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Resilient Energy Systems

RACE TO RESILIENCE

Investing In Resilient Energy Systems

Universal access to resilient energy systems is key for sustainable and inclusive economic growth

A resilient energy system is capable of absorbing climate shocks and ensuring provision of power during and after climate-driven hazards. If resilience is not built into energy systems, energy provision is put at risk from climate hazards, and substantial economic and societal impact could ensue. For the purpose of this analysis, energy systems refer to generation, distribution, transmission and consumption of electrical power.

Macro-trends are increasing the importance of building resilience into energy systems

Climate hazards are increasing in prevalence and intensity, increasing the number of exposed people and the energy systems that serve them. By 2030, Race to Resilience analysis estimates that over 50% of the world's population will be exposed to climate hazards. This analysis suggests that 1b-1.5b people may have more than 25 percent of their working hours exposed to 34C wet-bulb temperatures, with significant disruption to their livelihoods.

Energy systems are expanding to meet growing demand, in order to serve a growing global population with increasing energy consumption and meet the demand for electricity as the global economy decarbonises. In many cases, energy infrastructure is expanding in regions with high levels of existing hazard exposure, such as Africa and South Asia. Estimates vary, and depend on broader assumptions, but suggest 40-50 percent growth in installed generation capacity between 2020 and 2030[1].

The nature of energy system vulnerability is shifting as a result of the energy transition. Generation technologies such as solar, hydropower and nuclear energy have different vulnerability profiles and resilience-building requirements. For example, hydropower is vulnerable to heat stress and drought as evaporation reduces reservoirs required to generate power[2]. IEA predicts renewable generation capacity could increase by 60 percent from 2020 to 2026[3].

Building resilience into expanding and transitioning energy systems is critical to safeguard the positive impacts of increased access and clean energy, whilst ensuring wider community and societal resilience.

[1] IEA World energy outlook 2020 report, Enerdata analysis
[2] C2ES (2022) Drought and climate change
[3] IEA Renewable 2021 report

Increasing climate hazards risk damaging and disrupting energy systems

Climate hazards can impact energy systems in two primary ways. **1) Hazards such as flooding, storms and wildfires can damage infrastructure**, resulting in disruptions to electricity provision until repairs are made or energy is redeployed from functioning parts of the grid. It is estimated that 30-40 percent of power lines and generation capacity would be exposed and vulnerable to riverine flooding, coastal flooding and/or wildfires in a 2°C world[4].

2) Extreme heat can reduce the effectiveness of power generation and transmission, whilst also increasing demand through increased use of powered cooling. Examples of reduced effectiveness include increased losses during transmission[5] and reduced output efficiency of solar panels[6]. The impact is an energy deficit that could cause black-outs or brown-outs in periods of extreme heat. It is estimated that in a 2°C world, 10-20 percent of power generation and 50-60 percent of power lines could be at risk of reduced efficiency due to temperatures exceeding 40C for more than 7 days per year[7].

There are 7 key investment areas that support universal access to resilient energy systems

These investements provide access to improve the resilience of disconnected communities, develop flexible and responsive systems that can withstand climate variability and protect at risk infrastructure from acute climate hazards.

	Investment areas	Focus
Provide access to disconnected communities	1 **Off grid / back-up solutions**	**Developing independent networks** to improve the rate and quality of electricity access
Develop a flexible and responsive system with sufficient redundancy	2 **Diversified renewable power**	**Developing a diverse set of distributed renewable generation assets** to avoid concentration in exposed areas and produce flexible capacity
	3 **T&D build-out**	**Building out T&D network** to enable the integration of distributed renewables
	4 **Storage solutions**	**Developing electricity storage solutions** to enable the integration of diversified, variable renewables
	5 **Smart grid technology**	**Building new or retrofitting existing grids with smart technology** to enable flexible management of supply and demand and improve ability to maintain provision
Protect at risk system infrastructure	6 **Asset hardening**	**Upgrading infrastructure and components** to maintain generation, transmission and distribution during and after hazard events
	7 **Planning tools and data**	**Developing hazard and exposure data and analytics capabilities** to inform the location and design of new build assets and retrofits

[4] McKinsey & Company analysis, with calculations based on the RCP 8.5 and a multi model ensemble
[5] Kosec et al. (2017) Dynamic thermal rating of power lines
[6] World Economic Forum (2022) Why don't solar panels work as well in heatwaves?
[7] McKinsey & Company analysis

Whilst capital is flowing into these areas, there is a need to increase investment, especially in LDCs

There is already significant investment flowing into both energy access and the development of flexible and responsive systems. Whilst both are experiencing a well-coordinated push for increased investment, more capital is required to reach the Breakthrough 2030 goal of universal access to diverse, distributed and reliable energy.

In asset hardening, the challenge is even greater. Developed country utility companies are raising and deploying capital for hardening, and governments ar providing technical and funding support such as the United States Department of Energy $20B 'Building a Better Grid Initiative'. However, developing country utilities and governments struggle to fund hardening, and have growing volumes of infrastructure at risk of climate hazards. Investment gap analysis shows the investment shortfall in LDCs would be as much as four times the needed capital to harden exposed assets[8].

There are a number of opportunities for investors to fund resilience building activity

Opportunities to unlock investment in the identified areas include:

- Multilateral Development Bank (MDB) supported blended finance products that can catalyze private financing for utilities, government and public-private partnerships projects to support asset hardening, smart grid installation and T&D build-out in countries with high climate hazard exposure
- Debt and equity to scale Original Equipment Manufacturers (OEMs) developing and manufacturing hardened equipment and smart grid technologies and retailing to emerging markets with high climate hazard exposure
- Early-stage investment in affordable smart grid technologies and digital planning solutions

[8] McKinsey & Company analysis