the energy sector.

Environmentally integrated principles to be used to inform the recovery process

- Promote as much as possible the use of nature-based solutions for building the resilience of energy sector components and assets against natural hazards.
- Ensure that rehabilitated assets and networks do not negatively affect surrounding ecosystems and do not increase pollution of the environment.
- Ensure that the risk management of stranded assets of the energy sector, including possible decommissioning, does not negatively affect surrounding ecosystems and do not increase pollution of the environment.
- Ensure that any hazardous and other solid and liquid waste generated by the various components of the energy network, including the administrative and staff premises, are treated according to environmentally best practices, including maximizing reuse partly through waste to energy technologies.

- Taking advantage of innovative new technologies to promote green and sustainable recovery, including through renewables and modular approaches.

- Optimizing recovery across users and sub-sectors. The recovery vision should apply to: i) all components of the energy sector discussed in section 1 including generation, storage transmission and distribution; ii) assets owned by the public and private sectors, as well as those under private-public partnership (PPP); and iii) all users and uses of energy, including domestic uses of cooking, heating and cooling, and commercial uses.

Flex-grid installations in Kobong and Thapaiban, Lao PDR[54]

In Lao People's Democratic Republic (PDR), the villages of Kobong and Thapaiban do not receive any national electricity supply, thus, had lived mostly without power. Being remote, they lack access to a regional market and thus have limited potential for economic growth. However, the two villages were ideal candidates for a new approach to electrification – the flex-grid, based on the notion of electricity grids that grow organically. Thanks to modular and easily expandable generation and storage technology, the rate of growth can adapt to a local community's socio-economic development.

A tariff model was developed, in a participatory manner with the Government of Lao PDR and the target communities, with the aim of ensuring sustainable operation and system maintenance and financing spare parts and any necessary support work by the local service partner.

Automation is also ongoing to autonomously detect: i) roof areas from high-resolution satellite data based on a pattern recognition algorithm, and ii) household affiliation, estimated energy consumption and probability of productive use applications. Such cloud-based applications can significantly shorten the time needed to plan off-grid electrification projects and, in a further step, compare real data with planning data. This would enable further improvements in planning in the future.

3.2 Recovery vision

Based on the above principles, a recovery vision can be developed, to enable the lead authority (the ministry of energy) to convey its recovery priorities and consolidate a national or subnational consensus around them. An example of a recovery vision is: *reinforce the energy sector's resilience to natural hazards, while fostering the*

54 Flex-Grid Installations in Kobong and Thapaiban, Lao PDR, UNDP Global NDC Support Programme, 2021, Flex-Grid Installations in Kobong and Thapaiban, Lao PDR (undp.org).

equitable, inclusive and participatory recovery of the sector's infrastructure and services based on BBB principles and principles of resilient infrastructure.

Build Back Better starts with forming recovery objectives –
Wenchuan Earthquake 2008: recovery and reconstruction in Sichuan Province[55]

Build Back Better was adopted as a principle for post-disaster recovery in the wake of the Wenchuan Earthquake. In practice, this meant that the outcomes of post-disaster recovery and reconstruction should improve on pre-disaster conditions, and that the quality of life in the region should be substantially improved, by reducing pre-existing vulnerabilities. The principle was adopted early in the planning stage in order to more effectively define the objectives of the recovery. These objectives, set by the State Overall Planning (SOP), were designed to be realistically achievable by government departments involved in the response efforts. In brief, the principal sub-objectives utilizing the Build Back Better modus operandi are the following:

- Housing must be available to each family.
- At least one member of each family should have a stable job, and that person's income should surpass the pre-disaster level.
- Each person should have access to basic public services, including education, sanitation, medical treatment, and so on.
- Infrastructure – such as transportation, communication, energy, water supply and so on – should be improved from pre-disaster conditions.
- Government organizations should emphasize resuming normal economic activity, with a special effort to increase regional growth.
- Ecological and environmental concerns must be accounted for in the recovery process.
- The region should be more capable of disaster prevention and mitigation in the future.

3.3 Development of programmatic approach for the recovery of the energy sector

The energy sector national recovery framework needs to be structured under a consolidated centrally led government programme to support the achievement of recovery goals, transformative targets and principles, and priorities. In the cases of local recovery programmes, a recovery planning agency or centre could be located within a subnational recovery planning and oversight entity, while linkages to national sectoral agencies (ministerial and regulatory) remain crucial to ensure that the transformative aims of the framework are met (in terms of BBB, renewables, and so on). This is particularly important as these transformative processes may require capacities that are not available at local level. A sample programmatic approach is shown in Figure 4, based on:

a. Consistent application of the recovery policy resilience building principles, and associated activities, as articulated in section 2.1, across all energy sector programmes and projects;

b. Harmonized and mutually reinforcing recovery results and outcomes across sectors, provided that resilience building principles are mainstreamed across all sectors;

c. Needs prioritization within the energy sector, depending on agreed upon criteria for prioritization within the sector and across sectors;

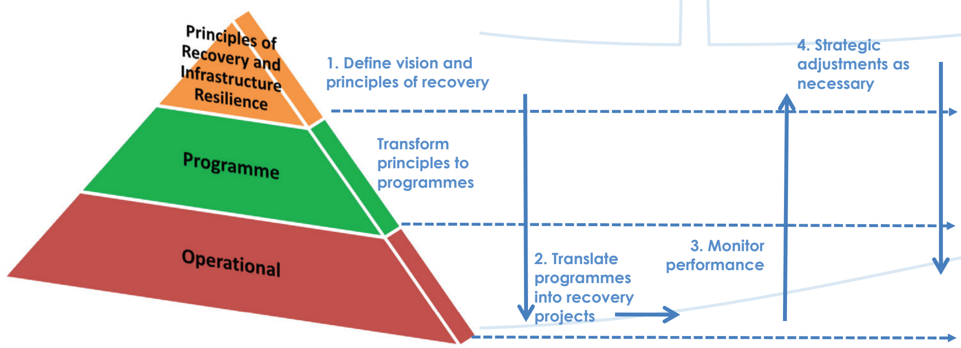
55 Wenchuan Earthquake 2008: Recovery and Reconstruction in Sichuan Province, Recovery Status Report 04, developed as collaboration between the China Earthquake Administration. Department of Civil Affairs of Sichuan Province, ILO, UNISDR and the IRP, 2011. Wenchuan Earthquake 2008: Recovery and Reconstruction in Sichuan Province - Recovery Status Report (ilo.org)

d. Sequencing of recovery activities according to the agreed order of prioritization to ensure the planned outcomes;

e. Mutually reinforcing government agencies, NGOs, communities, and private sector activities, based on resilience building principles, complementing each other within a government-led recovery framework;

f. A central node to evaluate recovery, monitor adherence to agreed principles, and enable strategic adjustments to be made as required.

Figure 4 *A programmatic approach for resilience building of the energy sector through the recovery process*



3.4 Establishment of sectoral recovery programmes

The lead energy sector recovery agency should translate policy priorities into programmes and projects, with identified financial and human resources required for implementation, together with a timeline and sequence of implementation. Establishing an energy-sector recovery programme early allows time for iteration to ensure it is in line with the sector's overarching vision, objectives and principles. Possible programme components include:

- Increasing proportion of households with primary reliance on clean fuels and technology.
- Increasing private sector reliance on clean fuels and technology.
- Improving the inclusivity and reach of the energy sector basic services.

Gender-based violence, resettlement and provision of electricity[56]

In the wake of Typhoon Haiyan, which struck the Philippines in 2014, the particular impacts of resettlement on risks facing women were significant and needed to be addressed to ensure that women's rights are protected and strengthened throughout the process. For example, the bunkhouses established following the typhoon have been identified as creating increased risks of gender-based violence. These risks reflect the lack of necessary standards in construction and design, including with respect to adequate space for privacy, and electricity to ensure well-lit pathways. The absence of livelihoods opportunities further compounds vulnerability. Additional measures are needed to ensure that bunkhouses and other transitional shelters reinforce the protection of women and girls while they await resettlement.

56 In the shadow of the storm, Getting Recovery Right one Year after Typhoon Haiyan, Oxfam Briefing Paper, November 2014, In the Shadow of the Storm: Getting recovery right one year after typhoon Haiyan - Oxfam Policy & Practice

3.5 Prioritization of sectoral recovery programmes

Sectoral prioritization takes place at multiple levels:

i. **At the financial level:** different amounts of financial support are allocated to different sectoral recovery programmes based on the estimated sectoral needs;

ii. **At the temporal level:** some programmes need short-term and immediate support. Other programmes may be considered for receiving more medium-term or longer-term support.

The PDNA process should have developed prioritization criteria to be used at both financial and temporal levels, including:

- Meeting the urgent energy needs of the affected population, with special emphasis on pro-poor, pro-vulnerable, and gender-sensitive agendas;
- Restoring to pre-disaster levels, followed by improvements based on BBB;
- Actions that can yield early results effectively (within 18 months);
- Opportunities for greater impact, in geographic areas with large populations with urgent energy needs;
- Institutional and technical capacity of municipal services to enable them to resume delivery of basic energy services, including operations and maintenance;
- Addressing key energy obstacles associated with the return of internally displaced persons to their original areas of residence;
- Recovery initiatives that contribute to peace where relevant
- Potential to generate sustainable livelihoods, including through building the capacity of local companies in the renewable energy sector
- Balance between public and private sector recovery
- Balance between physical infrastructure reconstruction and less visible recovery (such as capacity building and governance)
- Restoration and rebuilding of critical energy sector infrastructure and services.

Energy sector prioritization for the FFS – Iraq[57]

After the liberation of large governorates of Iraq from ISIL, the coalition to defeat ISIL, in conjunction with UNDP Iraq and the Government of Iraq, embarked on a process to rebuild large sections of the destroyed governorates, with particular emphasis on the sectoral recovery of housing, water, electricity, sewage, municipal services and infrastructure, roads and bridges.

Inter-sectoral and sectoral prioritization criteria for reconstruction projects included factors that will encourage internally displaced persons to return and not undergo secondary displacement, the degree of severity of the damage, and the number of people that will benefit from the restored services.

57 Funding Facility for Stabilisation 2021 Annual Report, UNDP Iraq, 2022.

3.6 Development of an energy sector recovery policy

The above vision, principles, programmes and prioritization criteria should be consolidated in an energy sector recovery policy, with detailed finance and implementation arrangements. The policy should be developed by the ministry of energy (the lead sectoral recovery agency) and be backed by the country's highest political and policy-making levels, planning ministry/agency and financial institutions.

Creating a new recovery policy in the aftermath of a disaster may be time consuming at a time when recovery needs are urgent. However, the absence of a recovery policy may lead to incoherent and inconsistent implementation, and miss the opportunity for BBB according to resilient infrastructure principles. This shows the importance of having established a recovery policy before the disaster, as part of the overall resilience building programme for the energy sector to be developed and implemented by the ministry of energy.

The following considerations should be addressed in the recovery policy:

- Coordination with the national lead recovery agency.
- Coherence and integration with any existing national resilience building plan for the energy sector (or embarking on the development of such a resilience building plan if it does not already exist). Such a plan should include the resilient infrastructure principles and should adopt a long-term view on: i) disaster risk reduction; ii) climate change adaptation; iii) environmental and social safeguards; iv) gender sensitivity; and v) protection of vulnerable groups.
- Coherence and integration with the main environmental protection policies including ecosystem and biodiversity protection, solid waste management (municipal, hazardous and medical), liquid waste management, pollution prevention laws and policies.
- Recognize recovery as an opportunity to avoid the re-introduction of stranded assets, which may have originally arisen because of the physical effects of climate change and the societal and regulatory responses to climate change.[58]
- Public sector facilitation of private sector recovery through the provision of affordable energy, in the short term.
- Promotion of sustainable employment opportunities, by developing local skills for construction, operation and maintenance of renewable energy infrastructure.
- The eligibility criteria for benefits in sector-specific issues, such as lower energy tariffs and incentives for investing in renewables.
- Independent oversight and transparency through the energy regulatory body.
- Public-private partnership, particularly in investment for renewable energy generation.

58 Stranded Assets: A Climate Risk Challenge.

Decarbonization, asset stranding and development pathways in developing countries[59]

The Paris Agreement has significant implications for the scale and pace of decarbonization required. However, the faster the pace of decarbonization, the greater the chance of asset stranding in different sectors, and the larger the likely economic, social, and political consequences that might need to be managed. The impact of such asset stranding needs to be monitored closely, particularly in developing nations where stranded assets could destabilize efforts to improve economic growth and socioeconomic development. Early action on climate change in developing countries avoids lock-ins and is cost-effective: delays today need to be offset by faster decarbonization tomorrow, meaning higher costs and stranded assets.

However, many developing countries are dependent on a range of natural resources for a significant proportion of their export incomes; and a large proportion of citizens are employed in sectors potentially affected by climate change and stranded asset risks; including the fossil fuel industry, agriculture and forestry, and tourism.

The reallocation of resources and compensation for those individuals and communities affected by climate change and related policies could help to facilitate a just transition. However, this is more likely to occur in developed countries, where citizens tend to be able to demand higher relocation costs and stronger unions demand higher settlements for loss of earnings. Indeed, evidence suggests that job losses are not a direct result of national climate policies, but rather are caused by a lack of social policies and by lack of investment in alternative mitigation measures.

It should be recognized that physical assets are not the only type of assets that can become stranded: stranding of human capital has occurred frequently in history as a result of shifting environmental and energy landscapes, and will likely occur in the coming decades as a result of physical climate change impacts and societal responses to climate change. Local know-how and expertise developed over decades of experience and education could become stranded, alongside the stranding of social networks within specific industries. Both are seen as important to increasing community productivity and resilience to risks and shocks. In particular, stranding of fossil fuels could have a profound effect on labour dynamics and local communities in many developing countries. In fragile countries, this stranding will exacerbate the lack of social stability and security that are already closely linked with environmental degradation, unemployment and social cohesion – thereby increasing the risk and drivers of conflict.

The energy sector recovery policy, and the national recovery policy in general, should recognize these dynamics and seek to address them in a holistic manner while linking to broader development objectives and to other sectoral recovery policies that need to account for stranding risks including the agriculture and forestry, and the tourism sectors.

Source: Stranded Assets: A Climate Risk Challenge, Inter-American Development Bank, 2016.

3.7 Checklist

This checklist covers the various steps required to develop an effective planning, vision, policies and strategies for the resilient recovery of the energy sector.

59 Stranded Assets and Multilateral Development Banks, Caldecott, Inter-American Development Bank, 2015.

Ministry of energy and regulatory body

- Define a national vision for recovery, incorporating the infrastructure resilience building principles of: i) adaptive transformation; ii) environmental integration; iii) protection by design; iv) social engagement; v) shared responsibility; and vi) continuous learning;
- Ensure the vision is coherent with the sector's broader, longer-term development goals and growth including: i) the proportion of the population with access to electricity; ii) the proportion of the population with primary reliance on clean fuels and technology; iii) the renewable energy share in total final energy consumption; and iv) energy intensity measured in terms of primary energy and GDP.
- Formulate a recovery policy which prioritizes energy sector recovery investments, linked to any existing pre-disaster resilience building plan, and defines key programmes and projects;
- Ensure that the recovery policy identifies stranded asset risks, mitigates their impacts and avoids the reintroduction by the recovery process of new stranded assets.
- Ensure consensus of all participants on the policy framework, vision and principles, partly through setting up consultative processes for inclusive planning;
- Develop a programme framework that sequences and enables criteria-based prioritization for energy sector recovery;
- Align the recovery policy with the national de-carbonization pathway, in particular the Nationally Determined Contributions and BBB;
- Communicate the top recovery priorities to donors, recovery partners and affected communities;
- In conflict situations, ensure that recovery of the energy sector is impartial and contributes to mitigating the societal, economic, security, environmental and political dimensions of fragility.

Private sector, CSOs and NGOs

- Contribute to development of recovery vision and policy
- Support the development of guiding principles
- Contribute to increasing the proportion of energy from renewable sources.
- Contribute to inclusive recovery that leaves no one behind and attempts to reach the furthest behind first.
- Contribute to mitigating the impacts of stranded assets.
- Contribute to decreasing the energy intensity of GDP.

4 Institutional arrangements

4.1 Selecting an effective lead agency to lead the energy sector recovery

Ideally, the lead energy sector recovery agency should be identified before a disaster as part of the country's disaster recovery framework, which should have been prepared in advance. This should include a *prior* assessment of capacities to plan and implement recovery, covering the required human, financial and technical resources. This should also include capacities to evaluate tenders, manage large contracts and associated accelerated procurement, and adhere to international anti-corruption, transparency and accountability guidelines and standards.

For the energy sector, recovery efforts for the energy sector must be led by the ministry of energy, which can bring together all the public and private providers of energy - thermal and renewable. Furthermore, the ministry of energy should have additional or "new" capacities to handle the large workload of repair and reconstruction. Table 3 summarizes the envisaged required capacities and challenges for the ministry of energy when acting as the lead energy sector recovery agency. It should be recognized that the challenges identified in Table 3 are best addressed through the establishment of a Project Management Unit (PMU) to: i) meet the additional required cross-sectoral and multi-stakeholder coordination needs; ii) facilitate additional expertise that may be required in the adoption and implementation of innovative technologies; and iii) manage the overall process from procurement through delivery, monitoring and evaluation.

The adequacy of the ministry of energy to act as the lead agency, and the required additional needs that may be met through the PMU, may be assessed (and enhanced) using the following criteria:

a. magnitude and nature of the disaster, and agency's capacity across various scales and types of disasters;

b. current governance structure;

c. agency's prior disaster recovery experience;

d. agency's prior infrastructure resilience building experience;

e. agency's prior experience of renewable energies and of managing stranded assets and mitigating their risks;

f. agency's mandate regarding liaising with affected communities to contribute to the recovery process, and agency's capacity to work with international donors, local authorities and NGOs; and

g. overarching coordination, monitoring, oversight, and control frameworks in operation among the country's agencies, line ministries, local governments, and civil society.

Table 3 *The ministry of energy as the lead energy sector recovery agency*

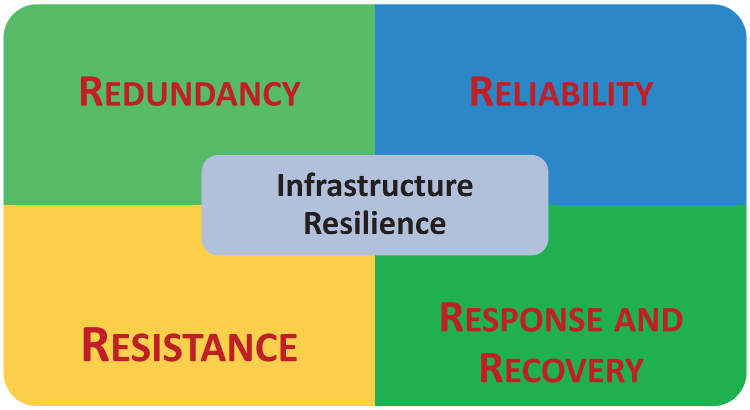
Description	Recovery frameworks under which individual line ministries work independently to manage recovery – and to supervise and implement projects – in their sectors
Required capacities	Capacities of government line ministries must be adequate or strengthened to deal with additional urgent responsibilities
Envisaged additional capacities for recovery	Higher capacities will be required for: i) procurement, ii) delivery, iii) monitoring, and iv) coordination.
Challenges	• Rapid recruitment of temporary human resources may not adequately supplement the capacities. • Recovery coordination may be difficult if ministry of energy staff lack sufficient experience. • Line ministries may struggle to focus on recovery programmes at the expense of longer-term goals.
Proposed solution to identified challenges	The ministry of energy can establish a PMU to meet the addition coordination needs and technical capacities; and to manage the overall recovery process.
Coordination with other sectors and institutions	The ministry of energy, through its PMU and its representatives in the overall national recovery committee, will liaise with other institutions and sectors to ensure it is not undermining the recovery objectives of other sectors and vice-versa.

4.2 Transitioning from disaster recovery and reconstruction to post-disaster development plans for resilience building in the energy sector

Clear and specific guidelines must be written into the legal mandate of a recovery agency to support its transition from the overall recovery effort in the post-disaster phase. After that point, efforts should continue to focus on building the resilience of the sector under the leadership of the ministry of energy, and with oversight from the regulatory authority, while adhering to the resilience building principles,

Doing so may require a clear transitional strategy, which may be triggered by pre-determined milestones, institutional design, or both. A pre-determined milestone could be the achievement of a major recovery target set by a national government (such as restoration of a certain percentage of damaged services).

Figure 5 *Recovery mandates as part of wider resilience building mandates*



Recovery as part of wider efforts to build infrastructure resilience[60]

Figure 5 shows the linkages between Principle 1 and Principle 3 of infrastructure resilience, as set out in the United Kingdom guidelines for improving infrastructure resilience, which highlight the following elements of resilience:

- The **Resistance** element of resilience is focused on providing protection. The objective is to prevent damage or disruption by providing the strength or protection to resist the hazard or its primary impact. Where the resistance strategy is the only component of a resilience strategy, significant weaknesses occur as protection is often developed against the kind of events that have been previously experienced, or those predicted to occur based on historic records.
- The **Reliability** component aims at ensuring that the infrastructure components are inherently designed to operate under a range of conditions and hence mitigate damage or loss from an event. This leads to insufficient awareness or preparation for events outside the range, and hence significant wider and prolonged impacts can occur.
- The **Redundancy** element is concerned with the design and capacity of the network or system. The availability of backup installations or spare capacity will enable operations to be switched or diverted to alternative parts of the network in the event of disruptions. The resilience of networks reduces when running at or near capacity, although in some sectors or organizations, it is recognized that it may not always be feasible to operate with significant spare capacity within the network.
- The **Response and Recovery** elements aim to enable a fast and effective response to and recovery from disruptive events. The effectiveness of these elements is determined by the thoroughness of efforts to plan, prepare and exercise in advance of events.

Source: Keeping the Country Running: Natural Hazards and Infrastructure, A Guide to improving the resilience of critical infrastructure and essential services, UK Cabinet Office, 2011.

60 Keeping the Country Running: Natural Hazards and Infrastructure, A Guide to improving the resilience of critical infrastructure and essential services, UK Cabinet Office, 2011.

4.3 Legislation to delineate roles and responsibilities

4.3.1 Wider legislative environment for disaster risk management

Resilience depends on developing or sustaining the laws, regulations, and guidelines that require utilities to: (i) develop resilience building programmes along the principles discussed earlier; (ii) apply appropriate safety standards to resilient power facilities, both in the installation/construction phase and during regular maintenance and operations; (iii) prepare emergency action plans to be submitted to the relevant authorities; and (iv) prepare recovery plans linked to all of the above. It is also crucial that governments create clear legal structures or institutional entities that will be responsible for coordination and enforcement of disaster risk management (DRM) provisions rather than simply disaster management (DM). Indeed, countries that have moved from a culture of DM to one of DRM are more successful at developing and implementing sound recovery policies based on BBB and the full set of infrastructure resilience principles.

4.3.2 Legislative modification to allow use of new technologies and to embrace new practices, aligned with the Nationally Determined Contributions

As discussed throughout this guidance document, emerging practices and opportunities stress the importance of "systems" thinking and of adopting new technologies. To this end, existing legislation should be reviewed and modified to:

- Promote a coherent and integrated set of DRM policies and strategies across stakeholders, namely the energy sector line ministries and regulatory authorities, DRM agencies including civil protection and critical national infrastructure operators, and regulators. This should enforce common scenarios and standards for risk assessments and risk management measures across policies and hazards.
- The use of new practices for different grid topologies, and the use of modular approaches, to ensure maximum flexibility and minimum disruption times and green recovery in an efficient and effective manner.

4.3.3 Legislative environment for the recovery of the energy sector

Legislation should clearly codify the functions and authorities of the implementing institutions, clarify funding mechanisms, and establish triggers for transitioning to development activities. The existence of a pre-disaster legislated-for recovery framework, coupled with a pre-disaster legislated-for resilience building programme for the energy sector, would: i) avoid duplication due to legislative confusion over institutional ownership and responsibility; ii) delineate responsibilities, including which agency will reconstruct which asset; iii) delineate which institutions will monitor adherence to BBB and infrastructure resilience building principles, and identify criticality gaps; and iv) thus set the basis for an orderly recovery process based on organizing recovery institutions and implementing programmes.

A recovery framework should legislate the handover/phase over arrangements to the agencies that will be responsible for the operation and maintenance of the reconstructed assets. The legislation should also include mechanisms for building the capacity of these agencies to facilitate effective and efficient recovery by ensuring that operations and maintenance will be continued.

Funding Facility for Stabilization (FFS) Iraq Windows 1 and 3[61]

After seven years of recovery efforts to help the Government of Iraq to restore electricity to areas occupied by ISIL, to help internally displaced persons to return to their homes and to resume the livelihood activities, the multi-donor FFS Project began preparations for handing over the efforts to relevant line directorates and governorates in the 31 areas where it is working in Iraq.

Work on the development of the FFS Transition Strategy began late in 2021 to prepare for the actual handover at the end of 2023. From the outset, the selection and prioritization of energy sector recovery projects was informed by handover considerations including the availability and capacity of staff that will be responsible for the operations and maintenance of handed-over projects. In turn, this ensured ample time to: i) identify capacity gaps; and ii) build capacities accordingly.

4.4 Legal mandates for cross-jurisdiction assets and private assets

Depending on the governance structure and degree of administrative and financial decentralization in the country, important sectoral assets may cut across local governments' jurisdictional boundaries. This necessitates further delineation and understanding of roles and responsibilities regarding the recovery process. Examples include energy services in a city/region being supplied by energy generation plants in another city/region. The pre-disaster resilience building plan should highlight these issues and include long-term plans to improve redundancy, reliability and the renewable share of the energy portfolio. This will then enable the recovery agency to simply build on these plans, refine them as necessary, and begin to implement them. However, sectoral development policies (such as a national resilience building programme for the energy sector) – instituted by the central authority (central government/ministry of energy) but implemented by lower tiers of government and civil society – require dialogue and coordination among the different partners. Pre-disaster legal mandates on the implementation authority at each level of national and local government help to clarify roles among different levels of government.

Protecting a nation's electric infrastructure is essential to its safety, economy and security. Therefore, investing in resilient infrastructure is a priority for the government. However, the way this is achieved, in the wake of a disaster, needs careful consideration when private entities in some countries own and manage more than 80 percent of the energy infrastructure. These issues should be clearly delineated in relevant legislation.

Disasters can heavily affect privately owned assets such as houses and businesses. In addition, many response plans identify roles for the private sector in response and immediate recovery (including debris removal, generation of energy and reconstruction). However, some of these assets, with a role to play in response and recovery, may be damaged and partially/totally destroyed. To enable the lead institutions to act effectively, clear pre-disaster delineated mandates are required on: i) the role of the private energy sector in the recovery process; and ii) the responsibility that recovery institutions may have to repair or replace private sector assets, particularly including how they should assist the private sector to play its role in mid- and long-term recovery.

4.5 Legal mandates for post-disaster land-use planning

Land use and land-use planning can be important aspects of post-disaster recovery and reconstruction, especially from disasters such as earthquakes, hurricanes or heavy floods. This is particularly important for small island developing states (SIDS) that may have historically had significant proportions of their tourism (and employment)

61 Funding Facility for Stabilisation 2021 Annual Report, UNDP Iraq, 2022.

and energy infrastructure on the coast, which due to climate change is now more exposed and more vulnerable to hurricanes, storm surges and the slow onset of sea level rise.

The exposure of the energy infrastructure may be gradually reduced by moving it to higher grounds, and through building redundancy using renewables at household and micro, small and medium enterprise level, as part of national resilience building Programmes for the energy sector. This can be achieved through both incentives (as will be discussed in section 5) and legislation.

Land use planning can be part of the legislative instruments available for the government to: i) reduce the exposure of the energy sector main assets; and ii) enable the instalment of renewable energy assets. While such legislation may be modified based on the post-disaster needs, clear pre-disaster land-use legislation for the energy sector would expedite the recovery process, while ensuring that it is based on sound planning principles.

4.6 Staffing requirements

4.6.1 Recovery team leadership

The importance of politically respected, competent, and empathetic leadership for the energy sector is crucial for ensuring political and community ownership and recovery financing. This is particularly important for facilitating the transformative process required to build resilient energy infrastructure and services for the twenty-first century. Leadership traits include:

- Being committed to the recovery process and all its transformative principles.
- Strong team-building skills, and ability to reach out to affected people.
- Securing necessary resources from different sources.
- Ability to overcome institutional barriers.
- Ability to ensure that inclusive and participatory processes are enforced.

4.6.2 Staffing considerations

The national government, the ministry of energy and the energy regulatory authority, may need additional expertise to respond to sectoral recovery needs, particularly if the recovery is ushering in the beginning of a transformative process towards: i) new forms of energy generation based on renewables; and ii) new commitment to the principles for resilient infrastructure for the energy sector.

The pre-disaster recovery framework, and the national resilience building plan for the energy sector, should: i) assess the capacity required for effecting the transformative process; and ii) begin to build institutional capacity accordingly. However, it may still be necessary to reassess capacity after the disaster, particularly capacity required to effect a transformative shift towards a more resilience energy sector. A rapid capacity assessment should result in: i) assignment of roles and responsibilities commensurate with capacities, including for line ministries, agencies and subnational entities; ii) an understanding of the capacities and limitations of the various recovery stakeholders; iii) better informed designation of the lead agencies; iv) recovery roles for the private sector, CSOs, professional associations and NGOs commensurate with their respective capacities; v) a refined capacity strengthening strategy to improve the short- and long-term transformative performance of all the implementing agents, and vi) any short- and longer-term needs to solicit external expertise to provide direction to programmatic activities. To this end, staffing procedures should form an integral part of the institutional framework for recovery.

4.6.3 Immediate human resource needs

Human resource capacity will invariably need to be strengthened by the addition of new personnel, often with specialized skills, particularly when embarking on the transformative process to build a resilient energy infrastructure. Global good practice may be taken advantage of by drawing expertise from other sources, including humanitarian response agencies, the domestic and international private sectors, civil society, and international NGOs. Significant benefits can also arise from forming recovery teams that are well connected to the wide variety of recovery stakeholders.

4.6.4 Long-term human resource needs

Long-term staffing requirements should include the capacities required for building a more resilient energy infrastructure; and include inputs from the ministry of energy, which is responsible for building the resilience of the energy sector in the long term.

Additional staff may be required to organize and implement the handing over of the recovery portfolio to the development agencies, as existing recovery staff may be resistant and reluctant to implement handover processes. The lead recovery agency should therefore consider recruiting liaison officers and transition teams early in the planning stage. These individuals can then participate from the beginning as planning partners in the recovery.

4.6.5 Capacity needs for recovery based on cleaner energies

The effectiveness of the energy sector in effecting a recovery process that significantly increases the share of renewables in the energy-mix portfolio relies on the performance of its institutions. This requires understanding of each institution's roles and responsibilities. Efforts towards capacity building must be directed at identifying opportunities for partnership, simplifying the regulatory system, and promoting research and development on sustainable energy solutions in the region. In addition, local staff are better suited to identifying priority projects and optimum options for implementation; therefore, it is crucial to build capacity in areas like project design, project management, and collection and interpretation of sectoral data, as well as providing specialized training on renewable energy-related fields such as:

- Assessing current human, institutional, and education/training/research capacity at national level to identify key gaps;
- Recognizing and promoting institutional capacity building as an integral instrument for policy de-risking including, for example, institutional capacity for renewable energy policy design, resource assessments, grid connection and management, and skills development for local operations and maintenance;[62]
- Creating shared databases of existing regional training materials, available training tools and curricula, and education programmes;
- Collaborating with regional and international organizations providing capacity building in the areas of intervention;
- Encouraging exchange of experiences and best practices among countries;
- Encouraging development of national and regional professional networks;
- Facilitating training and education programmes for key energy stakeholder groups, including: policymakers, financial institutions, the labour force, and the private sector;

62 Derisking Renewable Energy Investment

- Establishing national RE and energy efficiency technology centres, based on available resources, potential and technological experience; and
- Strengthening civil service schemes that promote specialization and retention. In many developing countries, the public sector is affected by high mobility, which affects staff and institutional specialization, replication and sharing of technical knowledge, institutional memory, and project continuation. Stable and specialized staff will contribute to identifying critical priorities and projects, ensuring continuation and collaboration between projects, improving regional and international interventions and technical assistance, and providing institutions with an important array of tools and other relevant knowledge.

4.7 Relationship with international agencies and development partners

The lead recovery agency undertaking transformative recovery processes in the energy sector should account for the following considerations that will facilitate the role of international agencies in the recovery process:

- International agency funding requires the recipient government to provide strong financial tracking and reporting mechanisms. Without such mechanisms, international organizations may be reluctant to contribute directly to the government's recovery budget. Instead, donors may choose to manage their own recovery funding alongside the national system. Having a national resilience building plan for the energy infrastructure will allow donors to fund projects that serve the overall development and resilience building objectives of the sector.
- The existence of long-term resilience building plans – based on global good practice such as the principles for building infrastructure resilience and BBB – generates confidence in the soundness of these programmes and their ambition to contribute to international agendas such as the SDGs, climate change adaptation, the humanitarian agenda, the Sendai Framework for Disaster Risk Reduction (SFDRR), the new urban agenda and others. In turn, this may encourage partners to make long-term commitments to projects that they have pledged to fund and implement.
- Partners' long-term involvement must be balanced with the need to ensure that the lead agency does not cede control of the recovery programme to international agencies and development partners. This is both particularly important and difficult to achieve in fragile contexts where international donor engagement is necessary, but special care should be taken to ensure that it improves rather than weakens state-society trust and state legitimacy.
- By clarifying from the outset the role of international agencies and development partners, and by linking sectoral development and resilience building plans to important international development agendas, the government can identify avenues for international donor participation in the recovery.

4.8 Checklist

This checklist covers the various steps required to develop an effective institutional arrangement for the resilient recovery of the energy sector.

Ministry of energy and regulatory body

- Decide on appropriate institutional arrangements.
- Provide a legal mandate for recovery which clarifies institutional roles and responsibilities, including on the private sector and land use planning.

- Designate the lead recovery agency and an effective recovery leader.
- Clarify the roles of international organizations and development partners.
- Coordinate recovery efforts across sectors with multiple stakeholders.
- Identify and ensure that appropriate human resources are available throughout the recovery, particularly to effect the transformative shift towards a more resilient energy sector infrastructure and basic services.

Private sector, CSOs and NGOs

- Ensure continuity between humanitarian and recovery work.
- Build capacity to contribute to the transformative recovery process of building a more resilient energy infrastructure.

5 Financial mechanisms

Five major financing challenges[63] that policy-makers face are addressed in this section:

1. To quickly quantify the economic costs of the disaster.
2. To develop recovery budgets.
3. To identify the sources of financing as well as financing gaps.
4. To coordinate and allocate financial resources.
5. To set up mechanisms to manage and track funds.

5.1 The economic cost of the disaster for the energy sector – PDNA

During an assessment after a disaster, the damages to physical assets are valued, first, in physical terms (number, extension of area or surface, as applicable). Second, damages are assigned monetary value, expressed as the replacement costs, according to the market prices prevailing just before and after the disaster. Figure 6 shows typical monetarized damage to physical assets in the energy sector, disaggregated by sector component and ownership. The issue of ownership is particularly important as: i) these assets will have a role to play in the overall recovery of the economy and livelihoods; and ii) responsibility for the reconstruction of privately owned assets may be subject to different considerations, depending on the national/sectoral recovery framework and institutional setup.

Figure 6 *Example of monetarized damage to physical assets in the energy sector*

Sector	Subsector	Cost of Damage	Remarks
Public – Nepal Electricity Authority	**Generation**		
	Hydropower. Severely damaged	200	*Not in operation*
	Partially damaged	800	*In operation*
	Under construction	400	
	Total generation	**1,400**	
	Transmission	**347**	
	Distribution	**1,829**	
	Total Public	**3,062**	
Private	**Generation**		
	Hydropower. Severely damaged	2,294	*Not in operation*
	Partially damaged	85	*In operation*
	Under construction	3,950	
	Distribution (meters)	1,497	
	Total private	**7,826**	
Total grid			

63 Disaster Recovery Framework Guide, Revised Version.

Sector	Subsector	Cost of Damage	Remarks
Alternative Energy Promotion Centre	Micro-hydro projects	747	
	Solar home system and ISPS	3,658	
	Total off-grid	4,405	
Contingency		2,000	
Grand total electricity		17,807	

Source: Government of Nepal National Planning Commission, Nepal Earthquake 2015 Post Disaster Needs Assessment Vol. B: sector reports, 2015, https://www.npc.gov.np/images/category/PDNA_volume_BFinalVersion.pdf.

The costs above are those estimated during a needs assessment such as a Post Disaster Needs Assessment. Calculation of recovery costs would have to account for additional costs. These include: i) improvements associated with risk reduction in similar types of technology pre-disaster; ii) improvements in quality of and access to services for the most vulnerable groups, including women-led households in rural areas and urban informal settlements; iii) improvements due to the replacement of traditional technologies with modern renewable technologies; and iv) cost increases due to problems in the global and regional supply chains in case of a global/regional disaster.

The cost of hardening energy infrastructure varies with the hazard and the infrastructure involved. Figure 7 shows costs for floods, earthquakes, and cyclones, together with the change in damage probability.[64]

Figure 7 *Cost of Power Infrastructure Hardening*

	Earthquakes		Cyclones		Floods	
	Cost increase	Damage probability is reduced by	Cost increase	Damage probability is reduced by	Cost increase	Damage probability is reduced by
Thermal plants	20%	10	10%	3	2%	Risk very low
Nuclear plants	5%	10			2%	2
Hydropower plants	20%	2			5%	1.3
Solar plants	5%	5	15%	2.5		
Wind farms	5%	1.2	5%	2		
T&D lines	15%	Residual risk very low	20%	2		

Source: Stronger Power: Improving Power Sector Resilience to Natural Hazards, Lifelines: the Resilient Infrastructure Opportunity, World Bank, 2019, World Bank Document.

A cautionary note must be given in this regard. Aleatory, epistemic and statistical uncertainties due to climate change mean that the past is no longer a reliable indicator of the future.[65] In turn, this implies that paying the extra cost for designing the infrastructure components to be able to withstand a 100-year return period event may actually mean that these components may fail due to lower severity events, such as weather-related hazards, becoming more frequent and more severe. Hence, it is equally important, if not more so, to also invest

64 Stronger Power.

65 Global Assessment Report on Disaster Risk Reduction 2022, UNDRR, Geneva.

in other resilience building strategies, including strategies to make the grid more flexible and redundant, such as modular approaches.

5.2 Recovery budgets

5.2.1 Disasters affect public finances

Disasters force the reallocation of government budgets and a search for supplementary revenue. Simultaneously, disasters reduce direct and indirect tax revenues by disrupting economic activity. This may take place against a background of very costly infrastructural damage to the energy sector.

The situation is further complicated in developing countries, which often have large debt-to-GDP ratios even before disasters. Many of these countries may not be able to secure funding through loans in the international market. Weak governance practices, as manifested by low government effectiveness and limited accountability and transparency of spending of public finances, reduce further the potential for a sound recovery. This places extra pressures on state-society trust, particularly in fragile states where the significant damages may be perceived and/or traced back to corrupt practices, thereby further increasing the likelihood of civil strife and conflict.

5.2.2 Ongoing post-disaster budget review

A budget review should be conducted from a recovery perspective, based on the recommendations of the post-disaster needs assessments, leading to proposals for sequencing, prioritizing, financing and implementing arrangements for the recovery and reconstruction of the energy sector. During the subsequent phase, the lead agency needs to analyse the budgets for variances from actual performance.

5.2.3 Private funds gap analysis

There are two main considerations for post-disaster budgeting:

- **How to capture the overlap between public and private financing.** Reconstruction of public goods can be financed by the public or the private sector. Private assets are almost always reconstructed by private finance.
- **How to allocate public resources for key private goods.** A significantly affected private sector may not have the resources necessary to rebuild based on BBB and principles of resilient infrastructure, some of which are considered public goods, which are critical for building resilience, and there may be a gap in private funds.

5.3 Sources of financing and financing gaps

5.3.1 Identifying sources of financing

The lead energy sector recovery agency should ensure that all funds are allocated in accordance with the national recovery priorities and with the energy sector resilience building programme, while adhering to principles of infrastructure resilience including BBB. This must be assured, irrespective of whether the funds are channelled on or off the national budgetary system.

A main challenge of post-disaster recovery is to mobilize additional resources, so that recovery is not at the expense of ongoing development processes. Depending on the nature and scale of the disaster, additional recovery funding can come from domestic or external resources as discussed below.

5.3.2 Domestic funding

In developed countries, power utilities rely on a diverse range of financial instruments:

- Reallocation among budget items away from mildly affected sectors towards more severely affected ones.
- Issuing sovereign reconstruction or development bonds.
- Levying a tax or surcharge for recovery.
- Introducing policy incentives for the private sector to share recovery costs.
- Voluntary civil society and private philanthropic contributions.
- Insurance.
- Credit-line instruments

However, most of these instruments are rarely available in developing countries. Alternatives include reserve funds, which are trust funds held specifically for contingent events that affect the electricity sector.

FONDEN - Mexico Reserve Funds[66]

In Mexico, the Natural Disasters Fund (FONDEN) is a financial mechanism that provides federal agencies and Mexican states with immediate liquidity to finance recovery from natural disasters. FONDEN has a mandate to: (i) finance post-disaster emergency assistance (through a revolving fund); and (ii) provide the 32 Mexican states and line ministries (for example, the Ministry of Infrastructure, Ministry of Health, Ministry of Education, and Ministry of Human Development) with financial resources if losses from natural hazards exceed their budgetary capacity.

FONDEN was originally established as a budgetary tool through which federal funds were allocated on an annual basis for expenditure on post-disaster response. Since then, FONDEN has evolved, with changes to its operating rules and procedures to improve its overall efficiency and effectiveness. The introduction of several additional windows has further strengthened DRM practices. In 2005, the Government of Mexico empowered FONDEN to develop a catastrophe risk financing strategy to leverage its resources, relying on a layered combination of risk retention and risk transfer instruments. In 2006, FONDEN issued the world's first government catastrophe bond, which was renewed in 2009. FONDEN now provides one of the most sophisticated disaster financing vehicles in the world – and the FONDEN system is continuing to evolve to meet Mexico's DRM financial requirements.

5.3.3 External/international sources of funding

External resources for post-disaster recovery can be sourced from multilateral development banks, regional development banks, bilateral development partners, international NGOs, private philanthropies and charities, fundraising campaigns and green climate funds. Figure 8 below shows a number of global funds.[67]

66 Fonden – Mexico's Natural Disaster Fund – A review, World Bank, 2012.
67 The enhancement of resilience to disasters and climate change in the Caribbean through the modernization of the energy sector, Studies and Enhancement Series No. 84, United Nations ECLAC Sub-regional headquarters for the Caribbean, 2020.

Figure 8 *Global funds supporting post-disaster recovery*

Entity	Description	Areas supported
Global Environmental Facility (GEF)	Through GEF-6, the World Bank's Global Environmental Facility (GEF) oversees a $1,260 million climate change mitigation fund. The GEF can support the development, adoption of policies strategies legislation regulations, capacity building and financial or organizational mechanisms that accelerate mitigation technology innovation and uptake. GEF-6 Program 1 has the goal to promote the timely development, demonstration, and financing of low-carbon technologies and mitigation options.	Energy efficiency; renewable energy; sustainable transport.
Green Climate Fund (GCF)	Guided by the United Nations Framework Convention on Climate Change, the GCF has the objective to catalyse funds to multiply the effect of its initial financing by opening markets to new investments from the public and private sectors. It aims for a 50:50 balance between mitigation and adaptation investments over time. According to the GCF, only revenue generating activities are candidates for funds. Its other criteria for funding are: (i) impact result potential (to fund's objective), (ii) paradigm shift, (iii) needs of the beneficiary country, (iv) country ownership and institutional capacity, (v) economic efficiency of the project, and (vi) financial viability for revenue generation) (GCF, 2016)	Low-emission energy access and power generation; low-emission transport; energy efficient buildings, cities and industries, sustainable land use and forest management; enhanced livelihoods of the most vulnerable people, communities, and regions; increased health and well-being, and food and water security; resilient infrastructure and built environment to climate change threats; and resilient ecosystems.
Carbon War Room (CWR)	The Carbon War Room aims at providing market-based solutions to climate change and focuses on solutions that can be implemented using proven technologies under current policy landscapes. CWR often participates in projects or operations where goods and/or services are procured by an entity or government. The CWR launched the Ten Island Challenge to accelerate the transition of Caribbean island economies from heavy dependence on fossil fuels to renewable resources. This project intends to reduce CO2 emissions and costs from the Caribbean islands. It was also designed to increase private investment on the islands, improve energy efficiency, and reduce each island's dependence on imported fossil fuels.	Renewable, distributed electricity; the energy efficiency of freight and trucking buildings; and fuel-efficient ships.
OPEC Fund for International Development Energy	The Organization of the Petroleum Exporting Countries (OPEC) established the Fund for International Development (OFID) in 1976 in order to stimulate economic growth and alleviate poverty in developing countries. OFID's resources consist of voluntary contributions made by the organization's member countries and the accumulated reserves derived from its various operations. In order to optimize the impact of its contributions, the OFID cooperates with bilateral and multilateral agencies of its member countries, the regional development banks, the World Bank Group, and the specialized agencies of the United Nations as well as a host of NGOs.	Transportation; finances; agriculture; water and sanitation; industry; health; telecommunications; and education.

Source: The enhancement of resilience to disasters and climate change in the Caribbean through the modernization of the energy sector, Studies and Enhancement Series No. 84, United Nations ECLAC Sub-regional headquarters for the Caribbean, 2020.

An increasing number of investors are also interested in the ecological and social benefits of their investments, in addition to the financial return on investments. Pre-disaster plans for Building Back Better and more resilient infrastructure should be complemented by reaching out to such investors for potential funding. Identifying and establishing such relationships before a disaster would make it much easier to engage investors in the recovery process for the energy sector, based on BBB and resilience-building principles.

The case for building an energy sector in Vanuatu[68]

There is no real infrastructure – including drinking water, sewage networks and electricity – on several of the 61 inhabited islands of Vanuatu. Electricity is very important for achievement of many of the SDGs. Approximately $12 million would be needed to electrify all the inhabited islands of Vanuatu.

UNDP Pacific is working with local governments and the private sector to put together a portfolio based on innovation, transparency and trust to attract ecological and social impact investors. Innovation is needed to create renewable energy solutions based on tailored technologies and business models aligned to the context of the rural situation (such as solutions combining the simplicity of solar home system with the power of a mini grid). Transparency will show investors that the technologies run, the business model works and the impact is right: this can be done through cloud-based monitoring systems as used on Lelepa (one of the islands of Vanuatu). Trust will enable difficulties to be faced openly and a long-term approach to be promoted.

5.4 Coordination and allocation of financial resources

Experience has shown that if governments do not establish an extensive financial framework for the recovery in the short, medium and long terms, only short-term interventions will tend to have enough funding for implementation. However, medium- and long-term recovery programmes are equally important for sustainable recovery and for ensuring resilient energy infrastructure.

Therefore governments should ensure that they establish complete financial frameworks with predictable and multi-annual funding that is aligned with the sectoral recovery and resilience building programmes.

Funds from the private sector and NGOs (outside the government budget) are critical for recovery, as in many instances government funding is not sufficient. The programmatic approach can help coordinate funding sources, ensure communication among different sources of funds, and ensure that monies spent do not duplicate efforts. For example, private sector funds may be allocated to a specific sector or area and funds coming from NGOs could be allocated to social needs.

An important step toward fulfilling recovery objectives is setting up financial systems that allocate and disburse funds from one level of government to another and/or communities or systems that manage external resources. In large-scale disasters, external resource flows usually are significant. Therefore, recovery financing will likely be managed through both the government's budget (on-budget) and off-budget funding. The financing systems should be set up to respect transparency, accountability and integrity, in particular to control the risks of corruption.

68 How to Scale Impact: Thinking Big, A. Medici, 2020.

5.5 Management and tracking mechanisms – auditing, monitoring and oversight

Determining which monitoring system is most appropriate depends on the magnitude of the disaster, the number of actors engaged in recovery spending, the quality of their reporting, and the existing capacity of the national agency responsible for it.

An important aspect of fund tracking is to identify where there are surpluses and deficits in financing. These gaps or excesses can be sectoral as well as geographical. Key benchmarks for the financial monitoring and evaluation system are the production of timely and comprehensive estimates of:

- Funds allocated and spent covering all sources: domestic, international, public, and private
- Recovery progress
- Economic and social impacts.

Auditing and monitoring oversight is designed at three levels.

- The highest level is overall recovery programme monitoring.
- Programme-level monitoring builds on sector-level monitoring, which consolidates the reporting of each sector.
- At the lowest level is monitoring of individual projects.

The auditing and monitoring system should be designed to integrate oversight at all three levels. Special additional systems may be required to monitor inflows, and the use and impact of recovery financing.

Both internal and external audits are required because they serve different purposes.

- The scope of an external audit is much more defined with a set end. External audits typically focus on the accuracy of historical financial statements, or focus after the fact on a distinct event and ask the question, "What, if anything, went wrong in managing recovery expenditures?"
- The scope of an internal audit is broader and more open-ended.[69] They focus on an ongoing process and assess risks and controls to answer the question, "What could go wrong in managing recovery financing at various levels?"

A government must ensure that resources are spent for their intended purposes. It must also ensure that sufficient resources are allocated to the sectors and projects in need, and that the amount of financing distributed is proportionate to the needs of recipient sectors or projects.

69 Good Internal Control and Auditor Independence, M. Locatelli, The CPA Journal, 2002.

The use of monitoring, reporting and verification of climate change tools[70]

Pre-disaster transparent, easily accessible and tracking systems – including those used for facilitating sectoral climate change reporting – may be contextualised to the case of recovery reporting. For example, the Ministry of Environment and Forestry developed Kenya's Monitoring Reporting and Verification (MRV) system to facilitate climate change reporting by sectors, as required by the Climate Change Act, 2016. Kenya's MRV system allows the following to be tracked and reported at both national and international levels:

1. The implementation and impacts of mitigation actions, including the national greenhouse gas inventory, to enable tracking of progress on implementing and achieving the mitigation component of the NDC.
2. The implementation and impacts of adaptation actions, including information related to climate change impacts, vulnerabilities and adaptation.
3. Climate finance flows: external support (finance) needed and received towards these actions, including information on financial, technology development and transfer, and capacity building needs and support received from developed countries. Such support could be financial, technology transfer or capacity building.
4. SDG impacts based on the UNDP Climate Action Impact Tool (CAIT), also known as the UNDP SDG tool.

The adoption of such tools would also enable tracking, and reporting to donors, including of environmental, social and gender considerations associated with the use of the recovery funds.

Combined monitoring of projects and impacts on beneficiaries – the case of FFS Iraq[71]

Monitoring of recovery efforts should include completion rates of projects, together with the profile of the beneficiaries and the impact of projects on beneficiary population. The Funding Facility for Stabilization (FFS) supports the Government of Iraq to stabilize areas liberated from ISIL. In June 2015, based on a commitment of the international community, UNDP established the Funding Facility for Immediate Stabilization (FFIS) to provide rapid stabilization assistance across four areas of work, or "windows". The four windows, identified as critical to facilitate the return of internally displaced persons and to restore trust between the government and the people, are: (1) public works and light infrastructure rehabilitation; (2) livelihoods; (3) capacity support to local governments; and (4) social cohesion. Progress against set targets has been steady and consistent.

A strong, multi-layered monitoring mechanism is in place on the ground during the implementation phase to closely supervise contracted work and ensure: (i) progress against timelines; (ii) quality of work; and (iii) adherence to bill of quantities standards and specifications. The monitoring mechanism includes FFS engineers, specialized monitors, government/end-user oversight and third-party in-depth monitoring.

The monitoring also includes: (a) cumulative accrued benefits (2015-2021); (b) disaggregated beneficiaries according to gender; (c) completed projects by sector; and (d) the impact of the projects in terms of the successful return of internally displaced persons and severity of conditions. It is worth noting that the last indicator is based on combining data from two United Nations agencies.

It is critical to establish a tracking system very early to ensure that funds are spent on the intended purposes. The tracking system should capture how aid flows at the individual sector level as well as project level. An effective aid tracking system should incorporate the tracking of multiple streams of funding, including public sources, donor funds (on- and off-budget), private sector contributions, and NGO sources.

70 Monitoring, Reporting and Verification Tool of Kenya, Nairobi.
71 Funding Facility for Stabilisation 2021 Annual Report, UNDP Iraq, 2022.

5.6 Checklist

This checklist summarizes the key steps required to mobilize and manage resources towards resilient recovery of the energy sector. Furthermore, Annex 1 provides sample Sectoral Recovery Budget Lines and Associated Project Categories that can also act as further checks that important energy recovery considerations are being allocated funds and accounted for.

Ministry of energy, regulatory body and ministry of finance

- Conduct funding gap analysis and budget review.
- Identify domestic sources of funding.
- Identify external sources of funding.
- Organize an international appeal or donor conference to access international funding for building a resilience energy sector based on renewable energy.
- Define a mechanism to manage inflow of funds, disburse funds between levels of government, or directly to communities or systems, in order to promote BBB and the use of renewable energy.
- Coordinate and allocate funds.
- Set up a system for aid budget monitoring and tracking.
- Strengthen the public financial management system.
- Engage independent external third-party auditing services and establish an effective internal audit function

Private sector, CSOs and NGOs

- Prioritize funding recovery solutions based on BBB and renewable energy.
- Where applicable, access green climate recovery and investment funds.

6 Implementation arrangements

6.1 Standard implementation procedures

Existing project approval, procurement, reporting and staffing procedures in the country may need to be simplified to meet the pressing demands of the recovery process, while adhering to best practices of accountability and transparency. In some cases where state-society trust is weak, standard implementation procedures present an opportunity to improve this trust.

Often recovery projects are stalled due to lengthy bureaucratic procedures for project approval and procurement. Even if fast-track approval processes exist, at times responsible officers are reluctant to use them due to perceptions of corruption. The authority given to the ministry of energy by the government can play a critical role in promoting the use of simplified procedures and processes across all sectors and entities for more rapid implementation.

The ministry of energy should be seen as the main implementing body. To do so, its capacities may be enhanced as discussed earlier, partly through the establishment of a PMU to oversee and coordinate all implementation efforts. Where there is weak government capacity, the international donor community can agree on an external implementing agency to quickly implement important recovery projects, while also building the capacity of the ministry of energy (and other relevant government institutions as necessary) for handover, including on operation and maintenance, to sustain recovery gains.

FFS Iraq as an implementation mechanism[72]

The FFS is not only a multi-donor facility for funding the recovery of severely damaged areas in Iraq. It is also an implementation mechanism to implement projects across four windows, while accounting for gender and sustainability best practices, and adhering to international best practices for transparency and accountability.

Since 2015, the FFS project has implemented thousands of infrastructure projects across the housing, water, wastewater, roads and bridges, municipal, health, education and electricity sectors. This has led to significant improvements in the lives of the Iraqi people.

For example, in Mosul alone, 40 substations were completed between 2017 and 2021, making a tremendous difference for the city. In 2017, the electricity grid was largely out of order, while by the end of 2021, Mosul was receiving an average of 12-23 hours of electricity per day in summer, and 8 hours per day in winter (the remaining shortages are largely due to a shortage of power supply rather than to the distribution network).

6.2 Resilience building standards and best practices

In Table 2, the six main principles for building infrastructure resilience were explained, together with example activities and expected benefits under each principle. These are i) adaptive transformation, ii) environmental integration, iii) protection by design, iv) social engagement, v) shared responsibility, and vi) continuous learning.

As the recovery moves into the implementation phase, the above six principles need to be translated into practical recovery and reconstruction standards. Local stakeholders from both the government and civil society – including international donors, international implementing agencies, national and international NGOs and the private sector – can work together to detail these standards. In most cases, this entails selecting the most appropriate best practice guidance and/or construction and retrofitting standards. Special care must be taken to account for the

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exposure, vulnerability, and capacity and risk specificities of the location in the country/city under consideration (for example, small island developing states' higher exposure and vulnerability to cyclones in the near term and to sea level rise in the mid-to-long terms).

Reconstruction standards can also cover implementation mechanisms

Reconstruction standards (related mainly to the third principle of Infrastructure resilience in Table 2, namely protection by design) are specific to the natural hazard under consideration and the infrastructure component of the energy sector as shown in Figure 1. It is recommended that governments prepare pre-disaster reconstruction standards and criteria as part of their energy sector infrastructure resilience building programmes.

Ensuring compliance with reconstruction standards during the implementation phase is key to resilient recovery and to building the resilience of the energy sector in general. To ensure compliance, construction monitoring teams (CMTs) could be established by the lead agency to monitor technical aspects of both the inputs and outputs of reconstruction. In addition to alerting the relevant authorities of any missteps or lack of adherence to standards by the implementers, the lead agency should also support implementation entities to correct their procedures.

Best guidance for adhering to the principles of infrastructure resilience

In addition to the above, the recovery process should abide by all the principles of infrastructure resilience, as elaborated in Table 2. For example, after an earthquake, the recovery process must conform to appropriate seismic safety (Principle 3 *protection by design*), technological standards (Principle 1 *adaptive transformation*), and environmental standards (Principle 2 *Environmental integration*). The recovery process could also try to promote the use of renewable energy as a percentage of power generation ability of the country (Principle 2 *Environmental integration*). The recovery process should also ensure that first consideration is given to local resourcing of materials and technical expertise (Principle 4 *Social engagement*). There is a need to ensure that all best practices for promoting all the principles of infrastructure resilience have been identified by the government in advance.

6.3 Recovery adapted procurement, including e-procurement

Recovery-specific procurement considerations include: i) pre-arranged procurement; and ii) fast-track procurement. As part of the pre-disaster resilience building programme for the energy sector, these procurement systems should be put in place after validation.

Pre-arranged procurement

Pre-arranged procurement pre-establishes a list of qualified contractors. This list can be categorized by type of expertise and competencies, and must ensure that the contractors are able to deliver based on the infrastructure resilience building principles. Having a prequalifying system in place expedites the issuing of contracts and evaluation of tender responses. A pre-qualifying system also eliminates inexperienced contractors, unable to adhere to infrastructure resilience principles, who will therefore significantly underbid other contractors mainstreaming infrastructure resilience principles.

Fast-track procurement

Fast-tracking procurement means using simplified, agreed tender and purchasing processes to quickly get goods and services to the areas in which they are needed. Fast-tracked procurement systems may also be used by both the private sector and NGOs. To facilitate oversight and monitoring, all stakeholders would need to share some of the same procedures. As part of the third-party audit, procurement needs to be scrutinized closely.

Environmental, social and governance (ESG) procurement

The demand for fast-track procurement should ideally not lead to a neglect of abiding by best practice guidance and regulations on ESG. This is more likely to be possible in the wake of a disaster if there are already mechanisms in place for enforcing ESG procurement principles prior to the disaster. One such mechanism is the EU good practice on Green Public Procurement (GPP) or green purchasing.[73]

6.4 Government coordination and local implementation

A tiered implementation that balances national government policy setting (through the national resilience programme for the energy sector) with implementation at local level is recommended. Programmes should be implemented at local level, closest to the affected communities and individuals. The lead agency is responsible for establishing and overseeing the coordination mechanisms that guarantee coherent policy application and effective implementation at the regional and local levels, including assigning different areas of recovery to governmental or nongovernmental agencies based on their areas of expertise.

Mechanisms should cover implementing agency coordination at the vertical (national government and local administration) and horizontal (private sector, NGO, and CSO) levels. The PMU at the ministry of energy, in liaison with the national recovery agency and the respective focal points represented on the national recovery committee, can set up different types of coordination mechanisms, depending on the type of coordination and stakeholders. These include:

- National and local government coordination to ensure common understanding of energy recovery vision, objectives, policy, principles and programmes. Such coordination also provides local governments with access to national decision makers, thereby giving them the opportunity to provide updates on the required human and financial resources as well as progress and challenges.
- Inter-ministerial coordination, which is required to ensure a common vision on the cross-sectoral recovery principles including: i) infrastructure resilience principles and BBB, ii) climate change adaptation, iii) inclusivity, iv) avoidance of reintroduction of stranded assets, and v) reducing the energy intensity of the economy. This form of coordination also ensures common understanding with the ministries implementing the energy sector recovery programmes and projects on: i) the vulnerability and resiliency of the network components, ii) redundancy weak and strong points across the network, and iii) the energy recovery policy vision, objectives and principles.
- Donor coordination, which can be accomplished by the lead agency assigning a donor lead responsibility for specific sectors or projects. This coordination is also important for reporting on progress and for reassuring donors that recovery projects are being implemented in a transparent and accountable manner, while adhering to best practices and principles.
- Public and private sector coordination, to ensure common understanding of weak and strong network redundancy points across the network. This also ensures proper understanding of the vulnerability and resiliency of the various network components to various hazards and to systemic risks.
- Coordination of renewable- and fossil-fuel-based, private and public stakeholders (owners, operators and regulators) to ensure common understanding of: i) weak and strong network redundancy points; ii) the vulnerabilities and resilience of the various network components; iii) the most suitable locations for applying innovative technologies for electricity generation; and iv) options and potential of network at various locations to benefit from additional generated power from various innovative technologies, including modular technologies

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- Community-based NGOs and CSOs, to ensure common understanding of: i) weak and strong network redundancy points in their areas of work; ii) the vulnerabilities and resilience of the various network components in their areas of work; iii) the most suitable locations for applying innovative technologies for electricity generation in the communities they serve; and iv) cascading vulnerability at community and household level due to interruption of energy services.

A country with a history of centralized power could benefit from centralizing implementation within a single agency, because the agency is likely to have stronger capacities than those at local levels. In countries that are effectively decentralized and where fiscal capacity is strong at local levels, local implementation is likely to be the best solution.

Local decision-making empowers the implementing agencies and creates greater ownership of the decisions among affected communities. Governments of countries that have decentralized forms of governance by law but have not yet reached full operationalization of the decentralization should also be wary of devolving too much responsibility to the local levels. For instance, the law may provide for fiscal decentralization but in reality, transfers from central to local governments may be inexistent or incomplete, and local fiscal capacity weak.

Local implementation helps to build community ownership of the recovery process. Involving people and communities on the ground will empower them and provide them with opportunities to find local solutions to local problems. Additionally, local implementation could build, if necessary, the capacity of implementing agencies to manage small- to large-scale projects.

6.5 Community participation

Even though the energy sector is usually capital intensive, renewable and innovative technologies enable households and communities to invest in energy generation.

At the household level, disasters are an opportunity to Build Back Better. This includes the rehabilitation and reconstruction of housing units to be more energy efficient. It also includes investment in renewable energy for individual houses and buildings.

At the community level, this may also include investment in innovative renewable modular technologies and micro grids that can act independently of the overall network. This can be particularly useful in SIDS and in remote rural areas. Opportunities for communities to participate in the rehabilitation and reconstruction of the energy sector are not limited to contributing to the community grid (whether it is independent or part of the local network). They also include investing in renewable energies for community-based infrastructure. Finally communities have a major role to play in lobbying and advocating for the use of cleaner renewable energies. This is particularly the case for vulnerable communities whose land, air and/or water resources and livelihoods are increasingly vulnerable due to the use of non-renewable energy generation plants.

Making the case for community resilience microgrids[74]

Community resilience microgrids are designed to serve multiple customers located within a community – a neighbourhood, district, or local government jurisdiction. Their primary purpose is to provide emergency power during periods of utility power grid outages. While potentially serving the needs of both public and private entities, these microgrids must be connected to utility distribution networks and be capable of some level of safe islanding. They are dedicated primarily to public purposes such as emergency shelters, critical infrastructure, or vital community services. The growing interest in community resilience microgrids is reflected in an 8.8 percent compound annual growth rate for North America.

For example, Princeton University Microgrid was built as a campus/institutional microgrid, and comprises a 15 MW combined heat and power (CHP) plant that supplies the university with approximately 50 percent of its annual electricity consumption, and all of its steam and chilled water, a 4.5 MW solar PV farm that supplies 6 percent of annual consumption, a 2.6 million gallon thermal water storage facility, and backup diesel generators available to black-start the CHP plant during outages. During Superstorm Sandy, the grid served as a place of community refuge for days with first responders, students, and other community members using the campus for shelter and critical electric power.

6.6 Enabling environment for the role of the private sector

The private sector plays a significant role in the recovery and reconstruction process: i) it designs the structures and infrastructure that are built; ii) it supplies the materials that enable reconstruction; and iii) it performs the construction itself. Therefore, participation of the private sector in recovery planning and operations is paramount to ensure that resilience building principles and BBB are adhered to. The private sector can play three roles in disaster recovery:

1) A formal relationship that links private entities to the official response and recovery institutions in the form of public-private partnerships (PPPs). PPPs can be fostered and the relationships built as part of the energy sector resilience building programme, which can then automatically continue to be used for disaster recovery. The benefits of PPPs include:

- PPPs enhance the government's and the private sector's ability to recover from financial losses; loss of market share; and damage to infrastructure, equipment, products, or business interruption by assembling resources and forces and making preparedness a win-win option. In this sense, PPPs also help countries and cities recover their regional/global role, including in regional and global supply chains.
- PPPs facilitate the government's job by making compliance with regulatory and safety requirements, and infrastructure resilience principles, everybody's business.
- PPPs can also increase oversight to prevent corruption, which is a major risk in the wake of a disaster, and is also a major driver of future disaster risk.
- PPPs reinforce social bonds among community members, local governments, and the business community.

Expert and industry associations – such as those for engineers, agriculturalists, and educators – can serve as focal points for expert advice on recovery and reconstruction planning. The expert and industry associations can evaluate tenders and contracting bids, and act in other positions that require widespread industry knowledge. Regarding tenders, the associations can provide an increased level of transparency and fairness to the selection process. Both are particularly useful when the influx of donor money makes tender selection a contentious issue.

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Engagement with such professional associations should have started as part of efforts to raise awareness and build capacities to develop and implement the pre-disaster resilience building programme for the energy sector.

6.7 Monitoring and evaluation mechanisms

Monitoring and evaluation (M&E) systems can be used to track both funding and programme implementation. To be functional, a monitoring and evaluation process requires proper data collection and a computer-based management system with associated staff to manage and monitor the recovery programmes. The system should also be able to provide information on how the recovery interventions are contributing to national policies and strategies, particularly the pre-disaster resilience building programme of the energy sector. A digital M&E platform is an efficient, effective and transparency-building tool; however, in certain fragile and post-disaster contexts, digital data collection and collation may pose challenges. Finally, the system should track not only the recovery programmes managed by the government, but also those of the various partners. This is particularly important to demonstrate how all efforts are feeding into the resilience building programme.

Importantly, monitoring and evaluation mechanisms provide substantive inputs into the periodic evaluations that donors require to continue funding projects. Establishing an M&E system involves defining: i) what to monitor and evaluate (activities and outcomes); ii) when to monitor and evaluate (timing and frequency); iii) how to monitor and evaluate (tools and indicators); iv) who will monitor and evaluate; and v) how to use the results. An effective M&E system for recovery should be able to:

- Track the physical progress of reconstruction activities and how they relate to the resilience building programme.
- Track the results of other recovery activities outside the scope of reconstruction.
- Provide regular and comprehensive information on allocation and disbursement of funds, both public and private.
- Provide data for financial and Environmental, Social and Governance (ESG) audits of the recovery programmes.
- Inform an outcome-based mid-term review of recovery implementation.

The existence of a pre-disaster M&E system to oversee implementation of the national resilience building programme for the energy sector helps to ensure that M&E systems will be mobilized properly in the post-disaster recovery implementation phase.

Finally, to increase transparency, grievance response mechanisms should be created. These enable the various stakeholders in the recovery process, as well as communities that benefit from it, to express themselves on what works and what does not, and to reflect on how to adopt corrective measures. Grievance reporting should not be limited to reporting on corruption and lack of transparency/accountability. Instead, it should include the ability to report grievances related to not abiding by the infrastructure resilience building principles including BBB. To this end, as part of the awareness raising and communication strategy of the recovery, affected communities and all stakeholders should be familiar with these resilience building principles.

6.8 Consolidating transparency and accountability

One of the challenges in implementing a recovery programme is to control corruption and increase transparency. These two goals require the institution of an audit system. In addition to the traditional public auditing of procurement and disbursements, the audit should also include an Environmental, Social and Governance (ESG) audit on the recovery process itself and the delivered benefits. In most countries, financial audits of accounts and expenditure are well-established. However, ESG audits are relatively new, evolving concepts. Building the capacity of relevant stakeholders (including the private sector, NGOs and professional associations) to carry out ESG audits should form part of pre-disaster preparedness efforts to develop and implement resilience building programmes for the energy sector. The ESG audit should engage all stakeholders, including NGOs, homeowners, donors, and the implementing agency. Finally, the transparency and accountability process should be reinforced by third-party financial and ESG audits.

6.9 Communication strategy

Throughout the recovery process, maintaining ongoing dialogue and sharing information, through regular meetings, with all other stakeholders and partners in the recovery results in several benefits. These include: i) consolidating state-society trust; ii) reassuring the international donor community; iii) contributing to the transparency of recovery; iv) building credibility and consensus on recovery goals; v) identifying coverage gaps and project overlaps; vi) creating a space for an open discussion and feedback among multi-stakeholders; and vii) serving as a mechanism by which to redress grievances.

Internal communication should include all stakeholders directly involved in the recovery process, using a variety of mechanisms such as: i) a dedicated internal information-sharing website that includes access to the M&E database; ii) peer dialogues among government agencies; iii) focus group discussions with communities; and iv) policy dialogues with donors.

Existing internal communication systems set up before a disaster as part of the effort to develop and implement a resilience building programme for the energy sector may be modified and used to create an internal communication system adapted to the recovery needs once a disaster strikes.

An effective public communications strategy can raise awareness of the recovery effort among the general public, both nationally and internationally, particularly in donor countries. Part of the communication strategy should be to stress the adherence to BBB and resilience infrastructure principles, and it should also inform public expectations on the scope and timeframe of the recovery.

Finally, by recognizing the visible signs of early physical recovery and announcing longer-term goals related to building the resilience of the energy sector, an effective public communications strategy can keep the entire recovery community and the general public galvanized for subsequent phases of recovery and reconstruction.

6.10 Checklist

This checklist summarizes key steps required to expedite the implementation of recovery projects and programmes, while adhering to the main principles for building the resilience of the energy sector.

Ministry of energy, regulatory body and main recovery agency

- Set up and run different coordination mechanisms. Coordinate responsibility for recovery across the national government, local government, donor, civil society, and community levels
- Include civil society, the private sector, affected communities and NGOs in the recovery process and build their capacity on BBB, renewable energy and infrastructure resilience principles.
- Establish standard procedures for project approval, procurement, e-procurement, reporting, and contracts.
- Define state-of-the-art reconstruction standards to be used, ensuring they are based on BBB; and ensure that all infrastructure resilience principles are being recognized and adhered to as per best practice guidelines.

- Set up rapid procurement procedures, including e-procurement and green procurement, while adhering to transparency and accountability standards.
- Support decentralized implementation of the recovery activities, while building capacity at local level.
- Establish good internal communication among recovery partners. Discourage recovery actors from working in isolation and raise awareness about the existing/to-be-developed infrastructure resilience programme for the energy sector.
- Raise awareness of recovery progress through effective public communication. Set clear and realistic goals to minimize unrealistic expectations and provide a grievance redress mechanism to communities.
- Ensure transparency and accountability in all activities linked to the recovery programme.
- Promote third-party financial and social audits.
- Monitor and evaluate the recovery projects.
- Propose mid-course corrections for improving recovery activities.

Private sector, CSOs and NGOs

- Build capacity and raise awareness on BBB, renewable energy and infrastructure resilience principles for the energy sector.
- Build capacity and raise awareness on the existing/to-be-developed infrastructure resilience programme for the energy sector.
- Independently monitor and evaluate implementation and adherence to BBB, renewable energy promotion and infrastructure resilience principles.

7 Tools and resources

7.1 International agreements and normative instruments

- Sendai Framework for Disaster Risk Reduction, United Nations, 2015.
- The COP21 Paris Agreement on Climate Change, United Nations, 2015.
- The 2030 Agenda for Sustainable Development, United Nations, 2015.
- The New Urban Agenda, United Nations, 2016.
- Agenda for Humanity, United Nations, 2016.
- Addis Ababa Action Agenda of the Third International Conference on Financing for Development, United Nations, 2015.
- Small Island Developing States Accelerated Modalities of Action (Samoa Pathway), United Nations, 2015.

7.2 Policy briefs, technical notes, manuals and guidelines

- National Disaster Recovery Framework, 2nd edition 2016, Homeland Security, U.S.A.
- Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility, 2021.
- Emergency Response and Recovery, Non statutory guidance accompanying the Civil Contingencies Act 2004, 2013, United Kingdom Government.
- Aligning NDCs with Green Recovery, Guidance Framework, UNDP 2022.
- The Rise Framework Executive Summary, World Bank 2022.
- Green Recovery for Practitioners Fiscal Policies for a Sustainable, Inclusive and Resilient Transformation, GIZ 2021.
- Guide to Engaging Local Actors in Disaster Recovery Frameworks, IRP 2019.

7.3 Reports and publications

- Global Assessment Report on Disaster Risk Reduction 2022, UNDRR 2022.
- Rebuilding for a Resilient Recovery Planning in California's Wildland Urban Interface, NEXT10 2021.
- GAR Special Report on Drought 2021, UNDRR, 2021.
- A Green and Resilient Recovery for Europe, EU Working Paper 2021.
- Literature Review on Law and Disaster Recovery and Reconstruction, IFRC 2020.
- Sustainable Energy for Disaster Resilience - Cyclone Fani Response 2019, SEEDS 2020.

- Global Assessment Report on Disaster Risk Reduction 2019, UNDRR, 2019.
- Disaster Recovery Framework Tropical Cyclone Winston, 2016.
- Lao PDR Strengthening institutional capacities for resilient recovery Country Case Study Series, Disaster Recovery Framework Guide, IRP 2014.
- Mozambique Recovery from Recurrent Floods 2000-2013, Recovery Framework Case Study, IRP 2014.
- Pakistan Earthquake 2005 The Case of Centralized Recovery Planning and Decentralized Implementation, Country Case Study Series, Disaster Recovery Framework Guide, IRP 2014.
- Philippines Typhoon Yolanda Recovery, Recovery Framework Case Study, 2014.
- Senegal Urban Floods, Recovery and Reconstruction since 2009, Recovery Framework Case Study, IRP 2014.
- Yemen Tropical Storm, October 2008, Recovery Framework Case Study, IRP 2014.
- The Great East Japan Earthquake 2011, Recovery Status Report, IRP 2013.
- Driving transformational climate action and green recovery in MENA, Middle East and North Africa Climate Roadmap (2021-2025), World Bank, 2021.
- Nsanje District Floods 2012 Disaster Impact Assessment & Transitional Recovery Framework, Recovery as a Means to Resilience, UNDP, GFDRR, 2012.

7.4 Websites and platforms

- United States Department of Energy Efficiency and Renewable Energy Network (EREN) www.eren.doe.gov
- Center for Energy Efficiency and Renewable Energy (CEERT), www.cleanpower.org
- National Renewable Energy Laboratory (NREL), www.nrel.gov
- Renewable Energy Policy Project (REPP), www.repp.org
- CADDET Renewable Energy, www.caddet-re.org
- Clean Energy Basics NREL, www.nrel.gov/clean_energy/
- European Renewable Energy Exchange (EuroREX), www.eurorex.com
- Planet Energy – The Renewable Energy Trail, www.dti.gov.uk/renewable/ed_pack/index.html
- Solstice, Center for Renewable Energy and Sustainable Technology (CREST), http://solstice.crest.org
- Prevention Web, PreventionWeb.net: the knowledge platform for disaster risk reduction
- International Energy Agency, IEA – International Energy Agency
- International Recovery Platform, International Recovery Platform | IRP (preventionweb.net)
- Global Facility for Disaster Reduction and Recovery, GFDRR

- European Union countries' recovery and resilience plans, European Union countries' recovery and resilience plans | Bruegel
- Global Health Security Index, Report & Data - GHS Index
- Inform Risk, Early Warning and Severity tool, INFORM - Global, open-source risk assessment for humanitarian crises and disasters (europa.eu)
- Learning for a Green Recovery, Learning for a Green Recovery | PAGE (un-page.org).
- Relief Web, ReliefWeb - Informing humanitarians worldwide.

Annex 1

Project title: Sample Country X Recovery Budget Lines and Sample Project Categories

Project executing department: **Project implementation period:**

Departmental Budget Line			Year 1			
			Budget	Expenditure		Reporting period balance
10	**Budget Code**	**PERSONNEL COMPONENT**		**Actual**	**Committed**	
		Project personnel				
		Energy Sector DRF Coordinator				
		Sub-total				
		Consultants/staff				
		Infrastructure resilience building				
		Renewable energies				
		Stranded assets				
		Gender and vulnerable groups				
		Monitoring, tracking and reporting				
		Sub-total				
		Administrative support				
		Administrative assistant				
		Others (add as necessary)				
		Sub-total				
		Component total				
		SUB-CONTRACT COMPONENT				
		Sub-contracts (MOUs/LOAs for supporting organizations)				
		Sub-total				
		Sub-contracts (for commercial purposes)				
		E.g. Printing of outreach materials				
		Sub-total				
		Component Total				
30	**TRAINING/WORKSHOP COMPONENT**					
		Trainings				
		Infrastructure resilience building				
		Renewable energies				

Departmental Budget Line			Year 1			
			Budget	Expenditure		Reporting period balance
		Stranded assets				
		Gender and vulnerable groups				
		Monitoring, tracking and reporting				
		Sub Total				
		Meetings/conferences				
		Meetings for monitoring project progress				
		End of project review workshop				
		Sub-total				
		Component Total				
40	**EQUIPMENTS & PREMISES COMPONENT (PROCUREMENT)**					
		Non-expendable equipment				
		Project office expenses				
		Utilities				
		Sub-total				
		Component Total				
50	**Travel of personnel**					
		Travel (international, domestic, per diems)				
60	**MISCELLANEOUS COMPONENT**					
		Operation and maintenance of equipment				
		Vehicle costs (maintenance and fuel)				
		Sub-total				
		Reporting Cost				
		Compilation, production and publication costs				
		Sub-total				
		Sundry				
		Internet and communication costs - internet, telecoms and courier				
		Sub-Total				
		Monitoring and evaluation/ financial audits				
		Monitoring and evaluation				
		Financial audits				
		ESG Audits				

Departmental Budget Line			Year 1			
			Budget	Expenditure		Reporting period balance
		Component Total				
	SUB TOTAL USD					
		Project support costs X %				
	GRAND TOTAL USD					

Energy Sector Recovery - Activity budget - Summary all projects	2023			
OUTCOME 1. People in the Country have better access to affordable, renewable energy (related to UNCT Sustainable Development Framework Outcome)	Budget	Expenditures		Balance at end of reporting period
Output 1.1 More resilient energy infrastructure to natural and man-made shocks		**Actual spend**	**Committed/ obligations**	
1.1.1. Projects to enhance abiding by infrastructure resilience principles				
1.1.2. Projects to increase percentage of renewables in the energy portfolio				
1.1.3. Project to increase accessibility and inclusiveness of energy sector services				
1.1.4 Projects to increase reliance on innovative technologies				
1.1.5 Projects to decrease risk of stranded assets				
Output 1.2 add as necessary				
1.2.1 add as necessary				
5. REPORTING COSTS (below are examples)				
5.1 Translation costs				
5.2 Printing costs				
6. PROJECT MANAGEMENT COSTS				
6,1				
Add items (and rows) as necessary				
7. MONITORING AND EVALUATION/ FINANCIAL AUDITS/PROJECT SUPPORT COSTS				
7.1 Monitoring and evaluation				
7.2 Financial audits				
7.3 ESG Audit				
Total USD				

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