Safeguarding NDC Implementation: Building resilience into energy systems

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This short brief aims to enhance awareness and highlight the importance of integrating weather and climate-related risk into the planning stages of energy infrastructure development. As countries are developing long-term low-carbon development strategies and pursue mitigation measures as part of their Nationally Determined Contribution (NDC), ***it is essential to increase understanding about the need to identify and assess climate-related risks when appraising new energy projects or managing infrastructure portfolios****. Taking into consideration the potential risks of climate change will improve the response rate of the energy system to environmental stresses while safeguarding investments into mitigation efforts and the integrity of energy assets and systems.*

Introduction

Climate change presents both opportunities and risks for the energy sector. There will be growing demand for clean, renewable and low-emission energy infrastructure that helps achieve national greenhouse gas (GHG) emission reduction targets laid out in countries' NDCs. Likewise, financial institutions are increasingly interested in investing in sustainable and efficient energy infrastructure, providing vital opportunities to attract financing for NDC implementation (Climate Finance Advisors, 2017). However, the increased frequency and severity of extreme weather events may disrupt supply, alter demand patterns (e.g., increasing peak demand for cooling during heat waves) and potentially damage energy infrastructure. Traditional design thresholds have been developed according to historical environmental conditions and stresses. The increasing probability of failures due to outdated design standards and codes based on past experience will jeopardize safe and efficient operation of energy systems and will likely lead to a reduced asset life expectancy, higher operating costs, lost revenue and long-term delivery disruptions (Acclimatise, Climate Finance Advisors, & Four Twenty Seven, 2018).

Bankable project proposals typically include:

- A strong feasibility study showing high probability of success
- A tailored financial model indicating adequate future cash flows
- A superior risk mitigation plan, where mitigation measures are implemented and risks are allocated to appropriate parties (International Renewable Energy Agency, 2018)

To ensure bankability and attract private capital for NDC projects as well as the integrity of future energy systems, it is imperative to fully understand asset vulnerability and the potential effects on revenue. Unless donors, investors and lenders are satisfied with the risk profile or riskiness of a project, they are unlikely to make an investment. Often, the bankability of a project is determined at the development and planning stages of a project, putting early risk assessment at the centre of bankability (Rana, 2017). Identifying and quantifying the risks arising from physical changes expected to occur as the planet warms must be a critical part of the traditional risk assessment and management process. Likewise, incorporating climate-related risks during the planning phase will strengthen the case for investors and lenders.

The Intergovernmental Panel on Climate Change Fifth Assessment Report (2014) defines an **energy system as "all components related to the production, conversion, delivery, and use of energy**."

Why Incorporate Resilience into Energy Systems?

The energy sector will be exposed to several climate-related risks that arise from increasing temperatures, variability in rainfall patterns and increased frequency of extreme weather events. Climate-sensitive locations such as low-lying coastal areas will be particularly susceptible to climate risks and impacts. Given the importance of energy in the economy and in the promotion of development, it is vital that vulnerabilities within the energy sector be reduced. The European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF) outlines the main impacts of climate change on different types of energy infrastructure (Table 1).

Table 1. The main physical impacts of climate change on energy generation sources by climate stressor

Climate Stressor	Warming Trend	Precipitation	Cyclone	Sea Level
Hydro Power	High temperatures may induce glacier melting, increasing water quantities in hydro basins. Extreme temperatures may affect energy generation due to increased reservoir evaporation.	Changes in precipitation may increase runoff variability. Droughts may affect runoff and energy output.	Equipment damage may decrease output.	No significant impact.
Wind Power	Increased temperatures may decrease air density, decreasing energy output.	No significant impact.	Alteration in wind speed may increase output variability. Damage from cyclones may decrease plant lifetime and output.	Sea-level rise may damage off-shore infrastructure.
Biomass	Increased temperatures may affect crop yield and irrigation needs. Extreme temperatures may induce fires and threaten crops.	Precipitation fluctuations may cause variable irrigation needs. Droughts may affect crop yield.	Storms may threaten crop yield.	Erosion and salinization may threaten crop productivity
Solar Power	High temperatures may reduce solar PV cell efficiency. High temperatures may alter concentrated solar power (CSP) efficiency.	Increased cloud cover may decrease solar PV generation output. Droughts may affect CSP generation.	Extreme events may damage structures and decrease plant lifetime.	No significant impact.
Thermal Power	Higher temperature of cooling water may decrease plant efficiency.	Increased water content may affect fossil fuel quality. Droughts may affect water availability for cooling.	Cyclones may damage plant infrastructure.	Sea-level rise may increase risk of damage to off-shore infrastructure and coastal stations.

Source: EUEI PDF, 2017, pp. 20–21

The climate-related physical risks and impacts outlined above may seriously damage grid infrastructure and threaten the long-term reliability of energy supply. Power interruptions or under-supply may cause lengthy and costly repair, loss of business within local economies or loss of profitability for energy companies, creating setbacks for economic and social development in many sectors (World Energy Council [WEC], 2015). For high-risk energy infrastructure (due to location or design), rising insurance premiums and exclusionary clauses may make it increasingly difficult to obtain insurance at reasonable rates. Thus, long-term investments that consider how climate risks may affect supply will be critical to ensuring delivery of reliable and sufficient power. Equally important, securing energy supply and distribution will help stabilize a developing economy by increasing resilience in other key sectors and creating desirable opportunities for future investment, including those related to renewable energy projects or emission-reducing technologies (EUEI PDF, 2017).

Understanding and assessing the numerous financial and non-financial impacts of projects, including climate change impacts, will likely strengthen funding proposals and the bankability of projects financed by bilateral or multilateral investment agreements (WEC, 2015). Donors, energy companies and long-term investors are more likely to invest when they are confident that project risk assessments have been thorough and include risks related to climate (EUEI PDF, 2017). Incorporating climate risks into the planning stages of energy infrastructure projects can build confidence that financial returns will be reliable and stable over the long term or that public funds are spent wisely (WEC, 2015).

Building resilience into energy systems can also support mitigation efforts by lowering carbon emissions while decreasing vulnerability (EUEI PDF, 2017). For example, investing in renewable energy projects can address resilience and mitigation objectives by diversifying energy supply while reducing carbon emissions from fossil fuel combustion. Another opportunity may be to replace aging energy infrastructure using decentralized energy systems with renewable energy sources, supporting resilience and mitigation by reducing widespread power outages and reducing GHG emissions (Ebinger & Vergara, 2011). Greater demand for pollution controls will favour renewable energy investments and provide positive health impacts. In addition, increasing energy efficiency and management can help stabilize energy grids, making them less susceptible to failure from increased supply and demand (International Energy Agency [IEA], 2015).

Finally, consideration of climate risks in energy investment decisions demonstrates foresight, responsibility and best practice in infrastructure development. Stakeholders must work together to ensure that the business case for investments in energy infrastructure resilience can be made. For example, finding ways to account for climate risk through financial models and cost-benefit analysis may provide access to new sources of funding or insurance coverage through risk transfer instruments such as catastrophe bonds (WEC, 2015).

What is a Resilient Energy System?

Resilience in the energy sector is defined as "the capacity of the energy system or its components to cope with a hazardous event or trend, responding in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation" (IEA, 2015, p. 1).

A helpful way to categorize resilience in relation to energy systems is assessing the three Rs:

- **Robustness** refers to how well energy infrastructure can survive the sudden and gradual impacts of climate change.
- **Resourcefulness** takes into consideration how well energy systems can be managed and operated through an extreme weather event.
- **Recovery** refers to how well energy infrastructure can be brought back to full operation after a disturbance (IEA, 2015).

Strategies to increase robustness may include enhanced building codes, built natural infrastructure to protect coastal energy infrastructure from sea-level rise or extreme weather events (e.g., vegetation), or cooling processes for thermal power plants that use water resources more efficiently to address future scarcity (Inter-American Development Bank, 2015; IEA, 2015). For resourcefulness, strategies may include capacity building through training in modelling, forecasting and data management, as well as emergency response training. Enhancing recovery may include detailed logistical planning for supply interruptions, strategically locating emergency response resources, and using smart meters and automatic switches to bring infrastructure back into operation (IEA, 2015).

The required investment and resources to strengthen the robustness, resourcefulness and recovery capacities of an energy system will largely depend on existing characteristics, including exposure and sensitivity of the system to risks. These variables will determine the overall vulnerability and the ability or capacity of the system to adapt to identified hazards and risks. Whether an energy system is vulnerable to climate change, to what extent and how these risks affect the financial performance can only be determined through comprehensive risk assessments that consider physical and environmental impacts posed by current and future climatic changes.

Managing Climate Risks for More Resilient Energy Systems

Building resilience into energy systems can be addressed through a combination of different strategies and approaches:

Climate vulnerability risk assessments entail an evaluation of vulnerabilities and long-term local weather and climate variability that may affect a proposed energy infrastructure project over its lifetime. It helps to identify and quantify the physical climate-related risks on specific assets in specific geographies and will be critical to a comprehensive understanding of the vulnerabilities an energy system may face as well as the potential effects on revenues, expenditures and financing (Acclimatise et al., 2018). Information gained through a climate risk assessment should be used to proactively manage or adjust planning related to energy infrastructure projects to prevent maladaptation or capitalize on new opportunities. Important to note is that risk-based planning also requires stakeholder engagement and collaborative partnerships, as well as plans adapted to the local context that can be revised according to new information and outcomes. This is essential, as outcomes may also be tied to other societal factors that influence energy demand, such as population growth, development policies, and changes in energy distribution and transportation (Asian Development Bank [ADB], 2012; Ebinger & Vergara, 2011). The Sustainable Asset Valuation Tool (SAVi) was designed to meet this demand. SAVi assesses the extent to which environmental, social and economic risks and externalities may affect the financial performance of infrastructure assets. With this type of information on hand, governments are able to determine the climate resilience of planned energy infrastructure and prioritize projects as part of their NDC implementation strategy.

Technological strategies are engineering-based strategies that involve building protective measures into infrastructure through design of new infrastructure or refurbishment of vulnerable components in existing infrastructure (Ebinger & Vergara, 2011). These strategies, also known as hard solutions, are built to be "fail-safe," meaning that they help infrastructure resist the impacts of climate change (WEC, 2015). Strategies may include higher building standards, building redundancy into systems, enlarging or retrofitting cooling systems, diverting water for power generation, and building back-up generators or cooling systems (ADB, 2012).

Green infrastructure strategies include strategically planned networks of natural and semi-natural areas designed and managed to deliver a wide range of ecosystem services to mitigate unintended weather and climate-related risks (European Commission, 2016). Natural infrastructure can help enhance stormwater management capabilities in ways that reduce vulnerabilities to flooding, erosion and greater storm surges, particularly in coastal areas. In urban environments, green spaces can also mitigate the urban heat island effect through cooling. Green infrastructure is increasingly being recognized as an important option to enhance resilience and should be considered as part of a "multiple lines of defense" risk management strategy.

Behavioural strategies are non-engineering-based strategies that involve creating systems that can recover quickly from disruptions and respond differently based on new information (WEC, 2015). They may consider relocation of infrastructure, anticipating extreme weather events through forecasting, or adjusting maintenance and operation of infrastructure (Ebinger & Vergara, 2011). Further, these strategies could include more robust safety procedures, early warning systems, measures to increase energy efficiency, and improved coordination between key stakeholders in government and industry (ADB, 2012).

Financial strategies may include expanded insurance requirements as one of the most typical risk-sharing instruments. In general, the insured party pays a higher premium to the insurance company, which in return covers the risks regarding one or more of the identified climate-related risks (European Climate Adaptation Platform, 2015). Other strategies to minimize the financial impact and plan for physical climate-related risks could include larger debt service reserve accounts or maintenance reserves as well as higher pricing in the face of greater cash-flow variability due to potential risks for cost and from climate and weather-related impacts (Acclimatise et al., 2018).

Conclusion

Investment into sustainable energy systems is a powerful driver of development and economic activity and critical to meeting the goals set out in the Paris Agreement. Increasing the share of renewable and clean energy is at the heart of many countries' NDC pledges to lower GHG emissions. As countries pursue the implementation of their NDC commitments, it is critical to enable informed decision-making by governments that takes into consideration the potential impacts of various climate and weather-related risks. Comprehensive risk analyses and designing a combination of risk mitigation strategies will ensure:

- **Improved robustness, resourcefulness and recovery capacities of energy systems to the risks of climate change.**
- **Energy systems can be brought back to full operation after a disturbance.**
- **Projects are financially viable and able to attract investments from the lending community.**
- **The overall ability and effectiveness of the energy sector is improved to respond to and deal with climate-related risks.**

Taking into consideration the anticipated risks and impacts of climate change should not be seen as putting the emphasis on adaptation but rather as a key element of energy security in an overall strategy to strengthen and safeguard NDC implementation.

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