WORKING PAPER

Unlocking a Renewable Energy Future

How Government Action Can Drive Private Investment

Norma Hutchinson, Maggie Dennis, Emil Damgaard Grann, Tyler Clevenger, Michelle Manion, Johannes Bøggild, Jennifer Layke

Working Papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate timely discussion and critical feedback, and to influence ongoing debate on emerging issues. Working papers may eventually be published in another form and their content may be revised.

WORLD RESOURCES INSTITUTE

Ørsted

Photo by Nicholas Doherty/Unsplash

There has never been a more decisive moment for the energy transition: WRI analysis shows that the world must produce nearly six times more renewable electricity by 2030 to avoid the worst climate impacts. 60 countries and counting have committed to zero carbon targets, and nearly 1,500 companies have adopted science based emission reduction targets. We must now focus on the enabling environment that will unlock capital at scale for renewable energy.

The good news is that we increasingly understand what we need to do to create a renewables-based electricity system. The Energy Transitions Commission, the International Renewable Energy Agency, and the International Energy Agency have recently published pathways showing how to achieve this goal. The shift to a strong, fair and net-zero economy of the future is closer than ever before.

Unlocking a Renewable Energy Future: How Government Action Can Drive Private Investment, written in partnership between World Resources Institute and Ørsted, the world's largest developer of offshore wind power, provides decision-makers with solutions they can use today. This is a critical moment: the energy policy decisions taken—or not taken—by governments over the next decade will determine whether or not we are able to avoid a climate emergency that would last for generations to come.

Manish Bapna
President and CEO (Interim)
World Resources Institute

Mads Nipper
CEO and Group President
Ørsted

CONTENTS

Authors: Norma Hutchinson, Maggie Dennis, Emil Damgaard Grann, Tyler Clevenger, Michelle Manion, Johannes Bøggild, Jennifer Layke

Citation: Hutchinson, N., M. Dennis, E. Damgaard Grann, et. al. 2021. "Unlocking a Renewable Energy Future." Working Paper. Washington, DC: World Resources Institute. Available online at: https://doi.org/10.46830/wriwp.20.00077

Executive Summary

HIGHLIGHTS

- The global transition to renewable energy is likely to be financed largely by the private sector, including utility companies, corporations, project developers, and various investment funds.
- One critical element of the energy transition will be decarbonization of the world's electricity supply. The needed technology is developing rapidly and the scale of the requisite investment is manageable, but current rates of deployment remain well below what is required to avert the worst impacts of climate change.
- Challenges that inhibit decarbonization of the power sector fall into three categories: market structure that lacks appropriate incentives to catalyze private investment in new projects, lack of public support for siting renewable energy development, and incompatible or inadequate grid infrastructure.
- Governments will play a critical role in scaling renewable energy capacity by providing regulatory frameworks and policy solutions to the challenges that are slowing down private sector investment.
- Top priorities for governments will be to establish renewable energy targets, policies, and market instruments that incentivize and de-risk green energy investments; improve planning and permitting, and address community concerns, while balancing other concerns; and invest in modern electricity grids and infrastructure.

THE URGENT NEED TO DECARBONIZE THE WORLD'S ENERGY SUPPLY

The production and use of energy currently generates the largest share of greenhouse gas (GHG) emissions and is responsible for 73 percent of all global emissions (Climate Watch 2021). To keep average global temperature rise below 1.5°C above preindustrial levels, in line with the Paris Agreement goals, GHG emissions need to be roughly halved by 2030 and virtually eliminated by 2050 (IPCC 2018). Alignment with a 1.5° pathway means that countries must decarbonize their power sectors by midcentury and increase the share of renewable energy capacity in electricity generation—including solar, wind, hydropower, and geothermal—at six times the current rates by 2030 (Lebling et al. 2020). In the coming decade, renewable energy will need to generate anywhere from 55 to 90 percent of the global electricity supply, a sharp increase from today's 27 percent (IEA 2020d).

Fortunately, much of the technology and capacity needed to scale the clean energy transition is commercially available today and already cost-efficient. Utility-scale solar photovoltaic (PV) and onshore wind projects, for example, are currently the cheapest sources of power in more than two-thirds of the world (BloombergNEF 2020). However, to enable the clean energy transition, $131 trillion in investments will be needed between now and 2050, a 30 percent increase over current planned investment allocations. A significant portion of this investment is expected to come directly from the private sector

(IRENA 2021). But to mobilize the private capital needed, government intervention in the form of clear, comprehensive policy frameworks will be crucial to address some of the key challenges that have held back more aggressive investment commitments from the private sector. This paper includes a range of the solutions to incentivise private investments.

KEY FINDINGS AND RECOMMENDATIONS

We highlight three overarching challenges (Box ES-1) that must be addressed to scale investment in renewable electricity supply:

- Strategically channeling investment into renewable energy to incentivize private sector participation
- Identifying the right geographies and areas for renewable energy development
- Building enabling transmission and grid infrastructure

Countries and regions have varying potential for renewable energy deployment, are at different stages of the renewable energy transition, and will face correspondingly different challenges. In some locations, distributed, highly localized renewable energy solutions bring the best package of advantages: energy access, energy security, and resilience. In other locations, more centralized, utility-scale solutions are optimal. Market design that rewards flexibility on both demand and supply sides, and recognizes the full set of societal benefits of renewable energy resources is also needed. Therefore, solutions should not be viewed as a prescriptive set of actions, but as a menu of strategies that can be leveraged to accelerate renewable energy deployment. It is our hope that this working paper can support country-level dialogues between public and private sector actors about how scaling can be accelerated, for example, through institutional and technical capacity-building.

Box ES-1 | ***Three Challenges and Proposed Solutions to Scaling Investment in Renewable Energy***

Challenge I: Lack of enabling policy and regulatory frameworks that prioritize and appropriately incentivize renewable energy technologies

Solution set I: Establish long-term renewable energy targets and create an enabling environment for deployment. Ambitious targets help signal to investors that renewable energy is a high-priority market. However, targets are most effective when paired with an economy-wide strategy to transition investment from fossil fuel to renewable energy. Tools governments can use include targeted policies, like contracting and funding structures that reduce investment risk, tax credits, or accelerated depreciation; and regulations that secure increased competition and a greater private sector role in energy supply. Finally, governments can capitalize on renewable energy opportunities to deliver on broader social and economic goals, such as increasing energy access and job creation.

Challenge II: Community concerns over renewable energy projects and inefficient processes for planning, permitting, and approval of renewable energy projects

Solution set II: Improving planning, permitting, and public engagement. Before a renewable energy project is initiated, governments can lay the groundwork for success by engaging local communities through participatory siting approaches and proactive management of economic concerns and land-use risks. To streamline this engagement process, governments can adopt standardized renewable energy permitting and spatial planning processes that account for environmental and socioeconomic impacts.

Challenge III: Grid infrastructure that does not support renewable energy integration

Solution set III: Invest in modern electricity grids and infrastructure. Governments can enable renewable energy development by planning for energy variability and grid flexibility needs. Investments in transmission infrastructure and operational improvements to grid management may also be necessary. Increased energy storage is critical. Governments can incentivize this by investing in research and development for storage technology and by putting in place incentives for energy infrastructure.

ABOUT THIS WORKING PAPER

This working paper focuses on the challenges and solutions to scaling investment in renewable electricity generation. We note that decarbonizing the power sector and enabling the clean energy transition will require a broader and more coordinated set of solutions and technologies, including more aggressive deployment of variable renewable energy (VRE), the use of energy efficiency measures, and significant support from energy storage technologies and a flexible demand response.

The working paper is the product of a partnership between Ørsted and World Resources Institute. Our findings and recommendations were developed through a review of current literature, an expert convening, and a series of expert interviews. The information presented also draws on Ørsted's experience as a renewable energy developer. The review of current literature included recent English language articles published in international trade publications and academic journals, as well as articles and reports from relevant government departments and agencies, research organizations, trade associations, and nonprofits. Experts from multiple sectors were interviewed early in the research process to identify useful data sources and to discuss challenges and barriers to scaling clean energy investments. We also shared and sought feedback on potential policy recommendations via a virtual roundtable dialogue. The experts interviewed were chosen based on existing relationships with Ørsted and World Resources Institute, and for their knowledge and interest in the challenges and recommendations outlined in this working paper. The full set of participants is detailed in the Acknowledgments section.

PURPOSE OF THIS WORKING PAPER

Our objective is to provide governments, policymakers, and regulators with actionable policy solutions they can use to scale private sector investments in renewable electricity over the coming years. We begin with a broad discussion of the impact of—and scale required for—the energy transition, and then provide an overview of key challenges that typically hinder private investment in renewable energy, along with a set of proposed solutions. We spotlight case studies and examples where scaling strategies are being implemented successfully. In addition, our analysis provides a nuanced review of how to build conducive enabling environments to attract investment and deliver desired results in markets of varying maturity.

Many of the policy recommendations and solutions we outline can be modified and applied to different industries, technologies, and markets. The information we provide is not meant to be exhaustive, and successful implementation of some of the solutions outlined will vary substantially by country. Though this report provides policy examples from both developed and emerging markets, it does not delve into specific national political economy conditions or comparisons. Solutions presented represent critical enablers for clean energy investment and development, but prioritization of challenges and solutions will vary depending on context.

Figure ES-1 | *Challenges and Solutions to Unlock Private Investment*

Box 1 | ***The Benefits of an Energy Transition***

To enable the energy transition, $131 trillion in investments will be needed between now and 2050 (IRENA 2021). The transition will require distributional shifts that cause significant job losses in the fossil fuel industry, yet this increased investment can reshape our economies and spur innovation and new businesses. At a macro-level, the fuel savings and avoided health care costs from reduced air pollution, and positive economic benefits from better health and lower environmental damage, will outweigh these costs. Although fossil fuel industries lose market share and workers, the energy transition will grow employment in clean technology supply chains, manufacturing, and installation and maintenance.

The benefits of the energy transition include the following:

- More than 40 million new jobs in the renewable energy sector (IRENA 2020b) and more than 20 million new energy efficiency jobs by 2050
- Growth in global gross domestic product in 2050 by 2.4 percent, equivalent to cumulative gains of $98 trillion by 2050, compared to the business-as-usual energy scenario (IRENA 2020a)
- Increased energy resilience and grid flexibility globally against high-impact events, particularly as energy storage technologies mature
- Savings of more than eight million lives every year due to reduced air pollution from fossil fuels (Burrows 2021)
- Improved energy access for the almost one billion people around the world who are currently without access to electricity, and more affordable energy for consumers

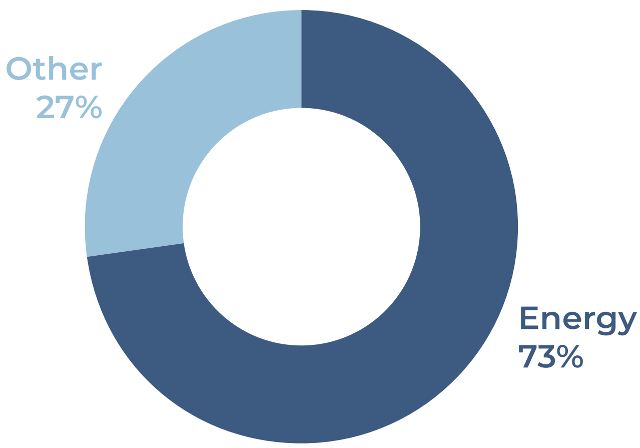
1. Setting the Scene for a Renewable Energy Transition

Nearly three-quarters of today's global greenhouse gas (GHG) emissions originate from the production and use of electricity and heat for buildings, transport, and industry (see Figure 1). To tackle climate change, we will need to shift from burning natural gas and coal in manufacturing, buildings, and cars, to running them on electricity. At the same time, we must quickly shift to generation from renewable energy technologies, improved efficiency, a modernized grid, and energy storage. This will be a radical transformation of our energy system—changing energy sources and decarbonizing electricity at the same time. A 1.5° climate pathway will require that GHG emissions fall to half our current levels by 2030, half again by 2040, and continue to decrease on that trajectory to achieve net-zero emissions by around mid-century (UNEP 2020).

So, what does that mean in terms of the amount of renewable energy needed? Findings from the *State of Climate Action: Assessing Progress toward 2030 and 2050* (Lebling et al. 2020) report show that to achieve the GHG emission reductions required by 2030, we must increase the share of renewables in electricity generation almost six times faster, phase out coal in electricity generation five times faster, and reduce the carbon intensity of electricity generation more than three times faster. The transformation of energy systems globally will be crucial to combat climate change and will also generate economy-wide benefits (Box 1).

The urgency of this moment cannot be overstated. Policy decisions taken—or not taken—by governments over the next few years will determine the viability of our climate, human, and economic systems for generations to come. Sufficient investment capital is available today to fuel the clean energy transition over this time period and beyond. However, many investors, particularly in the private sector, are deterred by the risks and uncertainties that go along with many attractive clean energy investments—and by the fact that these remain too high even as the technology costs themselves are no longer the barrier.

Figure 1 | ***Annual Global Greenhouse Gas Emissions***



Source: Climate Watch 2021.

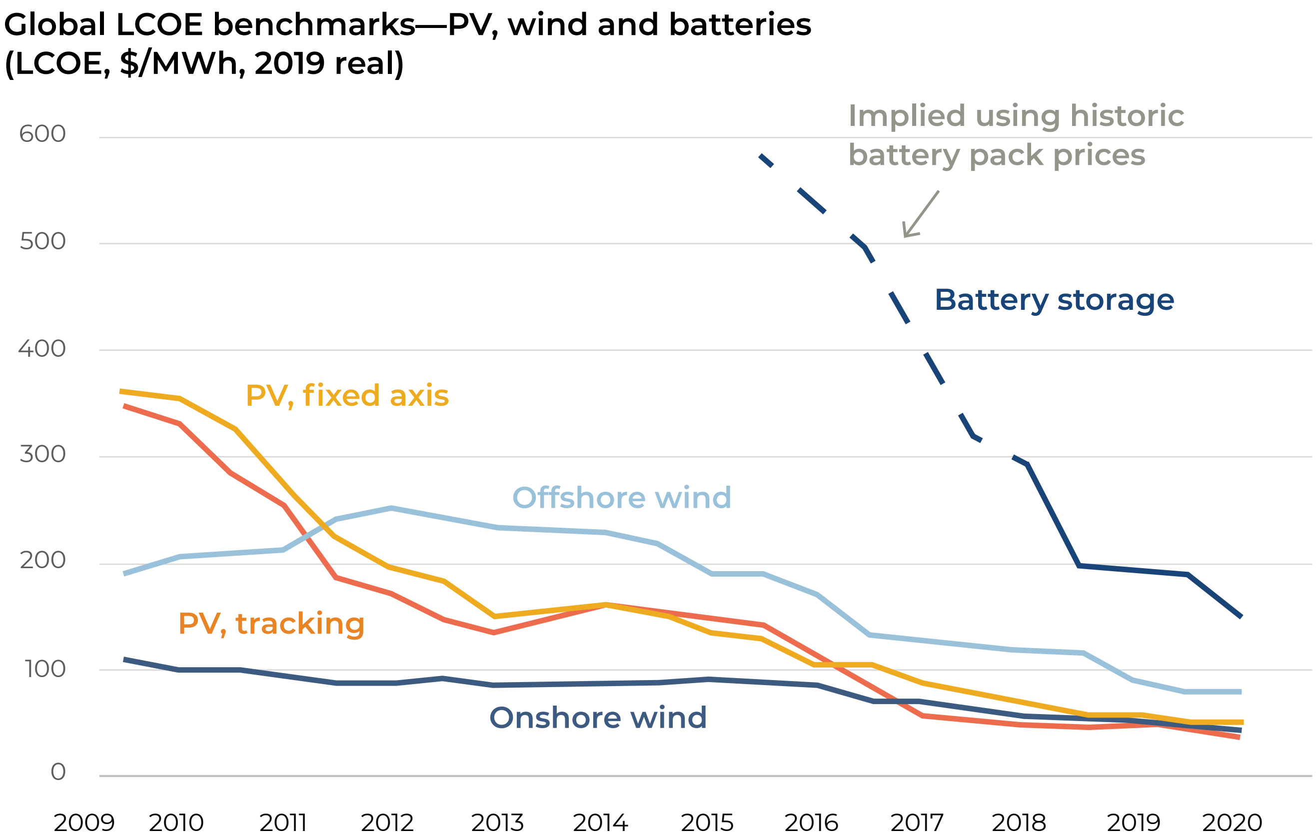
1.1 THE FALLING COST OF RENEWABLE ENERGY

Renewable energy is becoming more cost-effective than fossil fuel–based power generation. This remarkable shift has been the result of concerted policy efforts and incentives, including research and development (R&D) support, tax policy, utility obligations, tariff structures, and public and private procurement. This has enabled the private sector to invest, scale, and mature renewable energy technologies and supply chains.

From 2010 to 2019, global solar photovoltaic (PV) capacity alone grew 35 percent annually, while costs fell by 70 percent over the same period (Grubb et al. 2020; BNEF 2020). Wind energy also grew, with capacity increasing by 15 percent per year on average over the last decade (Grubb et al. 2020). Today, solar PV and onshore wind power are the cheapest sources of new-build power generation for at least two-thirds of the global population (see Figure 2) (BNEF 2020). Solar PV projects across Chile, countries across the Middle East, and China, or wind projects in Brazil, the United States, and India are approaching figures below $30 per megawatt hour (MWh) (BloombergNEF 2020)—lower than the costs of building and producing electricity from utility-scale plants that use coal or even the cheapest gas (Lazard 2019).

Renewable energy power purchase agreements (PPAs) and auctions projected for 2021 show that new solar PV and onshore wind project generation costs are lower by over one-half and one-third, respectively,

Figure 2 | *Levelized Cost of Energy Benchmarks, 2009–2020*



Note: LCOE = Levelized Cost of Energy; MWh = Megawatts/hour; PV = Photovoltaic.
Source: BloombergNEF, 2020.

The single biggest lever to decarbonization across sectors is the electrification of the economy and a massive deployment of renewable generation capacity to reduce emissions in the power sector and decarbonize transport, industry, and buildings.

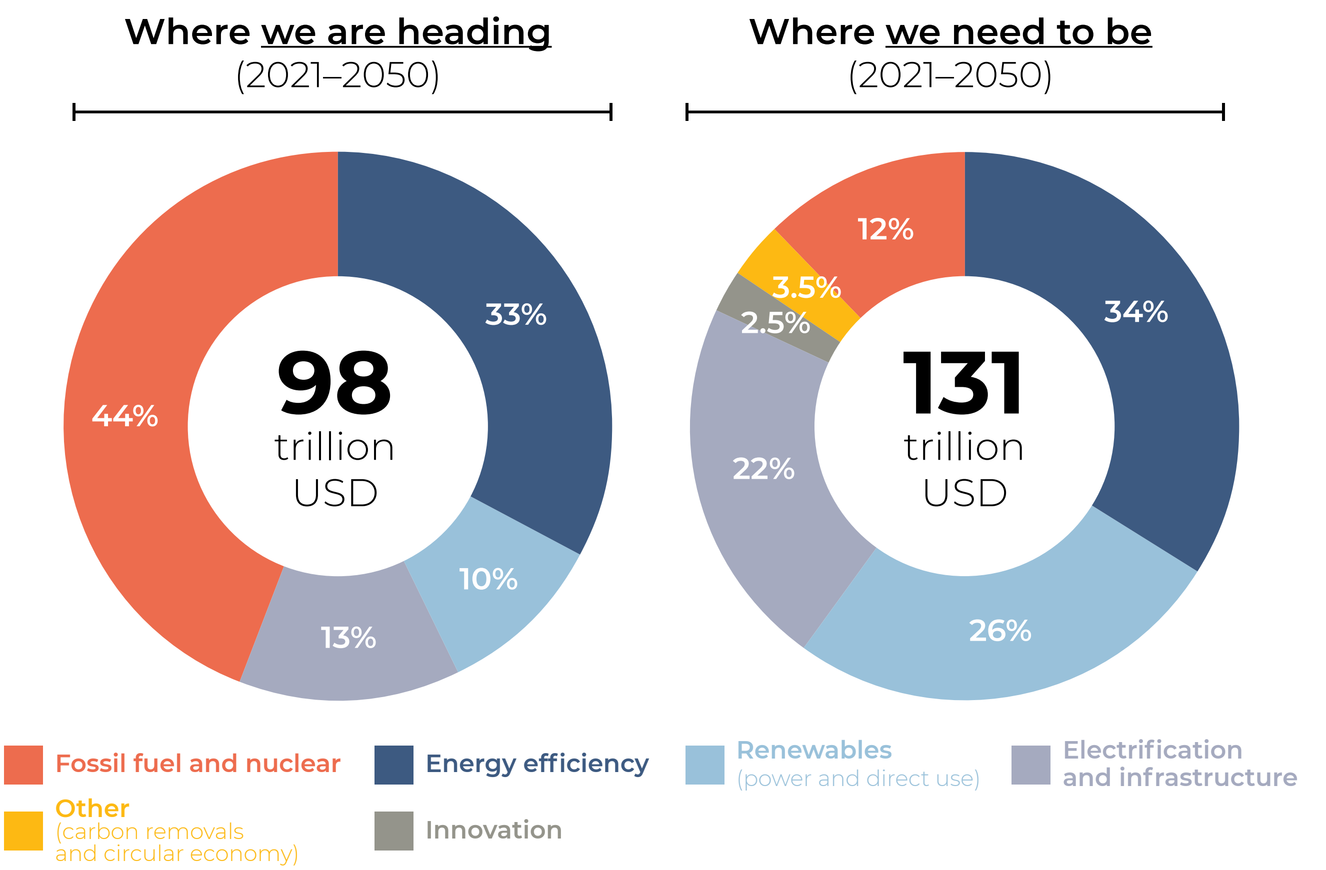
of costs of generation from existing coal-fired power plants (IRENA 2020a). In addition to dramatic reductions in capital costs, "soft costs" have also fallen as expertise in deployment has flourished (BNEF 2020). Even with these remarkable cost reductions, growth in fossil fuels still outpaces the growth in renewable electricity deployment. Thus, policymakers and investors must make dramatic interventions to address the remaining barriers to scaling our renewable energy-based power systems.

1.2 ALIGNING PUBLIC POLICY AND PRIVATE INVESTMENT

The role of partnerships between public and private actors is crucial for scaling investment. One term often used is "ambition loop,"[1] where positive experiences with a technology or market make it more desirable to expand activity and scale up activities. Among decision-makers and stakeholders, the idea of an ambition loop for climate action would link and align strong government action with unprecedented private sector mobilization, thus reinforcing the public sector's commitment and policies. These policies provide businesses with greater clarity and confidence to increase activity, thus reducing costs and in turn driving cost-effectiveness and faster progress in emissions reductions across nations.

Renewable energy technologies are one such area of opportunity. Due to remarkable reductions in the capital cost of generation, ongoing

Figure 3 | ***Investment Needed to Unlock the Energy Transition***



Source: IRENA 2021.

technology innovation, and improvements to capacity and know-how, the growth in renewable energy has been the success story of the last 15 years.

The single biggest lever to decarbonization across sectors is the electrification of the economy and a massive deployment of renewable generation capacity to reduce emissions in the power sector *and* decarbonize transport, industry, and buildings. While onshore and offshore wind, solar, and hydropower are mature technologies, the quest to decarbonize the global economy is now expanding to new industries. Several other technologies, such as concentrated solar thermal, geothermal, and green hydrogen, represent another wave of technological innovation. Green hydrogen, in particular, which is produced with renewable electricity via electrolysis, holds promise to decarbonize many hard-to-abate energy uses. To reach net-zero, additional R&D and testing of nascent technologies to decarbonize the industrial sector (such as low-carbon cement and steel production) will be necessary. In 2019, the estimated total public energy research, development, and demonstration (RD&D) budget for International Energy Agency (IEA) member countries increased by 6 percent, reaching $21.5 billion (IEA 2020e). Emerging technologies will need to undergo the same transformations on cost and scale that have been seen for solar PV, onshore and offshore wind power, and batteries.

The private sector will be critical to meet global climate targets: $131 trillion in investments will be needed between now and 2050 (see Figure 3). This is a 30 percent increase over current planned investment allocations, with a significant portion of this investment coming directly from the private sector (IRENA 2021). The policy solutions outlined in Section 2 are applicable across countries with varying potentials for clean energy and with differing electricity market structures, economic maturities, and investment climates. If governments implement place- and market-appropriate policy solutions focused on mitigating renewable energy investment risks, they will enable the private sector to scale renewable solutions and deliver the necessary capital.

Box 2 | ***Political Economy of Energy Transitions***

An energy transition requires systemic changes across economic sectors, institutions, and policy frameworks. Though the challenges are complex in any setting, the specific set of issues differ in developed and emerging economies (Arndt and Tarp 2017). Market maturity, clean energy potential, and institutional structures, as well as political and societal factors will impact which barriers to clean energy investment are most significant and which solutions will be most effective. Though this paper provides policy and program examples from both developed and emerging markets, it does not delve into political economy conditions or comparisons. Solutions presented represent critical enablers for clean energy investment and development, but prioritization of challenges and solutions will vary depending on context.

2. Enabling Renewable Energy Deployment

In this section, we identify a number of key challenges and gaps in policies and regulatory frameworks that, if recognized and addressed, could increase private sector investment in renewable electricity. With each challenge, we suggest actionable solutions governments can undertake and, where data are available, provide real-world evidence and case studies of existing policy effectiveness on the ground.

Governments can address the underlying conditions for investment through market design and commercial arrangements, including contractual frameworks. The enabling environment set by governments directly influences the financial viability and cost of capital for clean energy projects because capital markets factor in political, contractual, performance, and physical risk when determining equity

To facilitate renewable power generation at the lowest possible cost, governments need to implement mandatory policies that will require the lowest possible cost of capital and provide broader supportive policy frameworks that reduce revenue risk and stabilize revenues at a competitive cost of capital.

and finance conditions (Box 2). Recent capital market interest in clean energy projects suggests that there is appetite for accelerated financial investment. Yet a recent review of solar investment showed that only 10 countries received the bulk of investments in solar photovoltaics—despite widespread global solar opportunities (International Solar Alliance 2021).

CHALLENGE I: LACK OF ENABLING POLICY AND REGULATORY FRAMEWORKS THAT PRIORITIZE AND APPROPRIATELY INCENTIVIZE RENEWABLE ENERGY TECHNOLOGIES

To attract the private investment needed to enable the clean energy transition, climate and renewable energy targets at the national and subnational levels are essential. The success of implementation of these targets relies largely on a broader enabling policy framework, where renewable energy mandates are bolstered through complementary actions including financial and fiscal incentives (e.g., renewable energy auctions), fossil fuel retirement mandates, and other policies including reliability of technology and system integration changes (IRENA 2021). The success and maturation of the renewable energy industry, particularly in developing markets, will need to be underpinned by strong government targets that give investors clarity and access to de-risking mechanisms, including new business models, and help guarantee the return on their investments.

The absence of long-term climate and renewable energy policies and targets create unclear market signals for investors and developers

Aggressive, binding climate and renewable energy policies signal to investors that the clean energy transition is a long-term public priority. The lack of long-standing mandates and targets can create unpredictable investment environments for investors and, in turn, affect a project's investment risk and its associated revenue streams. Policy or regulatory risk, for example, is often associated with changes in legal or regulatory measures that have significant, adverse impacts on project development and can make projects less attractive for investors (IRENA 2016).

National and subnational policies that fail to outline a clear pathway for the phaseout of existing coal, diesel, and natural gas power plants, including eliminating fossil fuel subsidies, also pose significant challenges to the deployment of renewable energy. Between 2016 and 2017, one study found that G20 countries provided over $47.0 billion per year in public finance, fiscal support, and state-owned enterprise investment directly to coal-fired power production, and an additional $13.4 billion to coal production and consumption. Government support to the fossil fuel sector through consumption subsidies or subsidies that lower prices for the end-consumer often bolster these resources' economic competitiveness in the market against cleaner generation sources, allowing them to continue operating long after they have ceased to be cost-competitive (Bodnar et al. 2020).

Climate and renewable energy targets need to be complemented with fiscal and financial incentives to create an enabling environment

Climate and energy targets should be coupled with strong long-term financial policies and incentives to help address barriers to renewable energy for investors. For instance, financial incentives can improve access to capital, reduce the burden of upfront capital costs, and lower project financing costs. The implementation of such incentives can also help improve the competitiveness of these resources relative to fossil fuels. Investments in solar PV and wind projects, for example, have largely been driven by regulatory and pricing guarantees, including feed-in tariffs (FiTs) or investment/production tax credits, and governments are increasingly supporting the build-out of new renewable capacity with auctions.

Yet, the availability and permanence of financial incentives can change the commercial attractiveness of a project significantly. In Europe, financial incentives and subsidies for solar projects can account for up to 85 percent of a project's initial revenue, and, across the region, changes to subsidies have led to solar FiT cuts for new projects ranging anywhere from 15 percent to approximately 70 percent (Bassi et al. 2017).

Perceived project risks, arising from a lack of comprehensive policies, lead to higher project costs

The uncertainty of future electricity prices makes it difficult to predict a project's revenue. To manage the perceived revenue risks associated with uncertain electricity prices over a project's lifetime, investors and developers often add costs to their offer. With high upfront capital expenditure, the cost of capital or the return that owners require and the interest that investors and lenders demand, if they are to build a renewable project, all have a big impact on total project costs. All other things being equal, the financing costs of a project increase in line with the perceived exposure to risk, meaning that projects with higher perceived risks are less attractive for investors (Tweed 2016). To facilitate renewable power generation at the lowest possible cost, governments need to implement mandatory policies that will require the lowest possible cost of capital and provide broader supportive policy frameworks that reduce revenue risk and stabilize revenues at a competitive cost of capital.

In emerging markets in particular, renewable energy projects are perceived to have higher risks, directly affecting the competitiveness of such projects. Another such perceived risk is known as offtaker or counterparty risk, whereby a project's power offtaker (often a utility) may not fulfill or may default on the obligations outlined within its financial contract. In sub-Saharan Africa, for example, state-owned utilities typically act as the offtaker for renewable energy projects. Nonetheless, the financial situation of electric utilities in the region remains highly unstable, leading to more expensive project financing to compensate for a utility's low creditworthy status. In a study of 39

Denmark has set a goal to reduce GHG emissions

70% ↓

from 1990 levels by 2030

countries in sub-Saharan Africa, analysis showed that only 2 countries were fully able to recover their costs of supply, while 20 countries could not even cover operational expenses (Kojima and Trimble 2016). In Asia, subsidies and delays in transfer often put utilities at financial risk, highlighting the need for cost-reflective tariffs and the phaseout of inefficient subsidies to address offtaker risk.

SOLUTION SET I: ESTABLISH LONG-TERM RENEWABLE ENERGY TARGETS AND CREATE AN ENABLING ENVIRONMENT FOR DEPLOYMENT

Establish mandatory climate and renewable energy targets and binding policies at the national or subnational levels

DESIGN AND IMPLEMENT POLICIES THAT DIRECTLY SUPPORT RENEWABLE ENERGY

National and subnational policies that set mandatory targets for renewable energy resources can directly impact project profitability and improve risk-reward ratios, making projects more attractive to investors. Examples of direct policies include emissions reduction or renewable capacity targets (such as Renewable Portfolio Standards), quotas and performance standards, feed-in tariffs, competitive tendering or auction schemes, net-metering policies, and tax incentives (IRENA 2015; IRENA and CEM 2015; REN21 2015).

Jurisdictions that have set and maintained strong targets for renewable energy accompanied by binding policies and implementation and monitoring mechanisms have seen significant capacity deployed as a result. Denmark has set a goal to reduce GHG emissions 70 percent from 1990 levels by 2030 and now generates over 50 percent of its electricity from renewable sources (Diermann 2020). This has been achieved through transparent long-term planning and targets—enacted with wide political support—streamlined permitting procedures, strong interconnections, and well-functioning electricity market design.

Coupling clean energy policies with an ambitious, long-term GHG emissions goal can also be an effective signal to power markets. In 2019, the United Kingdom signed a binding target to reach net-zero by 2050, doubling down on the country's target of cutting emissions 80 percent by midcentury. Further, the government set a target to deploy 40 gigawatts (GW) of offshore wind by 2030, leading to the formation of the Offshore Wind Growth Partnership, a £250 million investment to develop the offshore wind supply chain across the country (BEIS 2019).

ESTABLISH STRONG ENVIRONMENTAL AND HEALTH STANDARDS FOR ELECTRIC POWER PLANTS

Setting standards and limits to address the environmental impacts of power plants can deliver critical public and ecological health cobenefits, while also making renewable sources and demand-side efficiency more economically competitive. Setting limits on emissions of key air pollutants from power plants will require some plant owners to make investments in capital-intensive pollution controls, some of which will be significant enough to shift the economics toward cleaner generation sources in many markets. In the United States, the Cross-State Air Pollution Rule (CSAPR) and the Mercury and Air Toxics Standards (MATS) are air quality regulations that aim to reduce emissions of pollutants like mercury, sulfur, and nitrogen oxides. Between 2008 and 2016, the CSAPR and MATS were responsible for 14 percent of total coal-fired plant retirements and a 6 percent reduction in coal production (Linn and McCormack 2019; Coglianese et al. 2020).

Further, setting limits or bans on deployment of new coal capacity and setting retirement dates for legacy coal plants is important. From 2005 to 2020, China enacted several measures to phase out coal plants, improve air quality, and increase energy efficiency. Reinforced by a national emissions cap and ultralow emissions standards, policies focused on making larger coal power plants more efficient through end-of-pipe control devices and on decommissioning small plants. Between 2014 and 2020, these policies prevented an estimated 187,000 premature deaths annually due to improvements to air quality in densely populated areas (Wu et al. 2019). In April 2021, China committed to reducing its coal generation.

Complement targets with structures and incentives to create an enabling environment for renewable energy development

IMPLEMENT FISCAL AND FINANCIAL INCENTIVES

Common examples of renewable energy financial incentives that can be used by governments include feed-in tariffs; renewable energy auctions; tax measures; rebates, grants, and performance-based incentives; and loan programs (see example in Box 3), guarantees, and credit enhancements (Cox 2016). Renewable energy auctions, in particular, are an effective tool to lower the cost of renewable energy technologies, as they allow project developers to bid against each other for long-term contracts to supply electricity at the lowest price. By the end of 2016, more than 70 countries globally had adopted this mechanism (REN21 2017).

REDESIGN AND RE-FORM POWER MARKETS TO BETTER ALIGN RISK WITH INVESTORS' RISK PROFILES

Electricity markets must be designed or reformed in such a way that they provide appropriate compensation for renewable electricity and ancillary services. This can be achieved either through the development of novel pricing mechanisms, with policies that ensure greater market transparency, or through market restructuring if adequate conditions exist. While power market modernizations can be an important foundation for countries looking to pivot to a clean energy-dominant economy, more mature markets may need to make additional adjustments to their market structures to reach higher penetration levels. New pricing mechanisms can help usher in new flexible clean energy generation by ensuring that the ancillary services they provide to the grid are fairly compensated.

A recent study found that if the southern United States had a competitive regional energy market, building and operating new renewables would be less expensive than running 92 percent of existing coal plants (Roberts 2020; EI/Vibrant Clean Energy 2020). From 2025 to 2040, a shift

Box 3 | *Chile's Concessional Loan Program*

Between 2008 and 2011, the Chilean Economic Development Agency (Corporación de Fomento de la Producción de Chile, CORFO) implemented a $138.8 million concessional loan program, known as the CORFO NCRE Loan Program, aimed at supporting commercial banks in Chile that were interested in providing long-term, low-interest loans for renewable energy and energy efficiency projects (Violic 2015). The CORFO NCRE Loan Program was financed by the Chilean Treasury and the KfW Development Bank and provided financing to 15 different renewable energy projects. The program is said to have successfully helped set the stage for longer-term lending options across the country. Since the implementation of the CORFO NCRE Loan Program, one-third of Chilean banks have engaged in the provision of affordable financing for renewable energy and energy efficiency technologies and projects (Cox 2016).

Box 4 | ***Blended Finance Allows Local Bank Leader in the Philippines to Create a 2.2 Gigawatts Renewable Energy Portfolio***

Blended finance typically uses a combination of philanthropic and public capital, such as technical assistance grants, to encourage investments from the private sector (Choi and Seger 2020). The partnership of BDO Unibank—the Philippines' largest bank with assets of $65.2 billion as of end-2020—with the International Finance Corporation (IFC) in the Sustainable Energy Finance (SEF) Program (funded by the Global Environment Facility), was critical in building the bank's capacity to engage in and finance sustainable projects in the Philippines. From 2010 to 2012, BDO worked with IFC to provide capacity-building to bank staff, run market awareness initiatives, and impart to clients the best international practices on clean energy. To make this happen at a time when banks did not participate in renewable energy project financing, IFC guaranteed up to 50 percent of BDO's loans for energy efficiency and renewable energy projects through its SEF Program.

The successful advisory engagement was the anchor for BDO's issuance of its Green Bond for $150 million in April 2018—the first such investment for the banking industry in the Philippines and Southeast Asia. The partnership also allowed for the creation of BDO's sustainable finance portfolio of $5.8 billion as of end-2020, with 2.2 GW of renewable energy projects valued at $1.6 billion financed to date.

to a competitive regional market would create savings to ratepayers of 30 percent, or an estimated $380 billion, and a 46 percent reduction in carbon emissions compared to current utility resource plans (EI/Vibrant Clean Energy 2020).

Reduce perceived project and revenue risk by implementing a variety of different government-backed mechanisms

IMPLEMENT PUBLIC RISK MITIGATION INSTRUMENTS AND GUARANTEES

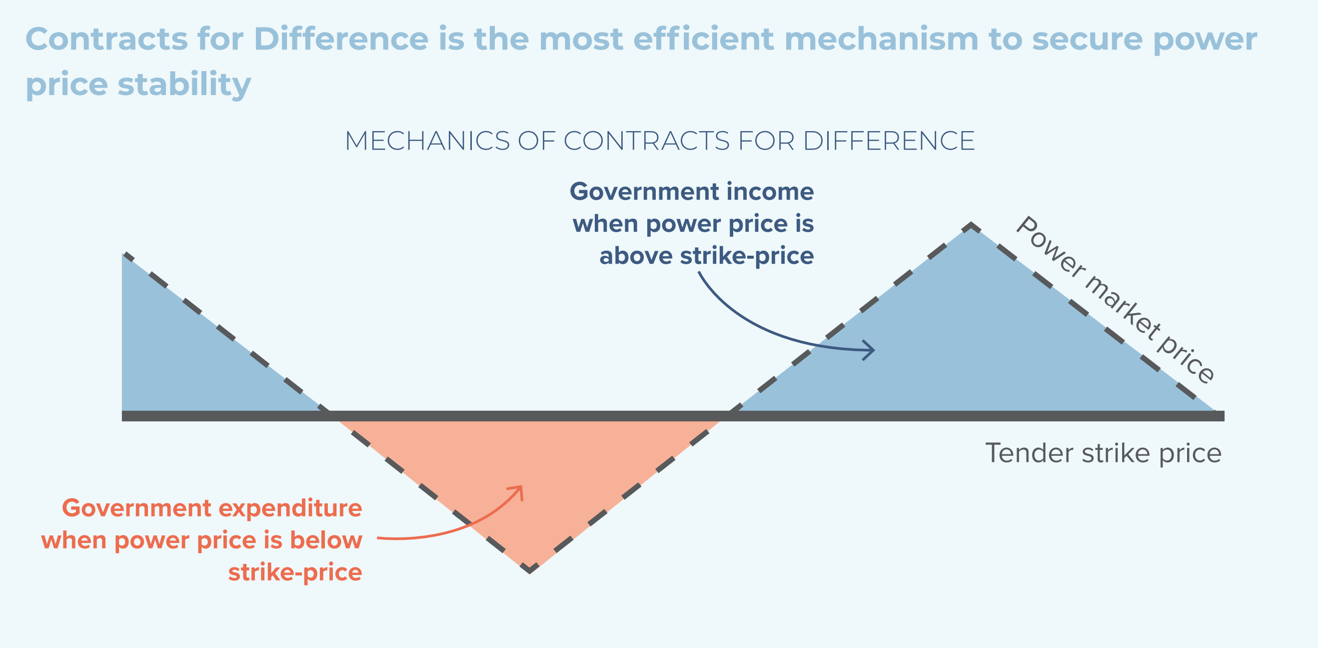
Governments can use existing risk mitigation instruments to address renewable energy project risks and protect investors. Examples of public risk mitigation instruments available today include government guarantees to backstop project risks that they are in a better position to take, as well as partial risk guarantees, which ensure government compensation for loss of revenue resulting from regulatory risk (IRENA 2016). In 2017, the Yap State Public Services Corporation, within the Federated States of Micronesia, developed a 3.6 megawatt (MW) wind-solar-diesel hybrid project to reduce dependency on imported diesel. The total cost of the project was $11.14 million, but the majority of the debt was financed by the Asian Development Bank. To reduce the risk of late- or non-payment of loan obligations by the Yap State Public Services Corporation, the Federated States of Micronesia provided a sovereign loan guarantee that covered late payment and default risk on the part of the borrower (ADB 2019). Similarly, the World Bank Group's Multilateral Investment Guarantee Agency (MIGA) political risk insurance helped mitigate some of the political risks that affected the development of the 250 MW Bujagali hydropower project in Uganda through "breach of contract" coverage for 90 percent of the equity investment. The use of MIGA drew in a higher level of private investment than any other comparable hydropower project in the region (Frisari and Micale 2015).

Concessional finance—through blended finance—is key to increasing the viability of public and private investments in countries where markets are not yet optimal for mobilizing commercial finance purely at market terms (OECD/The World Bank/UNEP 2018). Defined as the strategic use of development finance to mobilize additional finance for sustainable development, blended finance mechanisms are designed to encourage private investment by improving an investment's risk-adjusted returns (see Box 4).

ADDRESS REVENUE RISK THROUGH A TWO-WAY CONTRACT FOR DIFFERENCE (CFD) SCHEME

Another recent scheme that has been tried in several markets to address revenue risk is the two-way Contract for Difference (CfD), which can be used in combination with renewable energy auctions. This contracting approach provides risk and return sharing between governments and developers, and establishes a stable remuneration framework (see Box 5). It provides investment certainty and therefore reduces the cost of capital. In many large projects, the contractual partner in a CfD may be the government, itself, acting as the procurement lead.

Figure 4 | *Mechanics of Contracts for Difference*



Source: Ørsted.

The government guarantees that the developer will receive payment within a certain range over a period of time—typically 15 to 20 years. During that period, if the price of that electricity on the wholesale power market is higher than what was agreed, the government receives the extra revenue. Alternatively, if the price of the sale of that energy is lower than what was agreed, the government will make up the difference so that the project has a guaranteed payment at a price floor (see Figure 4). In a CfD scheme, the wholesale power price represents the basic remuneration, but the upside and downside risk are limited for the developer. This mechanism helps lower the cost of capital for renewable energy projects;

Box 5 | ***United Kingdom: Evolution of the Contract for Difference as a Market Mechanism***

In 2002, the UK government introduced the Renewable Obligation Certificates (ROC) scheme, mandating that power suppliers procure a certain share of renewable energy each year, either through self-generation or through certificates. This ensured a clear route to market for renewable developers and was successful in facilitating projects in the UK. In 2013, the ROC scheme was replaced with the current Contract for Difference (CfD) scheme, as part of a number of changes to the UK's electricity market. The mechanism was designed to provide revenue certainty for developers to enable higher levels of investment, whilst simultaneously creating competition to provide an incentive to developers to reduce the cost of producing renewable power, ultimately reducing the cost to the consumer. A key aspect of the CfD is the two-way nature of the sharing of risk, with the developer receiving certainty on the price it receives, and with the consumer being guaranteed to benefit should the wholesale price be greater than anticipated.

The CfD scheme is now the government's main mechanism for supporting low-carbon electricity generation in the UK (BEIS 2020), with the Offshore Wind Industry Council predicting that it will facilitate £60bn of private investment in the UK in the six years from 2021-26. It is worth noting that the prices for Contracts for Difference awarded in Auction Round Three in 2019 were below the predicted wholesale price for the period in which they operate demonstrating the value that developers place on the revenue certainty that the contracts provide.

Public support over clean energy development is growing.

Over **90%** *of EU residents support setting ambitious clean energy targets while nearly* **80%** *of U.S. individuals said they prioritize developing clean energy sources.*

and as upfront investments compose a high share of the total costs of most renewable energy technologies, this will, in turn, help to lower the costs and more easily secure financing.

ENABLE THIRD-PARTY OWNERSHIP OF FINANCING STRUCTURES

Third-party financing predominantly occurs in two forms: leases and power purchase agreements (PPAs); both methods are predominantly used in the United States to finance solar projects. In a third-party PPA agreement, an energy system offsets the customer's electric utility bill, and the developer sells the power generated to the customer at a fixed rate, typically lower than that of the local utility. Partnerships such as the Clean Energy Investment Accelerator (CEIA) are working to promote the use of third-party financing structures across Colombia, Indonesia, Mexico, the Philippines, and Vietnam.[2]

The corporate PPA (CPPA) is an increasingly expanding mechanism that allows companies to bring bankable offtakers into the market to support low-cost renewable energy project financing. In practice, CPPAs are long-term contracts under which a business agrees to purchase electricity directly from an energy generator, typically over a period of several years or decades; these agreements can be leveraged to reduce project revenue or remuneration risk. CPPAs require certificates or some other mechanism to document ownership and facilitate trading of renewable energy, to verify sales as well as other regulatory prerequisites.

CHALLENGE II: LACK OF TIMELY, PUBLIC SUPPORT AND LOCAL OWNERSHIP EARLY IN THE TRANSITION PROCESS CAN POSE PROJECT DEVELOPMENT RISKS

A successful clean energy transition requires strategic planning to balance the need for faster deployment of renewable energy and public benefits with potential challenges. Clear permitting and consent processes are important as is a fair transition for fossil fuel workers and impacted communities. Nonetheless, public support for clean energy development is growing fast—over 90 percent of European Union (EU) residents support setting ambitious clean energy targets, while nearly 80 percent of individuals surveyed in the United States said they prioritize developing clean energy sources (European Commission 2019; Tyson and Kennedy 2020). Consumers of all types are interested in clean energy: a 2020 survey of U.S. consumers found that 65 percent of residential customers view renewable energy as beneficial for the national economy, and over 280 companies worldwide have joined the RE100 global initiative, committing to match their annual electricity demand with renewables (RE100 n.d).

Jurisdictions with significant fossil fuel infrastructure and employment face near-term political challenges for transitioning to clean energy

Reorienting fossil fuel–dependent economies to clean energy requires foresight, commitment, and political capital. Political challenges to clean energy can be particularly significant in regions where fossil fuel industries historically have been large contributors to GDP, employment, or government revenues (Garcia Casals et al. 2020; Nir 2020; Alova 2020). Clean energy certainly has significant potential to create jobs globally: 42 million renewable energy jobs, alone, are possible by 2050, while energy efficiency jobs would grow six-fold, employing more than 21 million more people over the next 30 years. However, policymakers must acknowledge that the clean energy transition means job losses will occur in fossil fuel industries (six million jobs in the fossil fuel industry may be lost in the same period) and that renewable energy job quality will need to be addressed (union representation, pay, and benefits in wind and solar industries are currently less than those in oil, gas, and coal) (IRENA 2020a; Volcovici and Sanicola 2020).

Moreover, some of the benefits of the clean energy transition—such as job creation—are not evenly distributed across geographies or time. Regions well-suited for wind or solar energy, for example, are often not located in the same areas as those with fossil fuel extraction or use. For instance, in Newcastle, UK, the world's largest coal export city, mines directly employ over 900 people in the region, while planed renewable energy projects will provide only 150 jobs in the same area (Visontay 2020; Southward 2019).

Planning processes often do not account for public and stakeholder inputs on potential local impacts

Though the popularity of clean energy has grown overall, local support for particular technologies can decline when citizens believe new energy infrastructure will negatively impact them or their community, or if developments will conflict with local land rights. Common concerns include decreased home values, noise, damage to wildlife, and perceived health problems (Gross 2020; Nir 2020). Utility-scale onshore wind and solar developments, for example, have faced opposition based on project size—onshore wind turbines are 50 meters tall on average, and solar developments can require 5 to 10 acres, or 2 to 4 hectares, per megawatt of generation capacity (DuVivier and Witt 2017; SEIA 2020).

Lack of consultation with local communities and failure to understand or recognize land rights are often at the heart of objections to project development. The Turkana Wind Project in Kenya, for example, has been mired in conflicts about land grabbing, negligence, and infringement on indigenous land rights, resulting in considerable delays for the $144 million project (Darby 2017; Reuters 2016; Cormack and Kurewa 2018). New transmission infrastructure developed to transport clean power to load centers can also provoke community opposition if power passes through but does not serve the local grid (Gross 2020; Nir 2020).

In 2013, Morocco initiated a plan to phase out gasoline and industrial fuel subsidies by 2017, redirecting savings to a $9 billion solar plan established in 2009. This planned build-out will create an estimated ***270,000 to 500,000 jobs by 2040.***

Potential land-use conflicts can occur between new clean energy developments, existing local industries, and conservation needs and can result in environmental degradation

Agriculture, tourism, and fishing industries may be impacted if land is cleared or coastal areas become inaccessible due to solar or wind developments (Nesamalar et al. 2017; Seetharaman et al. 2019). Wind developments (both on- and offshore) have also sparked opposition from military stakeholders, who cite potential interference with surveillance activities, air traffic and radar systems, and low-level flights (Durkay and Schultz 2016).

Even when clean energy developments do not interfere with existing industry practices, new projects and associated transmission infrastructure require significant areas of land, potentially leading to deforestation and fragmentation or loss of large habitat blocks (DuVivier and Witt 2017; McKenney and Wilkinson 2020; Kuvlesky et al. 2007). Fragile lands are particularly vulnerable to environmental degradation (Gross 2020). In the Mojave Desert, for instance, solar PV installations likely reduced conservation values; that is, how much the land contributed to the preservation of species and ecological diversity across a large area between 2009 and 2017 (Parker et al. 2018; USEPA 2009).

SOLUTION SET II: BUILD BROAD PUBLIC SUPPORT THROUGH INCLUSIVE AND TRANSPARENT PLANNING

Engage local stakeholders early on, in public processes that are transparent, inclusive, and sincere about addressing community needs

REDISTRIBUTE FUNDING FROM FOSSIL FUEL INDUSTRIES TO PROGRAMS THAT WILL FACILITATE A FAIR TRANSITION

There are increasing instances of jurisdictions with large fossil fuel employment that have successfully navigated the political and economic impacts of a clean energy transition. These jurisdictions have developed creative funding mechanisms to restore local tax revenues, support affected communities, and set the stage for a renewable energy–based economy. In the United States, Colorado and New Mexico are using securitized bonds to refinance utility investments that allow early retirement of coal-fired generation plants. Securitization laws focus on public interest outcomes; both Colorado and New Mexico enable bond financing to be used to mitigate negative community and worker impacts of coal phaseout (Lehr and O'Boyle 2020). In parallel to its securitization law, Colorado established the Office of Just Transition to work with communities directly to develop transition plans and programs (Holzman et al. 2020).

In some cases, eliminating fossil fuel subsidies can provide governments with revenues needed to address transition needs. Morocco, a country with excellent solar energy potential, initiated a plan in 2013 to phase out gasoline and industrial fuel subsidies by 2017, redirecting savings to a $9 billion solar plan established in 2009 (Coats 2017).

Planned build-out of renewable energy capacity will create an estimated 270,000 to 500,000 jobs by 2040 (Ouhemmou 2016).

ENGAGE EARLY WITH PUBLIC STAKEHOLDERS TO DESIGN PROJECTS THAT ALIGN WITH LOCAL INTERESTS, NEEDS, AND VALUES

Engaging local stakeholders early in the permitting and siting process can help ensure projects align with local needs, while building goodwill for new clean energy developments (Ørsted 2019b). Various local energy ownership models can be used to mobilize local support and buy-in. While specific arrangements vary, local ownership schemes allow citizens to be highly involved in project decision-making. Common models for community ownership include public-private partnerships, cooperatives, community trusts, and customer-owned enterprises (Gancheva et al. 2018). Denmark's Samsø Island, the world's first 100 percent renewable energy–powered island, is a highly successful example of local ownership in practice. The island, now carbon-negative, uses a shared ownership model, where offshore wind turbines are owed by investor groups, municipal government, and local cooperatives. Collectively, community members have invested over $1.9 million since the project began in 1998 (Lewis 2017).

Community involvement may be initiated and facilitated through channels such as city councils, county commissions, or special commissions. Developers and governments should be particularly mindful of public engagement efforts when initiating projects in communities that may lack the resources or the political capital to express their concerns. Though local ownership models are promising, addressing community concerns and gaining initial support can take significant time and resources (Fowler et al. 2015). In Humboldt, California, for example, the Redwood Coast Energy Authority (RCEA) started community engagement efforts in 2017 for a floating offshore wind development project expected to go online in 2024 (RCEA 2020). Though daunting, investment at this early stage can help set projects up for long-term success.

Establish clear permitting and siting processes for clean energy infrastructure that explicitly address environmental and social impacts

DESIGNATE RENEWABLE ENERGY ZONES TO STREAMLINE RENEWABLE DEVELOPMENT, MAXIMIZE ECONOMIC BENEFITS, AND MITIGATE ENVIRONMENTAL IMPACTS

Governments can designate Renewable Energy Zones (REZs), areas that are preapproved for renewable energy project development on the basis of high-quality renewable energy resources and suitable topography and land-use designations (Lee et al. 2017). Additional factors include proximity to existing or planned transmission infrastructure and highway corridors). REZs can steer projects away from vulnerable natural lands, streamline project approval, and create location-specific standards for renewable energy projects (AWEA 2020a).

Several tools support the REZ planning process, such as the Multi-criteria Analysis for Planning Renewable Energy (MapRE tool), which incorporates geospatial, statistical, energy engineering, and economic methods to comparatively identify and value high-quality wind and solar resources (LBNL 2020a). The Africa Clean Energy Corridor (ACEC) initiative used the MapRE tool to identify REZs across the Eastern and Southern African Power Pools. Results were used to rank regions based on selected socioeconomic, environmental, and cost-efficiency variables (Climate Initiatives Platform 2020). This enabled the project to strategically plan across the 21 countries included in the ACEC, identifying areas where interconnections between countries could promote low-cost energy access and zones with low environmental impact (Wu et al. 2015).

INTEGRATE CLEAN ENERGY WITH AGRICULTURE AND LOW-IMPACT AREAS

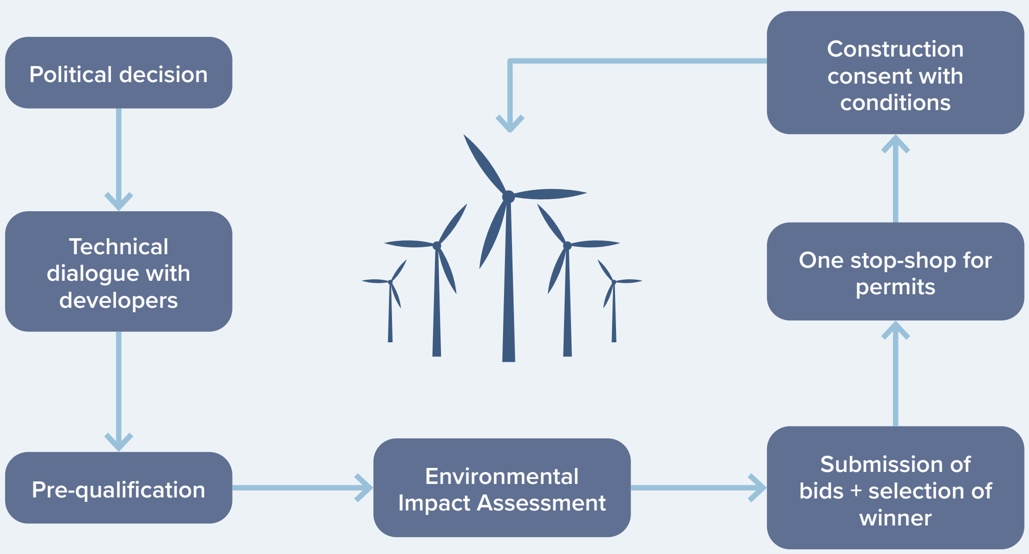
Integrating clean energy in agricultural lands and siting projects in low-impact areas like converted brownfields (Gross 2020) are promising approaches that allow renewable energy projects to coexist with other land needs and community priorities. Solar systems can be mounted on stilts, allowing livestock to occupy the same area or agricultural

Box 6 | *Danish Energy Agency's One-stop-shop for Offshore Wind Farms*

In Denmark, a number of permits are required by different authorities to develop and build an offshore wind farm. To facilitate this process, the Danish Energy Agency (DEA) established a "one-stop-shop" concept that grants project developers a single point of access to the permitting and approval process. As the coordinator behind the one-stop-shop, the DEA grants the permits needed to build an offshore wind farm and coordinates with relevant authorities throughout the process, including the Agency for Spatial and Environmental Planning, the Danish Maritime Authority, and the Danish Maritime Safety Administration.

Before the DEA actually begins processing a project developer's application, it initiates a hearing and consults with other government bodies to clarify whether there might be any other public interests or projects that could delay project implementation. When compared to the official administration of offshore wind farms in other countries, the Danish model has provided a quick, cost-effective process that benefits the operating budget of individual projects and the development of offshore wind turbines as a whole.

FIGURE B6. ONE-STOP-SHOP CONSENT PROCEDURE



Source: Danish Energy Agency.

machinery to operate beneath installations (Gross 2020; Mow 2018). Colocation can even be mutually beneficial in some cases—solar arrays can improve livestock and crop yields by providing shade, increasing soil moisture retention, or acting as pollinator habitats. Identifying possibilities for colocation early in the siting process can help lower overall installation costs by 3 to 8 percent per gigawatt compared to standard practice (Macknick 2016). One way to strengthen support for colocation is to reach a consensus on community compensation. For instance, farmers in the United States may receive up to $4,000 to $8,000 annually per turbine when leasing cropland for wind energy (AWEA 2020b).

Building out projects on brownfield areas enables new developments to leverage existing infrastructure, which can streamline the permitting and zoning processes and provide economic benefits to surrounding communities (USEPA 2020). This strategy also helps minimize environmental impacts and maintain the integrity of forests and other natural lands as carbon sinks (Gross 2020; McKenney and Wilkinson 2020).

Collaborate with stakeholders early in the process to identify possible land or marine competition and users

ESTABLISH A COMPREHENSIVE MARINE SPATIAL PLANNING MECHANISM FOR OFFSHORE WIND DEVELOPMENT

Marine Spatial Planning (MSP) processes bring together government agencies, industry, conservation, and local stakeholders with the goal of integrating offshore wind into a broader coastal system plan. MSP frameworks aim to reduce conflict and address future resource demands sustainably by identifying how and where sector activities can coexist. On average, a 1 GW offshore wind farm takes up an area of about 200 kilometers (km^2), yet only a small proportion of the area covered is actually taken up by the turbines, substation foundations, and cables. By increasing transparency and communication, MSP can inform allocation of marine space and identify trade-offs between mutually exclusive activities and those that can be integrated to maximize social, economic, and environmental benefits and facilitate opportunities for cross-border cooperation (Ehler and Douvere 2009). Denmark's Act on Maritime Spatial Planning provides an overview of how different parties can coordinate to allocate marine space efficiently and establishes a framework for MSP in Danish waters. Offshore activities that may be considered in this process include fishing, recreation, information and communication technology infrastructure, shipping, and defense.

Creating a structured process that accounts for the needs of multiple stakeholders saves time and development expenses (see Box 6). The Dutch MSP process for the North Sea reduced the cost of offshore wind permits by two-thirds, while developers involved in the Massachusetts Ocean Plan credit MSP for speeding up the subsea cable application process (Flannery and Ellis 2016).

CHALLENGE III: OUTDATED MANAGEMENT AND LACK OF GRID FLEXIBILITY CAN DELAY CLEAN ENERGY PENETRATION

Grid management operations must be updated and flexibility increased

Electric power grids are unique systems that function only when the supply of power exactly matches demand, at every moment of every day. Intermittent clean energy resources like solar and wind produce power variably when the sun shines and the wind blows. To accommodate increasing levels of variable renewable energy (VRE), most power grids will require major changes and upgrades to their physical infrastructure, planning and operations, and electricity market structures. Investors can be deterred from backing otherwise attractive projects unless they can be connected to the grid, regardless of the quality or scale of the clean energy resource.

A higher share of national and subnational resources must be allocated to improving grid management, infrastructure, and flexibility

By 2050, the share of renewable energy in the power sector is expected to increase to at least 80 percent (IRENA 2018). Countries around the world struggle with investor concerns that their grids may be unable to integrate clean power at such high levels. A recent study from the International Renewable Energy Agency (IRENA) estimates that reaching 85 percent renewable electricity globally by midcentury will require roughly $18 trillion of investment in transmission and distribution grid expansion, enhanced grid flexibility, and energy storage (2018). In nearly every country, considerable grid infrastructure and operational upgrades must be made to meet climate targets.

Insufficient transmission build-out to connect load centers to clean energy resources slows investment

Inadequate transmission and interconnection infrastructure can be a significant barrier to scaling clean energy, both in countries with nascent clean energy markets and in those with more established sectors looking to increase levels of penetration. For example, Australia has enough clean energy potential to power the entire country; however, an outdated transmission system built around large, centralized generation stations is constraining investments in northern Queensland, northwest Victoria, and large areas of New South Wales, all areas with excellent wind and solar resources (Hobday and Divissi 2019).

In instances where clean electricity generation exceeds electricity usage, the excess power can create an imbalance. This can lead plant generators to scale back, or curtail, the clean energy production below what is technically feasible. Curtailment of clean energy reduces electricity generation as well as the cost-effectiveness of the entire system (QI et al. 2018).

SOLUTION SET III: MANAGE RESOURCE VARIABILITY AND IMPROVE GRID FLEXIBILITY

Facilitate development of new grid infrastructure

As nations seek investments to bring their clean energy resources to greater scale, they need infrastructure to cost-effectively move electricity from resource-rich areas to major load centers. Where government policy addresses resource variability and grid management needs, investors will have greater confidence that projects will yield expected returns. Where grid constraints exist, or curtailment is a risk, investments are less attractive. Enhancing grid management and flexibility can be done both through new physical infrastructure like long-range transmission lines, technologies such as software that improve operations, as well as through demand response, load shaping, and efficiency to reduce peak demand.

PROACTIVELY PLAN FOR AND COORDINATE GRID BUILD-OUT

Governments should account explicitly for clean energy and distributed resources when planning new transmission infrastructure. In India, the national government is building out its grid specifically to accommodate the country's ambitious renewable energy targets, via infrastructure grants to state governments and a waiver on interstate transmission charges for solar and wind until 2022. Since 2013, its Green Energy Corridors program has explicitly sought to connect wind and solar resource-rich areas to load centers (IEA 2020b). In addition, proactive national-level planning that aligns regional/provincial governments can be the most effective way to navigate bureaucratic barriers that hinder infrastructure build-out.

China's state-owned electric utility recently completed a 1,000-mile ultrahigh voltage line designed to transport carbon-free electricity. This will help China move power from energy-rich interior regions to its more densely populated areas in the eastern part of the country. According to the utility, this project can generate nearly 10,000 new jobs, and similar projects look to play a key role in the country's coronavirus stimulus strategy (Bloomberg 2020).

STREAMLINE AND INVEST IN NEW TRANSMISSION AND DISTRIBUTION INFRASTRUCTURE

Transmission infrastructure is critical to bringing down levels of curtailment. For example, a $7 billion investment in transmission infrastructure enabled Texas to become the top U.S. wind-producing state, with wind energy curtailment falling from 17.0 to 0.5 percent following the expansion (Handleman 2015). Parallel investments in energy storage can also reduce curtailment and help mitigate the risk of interrupted power supply (Specht 2019). Countries with a patchwork of regulations across states, provinces, or regions may have trouble ensuring transmission build-out and interconnection in the time frame necessitated by a rapid scale-up. To expedite projects in such cases, federal governments can work with subnational governments to streamline interconnection processes and set a strong federal backstop siting provision, which typically provides backstop authority to an

China's state-owned electric utility recently completed a ***1,000-mile ultrahigh voltage line*** *designed to transport carbon-free electricity. According to the utility, this project can generate nearly 10,000 new jobs.*

organization to be exercised only if the state cannot authorize a facility siting or if it has withheld approval. In 2005, for example, the U.S. Congress passed the Energy Policy Act (EPAct) to give the Federal Energy Regulatory Commission a backstop siting role in the event of lack of action by a state energy commission. Integrating balkanized power markets within a country—and thereby reducing rates—can be a boon to customers. Research from the U.S. National Renewable Energy Laboratory found that forming a "macro-grid" across the United States would return more than $2.50 for every $1 invested (NREL n.d.).

Building grid interconnections between neighboring countries can also deliver greater grid flexibility and lower wholesale market prices (De Vivero et al. 2019). Denmark and Norway have both benefited from the interconnection between their wind-heavy and hydropower-rich grids, respectively. Similarly, the interconnector being established between Denmark and the United Kingdom helps balance out variable offshore and onshore wind conditions between the two nations. The European Internal Energy Market facilitates this kind of flexibility by allowing for barrier-free electricity trade across European nations (Ørsted n.d.).

Complement upgrades to physical infrastructure with technological, operational, and market enhancements

ESTABLISH STRONG TARGETS FOR ENERGY STORAGE

Utility-scale battery storage, which is half as expensive as it was just two years ago, could play an expanded role in providing sufficient capacity and energy to meet demand at all hours as more variable clean energy sources come online, and it has the potential to support power sector decarbonization (Colthorpe 2020). In particular, emerging technologies like longer-duration seasonal storage and green hydrogen will be important. Modeling studies of 100 percent clean energy and deep-decarbonization scenarios suggest that long-duration storage technologies could help address future grid needs when storm events reduce clean generation for days and when seasonal variability of clean supply extends for weeks. However, the ability to increase long-duration storage capacity will depend on achieving significant cost reductions.

In India, the national government is encouraging hybrid renewable energy and storage plants with 2.4 GW, solicited through two auctions in late 2019. Similarly, the state of New York followed up on an aggressive energy storage target with $280 million in incentives for bulk and retail energy storage projects. Currently, more than 8 GW of bulk storage projects are in the state's pipeline (Spector 2020).

IMPLEMENT DEMAND-SIDE SOLUTIONS

Demand-side solutions are often one of the most cost-effective ways to control energy demand and provide grid support. Examples of demand-side measures include investments in energy management systems that help customers track and reduce energy consumption, energy efficiency upgrades, and communication technologies that allow customers to automate and optimize their own electricity demand. By implementing demand-side measures to better manage the timing of loads, greater grid flexibility can be achieved to manage larger amounts of clean energy on the grid and help provide grid reliability. When demand-side resources are properly integrated and managed on the grid, they can boost the technical flexibility of a grid and even be combined with bulk storage technologies.

IMPLEMENT ADVANCED SYSTEM OPERATIONS AND MANAGEMENT STRATEGIES

Improved system operations and management have been shown to benefit grid resource balancing and can help smooth the path to high levels of clean energy penetration. Operational flexibility, enabled by digitization, advanced forecasting, and variable pricing, is a necessary complement to the technical flexibility outlined above (IRENA 2019). Peru, for example, has invested in a high spatial resolution nodal pricing system, which helps to detect transmission constraints (Foster and Rana 2020). National governments can leverage regulations to mandate or speed up the implementation of these systems, supported by updated market design and remuneration that captures the economic benefits of improved flexibility and precision (De Vivero et al. 2019). Ireland, whose electricity generation fuel mix includes the highest share of onshore wind power in the world at 37 percent, recently announced a €2 billion five-year plan to overhaul its electric power system, equipping it for 70 percent renewable electricity by 2030 and enabling peak penetration of 95 percent. The plan recognizes system interconnection across the country as central to achieving its aims (EirGrid Group 2019; Richard 2020). Further development and integration of digital innovations, such as blockchain and the Internet of Things, may provide additional grid flexibility in coming decades.

The 2020's are critical years in the fight against climate change. Governments and the private sector can secure a climate safe economy and environment by working together – but the foundational policy elements and finance must now scale at a rate we have not yet achieved.

3. Conclusion

Many recent papers note that this is the decisive decade for decarbonizing the electricity system – and electrifying new segments of the global economy like passenger vehicles and buildings. To succeed, governments and the private sector efforts must be aligned. This paper has reviewed three key elements that will determine success or failure in bringing investment to meet the aspirations of policymakers and renewable energy developers alike. These are: 1) setting and tracking targets for renewables and decarbonization, 2) support inclusive, timely and consistent siting and permitting processes, engaging local stakeholders early in the process, and 3) supporting grid and electricity system requirements with transmission and distribution systems that optimize renewable assets.

When designed and implemented well, government actions can reduce risks, create compelling business action, and drive private investment. In places where policies have succeeded in attracting private investment and building public support for clean energy, we observe the following characteristics:

- **Policies and market rules reflect ambitious goals and create an enabling environment for renewable energy.**
  - This includes markets where policies and binding targets are ambitious, and planning and funding recognizes that renewable energy technologies and an upgraded electrical grid are fundamental to achieving economic and environmental goals. They see renewables as a new economic driver, and an opportunity to bring investment into their communities.
  - Policies that are part of a comprehensive and consistent regulatory package, working together to achieve aligned public policy goals like clean and healthy air, water availability, and energy access, can be especially effective.
  - Investment in grid infrastructure can be complemented by the use of distributed and utility-scale energy assets. Grid infrastructure, transmission and digitalization are critical to the success of the renewable energy transition. By looking at the attributes at a system level and creating innovative contracting and renumeration approaches, the markets can reward rather than cut out new generating asset entrants.
- **Solutions match up with local conditions and level of market maturity.** Policies and incentives need to align with current local conditions for renewable energy deployment, both in terms of technical potential and how effectively the current power market compensates new clean energy generation.

- **Public and stakeholder engagement starts early and is sustained, and decision-making is transparent.** Siting and permitting processes should start *well in advance* of project initiation. Input must be sought in a truly inclusive manner. Criteria for and final decisions should be publicly documented. Policymakers in regions with significant presence and employment fossil fuel industries fare best if they anticipate and plan in advance for impacts on local tax revenues, employment, and economic development. In addition, consultations on siting should consider local values, land tenure and use, and balance the variety of considerations for specific cultural and ecosystem needs with the need to deploy renewable energy at a much greater pace and scale than currently.

The 2020's are critical years in the fight against climate change. Governments and the private sector can secure a climate safe economy and environment by working together – but the foundational policy elements and finance must now scale at a rate we have not yet achieved. Today's efforts to bring renewable electricity to market must quickly extend to countries that are earlier in their scaling journey. The technical knowledge is there, policymakers are setting targets, and as we look at this critical decade, it is time to overcome the remaining barriers to scaling renewable energy. This paper offers the policy and private sector community three key elements that can unlock the transformation of the power sector, which is crucial for society-wide decarbonization.

Glossary

CAPITAL COSTS	The cost of field development and plant construction and the equipment required for industry operations.
DEMAND RESPONSE PROGRAMS	Demand response programs (DSPs) are incentive-based programs that encourage electric power customers to temporarily reduce their demand for power at certain times, in exchange for a reduction in their electricity bills. Some demand response programs allow electric power system operators to directly reduce load, while others allow customers to retain control. Customer-controlled reductions in demand may involve actions such as curtailing load, operating onsite generation, or shifting electricity use to another time period. Demand response programs are one type of demand-side management.
DEMAND-SIDE MANAGEMENT	Demand-side management (DSM) is a utility action that reduces or curtails end-use equipment or processes. DSM is often used to reduce customer load during peak demand and/or in times of supply constraint. DSM includes programs that are focused, deep, and immediate such as the brief curtailment of energy-intensive processes used by a utility's most demanding industrial customers; and programs that are broad, shallow, and less immediate such as the promotion of energy-efficient equipment in residential and commercial sectors.
DISTRIBUTED ENERGY RESOURCES	Distributed energy resources (DERs) are small-scale energy generation technologies and storage technologies that produce electricity generation when needed. DERs are connected to the grid on a local distribution system.
POWER PURCHASE AGREEMENT	Power purchase agreement (PPA) is a contract with an energy project through which a customer agrees to purchase the energy produced by a generator over a specified period at a predetermined price per unit of energy. Types of PPAs include physical PPAs, financial PPAs, and other structures.
PROCESS EMISSIONS	Process emissions include carbon dioxide (CO_2) and other greenhouse gases emissions generated by a chemical reaction that occurs during an industrial process.
VARIABLE RENEWABLE ENERGY	Variable renewable energy (VRE) is a renewable energy source that is nondispatchable due to its fluctuating nature, like wind power and solar power, which only generate electricity when wind or sunlight are available.

Note: Several definitions have been aligned with the U.S. Energy Information Administration's Glossary. See https://www.eia.gov/tools/glossary/.

Source: Authors

Endnotes

1. To learn more about the ambition loop concept, read The Ambition Loop: How Business and Government Can Advance Policies That Fast Track Zero-Carbon Economic Growth, produced by We Mean Business, UN Global Compact, and World Resources Institute (2018): https://static1.squarespace.com/static/5bbe243651f4d40801af46d5/t/5c00266c0e2e728a28cee091/1543513751309/The-Ambition-Loop.pdf.
2. To learn more about the Clean Energy Investment Accelerator (CEIA), a public-private partnership between World Resources Institute, Allotrope Partners, and the U.S. National Renewable Energy Laboratory, visit the following website: www.cleanenergyinvest.org.

References

ADB (Asian Development Bank). 2019. *Federated States of Micronesia: Yap Renewable Energy Development Project.* Mandaluyong, Philippines: ADB.

Alova, G. 2020. "A Global Analysis of the Progress and Failure of Electric Utilities to Adapt Their Portfolios of Power-Generation Assets to the Energy Transition." *Nature Energy* 5: 920–72. https://www.nature.com/articles/s41560-020-00686-5?proof=t.

Arndt, C. And F. Tarp. 2017. "Measuring Poverty and Wellbeing in Developing Countries." *Oxford Scholarship Online.* 10.1093/acprof:oso/9780198744801.001.0001

AWEA (American Wind Energy Association). 2020a. "Agriculture." https://www.awea.org/wind-101/benefits-of-wind/wind-in-my-community/agriculture. Accessed December 2.

AWEA. 2020b. "Wildlife." https://www.awea.org/policy-and-issues/project-development/wildlife. Accessed December 1.

Bassi, A., K. McDougal, and D. Uzsoki. 2017. *Sustainable Asset Valuation Tool: Energy Infrastructure.* Winnipeg, Manitoba: International Institute for Sustainable Development.

BEIS (UK Department for Business, Energy and Industrial Strategy). 2019. *Industrial Strategy, Offshore Wind Sector Deal.* London: BEIS. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/790950/BEIS_Offshore_Wind_Single_Pages_web_optimised.pdf.

BEIS. 2020. "Contracts for Difference." March 2. London: BEIS. https://www.gov.uk/government/publications/contracts-for-difference/contract-for-difference.

Bloch, C., J. Newcomb, S. Shiledar, and M. Tyson.2019. *Breakthrough in Batteries: Powering the Era of Clean Electrification.* Basalt, CO: Rocky Mountain Institute.

Bloomberg. 2020. "China Mulls Stronger Clean Energy Goals for Next Five Years." https://www.jwnenergy.com/article/2020/9/18/china-mulls-stronger-clean-energy-goals-for-next-f/.

Bloomberg News. 2020. "A 1,000-Mile Long Clean Energy Artery Is Completed in China." *Bloomberg News* (blog), June 3. https://www.bloomberg.com/news/articles/2020-06-04/china-state-grid-completes-3-17-billion-clean-power-uhv-line.

BloombergNEF (BNEF). 2020. *New Energy Outlook.* New York, NY: BloombergNEF.

Bodnar, P., M. Gray, T. Grbusic, S. Herz, A. Londsale, S. Mardell, C. Ott, S. Sundaresan, and U. Varadajan. 2020. *How to Retire Early: Making Accelerated Coal Phaseout Feasible and Just.* Boulder, CO: Rocky Mountain Institute (RMI). https://rmi.org/insight/how-to-retire-early

Burrows, L. 2021. "Deaths from Fossil Fuel Emissions Higher Than Previously Thought." *Harvard John A. Paulson School of Engineering and Applied Sciences* (blog), February 9. https://www.seas.harvard.edu/news/2021/02/deaths-fossil-fuel-emissions-higher-previously-thought.

Burwen, J. 2020. “Energy Storage Goals, Targets, Mandates: What’s the Difference?” *Energy Storage Association* (blog), April 24. https://energystorage.org/energy-storage-goals-targets-and-mandates-whats-the-difference/bur.

Climate Initiatives Platform. 2020. “Clean Energy Corridors in Africa.” Climate Initiatives Platform. http://climateinitiativesplatform.org/index.php/Clean_Energy_Corridors_in_Africa.

Carbon Tracker Initiative. 2017. “Stranded Assets.” August 23. https://carbontracker.org/terms/stranded-assets/.

Choi, E. and A. Seiger. 2020. *Catalyzing Capital for the Transition toward Decarbonization: Blended Finance and Its Way Forward*. Stanford, CA: Sustainable Finance Initiative. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3627858.

Climate Watch. 2021. “Historical GHG Emissions.” April 20. https://www.climatewatchdata.org/ghg-emissions?end_year=2018&sectors=energy&start_year=1990

Coats, C. 2017. “Morocco’s Renewable Push Spurs Promise of Jobs.” *Forbes*, January 31. https://www.forbes.com/sites/christophercoats/2017/01/31/moroccos-renewable-push-spurs-promise-of-jobs/?sh=6478498b6392.

Coglianese, J., T.D. Gerarden, and J.H. Stock. 2020. “The Effects of Fuel Prices, Environmental Regulations, and Other Factors on U.S. Coal Production, 2008–2016.” *The Energy Journal* 41 (1): 55–81. https://www.iaee.org/en/publications/ejarticle.aspx?id=3452.

Colthorpe, A. 2020. “Spain’s 2.5GW Storage Target a Positive Step but ‘Challenging to Get There.’” *Energy Storage News* (blog), August 5. https://www.energy-storage.news/news/spains-2.5gw-storage-target-a-positive-step-but-challenging-to-get-there.

Cormack, Z., and A. Kurewa. 2018. “The Changing Value of Land in Northern Kenya: The Case of Lake Turkana Wind Power.” *Journal of Critical African Studies* 10: 89–107. https://doi.org/10.1080/21681392.2018.1470017.

Cox, S. 2016. Financial Incentives to Enable Clean Energy Deployment: Policy Overview and Good Practices. Golden, CO: National Renewable Energy Laboratory.

Dajani, M. 2019. “Challenges Remain in Understanding Energy Storage as Investment.” *Greentech Media (blog)*, December 27. https://www.greentechmedia.com/articles/read/the-remaining-challenges-in-understanding-energy-storage-as-an-investment.

Darby, M. 2017. “Kenya Clean Energy Revolution Dogged by Land Disputes.” *Climate Home News*, September 2. https://www.climatechangenews.com/2017/02/09/kenya-clean-energy-revolution-dogged-by-land-disputes/.

Davies, I., R. Watret, and M. Gubbins. 2014. “Spatial Planning for Sustainable Marine Renewable Energy Developments in Scotland.” *Ocean and Costal Management* 99: 72–81.

De Vivero, G., M. Kurdziel, and M. Hagemann, M. 2019. *Transition towards a Decarbonised Electricity Sector—A Framework of Analysis for Power System Transformation.* Cologne, Germany: NewClimate Institute. https://ambitiontoaction.net/wp-content/uploads/2020/02/Transition_Towards_A_Decorbanised_Electricity_Sector_A2A_full.pdf.

Deutsche Welle. 2020. “Germany and Hydrogen—€9 Billion to Spend as Strategy Is Revealed.” *Deutsche Welle* (blog). https://www.dw.com/en/germany-and-hydrogen-9-billion-to-spend-as-strategy-is-revealed/a-53719746.

Diermann, R. 2020. “Another 500 MW of Unsubsidized Solar for Denmark.” *PV Magazine*, May 28. https://www.pv-magazine.com/2020/05/28/another-500-mw-of-unsubsidized-solar-for-denmark/.

Durkay, J., and J. Schultz. 2016. “Energy Siting and Compatibility with the Military Mission.” National Conference of State Legislatures. May 20. https://www.ncsl.org/research/energy/energy-siting-and-compatibility-with-the-military-mission.aspx.

DuVivier, K., and T. Witt. 2017. “NIMBY to NOPE—or YESS.” *Cardozo Law Review* 38 (4).

Ehler, C., and F. Douvere. 2009. “Marine Spatial Planning: A Step-by-Step Approach towards Ecosystem-Based Management.” Intergovernmental Oceanographic Commission. https://unesdoc.unesco.org/ark:/48223/pf0000186559.

EirGrid Group. 2019. *Transform the Power System for Future Generations: Strategy 2020–25*. Dublin: EirGrid Group. http://www.eirgridgroup.com/about/strategy-2025/EirGrid-Group-Strategy-2025-DOWNLOAD.pdf.

Energy Transitions Commission. 2020. “Making Mission Possible: Delivering a Net-Zero Economy.” London: Energy Transitions Commission. https://www.energy-transitions.org/wp-content/uploads/2020/09/Making-Mission-Possible-Full-Report.pdf.

European Commission. 2018. “Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018.” Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN.

European Commission. 2019. “Citizen Support for Climate Action, 2019 Survey.” Brussels: European Commission. https://ec.europa.eu/clima/citizens/support_en#tab-0-0.

Evwind. 2019. “UK Government Affirms 40 GW Offshore Wind Commitment.” *Evwind*, December 19. https://www.evwind.es/2019/12/19/uk-government-affirms-40-gw-offshore-wind-energy-commitment/72645.

Flannery, W., and G. Ellis. 2016. “Exploring the Winners and Losers of Marine Environmental Governance.” *Planning Theory and Practice* 17 (1): 121–51

Flicking, D. 2020. “Coal’s Last Refuge Crumbles with China’s Renewables Plan.” https://www.bloomberg.com/opinion/articles/2020-09-21/coal-s-last-refuge-tumbles-with-china-s-renewable-energy-plan.

Foster, V., and A. Rana. 2020. *Rethinking Power Sector Reform in the Developing World. Sustainable Infrastructure.* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/32335. License: CC BY 3.0 IGO.

Fowler, E., K. Bunker, S. Doig, J. Mandel, and C. Owens Michelet. 2015. *RMI Community Energy Resource Guide*. Boulder, CO: Rocky Mountain Institute.

Frisari, G., and V. Micale. 2015. *Risk Mitigation Instruments for Renewable Energy in Developing Countries: A Case Study on Hydropower in Africa*. Climate Policy Initiative.

Gancheva, M., S. O’Brien, N. Crook and C. Monteiro. 2018. *Models of Local Energy Ownership and the Role of Local Energy Communities in Energy Transition in Europe*. Brussels, Belgium: European Committee of the Regions. https://cor.europa.eu/en/engage/ studies/Documents/local-energy-ownership.pdf.

Garcia Casals, X., B. Parajuli, and F. Ferroukhi. 2020. “Measuring the Socio-Economic Impacts of Transition: Focus on Jobs.” Abu Dhabi: International Renewable Energy Agency (IRENA). https://www.irena.org/publications/2020/Feb/Measuring-the-socioeconomics-of-transition-Focus-on-jobs.

Goodbody, S. 2016. “Building Solar Projects on Brownfields Is Hard Work. But There’s Massive Upside to Getting It Right.” *Greentech Media (blog)*, July 8. https://www.greentechmedia.com/articles/read/building-solar-projects-on-brownfields-is-hard-work.

Grant Thornton. 2011. *Independent Evaluation of FID Enabling for Renewables: Final Report to the Department of Energy and Climate Change*. Grant Thornton, United Kingdom.

Grant Thornton. 2015. *Independent Evaluation of the Electricity Market Reform: Final Report to the Department of Energy and Climate Change*. Grant Thornton, United Kingdom. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/468257/Independent_evaluation_of_Electricity_Market_Reform_-_Final_report_-_14_....pdf.

Gross, S. 2020. “Renewables, Land Use, and Local Opposition in the United States.” Washington, DC: Brookings Institution. https://www.brookings.edu/wp-content/uploads/2020/01/FP_20200113_renewables_land_use_local_opposition_gross.pdf.

Grubb, M., P. Drummond, and N. Hughes. 2020. *The Shape and Pace of Change in the Electricity Transition*. London: University College of London Institute for Sustainable Resources and We Mean Business Coalition.

Gupta, U. 2020. "Indian Reservoirs Could Host 280 GW of Floating Solar." PV *Magazine (blog)*, February 18. https://www.pv-magazine-india.com/2020/02/18/indian-reservoirs-could-host-280-gw-of-floating-solar/.

Hammar, L., D. Perry, and M. Gullström. 2016. "Offshore Wind Power for Marine Conservation." *Open Journal of Marine Science* 6 (1): 66–78.

Handleman, C. 2015. "Upgrades to Texas Transmission Lines Slashes Wind Curtailment." *CleanTechnica* (blog), August 20. https://cleantechnica.com/2015/08/20/upgrades-to-texas-transmission-lines-slashes-wind-curtailment/.

HEI (Health Effects Institute). 2019. *State of Global Air* 2019. Boston: HEI. https://www.stateofglobalair.org/sites/default/files/soga_2019_report.pdf.

Hise, C., B. Obermeyer, M. Ahlering, and J. Wilkinson. 2020. "Site Wind Right: Identifying Low-Impact Wind Development Areas in the Central United States." https://www.biorxiv.org/content/10.1101/2020.02.11.943613v1

Hobday, L. and L. Divissi. 2019. "Australia's Old Powerlines Are Holding Back the Renewable Energy Boom." ABC News, September 1. https://www.abc.net.au/news/2019-09-02/powerline-infrastructure-holding-back-renewable-energy-boom/11457694

Holzman L., M. O'Boyle, and D. Stewart. 2020. *Natural Gas: A Bridge to Climate Breakdown*. San Francisco: Energy Innovation.

IEA (International Energy Agency). 2020a. "India 2020: Energy Policy Review." Paris: IEA. https://niti.gov.in/sites/default/files/2020-01/IEA-India202020-In-depth-EnergyPolicy_0.pdf.

IEA. 2020b. "Renewables 2020." Paris: IEA.

IEA. 2020c. "Tracking Power 2020." Paris: IEA.

IEA. 2020d. "Share of Renewables In Power Generation In The Sustainable Development Scenario, 2000-2030." Paris: IEA.

IEA. 2020e. "Energy Technology RD&D Budgets 2020." Paris: IEA.

ILO (International Labour Organization). 2018. *World Employment Social Outlook* 2018. Geneva: ILO.

ISA (International Solar Alliance). 2021. *Realizing Energy Transition, Security and Access: Mobilizing $1 Trillion in Solar Investment*. Washington, DC: World Resources Institute (WRI).

IPCC. 2018. *Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report On The Impacts Of Global Warming Of 1.5°C Above Pre-Industrial Levels And Related Global Greenhouse Gas Emission Pathways, In The Context Of Strengthening The Global Response To The Threat Of Climate Change, Sustainable Development, And Efforts To Eradicate Poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

IRENA (International Renewable Energy Agency). (2015). *Renewable Energy Target Setting*. Abu Dhabi: IRENA.

IRENA. 2016. *Unlocking Renewable Energy Investment: The Role of Risk Mitigation and Structured Finance*. Abu Dhabi: IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Risk_Mitigation_and_Structured_Finance_2016.pdf

IRENA. 2018. *Global Energy Transformation: A Roadmap to* 2050. Abu Dhabi: IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_Report_GET_2018.pdf.

IRENA. 2019. *Adapting Market Design to High Shares of Variable Renewable Energy*. Abu Dhabi: IRENA.

IRENA. 2020a. *Global Renewable Outlook: Energy Transformation* 2050. (Edition: 2020). Abu Dhabi: IRENA.

IRENA. 2020b. *Renewable Energy and Jobs Annual Review 2020*. Abu Dhabi: IRENA.

IRENA. 2021. *World Energy Transitions Outlook: 1.5°C Pathway*. Abu Dhabi: IRENA. https://www.irena.org/publications/2021/March/World-Energy-Transitions-Outlook

IRENA and CEM (Clean Energy Ministerial). 2015. *Renewable Energy Auctions: A Guide to Design*. Abu Dhabi: IRENA and CEM.

Kojima, M., and C. Trimble. 2016. *Making Power Affordable for Africa and Viable for Its Utilities*. Washington DC: World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/25091/108555.pdf.

Kuvlesky, W., L. Brennan, M. Morrison, K. Boydston, B. Ballard, and F. Bryant. 2007. "Wind Energy Development and Wildlife Conservation: Challenges and Opportunities." *The Journal of Wildlife Management* 71 (8): 2487–98.

Lazard. 2019. *Lazard's Levelized Cost of Energy Analysis, Version 13.0*. Hamilton, Bermuda: Lazard.

LBNL (Lawrence Berkeley National Laboratory). 2020a. "India Renewable Energy Zones (IREZ)." Berkeley, CA: LBNL. https://mapre.lbl.gov/rez/irez/. Accessed December 2.

LBNL. 2020b. "SEAREZ." *Berkeley Lab*. https://mapre.lbl.gov/rez/searez/.

Lee, N., F. Flores-Espino, and D. Hurlbut. 2017. *Renewable Energy Zone Transmission Planning Processes: A Guidebook for Practitioners*. Golden, CO: National Renewable Energy Laboratory (NREL). https://www.nrel.gov/docs/fy17osti/69043.pdf.

Lehr, R., and M. O'Boyle. 2020. "Comparing 2019 Securitization Legislation in Colorado, Montana, and New Mexico." Securitization Brief. San Francisco: Energy Innovation. https://energyinnovation.org/wp-content/uploads/2020/09/Securitization-Brief_September-2020.pdf.

Lewis, D. 2017. "Energy Positive: How Denmark's Samsø Island Switched to Zero Carbon." *The Guardian*, February 23. https://www.theguardian.com/sustainable-business/2017/feb/24/energy-positive-how-denmarks-sams-island-switched-to-zero-carbon.

Lebling, K., M. Ge, K. Levin, R. Waite, J. Friedrich, C. Elliott, C. Chan, K. Ross, F. Stolle, and N. Harris. 2020. *State of Climate Action: Assessing Progress toward 2030 and 2050*. Washington, DC: World Resources Institute (WRI). https://www.wri.org/research/state-climate-action-assessing-progress-toward-2030-and-2050

Linn, J., and K. McCormack. 2019. "The Roles of Energy Markets and Environmental Regulation in Reducing Coalfired Power Plant Profits and Electricity Sector Emissions." *RAND Journal of Economics* 50 (4): 733–67.

Lou, T., D.S. Krishnan, and S. Sen. "Parched Power: Water Demands, Risks and Opportunities for India's Power Sector." Working Paper. Washington, DC: World Resources Institute.

Macknick, J. 2016. "Overview of Opportunities for Co-Location of Agriculture and Solar PV." National Renewable Energy Laboratory (NREL). PowerPoint Presentation, Clean Energy Economy Conference, Utica, NY, June 14. https://www.eanvt.org/wp-content/uploads/2013/01/NREL-Overview-of-opportunities-for-co-location-of-agriculture-and-solar-PV-1.pdf.

Macknick, J. 2019. "Co-Location of Agriculture and Solar: Opportunities to Improve Energy, Food, and Water Resources." National Renewable Energy Laboratory (NREL). PowerPoint Presentation, Joint Institute for Strategic Energy Analysis (JISEA) Annual Meeting, March 14. https://www.nrel.gov/docs/fy19osti/73696.pdf.

Madden, B., and M. Wilson. 2020. *Gigastack: Bulk Supply of Renewable Hydrogen*. Element Energy: Cambridge, UK. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/866377/Phase_1_-_ITM_-_Gigastack.pdf.

Makower, J. 2019. "The Growing Concern over Stranded Assets." *GreenBiz*, September 10. https://www.greenbiz.com/article/growing-concern-over-stranded-assets.

Massachusetts Department of Energy Resources. 2020. “Clean Peak Energy Standard Notices and Updates.” *Massachusetts Department of Energy Resources* (blog). https://www.mass.gov/info-details/clean-peak-energy-standard-notices-and-updates.

Maxwell, A. 2020. “How Chile Can Support Renewables and Resilience with Better Transmission.” *GreenBiz*, July 23. https://www.greenbiz.com/article/how-chile-can-support-renewables-and-resilience-better-transmission.

McKenney, B., and J. Wilkinson. 2020. *Clean and Green Pathways for Renewable Energy Buildout*. Arlington, VA: The Nature Conservancy.

Motyka, M., J. Thomson, K. Hardin, and S. Sanborn. 2020. “Energy Management: Paused by Pandemic but Posed to Prevail.” *Deloitte*, July 8. https://www2.deloitte.com/us/en/insights/industry/power-and-utilities/energy-study-of-businesses-and-residential-consumers.html.

Mow, B. 2018. “Solar Sheep and Voltaic Veggies: Uniting Solar Power and Agriculture.” *State, Local, and Tribal Governments* (blog), National Renewable Energy Laboratory (NREL), June 6. https://www.nrel.gov/state-local-tribal/blog/posts/solar-sheep-and-voltaic-veggies-uniting-solar-power-and-agriculture.html.

Murray, J. 2020. “UK’s Record Run without Coal Power Ends at 67 Days.” *Business Green* (blog), June 17. https://www.businessgreen.com/news/4016627/uk-record-coal-power-free-run-67-days.

Nesamalar, J., P. Venkatesh, and S. Charles Raja. 2017. “The Drive of Renewable Energy in Tamilnadu: Status, Barriers and Future Prospect.” *Renewable and Sustainable Energy Review* 73: 115–24.

New Climate Economy. 2018. *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times*. Washington, DC: New Climate Economy.

New Jersey Board of Public Utilities. 2020. *Order Directing the Utilities to Establish Energy Efficiency and Park Demand Reduction Programs*. June 10. https://www.nj.gov/bpu/pdf/boardorders/2020/20200610/8D--Order%20Directing%20the%20Utilities%20to%20Establish%20Energy%20Efficiency%20and%20Peak%20Demand%20Reduction%20Programs.pdf.

Nir, S. 2020. “He Set Up a Big Solar Farm. His Neighbors Hated It.” *New York Times*, March 18. https://www.nytimes.com/2020/03/18/nyregion/solar-energy-farms-ny.html?referringSource=articleShare.

Northwest Wind Resource and Action Center. 2015. “Wind Energy Permit Toolkit.” *Spark Northwest*. https://sparknorthwest.org/wp-content/uploads/WindPermitToolkit_WA_Sept-2015.pdf.

NREL (National Renewable Energy Laboratory). N.d. “Interconnections Seam Study.” Golden, CO: NREL. https://www.nrel.gov/analysis/seams.html. Accessed December 14, 2020.

OECD (Organisation for Economic Co-operation and Development)/The World Bank/UNEP (United Nations Environment Programme). 2018. *Financing Climate Futures: Rethinking Infrastructure*. Paris: OECD Publishing. https://doi.org/10.1787/9789264308114-en.

Oeko-Institut and Transport and Mobility Leuven. 2016. “Electric Mobility in Europe—Future Impact on the Emissions and the Energy System.” Leuven, Belgium: Oeko-Institut and Transport and Mobility Leuven. https://www.electrive.com/study-guide/electric-mobility-in-europe-future-impact-on-the-emissions-and-the-energy-systems.

Ørsted. 2019a. *Carbon Neutral to Stop Global Warming at 1.5C*. Sustainability Report 2019. Frederica, Denmark: Ørsted. https://orsted.com/-/media/annual2019/Sustainability-report-2019-online-version.pdf.

Ørsted. 2019b. “How Offshore Wind Can Help Decarbonize Europe.” Working Paper. Fredericia, Denmark: Ørsted. https://orsted.com/-/media/WWW/Docs/Corp/COM/About-us/whitepaper/Orsted-paper-Green-Deal-for-Europe-WEB.pdf.

Ørsted. 2020. “Taking Action to Stay within 1.5C.” Working Paper. Frederica, Denmark: Ørsted. https://orsted.com/-/media/WWW/Docs/Corp/COM/About-us/whitepaper/Orsted-whitepaper-globale-green-energy.pdf.

Ouhemmou, M. 2016. "Morocco Can Create 500,000 Jobs in the Renewable Energy Sector." *Morocco World News*, December 28. https://www.moroccoworldnews.com/2016/12/204743/morocco-can-create-500-000-jobs-renewable-energy-sector/.

Parker, S., B. Cohen, and J. Moore. 2018. "Impact of Solar and Wind Development on Conservation Values in the Mojave Desert." *PLOS One* 13 (12). https://doi.org/10.1371/journal.pone.0207678.

Pek, A. 2013. "Offshore Wind Energy Creates Opportunities for Tourism in the South Baltic Region." Brussels: Global Wind Energy Council. https://gwec.net/offshore-wind-energy-creates-opportunities-tourism-sector-south-baltic-region/.

Plechinger, M. 2021. "Viking Link Trading Goes from Chaotic to Difficult after Brexit Deal." *Energy Watch*, January 11. https://energywatch.eu/EnergyNews/Policy___Trading/article12680323.ece.

Public Utilities Commission of the State of California. 2020. "Decision 20-04-010: Order Instituting Rulemaking to Create a Consistent Regulatory Framework for the Guidance, Planning and Evaluation of Integrated Distributed Energy Resources." April 24. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M334/K734/334734544.PDF.

Ql, Y., J. Lu, and M. Zhu. 2018. "Wind Curtailment in China and Lessons from the United States." Washington, DC: Brookings Institution. https://www.brookings.edu/research/wind-curtailment-in-china-and-lessons-from-the-united-states/.

RCEA (Redwood Coast Energy Authority). 2018. "Integrated Resource Plan." Eureka, CA: RCEA. https://redwoodenergy.org/wp-content/uploads/2018/08/RCEA-2018-Integrated-Resource-Plan-redacted-1.pdf.

RCEA. 2020. "Offshore Wind Energy in Humboldt County." Eureka, CA: RCEA. https://redwoodenergy.org/community-choice-energy/about-community-choice/power-sources/offshore-wind-energy/. Accessed December 2.

RE100. n.d. "RE100 Members." Accessed December 28, 2020. https://www.there100.org/companies.

REN21 (Renewable Energy Policy Network for the 21st Century). 2015. *Renewables 2015 Global Status Report*. Paris, France: REN21 Secretariat.

REN21. 2017. *Renewables 2017 Global Status Report*. Pars: REN21 Secretariat.

Reuters. 2016. "Kenyan Wind Power Project Cancelled due to Land Disputes." Thomson Reuters. https://uk.reuters.com/article/kenya-electricity-idUKL8N1620QG.

Richard, C. 2020. "Ireland 'to Miss' 2030 Climate and Clean Energy Target." *Wind Power Monthly*, September 14. https://www.windpowermonthly.com/article/1694318/ireland-to-miss-2030-climate-clean-energy-target#:~:text=Onshore%20wind%20supplied%20nearly%2037%25%20of%20Ireland's%20electricity%20in%20the,unlikely%2C%20the%20industry%20body%20warned.

Roberts, D. 2018. "Utilities Have a Problem: The Public Wants 100% Renewable Energy and Quick." *Vox*, October 11. https://www.vox.com/energy-and-environment/2018/9/14/17853884/utilities-renewable-energy-100-percent-public-opinion.

Sakti, A., A. Botterud, and F. Sullivan. 2018. "Review of Wholesale Markets and Regulations for Advanced Energy Storage Services in the United States: Current Status and Path Forward." *Energy Policy* 120: 569–79. ISSN 0301-4215. https://doi.org/10.1016/j.enpol.2018.06.001.

Seetharaman, K., N. Patwa, and Y. Saravanan. 2019. "Breaking Barriers in Deployment of Renewable Energy." *Science Direct* 5 (1). https://www.sciencedirect.com/science/article/pii/S2405844018354240.

SEIA (Solar Energy Industries Association). 2020. "Siting, Permitting and Land Use for Utility-Scale Solar." https://www.seia.org/initiatives/siting-permitting-land-use-utility-scale-solar#:~:text=Research%20from%20the%20National%20Renewable,(MW)%20of%20generating%20capacity. Accessed December 1.

Sengupta, S., and K. Mehta. 2019. "Renewable Hybrid Energy Systems as a Game Changer in India." *McKinsey and Company* (blog), September 10. https://www.mckinsey.com/business-functions/sustainability/our-insights/sustainability-blog/renewable-hybrid-energy-systems-as-a-game-changer-in-india.

Shah, R., and P. Bloomer. 2019. "Respecting the Rights of Indigenous Peoples as Renewable Energy Grows." S*tanford Social Innovation Review*. https://ssir.org/articles/entry/respecting_the_rights_of_indigenous_peoples_as_renewable_energy_grows.

Southward, J. 2019. "Newcastle, the World's Largest Coal Export City, Sees Diversification as the Key for Future Prosperity." Australian Institute of Company Directors. June 1. https://aicd.companydirectors.com.au/membership/company-director-magazine/2019-back-editions/june/newcastle-otr.

Specht, M. 2019. "Renewable Energy Curtailment 101: The Problem That's Actually Not a Problem at All." *Union of Concerned Scientists* (blog), June 25. https://blog.ucsusa.org/mark-specht/renewable-energy-curtailment-101.

Spector, J. 2020. "Two Years In, New York's Storage Market Has Grown 'Faster Than We Expected.'" *GreenTechMedia* (blog), March 5. https://www.greentechmedia.com/articles/read/two-years-in-new-york-storage-market-has-grown-faster-than-we-expected.

Springer, N., and A. Daue. 2020. "Key Economic Benefits of Renewable Energy on Public Lands." New Haven, CT: Yale Center for Business and the Environment and the Wilderness Society.

TNC (The Nature Conservancy). 2020. "New York Leads on Climate." May 18. Arlington, VA: TNC. https://www.nature.org/en-us/about-us/where-we-work/united-states/new-york/stories-in-new-york/clean-energy-climate-leadership/.

Tweed, K. 2016. "Bigger Risk, Bigger Returns in Renewable Energy's Emerging Markets." *Greentech Media* (blog), April 20. https://www.greentechmedia.com/articles/read/bigger-risk-bigger-returns-in-renewable-energys-emerging-markets.

Tyson A., and B. Kennedy. 2020. "Two-Thirds of Americans Think Government Should Do More on Climate." *Pew Research Center*. June 23. https://www.pewresearch.org/science/2020/06/23/two-thirds-of-americans-think-government-should-do-more-on-climate/.

UNEP (United Nations Environment Programme). 2019. "Emissions Gap Report 2019." Nairobi, Kenya: UNEP.

UNEP, UNEP DTU Partnership. 2020. "Emissions Gap Report 2020." Nairobi, Kenya: UNEP. https://www.unenvironment.org/emissions-gap-report-2020USFWS.

UK Department of Energy and Climate Change. 2011. *Planning Our Electric Future: A White Paper for Secure, Affordable and LowCarbon Electricity*. London: UK Department of Energy and Climate Change.

USEPA (United States Environmental Protection Agency). 2009. "Conservation Value Method." Excerpt from the draft Science Advisory Board (SAB) Committee Report, V*aluing the Protection of Ecological Systems and Services*. https://yosemite.epa.gov/Sab/Sabproduct.nsf/WebFiles/conservation%20value/$File/conservation%20value-03-09-09.pdf.

USEPA. 2020. “Learn More about RE-Powering.” Washington, DC: USEPA. https://www.epa.gov/re-powering/learn-more-about-re-powering. Accessed December 2.

USFWS (US Fish and Wildlife Service). 2012. “Final Voluntary Land-Based Wind Energy Guidelines.” https://wind-energy-wildlife.unl.edu/download/USFWS% percent20factsheet% percent202012.pdf.

Violic, R. 2015. *NAMA Design Workshop: Financial Mechanism Design.*

Visontay, E. 2020. “Where Are the Jobs? NSW Coal Towns Cling to the Past until a Better Future Emerges.” *The Guardian*, November 14. https://www.theguardian.com/australia-news/2020/nov/15/where-are-the-jobs-nsw-coal-towns-cling-to-the-past-until-a-better-future-emerges.

Volcovici, V., and L. Sanicola. 2020. “Analysis: Biden’s Clean-Energy ‘Revolution’ Faces Challenge to Match Fossil-Fuel Jobs, Pay.” Thomson Reuters. October 30. https://www.reuters.com/article/us-usa-election-labor-renewables-analysi/analysis-bidens-clean-energy-revolution-faces-challenge-to-match-fossil-fuel-jobs-pay-idUSKBN27F1KN.

Von Hatzfeldt, S. 2013. “Renewable Energy in Chile: Barriers and the Role of Public Policy.” *Columbia SIPA Journal of International Affairs*, April 17. https://jia.sipa.columbia.edu/renewable-energy-chile.

Vu, T. 2020. “New Regulations Threaten Vietnam’s Remaining Coal Pipeline.” Working Paper. Lakewood, OH: Institute for Energy Economics and Financial Analysis. https://ieefa.org/wp-content/uploads/2020/10/New-Regulations-Threaten-Vietnams-Remaining-Coal-Pipeline_November-2020.pdf.

Vu, T. 2021. “IEEFA: Vietnam’s Extraordinary Rooftop Success Deals Another Blow to the Remaining Coal Pipeline.” January 12. Lakewood, OH: Institute for Energy Economics and Financial Analysis (IEEFA). https://ieefa.org/ieefa-vietnams-extraordinary-rooftop-solar-success-deals-another-blow-to-the-remaining-coal-pipeline/?utm_source=rss&utm_medium=rss&utm_campaign=ieefa-vietnams-extraordinary-rooftop-solar-success-deals-another-blow-to-the-remaining-coal-pipeline.

Weaver, J. 2019. “The Golden State Is Officially a Third Renewable and It’s Not Stopping There.” *PV Magazine*, February 25. https://pv-magazine-usa.com/2019/02/25/golden-state-is-officially-a-third-renewable-growth-not-stopping-though/.

Wu, G., R. Deshmukh, K. Ndhlukula, T. Radojicic, and J. Reilly. 2015. *Renewable Energy Zones for the Africa Clean Energy Corridor.* Berkeley, CA: International Renewable Energy Agency (IRENA) and Lawrence Berkeley Natural Laboratory (LBNL). LBNL-187271.

Wu, R., F. Liu, D. Tong, Y. Zheng, Y. Lei, C. Hong, M. Li, et al. 2019. “Air Quality and Health Benefits of China’s Emission Control Policies on Coal-Fired Power Plants during 2005–2020.” *Environ. Resource Letters* 14: 094016. https://doi.org/10.1088/1748-9326/ab3bae.

About the Authors

Norma Hutchinson is a research analyst within the global energy program. In this role, she supports research and analysis on deep decarbonization, innovative utility regulatory policy, and transportation electrification domestically and internationally.

Contact: norma.hutchinson@wri.org

Maggie Dennis is a research and report coordinator at WRI's Sustainable Business Center.

Contact: maggie.dennis@wri.org

Emil Damgaard Grann is Lead Global Public Affairs Advisor at Ørsted. He is responsible for Ørsted's global engagement with and advocacy towards global decision makers and opinion shapers to speed up the global energy transition. Emil manages Ørsted's activities in organisations such as WEF, ETC and Ørsted's work in relation to COP26.

Contact: edagr@orsted.com

Tyler Clevenger is a research analyst at WRI United States.

Contact: tyler.clevenger@wri.org

Michelle Manion was formerly a Lead Senior Economist at WRI. She is now the Vice President of Policy and Advocacy at the Massachusetts Audubon Society.

Contact: mmmanion@gmail.com

Johannes P. Bøggild is head of Public Affairs Denmark at Ørsted and member of the Steering Group of IRENA Coalition for Action. His work focuses on how to decarbonize the energy system and secure other societal benefits as a result of the transition to a world that runs entirely on green energy.

Contact: jopeb@orsted.com

Jennifer Layke is the Global Director of Energy at WRI. She leads a team of over 40 energy specialists around the world demonstrating approaches to deploying energy efficiency, renewable energy and energy access solutions.

Contact: jennifer.layke@wri.org

Acknowledgements

The content of this paper is the sole responsibility of the authors. However, the authors would like to thank the following individuals who offered perspectives and insights during phone interviews: Bharath Jairaj, Almo Pradana, and Deepak Krishnan, World Resources Institute; Suet Chee Chiong, Tamasek; Cecilia Tam, Organisation for Economic Co-operation and Development; Laura Moron, American Wind Energy Association; Elizabeth Press, International Renewable Energy Agency; Nadia Taobane and Rohit Khanna, World Bank; Patricia Monahan, California Energy Commission; Walt Musial, U.S. National Renewable Energy Laboratory; Sune Strøm, Philip Moore, Olivia Breese, and Daniel Nathan, Ørsted; and Matthew Sebonia, Southeast Asia Clean Energy Facility. The authors also thank Marlon Apanada for the significant role he played as a project manager for this engagement as well as management of the research and writing of this report. We also appreciate research support from William Cullen, who helped developed early drafts during his time as a WRI fellow.

We also thank the following individuals for their insightful comments and critical reviews of the draft report: Alexander Perera, Deepak Krishnan, Amy Meyer, Asger Garnak, Juan Carlos Altamirano, Giulia Christianson, and Daniel Soares, World Resources Institute; Cecilia Tam, Organisation for Economic Co-operation and Development; Rohit Khanna, World Bank; Tom Kerr, International Finance Corporation; Alexander Christian Newcombe, Anton Beck, and Andreas Karlsen, Danish Energy Agency; Jakob Askou Bøss, Filip Engel, Peter Beekmann, Øyvind Vessia, and Richard Crossick, Ørsted and the Net-Zero Asset Owner Alliance.

The authors would also like to thank Gregory Taff and Emilia Suarez of WRI's Research, Design, and Innovation Department for their insights and Romain Warnault for coordinating the production process, Billie Kanfer for design and layout, and Shazia Amin for copyediting.

ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

ABOUT ØRSTED

The Ørsted vision is a world that runs entirely on green energy. Ørsted develops, constructs, and operates offshore and onshore wind farms, solar farms, energy storage facilities, and bioenergy plants, and provides energy products to its customers. Ørsted ranks as the world's most sustainable energy company in Corporate Knights' 2021 index of the Global 100 most sustainable corporations in the world and is recognized on the Carbon Disclosure Project (CDP) Climate Change A List as a global leader on climate action. Headquartered in Denmark, Ørsted employs more than 6,000 people.

WORLD
RESOURCES
INSTITUTE

Ørsted