Powering Post-COVID-19 Resilient Recovery with Green Stimulus

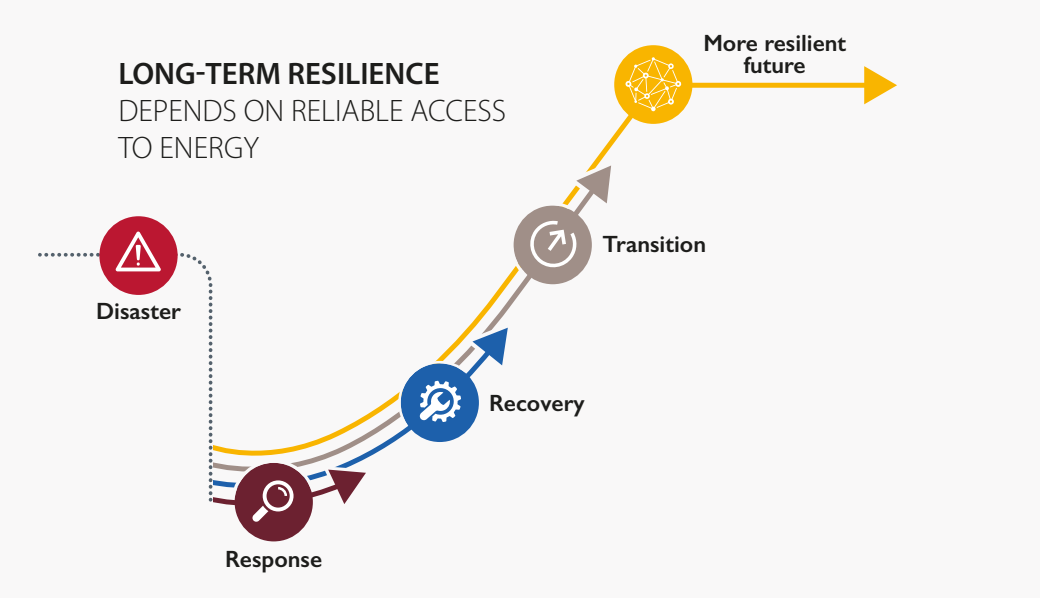

Figure 1. Timeline for resilience actions *Figure by Liz Craig, NREL*

Introduction

As the coronavirus (COVID-19) pandemic spread globally in early 2020, many governments enacted lockdown measures as an initial containment response. These lockdowns, while effective in slowing infection rates, have also had substantial economic consequences. A series of supply and demand shocks, workforce and supply chain disruptions, and other impacts of the pandemic and ensuing lockdowns have upended the livelihoods for much of the world's population. The International Monetary Fund estimates, as of this writing, that global growth in 2020 will contract -4.4%. Other thought leaders anticipate that before the disease runs its course, COVID-19 will likely lead to a fundamental restructuring for many major economies (IMF 2020; KPMG 2020a).

While there is scarcely an economic sector in any country that has not been affected by the spread of COVID-19, the impacts on and implications of the pandemic for power sectors worldwide have been particularly potent. The provision of safe, reliable, and affordable electrical services is essential to modern economies. Not only is electricity itself a critical service, but it is also an essential supplier to other critical services such as health care, water treatment, and disaster response.

Similar to other threats—whether human-caused, such as cyberattacks, or natural disasters—the COVID-19 pandemic has caused stress to the power sector by distorting business-as-usual paradigms for generating, transmitting, delivering, and using electricity (Lowder et al. 2020). And while there are particular impact characteristics associated with each category of threat (e.g., scope, scale, likelihood of occurrence, duration of resulting outages), the key to survivability through each of them is building resilience into power sector planning, operations, and investment.

Resilience is a cross-cutting technical, economic, and policy subject that spans response (short-term), recovery (mid-term), and transition (long-term planning) as shown in **Figure 1**. Power sector resilience specifically is the ability of the electricity system and its actors to anticipate, prepare for, and adapt to changing conditions, and to withstand, respond to, and recover rapidly from disruptions (Lee and Stout 2019; Hotchkiss and Dane 2019). It entails holistic planning, robust policy development, and the deployment of technical and institutional solutions at multiple levels and with the support of many stakeholders (such as planners, operators, regulators, load-serving entities, and generators, among others). This factsheet focuses on mid-term recovery and long-term planning to address the following question: **What economic recovery solutions following the COVID-19 pandemic can support power sector resilience, support future growth, decarbonize electricity generation, and strengthen the power sector against future threats?**

Power Sector Impacts of COVID-19

Worldwide, the spread of COVID-19 and the ensuing lockdowns have afflicted power sectors with a similar set of impacts. Commercial and industrial loads dropped precipitously, and residential demand escalated as employees shifted from office environments to working from home. These shifts in demand patterns increased stress on distribution-level networks while simultaneously idling

generation capacity on the supply side. The rise in residential electricity consumption was generally insufficient to offset the drop in the commercial consumption, and as a result many load-serving entities across the globe have experienced drastic decreases in electricity demand and resulting revenues losses at levels not seen since the Great Depression in the 1930s (Lowder et al. 2020; IEA 2020a).

Figure 2 plots the percent change in monthly power consumption as compared to the same month in 2019 and conveys the general trends for many other countries around the world. The numbers on the y axis represent the percentage change from the previous year, with the zero-line representing the 2019 baseline. The chart displays a sharp decrease in electricity demand during lockdown periods in the spring of 2020, a slow recovery back to or near pre-pandemic levels of consumption through late summer, and then another drop-off in late September/early October as cases resurged and governments again implemented restrictive measures approaching full lockdown. Since that time, demand has been on the rise again.

The pandemic has also introduced a host of distortions into many countries' power sectors. In those countries with bulk power marketplaces, declining demand has led to a collapse in wholesale energy prices, though consumers have not necessarily seen the benefits of this development, as their own electricity bills have risen during extended periods of working from home (Lowder et al. 2020). Ballooning consumer electricity bills have proved burdensome in several countries, and governments have stepped in to directly subsidize their electric bills, effectively positioning them as retail customers of last resort (Lowder et al. 2020).

Market distortions are also creating contractual issues on the independent power producer side of the power sector. For example, in Indonesia, several inflexible take-or-pay contracts from thermal generators have saddled the state-owned utility, Perusahaan Listrik Negara, with purchases for energy that it does not need because of slack demand. As a result, the utility has curtailed hydropower to reduce overall production, thereby increasing the carbon intensity of its generation mix (Fuqoha and Kresnawan 2020; Lowder et al. 2020; Ahmed 2020).

Green Stimulus

As countries continue to grapple with COVID-19 and navigate the economic fallout, well-designed green stimulus packages can support near-term recovery and enable longer-term power system resilience against future threats.

The term "green stimulus" encompasses fiscal measures (i.e., governmental tax and spending actions) that support short-term economic activity that enhances environmental and natural resource quality over a longer term (Strand and Toman 2010). The deployment of energy efficiency (EE) and renewable energy (RE) technologies, as well as associated initiatives (e.g., grid modernization, electrification of transport, and so on) have been demonstrably effective in providing this kind of short-run economic boost while simultaneously strengthening the resilience of the power sector. Along with green stimulus packages, concurrent action on the regulatory side—for example, the development of green building codes, updating grid interconnection standards, creating programs and marketplaces for demand-side efficiency, and others—can be a force multiplier in ensuring that public spending achieves maximum impact in near-term recovery and long-term power sector transformation.

Targeted and well-tuned green stimulus packages can create EE and RE jobs, spur economic growth, attract private investment to sustain that growth, generate

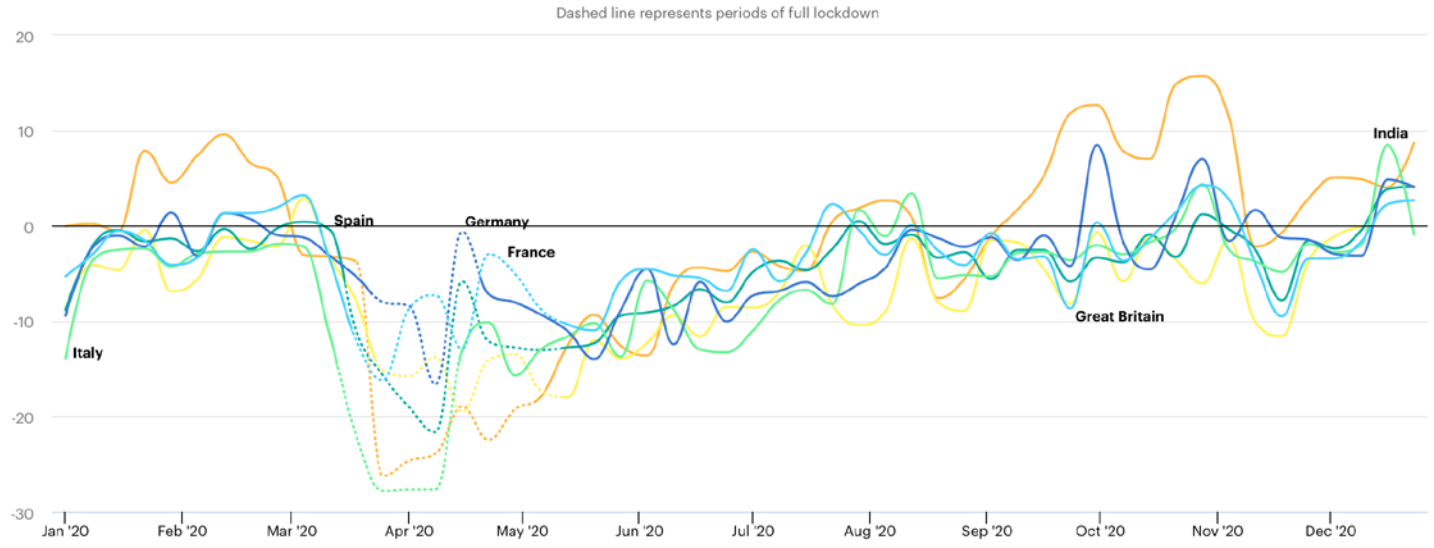

Figure 2. Year-over-year changes (in percent, y-axis) in weekly electricity demand in select countries, weather adjusted (Note: the upward swing in India's electricity usage is driven by a recovery in the commercial and industrial sectors, as well as a higher demand for irrigation relative to 2019, when a heavy monsoon season decreased agricultural energy use) *Figure from IEA 2020b*

co-benefits (such as improvements in air quality and human health through cleaner energy sources), and enable turnover/modernization of a country's infrastructure. Moreover, they can lay the groundwork for innovations that will keep countries competitive in the 21st century, decarbonize economies, promote environmental justice, and move the power sector beyond the models established in the 20th century to be more responsive to current and future threat landscapes (IEA 2020c; IMF 2020; Cox et al. 2017).

World governments have already dedicated unprecedented financial resources to combatting the economic downturn from the COVID-19 pandemic. In October 2020, the International Monetary Fund estimated that stimulus measures worldwide total almost $12 trillion, a figure that does not include the $900 billion U.S. economic relief package signed into law on December 27, 2020, nor the $1.9 trillion stimulus bill passed in March 2021 (Gopinath 2020; KPMG 2020b; White House 2021). Even at $12 trillion global stimulus was well over triple the amount of stimulus funds for the Global Financial Crisis of 2008–2009 (McKinsey 2020).

Presently, however, global stimulus and relief measures have not yet shown a clear preference for low-carbon or resilient investments. One study has found that, of the over $419 billion earmarked for energy sector support in G20 countries' stimulus packages, 52% has gone to fossil fuel interests, while only 35% or roughly $146 billion has gone to clean energy (energypolicytracker.org 2020). Compare this to an estimated funding level of over $500 billion for "green" investments in global stimulus packages following the 2008–2009 global financial crisis (Robins et al. 2009; Agrawala et al. 2020).

As of this writing, the COVID-19 pandemic has not subsided, and most of the world population remains uninoculated. The need for follow-on governmental stimulus after the initial wave of packages passed in the first half of 2020 is still very real for many countries, and there is a

Table 1. Power Sector-Related Recovery Actions Broken Out by Sector*

Sources: Cox et al. 2017; Cox et al. 2016; Cook 2018; ACEEE 2015; IEA 2020c; IMF 2020; Agrawala et al. 2020

Sector	Actions	Description
Transport	Electrify transport	Support deployment of electric vehicles in public transport, consumer, and heavy freight markets. Also support broader co-deployment of distributed energy resources (see below) and charging station infrastructure. Electrifying transportation systems can diversify fuel sources, which improves supply chain resilience, allowing for critical services mobility at times of supply chain disruptions, and other benefits.
Policy and Regulatory	Fossil fuel subsidy reform	Remove current incentives dedicated to reducing the cost of fossil fuels and the energy derived from their combustion. Budget surpluses can be used to provide energy cost relief to at-risk consumers, support renewables deployment, and other measures.
	Carbon pricing	Send durable price signals to incentivize investment in low- or no-emissions technology solutions and decarbonization measures.
	Incentives	Provide incentives for RE and EE technologies that align with decarbonization goals. For countries with existing energy policies that have established legal precedents and market familiarity, renewing and refunding these programs will likely be more effective than launching new initiatives.
	Financial stabilization	Policymakers and central banks can implement fiscal and monetary reforms and stopgap measures to prevent capital flight and calm unstable markets.
Power Sector	Distributed energy resources (DERs)	Enable higher penetrations of DERs to improve reliability, displace fossil-fired central generators, defer grid upgrades, and improve resilience.
	Advanced metering infrastructure	Deploy advanced metering infrastructure with robust cybersecurity architectures to provide utilities with greater visibility and control at the grid edge for demand-side management and faster emergency response.
	Advanced distribution management systems	Update management software and paradigms to optimize assets on the distribution network.
	Microgrids	Deploy distributed generation + energy storage measures with islanding capabilities to strengthen the resilience of critical load centers, , such as hospitals, bases, and community centers.
	RE	Incentivize buildout of utility-scale systems to provide bulk power, and firming technologies such as battery storage.
	EE	Support demand-side measures that will reduce the need for costly future grid upgrades, as well as provide utility bill savings for businesses and consumers. Invest in retrofits for commercial and residential buildings to relieve consumer energy expenditures.
	Transmission	Build out transmission infrastructure to facilitate RE integration and connect high-resource areas to load centers.
Business and Finance	Green bonds	Incentivize the market for tradable, high-demand financial products that finance green infrastructure upgrades.
	Public private partnerships	Co-invest with national and local governments to direct capital to resilient infrastructure.
Research and Development (R&D) and Innovation**	Public investment	Allocate stimulus funds to grow public R&D budgets and leverage private investment. R&D efforts should focus on gaps that present-day technologies do not address (e.g., solutions for industrial process emissions, long-duration energy storage, green hydrogen).
	Workforce training	Develop programs for upskilling labor to participate in and benefit from the green economy. Training is a critical component of green stimulus funding and one of the most effective ways to leverage the effectiveness of public investment.

** Because this table is focused on the power sector, these options generally represent mitigation measures, though adaptation investments should not be considered mutually exclusive. The Global Commission on Adaptation has additional information available on how adaptation investments can also drive economic growth (Global Commission on Adaptation 2020).*

*** "Shovel-ready" projects are effective public investments because they require little in the way of development capital and lead time before they can start producing economic benefits; however, for longer-term resilience considerations, it may be appropriate to invest in R&D for technologies with less track record or market readiness but high potential for power sector transformation.*

Figure 3. Power Sector Resilience Planning Process *Figure by Stacy Buchanan, NREL*

corresponding opportunity to include greener approaches to spending in follow-on stimulus tranches. For those countries where domestic funding may be limited, there may be an opportunity to leverage grants, concessional financing from multilateral development finance institutions and other forms of external capital. Cambodia, for example, has recently been approved for a $127.8 million loan from the Asian Development Bank to support the construction of transmission lines to improve reliable electric service. Additionally, the country is slated to receive grant funding of up to $6.7 million to pilot a utility-scale battery storage system (Khmer Times 2020). The project is expected to create 1,300 direct construction jobs as well as other indirect economic benefits that will accrue to Cambodian households (ADB 2020).[1]

Short-Term Recovery Measures

Table 1 presents a general, noncomprehensive suite of options available to countries to invest public dollars into economic recovery measures that support longer-term power sector resilience. All countries have their own social, political, and economic characteristics that inform decision-making around the appropriate level of stimulus and the types of infrastructure solutions. The options below represent general "buckets" where countries may consider investing resources to optimize recovery as befits their needs. All of these measures have been discussed in greater detail elsewhere, and the authors encourage those interested in further research to explore the sources given beneath the table caption. These measures represent general power sector transformation actions that many countries were evaluating before COVID-19 impacted their economies. Taken in the context of the pandemic, they confer the added benefit of serving as a means to economic recovery through job creation, infrastructure revitalization, and generally laying the groundwork for future growth. In this sense, the pandemic has created some urgency around power sector transformation efforts, accelerating the need for these kinds of projects and actions which can deliver short-term wins.

Investing in Long-Term Resilience

Ensuring that green stimulus packages strategically address long-term power sector resilience and decarbonization needs will require robust planning alongside consideration of investment options. Prioritizing resilience as a key metric to compare investments will assist policymakers in their evaluation of where to allocate stimulus funds.

Planning for power sector resilience requires engaging stakeholders, setting a shared vision for a resilient system, and charting the roadmap of how to get there. The exercise also requires gathering and analyzing power system designs and needs (critical loads, interdependencies, infrastructure), assessing vulnerabilities, developing strategies, and enabling policies to realize progress toward the shared resilience vision (Stout and Lee 2019). Several resources exist for policymakers, regulators, and the power sector to plan for resilience. The Resilience Roadmap (https://www.nrel.gov/resilience-planning-roadmap/) and the Renewable Energy Data Explorer (https://www.re-explorer.org/) provide data lists and aggregated spatial data that can support resilience planning. Additionally, the USAID- and NREL-developed Resilient Energy Platform (https://resilient-energy.org/) provides a centralized platform where users can access curated resources, training materials, data, tools, and direct technical assistance for planning resilient, sustainable, and secure power systems.

Traditional power sector planning processes, such as Integrated Resource Planning, offer an approach to inclusive sectoral planning that seeks to minimize power system risks while ensuring reliable power supplies (Scheller and Chikkatur 2014; Bruguera, Hellmuth, and Man 2019; Lowder et al. 2020). In Southeast Asia, the Lao PDR recently performed a government-led, stakeholder-inclusive power sector resilience planning process supported by USAID (Stout et al. 2020). The Lao PDR, a country highly dependent on hydropower, is facing changes in the timing, frequency and intensity of precipitation. Through their assessment, they determined several priority interventions, including supply diversification,

[1] While this project was likely in the early-stage development phase before the pandemic hit (and therefore not planned as a direct response), it provides an example of the kinds of investments that can generate both economic recovery and power sector resilience benefits.

which are being incorporated into their Integrated Resource and Resilience Planning process. Several countries are currently undertaking the Integrated Resource and Resilience Planning process; these activities can be further leveraged through green stimulus funding.

Rate-based infrastructure investments are another means by which load-serving entities can enhance long-term resilience. Jamaica Public Service Company Limited (JPS) has taken several measures during the COVID-19 pandemic to manage the challenges of continued delivery of reliable power, including the installation of remote measuring devices, smart meters, fault indicators, remotely operable switches, and improved distribution infrastructure to reduce outages and the amount of time staff needed to spend in the field addressing outages or issues. A general demand reduction has led to an increased percentage of renewables in the island's generation mix. JPS' hybrid energy storage system, consisting of 3 MW of low-speed flywheels and 21.5-MW Li-Ion batteries, has helped address issues associated with higher penetrations of variable RE. Services provided by this facility have included frequency regulation, spinning reserve support, and steady and transient voltage response (CAREC 2020a and 2020b). While these upgrades were not necessarily implemented as a pandemic response, they reflect the types of resilience upgrades that can deliver win-wins with right-sized stimulus funding.

EE programs also have a long history of providing not only consumer benefits, but also power sector benefits and cost savings writ large. While not implemented in response to the current crisis, Mexico's program to replace inefficient appliances in low-income households in response to the 2008–2009 global financial crisis has proven how public investments can yield outsized returns while also driving resilience. Over the course of the program's nine-year operation, approximately two million refrigerators and air conditions were replaced. This initiative, in addition to lightbulb upgrades, has resulted in an estimated electricity savings of almost 700 GWh, with a subsidy savings of $22 million and a payback period to the government of less than four years. It also created more than 1,600 new permanent jobs and 10,500 new temporary jobs (IEA 2020c).

Conclusion

Investing in EE and RE, as well as grid modernization and other innovative technologies, can promote not only the resilience of the power sector, but also of the communities that the grid supports. Green stimulus packages can drive these investments at scale, reinforcing traditional pillars of safety, reliability, and affordability in electrical service, while at the same time hardening the power system against future threats and hazards. In the challenging landscape of the COVID-19 pandemic, there exists an opportunity to rethink grid planning and renewables deployment and allocate funds that can drive economic growth near-term while transforming grid architectures for the long-term. As of this writing, economic development in many countries still lags, and several are reverting back to the kind of strict measures implemented in the initial pandemic lockdowns. Further government support to backstop lost business activity will likely be required for many such countries, presenting an opportunity to design stimulus and aid packages that target green growth. The lessons from the 2008 global recession indicate that this kind of spending can have transformative consequences for EE, renewable technologies, and society as a whole. The imperative today is to update these stimulus designs to cement the transition to a cleaner, more resilient power system to support future growth.

References

ADB (Asian Development Bank). 2020. "$127.8 Million ADB Loan to Help Expand Power Grid in Cambodia." https://www.adb.org/news/127-8-million-adb-loan-help-expand-power-grid-cambodia.

Agrawala, Shardul, Damien Dussaux, Norbert Monti. 2020. "What Policies for Greening the Crisis Response and Economic Recovery?: Lessons Learned from Past Green Stimulus Measures and Implications for the COVID-19 Crisis." *OECD Environment Working Papers*. Vol. 164. OECD Environment Working Papers, May 28, 2020. https://doi.org/10.1787/c50f186f-en.

Ahmed, Sara Jane. 2020. Philippines Power Sector Can Reach Resilience by 2021: COVID-19 Reveals Regulatory Weaknesses and the Need for Improved Incentives and Policies. Lakewood, OH: Institute for Energy Economics and Financial Analysis. https://ieefa.org/wp-content/uploads/2020/06/Philippines-Power-Sector-Can-Reach-Resilience-by-2021_June-2020.pdf.

Bruguera, Maya, Molly Hellmuth, and Derina Man. 2019. "Power Sector Resilience: Integrated Resource and Resilience Planning." USAID and ICF International. https://resilient-energy.org/training-and-resources/quick-reads/19514_usaid-nrel_irrp_factsheet-v7-release.pdf/view.

CAREC (CARILEC Renewable Energy Community). 2020a. "Smart Grid and Energy Storage for Caribbean Utilities in a Pandemic." https://community.carilec.org/t/carec-resilient-power-series-2020-episode-1-smart-grid-and-energy-storage-for-caribbean-utilities-in-a-pandemic/2534.

CAREC. 2020b. "Utility Preparations and Protocols for Hurricanes in Pandemics: The Jamaica Public Services (JPS) Company Experience." https://community.carilec.org/t/06-17-20-carec-resilient-power-series-e3-utility-preparations-and-protocols-for-hurricanes-in-pandemics-the-jamaica-public-services-company-jps-experience/2555/3.

Cook, Jeffrey, Christina Volpi, Erin Nobler, and Kyle Flanegin. 2018. *Check the Stack: An Enabling Framework for Resilient Microgrids*. NREL/TP-6A20-71594. Golden, CO: National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy19osti/71594.pdf.

Cox, Sadie, Eliza Hotchkiss, Daniel E Bilello, Andrea C Watson, and Alison Holm. 2017. *Bridging Climate Change Resilience and Mitigation in the Electricity Sector Through Renewable Energy and Energy Efficiency: Emerging Climate Change and Development Topics for Energy Sector Transformation*. NREL/TP-6A20-71594. Washington, D.C.: USAID. https://doi.org/10.2172/1411521.

Cox, Sadie, Pieter Gagnon, Sherry Stout, Owen Zinaman, Andrea Watson, and Eliza Hotchkiss. *Distributed Generation to Support Development-Focused Climate Action: Emerging Climate Change and Development Topics for Energy Sector Transformation: An EC_LEDS White Paper Series*. NREL/TP-6A20-66597. Golden, CO: National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy16osti/66597.pdf.

Energypolicytracker.org. 2020. "G20 Countries." https://www.energypolicytracker.org/region/g20/.

Fuqoha, Iqlima, and Muhammad Rizki Kresnawan. 2020. "COVID-19 vs ASEAN Energy Sector; Electricity (Q3)." ASEAN Centre for Energy. https://aseanenergy.org/covid-19-vs-asean-energy-sector-electricity-q3/.

Global Commission on Adaptation. 2020. "Adapt Now: A Global Call for Leadership on Climate Resilience." https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/.

Gopinath, G. 2020. "A Long, Uneven and Uncertain Ascent." International Monetary Fund. https://blogs.imf.org/2020/10/13/a-long-uneven-and-uncertain-ascent/.

Hotchkiss, Eliza, and Alex Dane. 2019. *Resilience Roadmap: A Collaborative Approach to Multi-Jurisdictional Resilience Planning*. NREL/TP-6A20-73509. Golden, CO: National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy19osti/73509.pdf.

IEA (International Energy Agency). "2020a.Global Energy Review 2020." https://www.iea.org/reports/global-energy-review-2020.

IEA. 2020b. "Covid-19 Impact on Electricity." https://www.iea.org/reports/covid-19-impact-on-electricity.

IEA. 2020c. "Sustainable Recovery." https://www.iea.org/reports/sustainable-recovery.

IMF (International Monetary Fund). 2020. *World Economic Outlook, October 2020: A Long and Difficult Ascent*. Washington, D.C.: IMF. https://www.imf.org/en/Publications/WEO/Issues/2020/09/30/world-economic-outlook-october-2020.

Khmer Times. 2020. "Cambodia Gets $127.8 Million ADB Loan to Help Expand Power Grid." https://www.khmertimeskh.com/50763156/cambodia-gets-127-8-million-adb-loan-to-help-expand-power-grid/.

KPMG. 2020a. "Coronavirus (COVID-19) Tax Developments - KPMG United States." https://home.kpmg/us/en/home/insights/2020/04/taxnews-flash-coronavirus-covid-19-developments.html.

KPMG. 2020b. " President Signs Year-End Funding, COVID-19 Relief Legislation; Tax Provisions are Enacted." https://home.kpmg/us/en/home/insights/2020/12/tnf-president-signs-year-end-funding-covid-19-relief-legislation-tax-provisions-are-enacted.html.

Lee, Nathan, and Sherry Stout. *Planning a Resilient Power Sector*. NREL/TP-7A40-73618. Golden, CO: National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy19osti/73618.pdf.

Lowder, Travis, Nathan Lee, and Jennifer Leisch. 2020. *COVID-19 and the Power Sector in Southeast Asia: Impacts and Opportunities*. NREL/TP-7A40-76963. Golden, CO: National Renewable Energy Laboratory. https://doi.org/10.2172/1665768.

McKinsey & Company. 2020. "Total Stimulus for the COVID-19 Crisis Already Triple That for the Entire 2008–09 Recession." https://www.mckinsey.com/featured-insights/coronavirus-leading-through-the-crisis/charting-the-path-to-the-next-normal/total-stimulus-for-the-covid-19-crisis-already-triple-that-for-the-entire-2008-09-recession.

Ribeiro, David, Eric Mackres, Brendon Baatz, Rachel Cluett, Michael Jarrett, Meegan Kelly, and Shruti Vaidyanathan. 2015. "Enhancing Community Resilience Through Energy Efficiency." American Council for an Energy Efficient Economy (ACEEE). https://www.aceee.org/research-report/u1508.

Robins, Nick, Robert Clover, Charanjit Singh. 2009. *A Climate for Recovery: The Colour of Stimulus Goes Green*. HSBC Global Research. https://www.globaldashboard.org/wp-content/uploads/2009/HSBC_Green_New_Deal.pdf.

Scheller, Maria, and Ananth Chikkatur. 2014. *Integrated Resource Planning Models Need Strong Resiliency Analysis*. Fairfax, VA: ICF International. https://www.ourenergypolicy.org/wp-content/uploads/2014/10/Integrated_Resource_Planning_Models_Need_Stronger_Resiliency_Analysis.pdf.

Strand, Jon, and Michael Toman. 2010. *'Green Stimulus,' Economic Recovery, and Long-Term Sustainable Development*. Washington, D.C.: The World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/19956/WPS5163.pdf?sequence=1&isAllowed=y.

The White House. 2021. "President Biden Announces American Rescue Plan." https://www.whitehouse.gov/briefing-room/legislation/2021/01/20/president-biden-announces-american-rescue-plan/.

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This work was authored, in part, by the National Renewable Energy Laboratory (NREL), operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the United States Agency for International Development (USAID) under Contract No. IAG-17-2050. The views expressed in this report do not necessarily represent the views of the DOE or the U.S. Government, or any agency thereof, including USAID.

NREL/TP-7A40-78782 | March 2021
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