THE ROLE OF CONCESSIONAL CLIMATE FINANCE IN ACCELERATING THE DEPLOYMENT OF OFFSHORE WIND IN EMERGING MARKETS

REPORT

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Through the WB, ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable, and modern energy for all. It helps to shape WBG strategies and programs to achieve the WBG Climate Change Action Plan targets.

Foreword

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Climate mitigation and adaptation are critical considerations in the long-term economic development of emerging markets. Central to this is the provision of clean, affordable electricity that benefits both consumers and society. For many emerging markets offshore wind offers an opportunity to produce large-scale, clean electricity from abundant local resources, while keeping energy costs competitive and creating significant local economic opportunities.

However, development of offshore wind in emerging markets will not happen overnight, nor will it happen without support. Catalyzing an offshore wind industry in any new market will take time and the first projects will have an upfront cost premium—this cost premium should not impede the deployment of offshore wind and its potential to reduce carbon emissions across the globe. Making sufficient concessional financing available through public and private partnerships will be essential to reducing the costs of the first offshore wind "pathfinder projects" that will lay the foundation for growth of successful offshore wind markets.

Working with donor countries, development partners, private sector finance, and climate finance providers, we can achieve the first milestones in our journey to develop offshore wind in emerging markets. We believe that this will be key to achieving net zero, building up sustainable economies for future generations, creating greater energy independence, and avoiding the worst impacts of climate change.

The World Bank Group's Offshore Wind Development Program was launched in 2019 with the aim of accelerating the uptake of offshore wind in emerging markets. Since its inception, the program has worked with more than 20 countries, providing the support they need to make offshore wind a part of their long-term energy mix.

Using concessional finance to reduce the initial cost premium presents a high-impact opportunity to enable emerging market governments to commit to offshore wind and accelerate global decarbonization efforts.

PHOTO CREDIT: ØRSTED

Executive Summary

Offshore wind is critical to achieving global decarbonization goals and net zero emissions, both in developed and developing countries. It can provide large-scale, clean, reliable electricity generation with the potential to stimulate valuable economic benefits and industrial development. Estimates suggest that 2,000 gigawatts (GW) of offshore wind will be needed globally by 2050 to deliver the energy transition and limit temperature rise to well below 1.5 degrees Celsius (IRENA 2021). The global roll-out of offshore wind is growing quickly, with 21 GW added in 2021 alone, however developing countries—also known as emerging markets—are yet to deploy offshore wind; progress needs to be accelerated. This report explores the potential use of concessional, lower-cost financing to provide this acceleration and catalyze large-scale deployment in emerging markets.

Thanks to three decades of impressive scale-up, the cost of offshore wind has declined to the point where it is a competitive source of power in many established markets such as China, Denmark, Germany, the Netherlands, and the UK. This is driving rapid deployment in newer markets such as Japan, South Korea, Taiwan, and the United States, leading to strong, growing interest in emerging markets.[1] Recognizing this opportunity, the World Bank Group (WBG) established the Offshore Wind Development Program[2] in 2019 to support this interest and assist developing countries to accelerate their deployment of offshore wind. Initial analysis by the Program has identified an offshore wind technical potential of over 16,000 GW across 75 emerging market countries (ESMAP 2021). WBG has supported over 20 country governments to assess their offshore wind potential and is providing ongoing, in-depth, technical assistance to countries including Azerbaijan, Brazil, Colombia, India, the Philippines, Romania, South Africa, Sri Lanka, Türkiye, and Vietnam.

Despite the industry's cost reductions, the first projects in any new market will come at a cost premium as developers, investors, and lenders factor in a wide range of uncertainties, higher costs, and risks. These factors include different physical conditions, uncertain regulatory regimes, a lack of clarity on long-term market potential, inexperienced local supply chains, and commercial risks such as off-taker creditworthiness or currency convertibility. The majority of these issues can eventually be addressed through the experience and confidence gained from large-scale deployment. However, investment in "pathfinder projects" will likely be required to quickly bring costs down to the levels seen in

[1] Throughout this report, emerging markets are defined as low- and middle-income countries.

[2] The program is led by the Energy Sector Management Assistance Program (ESMAP) in partnership with the International Finance Corporation (IFC). For further information, see: https://esmap.org/esmap_offshore-wind

established markets.[3] Without mitigating measures, the first few pathfinder projects in each new market will require an off-take tariff far higher than the average cost of power in those markets—many of which have thriving solar and onshore wind sectors that represent the lowest cost of generation.

The higher cost of the first projects in a new offshore wind market presents an initial barrier of affordability for developing country governments and the ratepayers they represent. While there may be substantial long-term national benefits from building an offshore wind sector, including potential local economic development and the creation of long-term, skilled jobs, the near-term cost premium for early offshore wind projects represents a major obstacle to moving forward. Governments in emerging markets can find it hard to justify this higher initial cost even if they are aware of the rapid cost declines that will occur as the market matures in the country or region; a trend that has been observed in all established offshore wind markets. Removing this initial barrier is essential to accelerating offshore wind roll-out which, given the long development time required for projects, needs to happen quickly so that projects can be deployed within this decade.

Using concessional finance[4] to reduce the initial cost premium presents a high-impact opportunity to enable emerging market governments to commit to offshore wind and accelerate global decarbonization efforts. Financial support to lower tariffs for the first pathfinder projects can be tied to ambitious offshore wind policies that drive the investment needed to reduce costs for subsequent projects and build a local industry. Deployment of offshore wind in emerging markets would also have wider co-benefits through further global cost reductions and technological innovation—for example by accelerating the deployment of floating wind—thus representing a transformational opportunity for investment of scarce climate finance resources.

A coordinated public and private sector response is required to overcome the relatively high cost of the first offshore wind projects in emerging markets. Analysis undertaken for this study indicates that a representative pathfinder project—of 500 to 1,000 megawatts (MW)—in a large emerging market would have a Levelized Cost of Electricity (LCOE; see Annex B) of at least US$ 100 per megawatt-hour (MWh) without any kind of concessional finance support. The following measures to introduce concessional finance may be applied to reduce this LCOE to levels that are affordable and politically acceptable:

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[3] The term "pathfinder project" is used throughout this report to denote first-in-country projects that pave the way for subsequent commercial development. This term is more accurate than "demonstration" or "pilot" as these suggest that the technology is not yet proven, which is not the case for offshore wind.

[4] Put simply, concessional finance is below-market-rate finance provided by major financial institutions, such as development banks and multilateral funds, to developing countries to accelerate development objectives. (World Bank 2021d)

- ***Concessional public sector debt*** to finance core, or shared, infrastructure for initial projects thus reducing the private offshore wind developer's capital expenditure requirement. One example is to publicly finance the electrical export system and onshore transmission infrastructure, which could reduce overall private sector capital expenditure (CapEx) by 15 to 20 percent.
- ***Concessional private sector debt***[5] offered to developers bidding on initial projects, covering up to 50 percent of total debt requirements; this would be coupled with commercial financing to improve the overall terms of the debt package.
- ***Additional concessional public or private sector finance*** to help finance the upgrade of ancillary infrastructure, such as ports and transmission lines, or mitigate specific investment risks.
- ***Grants*** to cover a portion of the project CapEx where the above measures are insufficient; for example, this may take the form of a non-reimbursable grant to the project or as annual payments equivalent to an assumed carbon credit price (for example, US$ per metric ton of CO_2 emissions avoided).

The modeling for this study suggests that a combination of these measures will be required to sufficiently reduce the costs of the first offshore wind pathfinder projects. Table ES.1 describes the impact of different levels of concessionality on LCOE, based on a starting point of US$ 108 per MWh (Scenario 1A). If concessional private debt is the only instrument used (Scenario 1B and 1C) then there is a relatively limited impact on the tariff. That is, even with 50% of private debt provided under concessional terms (Scenario 1C), the LCOE only reduces to $91 per MWh. If the electrical export system is funded entirely with concessional public debt (Scenario 2A) with no other concessional support, the impact is also relatively limited, bringing the LCOE down by 13 percent to $94 per MWh. However, if the export system is covered by concessional public debt, 50 percent of the private debt is concessional, and 10 percent of the remaining CapEx is covered by a grant (Scenario 3C), then the LCOE falls to $70 per MWh, a level that is competitive with the long-term cost of conventional thermal generation in most emerging markets.

Achieving an LCOE of US$ 70 per MWh for a single 1 GW project in a large emerging market would require around US$ 480 million of concessional public debt for electrical export system infrastructure, US$ 827 million in concessional private debt, and US$ 245 million in project grants (see Figure ES.1). In this case, concessional finance could be blended with conventional sources of development finance at a maximum ratio of 1:1, plus commercial finance raised by private sector developers. The costs outlined here therefore represent a best estimate based on current assumptions, and further analysis would be required for each candidate country, taking into account relevant domestic cost and risk factors and the timeline for development. Furthermore, under a competitive process, tariff bids by developers can often surpass the best expectations of a bidding authority, so actual bid prices may be lower.

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[5] Sometimes known as 'blended concessional finance (IFC 2022), this financing combines concessional debt with other development finance to lower the overall cost of debt for the private sector borrower. When combined with regular commercial debt, the terms of the project's debt package are improved, thereby helping to reduce the cost of electricity and required tariff.

TABLE ES.1
Impact of Concessional Finance Support on the LCOE of a Representative 1 GW Pathfinder Project

SCENARIO	GRANT (% OF TOTAL DEVELOPER CAPEX)	LEVEL OF CONCESSIONAL PRIVATE DEBT (%)	TOTAL DEVELOPER CAPEX (US$BN)	EFFECTIVE PRIVATE DEBT INTEREST RATE (%)	LCOE (US$/MWH)
Base Case: no grants; no concessional public finance of export system; varying levels of concessional private debt to offshore wind project					
1-A	0	0	2.93	8.0	108
1-B	0	25	2.93	7.3	93
1-C	0	50	2.93	6.5	91
Concessional public debt to finance the export system; no grants; varying levels of concessional private debt					
2-A	0	0	2.45	8.0	94
2-B	0	25	2.45	7.3	81
2-C	0	50	2.45	6.5	79
Concessional public debt to finance the export system, plus varying levels of grants and concessional private debt to achieve competitive tariff					
3-A	25	0	2.45	8.0	70
3-B	13	25	2.45	7.3	70
3-C	10	50	2.45	6.5	70

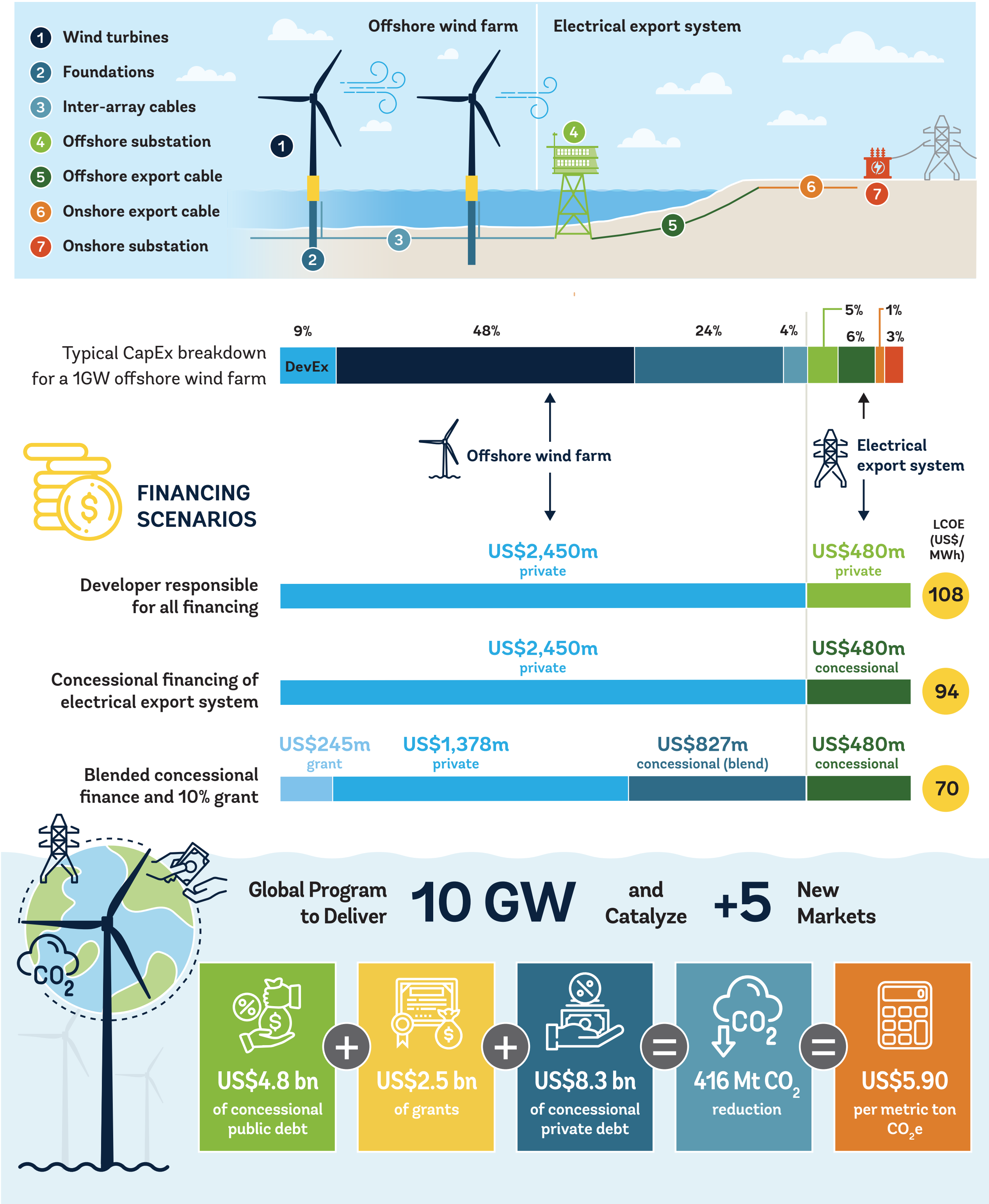
Source: World Bank Group analysis

Country-specific risk mitigation instruments may also play a role alongside grant and debt support, and could further reduce the cost of financing and hence project LCOE. These risk mitigation instruments, including guarantees and insurance (World Bank 2007b), are not included in this analysis, but should be assessed when designing support packages for different countries.

A major program to accelerate the deployment of offshore wind would need to target at least 10 GW of capacity across ten countries, requiring at least US$ 4.8 billion of concessional public debt, US$ 8.3 billion of concessional private debt, and US$ 2.5 billion in grants over an initial five-year period. While the focus would naturally be on large markets with high potential for decarbonization, there would also be strong justification to include smaller countries, where a single offshore wind project (even at a somewhat higher tariff) could represent a significant shift in the energy mix and lead to substantial savings in fuel imports and increased energy security.

FIGURE ES.1

Impact of Concessional Finance at 1 GW Project Scale and at a Global Scale for a 10 GW Global Program To Catalyze at Least Five New Markets



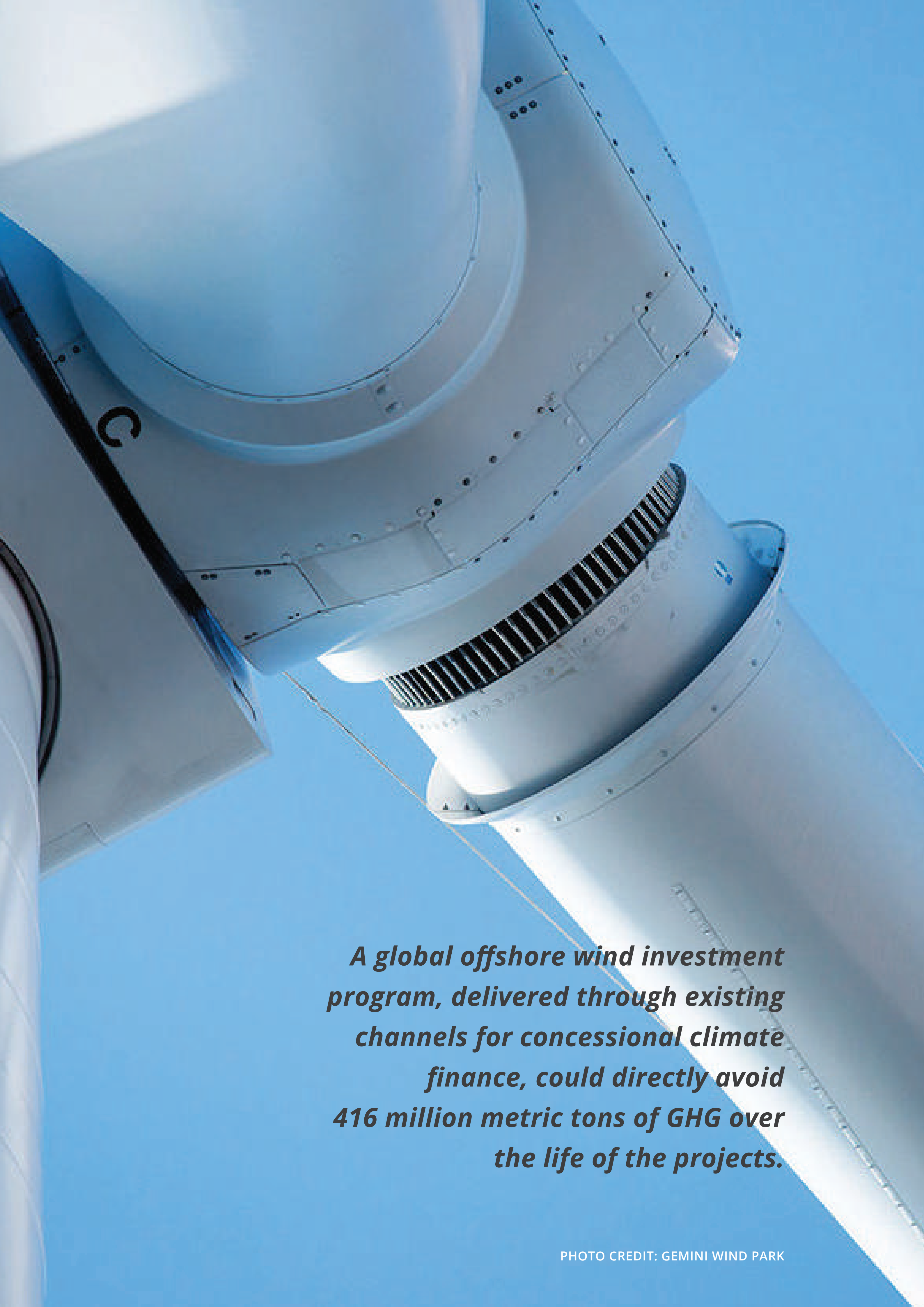
Source: World Bank Group

A global offshore wind investment program, delivered through existing channels for concessional climate finance, could directly avoid 416 million metric tons (Mt) of greenhouse gas emissions (GHG) over the life of the projects, translating into an emission reduction cost of roughly US$ 5.90 of grant funding per metric ton of carbon dioxide (CO_2).[6] This total quantity of emissions avoided is equivalent to the total annual CO_2 emissions of Türkiye (World Bank 2019a). By helping to introduce and scale up a whole new class of low-carbon power generation, such a program would help to put countries on a pathway for much greater GHG reductions through accelerated decarbonization. It would also help catalyze additional investment into the next wave of technological innovation, including floating wind and low-windspeed offshore turbines, thus further increasing the technical potential for offshore wind.

There exists the opportunity for a "grand bargain" between donor countries and emerging markets to accelerate the deployment of offshore wind to mutual advantage. On the part of key emerging market governments, this might involve a commitment to ambitious deployment targets and a willingness to absorb a tariff that is higher than for new-build solar or onshore wind, and should be supported by substantial concessional climate finance commitments by donor countries. This burden-sharing on cost recognizes the potentially significant benefits that offshore wind could bring to emerging market economies in terms of economic development and affordable, domestic sources of power. For donor countries, offshore wind represents a big-ticket opportunity to accelerate the pace of global decarbonization, combined with significant trade and export opportunities.

If the concessional finance is linked to substantial offshore wind targets in the policy commitments from the recipient emerging market governments—a target of at least 10 GW per country would be reasonable—then this finance should be seen as catalyzing a +50 GW global deployment on an accelerated timeline. Considering the need for immediate and rapid greenhouse gas emission reductions and global adoption of decarbonization pathways, we believe this represents good value for money and a highly strategic use of scarce donor resources.

[6] Assumes US$ 2.45 billion of grant to support 10 GW of offshore wind operating for 25 years at 40 percent net capacity factor, displacing generation at an average of 475 grams CO_2 per kWh (IEA 2019a).



A global offshore wind investment program, delivered through existing channels for concessional climate finance, could directly avoid 416 million metric tons of GHG over the life of the projects.

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ONE
INTRODUCTION

PHOTO CREDIT: VESTAS

1 Introduction

Offshore wind is growing rapidly around the world; from 2.5 GW operating in 2010, to 64 GW across 19 countries in 2022, to policy targets exceeding 300 GW by 2030, and further rapid growth expected beyond that (Global Wind Energy Council 2022). From its birthplace in Europe, offshore wind is quickly expanding in Asia and the United States, with strong prospects in other regions. In anticipation of the growing interest in emerging markets, the World Bank Group (WBG) launched its Offshore Wind Development Program in 2019 to support low- and middle-income countries looking to deploy offshore wind as part of their future energy mix. Under the Program a series of global knowledge products have been published, including an assessment of the technical resource potential in all emerging market countries based on the Global Wind Atlas and, more recently, the Program's flagship report, "*Key Factors for Successful Deployment of Offshore Wind in Emerging Markets*" (World Bank 2021). The Program has supported more than 20 governments to assess their offshore wind potential and is now providing in-depth, technical assistance to countries including Azerbaijan, Brazil, Colombia, India, the Philippines, Romania, South Africa, Sri Lanka, Türkiye, and Vietnam.

This report, which closely follows and builds on the *Key Factors* publication, was initiated under the Program and has been prepared by staff and consultants within the World Bank and International Finance Corporation (IFC) with funding provided by the Energy Sector Management Assistance Program (ESMAP). The report's objective is to assess the role that concessional finance can play in accelerating the deployment of offshore wind in emerging markets. While a growing number of WBG client country governments are either exploring, or actively developing, offshore wind in their jurisdictions, it has become clear that, despite impressive cost reductions globally, the first few "pathfinder projects" in each new market are likely to include a significant capital cost premium and higher financing costs. In addition, there are likely to be a range of other ancillary investments required to scale up offshore wind quickly and successfully, including the building of regulatory capacity, upgrades of the electricity grid, port expansions, and development of the local supply chain.

Although offshore wind, including these ancillary investments, represents a huge opportunity for economic development and job creation, it will be politically difficult for governments to approve projects with high initial tariffs, especially with the fiscal pressures introduced by the COVID-19 pandemic and recent disruptions to global supply chains and prices. Concessional finance—and in particular, sources of concessional climate finance that are available to support decarbonization efforts in low and middle-income countries—can play a catalytic role here. It can help bridge the cost gap expected for the initial projects within each market, justified by the global benefits achieved through accelerated decarbonization and the resulting reduction in greenhouse gas (GHG) emissions.

This report explores this catalytic role and analyzes—at a global level—the justification for, and practical deployment of, concessional finance to accelerate the deployment of offshore wind in emerging markets by private sector developers and investors. It is targeted at the following audiences, each of whom will view concessional finance from a different perspective:

1. **For developing country policy makers**: How can concessional finance be utilized to help reduce the cost of power from offshore wind and maximize economic development and jobs?
2. **For donor countries and climate finance providers**: Why should we support offshore wind? How should concessional finance be most efficiently deployed? How much funding will be required to achieve the scale of deployment required?
3. **For investors, including Development Finance Institutions (DFIs)**: How can concessional finance be used to most effectively leverage private sector financing?
4. **For private sector developers**: What role could concessional finance play in a project's structure and how will it help get projects built?

This report seeks to inform ongoing discussions on how to accelerate global decarbonization efforts, and the role of concessional finance in supporting such efforts. The report is also intended to complement national efforts to develop policies and strategies in support of offshore wind, including a series of country roadmap studies commissioned by WBG country teams with grant funding from ESMAP.

As a global study, this report does not contain an exhaustive list of possible options for the deployment of concessional finance and related project structuring. Each country will need to assess the options available in the context of their policy ambitions, electricity market, and financing constraints. However, the hope is that this report will facilitate that assessment within each country, and ultimately open up opportunities for securing access to sufficient volumes of concessional climate finance to kick-start and accelerate offshore wind development in emerging markets.

The report is structured as follows:

- **Chapter 2** considers the potential benefits of offshore wind, its current trajectory in terms of global expansion, potential barriers and challenges with deployment in emerging markets, and thus the rationale for concessional finance in accelerating deployment;
- **Chapter 3** looks conceptually at how concessional finance could be optimally deployed to support offshore wind in emerging markets;
- **Chapter 4** provides the results of financial modeling on a case study to assess the different options for concessional finance support; and
- **Chapter 5** summarizes the findings from this study and provides a series of recommendations based on the analysis and case studies.

TWO
WHY IS CONCESSIONAL FINANCE NEEDED FOR OFFSHORE WIND?

PHOTO CREDIT: VESTAS

2 Why is Concessional Finance Needed for Offshore Wind?

2.1 Offshore Wind Takes Center Stage

Offshore wind is a clean, reliable, and secure source of energy that has significant potential to transform the energy mix and generate economic value in countries that have a substantial wind resource. Rapid advances in technology and 60–70 percent reductions in price have driven a five-fold growth in the global offshore wind industry since 2011, with 64 GW operating globally by the start of 2023, including +21 GW commissioned in 2021 alone—the most in any year thus far (Global Wind Energy Council 2022). Nearly 23 percent of all global wind installations in 2021 were offshore, representing more than US$ 60 billion in annual investment—or eight percent of new global investments in clean energy. As the industry continues to expand rapidly, these figures are set to increase; global installations are expected to reach up to 30 GW per year between 2025 and 2030 (with cumulative installations of 380 GW forecast by 2030). This expected capacity increase represents US$ 700 billion of investments in offshore wind projects globally by 2030 (Global Wind Energy Council 2021).

Emerging markets such as Azerbaijan, Brazil, Colombia, India, the Philippines, Poland, Sri Lanka, South Africa, Türkiye, and Vietnam have begun exploring offshore wind development and are at various early stages of market preparation and project development. Interest by these countries in developing offshore wind has been driven by factors that include securing long-term and reliable energy supplies through domestic renewable energy sources,[1] pursuing economic and industrial development, and meeting national decarbonization commitments. WBG analysis of offshore wind technical potential across 75 emerging markets estimates a combined wind resource potential of +16,200 GW, including more than 5,500 GW of fixed potential and 10,700 GW of floating potential (ESMAP 2019). Furthermore, offshore wind typically has a higher capacity factor than onshore wind, and can in many cases be developed near to large coastal cities, helping to meet rapidly increasing demands for electricity.

[1] Drivers differ between markets, but frequent issues raised include: increasing challenges with siting and financing of coal-fired power plants; the increasing variability in hydro resources; and the increasing difficulty of finding suitable sites for onshore renewables.

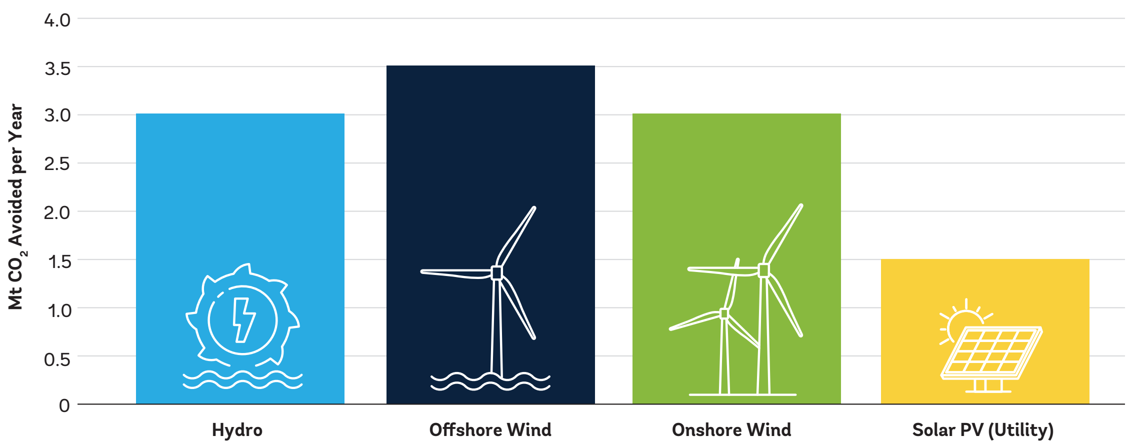
2.2 Role in Achieving Global Decarbonizing Goals

Offshore wind is one of the most effective forms of variable renewable energy in displacing coal generation and avoiding its own carbon emissions, (Offshore Renewable Energy Action Coalition 2020). Fossil fuels release on average 460 metric tons of CO_2 emissions per GWh of electricity generated, whereas a typical offshore wind project has life-time emissions equivalent to roughly nine metric tons of CO_2 per GWh (Amponsah et al. 2014). Analysis by the IEA, shown in Figure 2.1, found that a 1 GW offshore wind project could avoid 3.5 million metric tons of CO_2 per year when displacing coal generation, which currently accounts for approximately 38 percent of global electricity generation (IEA 2019b). This study found that offshore wind, when displacing large-scale coal generation, could be particularly effective at avoiding CO_2 emissions when compared with other forms of renewable energy.

To achieve global decarbonization goals, the vital contribution of offshore wind will be essential. Nationally determined contributions (NDCs), as part of the Paris Agreement, have brought a renewed urgency to efforts to decarbonize and invest in low carbon development pathways on a global scale, and thereby outpace the growth in fossil fuel exploitation, specifically new coal production. In the transition to net zero emissions over the next few decades, the global installed capacity of offshore wind will need to rapidly increase. The UN-linked Ocean Panel and Ocean Renewable Energy Action Coalition (OREAC) has emphasized offshore wind's critical role in achieving its 1.5°C pathway through providing 10 percent of the needed carbon mitigation by 2050 (Hoegh-Guldberg O. et al 2019). Similarly, the International Renewable Energy Agency (IRENA) estimated in its 1.5°C pathway, that the world would need around 382 GW of new installed capacity by 2030 (a ten-fold increase from today), and around 2,002 GW of new installations by 2050 (IRENA 2021). The same study also concluded that, to achieve the required capacity by 2050, US$ 177 billion needs to be invested in offshore wind every year, starting now. The International Energy Agency (IEA),

FIGURE 2.1

Annual Direct CO_2 Emissions Avoided (When Displacing Coal) Per GW of Installed Capacity by Technology



Source: (IEA 2020), *Sustainable Recovery* which reached similar conclusions, also estimated that, by 2030, new offshore wind capacity needs to be installed at a rate of at least 80 GW per year (IEA 2021). These global deployment targets will not be achieved without contributions from emerging markets.

2.3 Price Gap in Emerging Markets

The price of offshore wind has fallen dramatically in the past decade, with recent auction prices yielding tariffs under US$ 50 per MWh. In some mature markets, such as the United Kingdom (UK), the price of offshore wind is cheaper than new gas-fired or nuclear generation (UK.GOV 2021), and in Germany and the Netherlands, new projects require zero subsidies (BMWI 2017); (Netherlands Enterprise Agency 2019). There are many factors responsible for these cost reductions, but the main reasons include:

- **Scale:** Substantial economic efficiencies are achieved through larger wind turbine sizes and project capacities. Typical new project developments, in established markets, are planning to use +15 MW turbines in projects of at least 1,000 MW;
- **Risks:** The industry and its supply chain have matured as more experience has been gained. This has led to a better understanding and management of project, technology, and commercial risks; there have also been lower consenting and legal risks as frameworks are established and well-proven;
- **Debt:** The use of low-cost financing (which has only been possible because risks have reduced) has dramatically reduced the cost of financing. In established markets, up to 80 percent of a project may be financed by debt with a typical rate of 2 to 3 percent; and
- **Competition:** Demand to develop, supply, construct, finance, and operate offshore wind farms is high, and competition throughout a project's value chain has helped to drive down costs.

The first projects in any new market will be more expensive, and experience in new markets, such as Korea or Taiwan,[2] shows that it is not possible to immediately match the low prices seen in established markets. The higher cost of first projects is due to a range of issues and challenges, including:

- **Policy uncertainty**, which dampens the enthusiasm of initial investors as it may be unclear how the market will grow over time and yield economies of scale;
- **First-of-a-kind risk**, including uncertainties over the regulatory process and likely delays in steering the project through to completion;
- **Undeveloped local supply chains**, which require importation of a larger share of the project or costly investments in building domestic capacity;
- **Limited port capacity** near to the project site, which may require port infrastructure investment, or use of ports and ships from further afield;
- **Risks associated with power evacuation**, in particular interconnection with the main electricity grid and potential integration issues; and

[2] The first commercial-scale projects in Taiwan and Korea required tariffs of around US$ 200/MWh. In Korea, tariffs have been driven up by the comparatively low wind speeds, and Taiwan has ambitious local content rules. Taiwan has now started to deploy its first commercial-scale projects and witnessed tariff bids reduce to below US$ 90 per MWh in its 2018 auction.

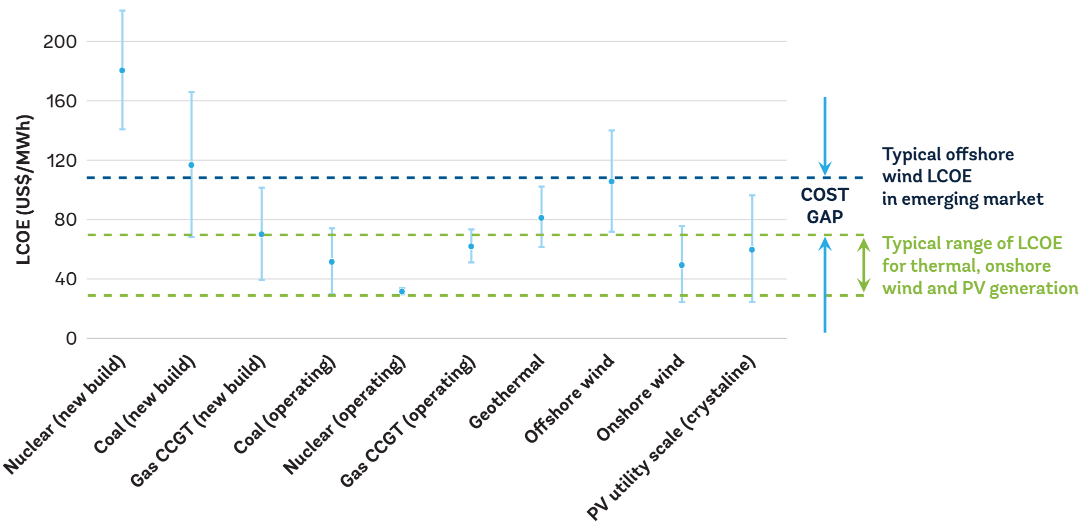
- **Limited capacity and availability of workers** with the necessary skills, including among suppliers.

The cost of financing infrastructure projects in emerging markets is also higher than for projects in high-income or OECD countries. This is due to conventional macroeconomic and project-related risks, which need to be adequately covered. In addition, emerging markets have introduced new technical risks not seen in Europe, related to unique wind patterns, seismic activity and extreme weather events, as well as different environmental and social impact risks. Some of these other risks, particularly those related to social and environmental sustainability, are critical to long-term growth of the industry and will be addressed in other reports from WBG.

In an emerging market, there will be an initial price gap between offshore wind and alternative forms of generation. This gap could cause a barrier if markets cannot afford this initial premium.[3] The current levelized cost of electricity (LCOE) for offshore wind reaching commercial operations in developed markets is typically between US$ 70 and US$ 100 per MWh, which is higher than typical LCOE for conventional thermal and onshore renewable generation, even at the lower end of this range, as shown in Figure 2.2.

FIGURE 2.2

The Typical Price Gap between Offshore Wind and Other Forms of Generation Including Thermal and Renewables



Source: (Lazard 2023)

[3] Both India and Türkiye have tried to start their offshore wind industries through competitive processes, but both found the price for the first project would have been too high to justify going ahead at the time. These competitions were subsequently paused, and both countries are exploring ways to reduce the price of their first projects.

A solution is required to reduce the price gap and enable offshore wind to immediately be an affordable option for governments in emerging markets. Reducing the price gap will allow governments to commit and hence accelerate the global uptake of offshore wind.

This price gap is likely to be greater for the first projects in emerging markets due to the aforementioned risk premiums.

A solution is required to reduce the price gap and enable offshore wind to immediately be an affordable option for governments in emerging markets. Reducing the price gap will allow governments to commit and hence accelerate the global uptake of offshore wind.

2.4 Concessional Finance Options

Concessional finance is best described as any financial resource or instrument extended on terms[4] or conditions that are more favorable than those usually available in a particular market. While there can be numerous sources and origins of concessional finance, this study considers only concessional funds provided by the largest reported contributing group—Official Development Assistance (ODA) as defined by the Development Assistance Committee (DAC)[5]— provided through bilateral or multilateral development finance agencies.[6] Furthermore, this study is particularly interested in concessional ***climate finance***, meaning ODA-tagged funds that are intended to support development activities that address climate change mitigation and/or adaptation.[7] Annex A provides an overview of the climate finance landscape, and where concessional climate finance sits within this.

While concessional climate finance can be accessed by a wide range of agencies and stakeholders, a substantial portion is channeled through multilateral development banks (MDBs) as implementing entities. MDBs leverage their superior credit ratings to raise—and provide to public- and private-sector recipients—low-cost financing that can then be blended with climate finance to achieve enhanced concessionality. This can help to achieve much greater scale, thereby enhancing the transformational impact of climate finance. Other key advantages of channeling scarce climate finance through MDBs are their in-country presence, the ownership that is achieved through client country implementation, and the due diligence that MDBs undertake on procurement, financial management, and environment and social standards. Major sources of concessional climate finance include the Climate Investment

[4] Differentiated credit, pricing, seniority, tenor, or share class.

[5] The 22 DAC countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

[6] Can also include: Third party and Philanthropic organizations, NGOs, Institutional Impact Investors, MDB self-funded trust funds if explicitly identified for use in concessional climate finance activities, and MDB sister entities (such as IFC).

[7] UNFCCC Standing Committee on Finance defines climate finance as "*finance that aims at reducing emissions and enhancing sinks of greenhouse gases and aims at reducing vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negative climate change impacts*".

Funds (CIF), Global Environment Facility (GEF), and Green Climate Fund (GCF), with a combined annual financing capacity of around US$ 3 billion per year. The features of each of these funds is summarized in Table 2.1.

Concessional climate finance directed through MDBs has a strong track record in supporting the scale-up of renewable energy technologies, including concentrated solar power (CSP) and geothermal. Climate finance provided by the GEF supported a series of early CSP demonstration projects in Egypt, India, Mexico, and Morocco starting in 1999. This led to a major scale-up program in Morocco starting in 2014 that benefited from GEF, CIF and other sources of concessional financing. The investment carried out by the government of Morocco, supported by concessional climate finance, has resulted in significant cost reductions in that country, and has indirectly supported wider deployment, for example in the Middle East. For geothermal, climate finance has been targeted at the thorny issue of test drilling, where high risks are not conducive to private sector investment. Once viable geothermal resources are confirmed, private sector investors can be invited to develop the power plant infrastructure under a competitive framework. As described in Box 2.1, climate finance for projects in Indonesia, Kenya and Mexico has led to an upswing in geothermal development and will allow those countries to access low cost, reliable power to support their economic development.

TABLE 2.1

Major Sources of ODA-Tagged Concessional Climate Finance

	GLOBAL ENVIRONMENTAL FACILITY (GEF), GEF-7	GREEN CLIMATE FUND (GCF)	CLIMATE INVESTMENT FUNDS (CIF)
Relationship to UNFCCC[14]	Official financing mechanisms under UNFCCC		Established outside UNFCCC
Description	Provides new and additional concessional funding to meet the agreed incremental costs of measures to achieve global environmental benefits.	Official financing mechanism under the Paris Agreement to support climate change mitigation and adaptation projects in developing countries.	It operates through 6 MDBs (ADB, AfDB, EBRD, IDB, IFC, IBRD) to provide financing to low- and middle-income countries.
Energy-related focus areas	Promotion of innovation and technology transfer for sustainable energy breakthroughs.	Energy generation, risk mitigation, energy efficiency, sustainable urban and transportation projects, as well as energy access projects.	• Providing large-scale financing to low-carbon technology projects in developing countries • Demonstrating the viability of renewable energy projects in low-income countries • Accelerating Coal Transition (ACT) through support for decommissioning and repurposing of coal power plants
Relevant administered funds	• Least Developed Countries Fund (LDCF) • Special Climate Change Fund (SCCF)	-	• Clean Technology Fund (CTF) • Scaling-up Renewable Energy in Low-income countries Program (SREP)
Instruments used	Grants	Grants, loans, equity and guarantees	Grants, loans, equity and guarantees
Energy-related portfolio and pipeline	~US$ 211 million	~US$ 950 million	~US$ 2.1 billion

BOX 2.1

Concessional Finance to Reduce the Cost and Risk of Geothermal

Geothermal energy has the potential to provide a low-carbon, low-cost, steady output and flexible power source in those countries with viable resource potential. Geothermal power can directly replace coal or gas in the electricity mix and support the integration of variable sources of renewable sources on the grid (Climate Policy Initiative 2015). Yet, this technology has been historically underdeveloped due to the high costs and risks of exploratory drilling. Validating the presence of commercially viable geothermal resources through drilling is an unavoidable step that represents around 15 percent of the total investment costs, but must be committed upfront, amounting to US$ 15–25 million per field. Commercial debt is often not available to finance this step and it takes over two years to provide sufficient confidence for investors to proceed with the development of a geothermal field (ESMAP 2015).

In this context, IFIs and climate funds have played a major role in targeting the risky and capital-intensive upstream phases of geothermal development through the provision of grants and concessional loans. This is well exemplified by the Global Geothermal Development Plan (GGDP) launched by the World Bank Group Energy Sector Management Assistance Program (ESMAP) and other multilateral and bilateral development partners in 2013. The GGDP allocated US$ 3.5 million of grant financing from ESMAP donors and a further US$ 0.8 million of World Bank Budget between 2013 and 2020 for technical assistance and project preparation. This initial preparatory work mobilized US$ 235 million in 2013 to be deployed through a new window within the CTF and helped mobilize further climate investment funds, in particular US$100 million from the GCF and US$ 75 million from the CTF in 2019 for the Indonesia Geothermal Resource Risk Mitigation Project (GREM). The GGDP has helped leverage US$ 125 million in IDA funds and US$ 400 million of IBRD funds for geothermal development, which is expected to increase as GREM moves on to the second phase of implementation in early 2023.

The CIF has also been a leading source of concessional finance for early-stage project exploration and development, helping expand markets in countries like Indonesia, where it supported various projects including the abovementioned GREM. This project aims to establish a US$ 455 million geothermal resource risk mitigation facility to provide financing to mitigate the risk of resource confirmation (including exploration and drilling) of public and private sector entities. The facility will consist of US$ 150 million from an IBRD loan, US$ 72.5 million from the CTF in the form of a loan and a contingency grant, as well as additional financing from the Green Climate Fund (GCF) (US$ 97.5 million) and the Government of Indonesia (US$ 75 million) (World Bank 2019b).

Concessional climate finance that is programmed through MDBs usually falls into two categories:

i) **Concessional lending to governments, public agencies, and state-owned enterprises** for public investment projects, where the dedicated funding from sources of climate finance is combined with conventional sources of finance available to the respective country from the respective MDB. In the case of the WBG, such projects would be financed by the World Bank under the terms relating to the International Bank for Reconstruction & Development (IBRD, which targets middle-income countries) or International Development Association (IDA, which targets low-income countries and is more concessional). Other DFIs operate with similar financing mechanisms and terms. Throughout this report this collective lending package for the public sector is referred to as ***concessional public debt***.
ii) **Concessional project finance to private sector developers or firms**, where the product deployed is often termed ***blended concessional finance****.* In the case of the WBG, such projects would be financed by the IFC with concessional finance provided in parallel with IFC conventional financing products. In the case of other DFIs, private sector lending may be carried by a department within the main institution, rather than through a subsidiary institution. This financing is deployed alongside commercial debt at maximum ratio of concessional private debt to commercial debt of 1:1, but lower volumes of concessional financing are often available. Throughout this report, this package of concessional debt financing to the private sector is referred to as ***concessional private debt***.

In many cases country investment programs relating to concessional climate finance will include both public and private sector financing, and will often involve more than one DFI.

2.5 Objectives for Concessional Finance Support

From a global perspective the primary motivation for accelerating the deployment of offshore wind is the substantial contribution it can make to decarbonizing energy systems. Since it is also an increasingly cost-effective option for electricity generation, and does not compete for scarce land resources, all countries with an offshore wind resource are likely to fully endorse this objective.

However, from a national perspective, particularly in the case of middle- or low-income countries, the primary motivation is likely to be somewhat different. While international commitments on climate change are an important consideration, national leaders and energy ministers will often be more focused on domestic policy priorities (such as meeting rising energy demand and enhancing energy security) and fiscal constraints.

Two key requirements have emerged from our engagement with WBG client governments when it comes to introduction of new technologies:

i) Ensuring that tariffs for all forms of electricity generation are affordable, and broadly in line with the country's average cost of power; and
ii) Maximizing opportunities for economic development and job creation.

Hence accelerating the deployment of offshore wind in emerging markets hinges on these two requirements being met, which will trigger and maintain the political interest and resulting policy commitments needed for deployment to happen at scale. While some governments may be willing to provide short-term tariff subsidies in the hope of rapidly getting to a zero-subsidy tariff situation and priming the supply chain, the total subsidy requirement will be prohibitive for many countries in view of the size of offshore wind projects and the volume required to reach sufficient scale for substantial cost reductions to be realized.

If the ability to utilize tariff subsidies is limited, then efforts to counter the issues outlined in Section 2.2 must logically center on reducing the capital cost of the first few projects, and lowering the cost of financing. This is likely to involve a range of interventions and instruments depending on the circumstances within each market. But the objectives will be broadly universal: to accelerate deployment of offshore wind and thus its contribution to global decarbonization goals, using concessional finance to arrive at a tariff that is affordable—both in the near term and once scale is achieved—while also generating national economic benefits and jobs. This is the most likely pathway to unlocking the policy commitments and resulting projects that are needed to achieve accelerated deployment in emerging markets.

THREE
HOW SHOULD CONCESSIONAL FINANCE BE DEPLOYED?

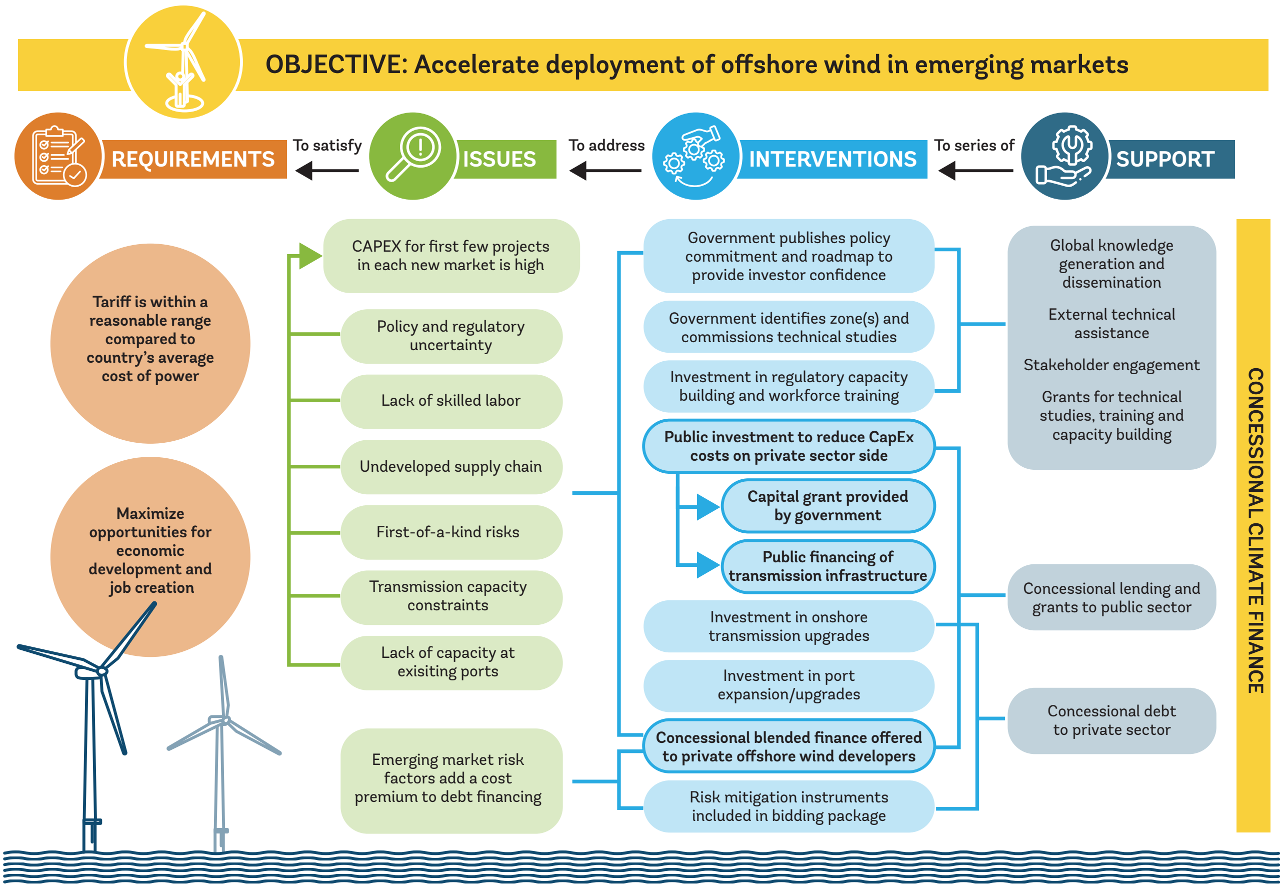
PHOTO CREDIT: VESTAS

3 How Should Concessional Finance be Deployed?

Without public support, the initial development of offshore wind in emerging markets is likely to result in a cost of power substantially higher than that of developing an onshore wind or solar photovoltaic (PV) project of the same size in the same market. Although offshore wind costs in established markets have reduced significantly over the past decade, it is expected that developing the first wave of offshore wind projects—even in emerging markets with high resource potential such as India, the Philippines, or Vietnam—will include a significant capital expenditure (CapEx) premium in the near to medium term. As described in Section 2.3 and illustrated by Figure 3.1, there are a range of factors that conspire to increase CapEx in the early stages of a market's development.

FIGURE 3.1

Theory of Change for Meeting the Requirements for National Political Commitments To Offshore Wind Development



Key Assumptions
A1. That government are motivated to deploy offshore wind to help meet growing energy demand, to support decarbonization goals and commitments, and improve energy security.
A2. Target countries have a good to excellent offshore wind resource.
A3. Offshore wind projects are private sector led and competitively procured.

Source: *World Bank Group*

In addition, project finance costs are higher in emerging markets due to higher risks and cost of capital. These costs contribute to an increased LCOE of the project,[8] and hence increase the tariffs required to make a project economically viable, particularly where there is no concessional finance or other public support provided.

As noted in Section 2.5, efforts to bring down the tariff to an acceptable level—defined according to each country's power market and political expectations—will rest on two major categories of intervention: i) reducing the CapEx of the project from the perspective of the offshore wind project developer; and ii) lowering the cost of financing. Other interventions, such as outlining a clear and credible policy, guarantees and risk mitigation instruments, support for supply chain and skills development, and investment in ancillary infrastructure such as ports, are also essential to establish an offshore wind market but may have less impact on the final tariff. These other interventions are discussed in the WBG report, "*Key Factors for Successful Deployment of Offshore Wind in Emerging Markets*" (World Bank 2021b).

The range of possible interventions are summarized in Figure 3.1, as part of a "theory of change" for offshore wind development, with the two key interventions highlighted. The potential mechanisms that could be deployed are described in further detail in this chapter, including how they could be structured into a delivery project or program.

3.1 Providing Policy and Regulatory Certainty

To establish and grow an offshore wind industry, governments need to provide developers and investors with both clarity and certainty. Governments have a critical role in outlining their policy objectives and generating credibility among investors by publishing a roadmap and by then implementing their roadmap through a well-understood project procurement cycle. As illustrated by the Offshore Wind Roadmap for Vietnam (World Bank 2021c), an ambitious and credible offshore wind capacity target is likely to have a significant impact on both the cost of generation over the long term, and on the economic benefits that the host country can expect to capture from the associated investments.

In the case of Vietnam, our analysis estimates that a doubling of volume targets over a 15-year period could (in the high-growth scenario, compared to the low-growth scenario), reduce the cost of energy by a further 20 percent by the end of that period. Furthermore, this would increase the local jobs created by 3.7 times during the period. Doubling of the volume roughly doubles the number of local jobs. The rest of the increase derives from a higher percentage of local supply and more export potential due to more local investment.

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[8] LCOE is proportional to the CapEx, OpEx, and cost of financing, therefore reducing any of these elements will help to lower the required tariff. LCOE is inversely proportional to the energy yield and project lifetime, therefore increasing either of these will also help to lower the tariff. Of these different drivers, public support can have the greatest impact on CapEx and the financing costs.

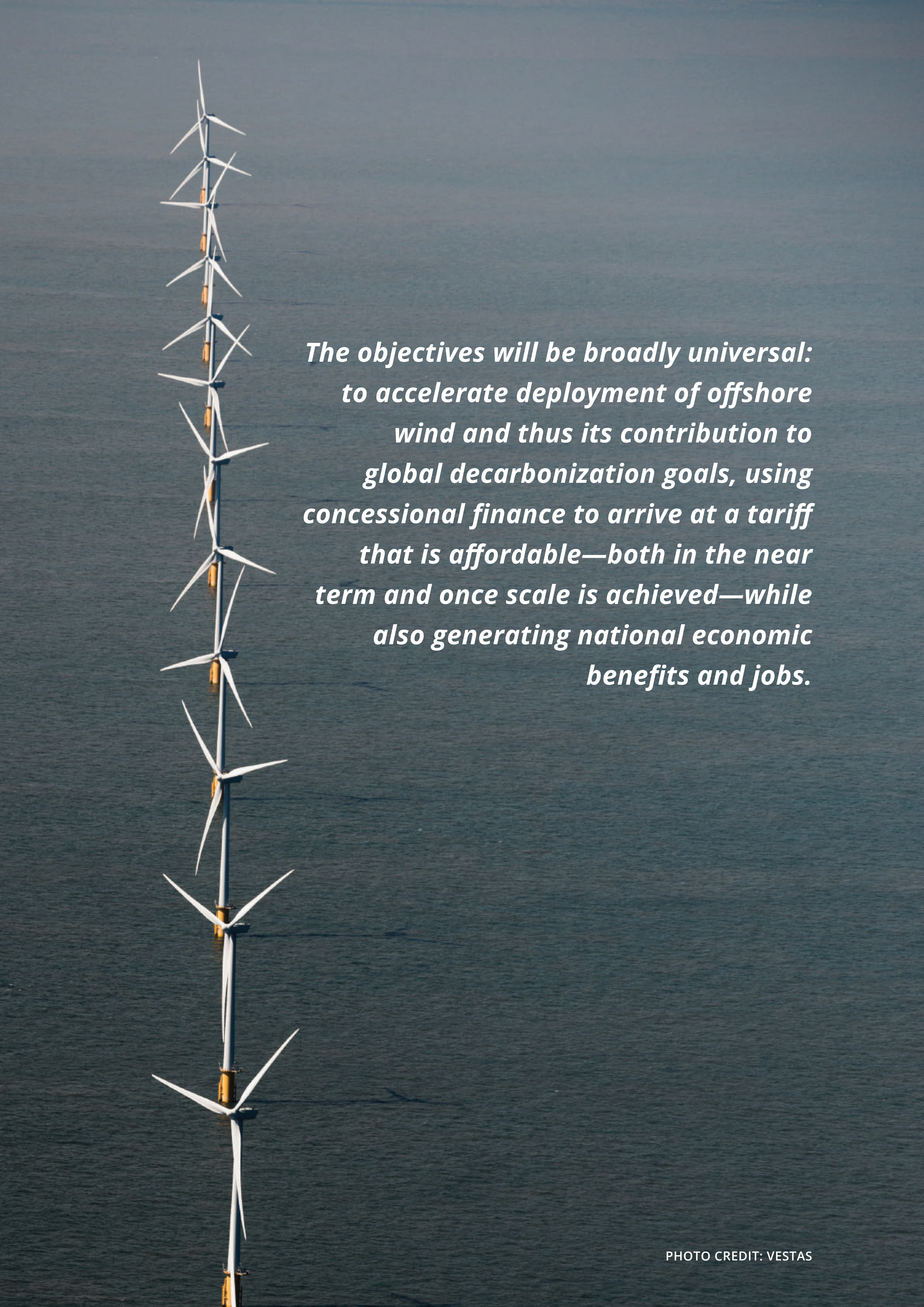
3.2 Catalyzing the Market

Beyond the fundamental policy and regulatory framework, governments can take proactive steps to help catalyze the market by reducing risks. In addition to providing a clear statement of policy, and evidence of commitment to that policy in the form of a credible offshore wind procurement cycle, governments can also help to catalyze the market through the following interventions:

- Providing clear guidance on offshore development zones;
- Covering some or all of the project development costs, by strategically commissioning preparatory works such as wind measurements, seabed surveys, and wildlife surveys;
- Carrying out extensive stakeholder engagement to understand and address environmental and social issues and concerns;
- Investing in regulatory capacity building through knowledge exchange, study tours, and training; and
- Investing in skills development along the supply chain, including establishment of training centers, support for an expansion in tertiary education courses, grants for training and retraining in key areas, and specific support to address gender imbalances within the existing workforce.

Governments are likely to have a range of opportunities available to them to support the above interventions, including freely available knowledge resources, bilateral and multilateral technical assistance programs, trade associations, allocation of existing public resources such as training and skills development budgets, and grant funding. In the case of more substantive initiatives for which governments may wish to seek grant funding from sources of concessional climate finance, this will usually be attached to a broader program of support that would include concessional lending, with the grant element a small percentage of the overall program. It is therefore important for governments to consider their objectives and needs as part of an overall scale-up strategy for offshore wind so that any components that may be eligible for grant funding can be presented as part of a much broader package of support—hence helping to catalyze the infrastructure investments that are required. Governments can also use this strategy to coordinate multiple bilateral or multilateral technical assistance programs to avoid overlap while also drawing from multiple perspectives and country experience.

Governments also play an important role in providing, where possible, a long-term off-take arrangement as well as financial and fiscal support measures. A bankable off-take agreement, with sufficient off-taker creditworthiness and a duration of at least the tenor length of typical financing, reduces the risk to lenders, thereby reducing the cost of capital and required tariff. Support measures such as generation-based incentives—and tax measures such as accelerated depreciation—can also be used to narrow the gap between the required offshore wind tariff and the prevailing electricity generation prices.



The objectives will be broadly universal: to accelerate deployment of offshore wind and thus its contribution to global decarbonization goals, using concessional finance to arrive at a tariff that is affordable—both in the near term and once scale is achieved—while also generating national economic benefits and jobs.

PHOTO CREDIT: VESTAS

3.3 Reducing Capital Costs

A typical 1 GW offshore wind project in a new market is expected to have a capital cost of roughly US$ 2.9 billion. This relatively high capital cost is balanced by an energy yield that tends to be far higher than other types of renewable energy generation, with typical net capacity factors of 45–55 percent. A project's CapEx is dominated by the cost to supply and install the wind turbines, which typically represents 45–50 percent of the capital cost. Figure 3.2 shows the breakdown of capital costs to supply and install the main elements of a project. The electrical export system, which comprises the supply and installation of the offshore and onshore export cables and substations, often represents around 15–20 percent of a project's cost. A project's development expenditure (DevEx), which comprises costs for surveys, engineering, contingencies, and insurance, is typically <10 percent of the total CapEx.

Countries with established offshore wind markets have adopted numerous models for delivering offshore wind projects, and these different approaches have implications for the roles and responsibilities of the public and private entities, as well as allocations of risk and cost. These market approaches can be broadly categorized based on the number of competitive stages in a project's development phase:

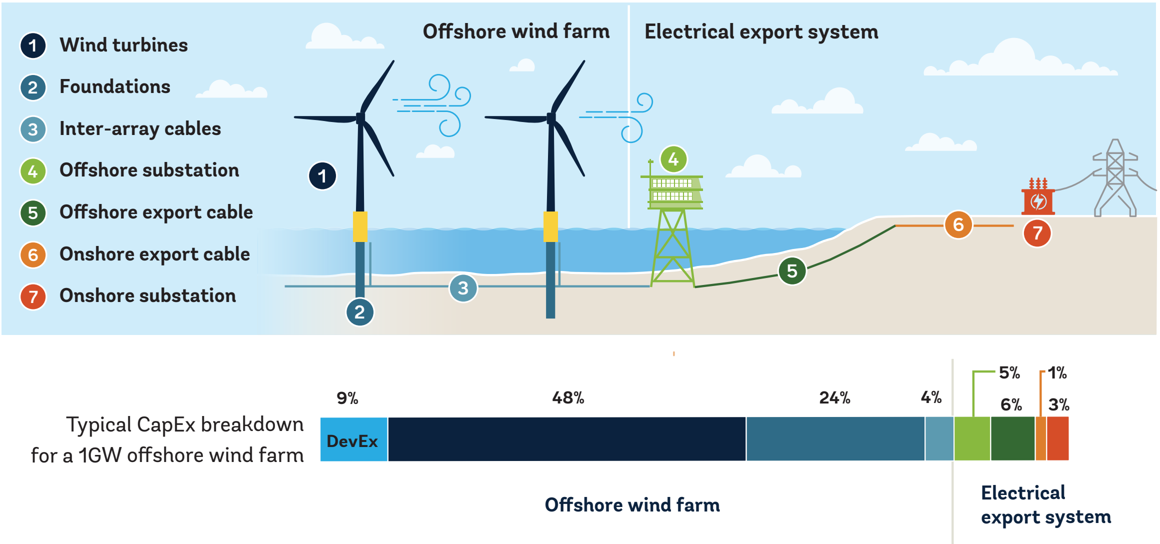
- **One-stage markets**: Centralized, government-led processes with a high degree of public sector involvement in the planning and preparation of projects prior to a single competition to award a lease/concession and tariff. The government takes responsibility for a large portion of the DevEx (and associated risks) and provides bidders with a pre-developed project to bid for.
- **Two-stage markets**: Decentralized, market-led processes with the private sector responsible for the development including site selection, site investigations, and permit applications, once a lease/concession area has been issued. The DevEx and development risks are taken by the developers, and there is a much lighter involvement from the government.

Both types of approach can work well if adequately resourced, and each emerging market's political, fiscal, and cultural settings will determine which route could be most appropriate for a government to choose. A more in-depth discussion on this issue is provided in "*Key Factors for Successful Deployment of Offshore Wind in Emerging Markets*" (World Bank 2021b). As stated in Section 3.2, grants could be used to fund some public sector DevEx costs and activities, especially in markets where a one-stage approach is followed. Donor grants to India and Türkiye (Clean Energy Co-Operation in India 2016) & (European Union 2019), for example, are funding wind resource measurements and seabed surveys, to provide data for future project auctions. By reducing some of the private sector development costs and risks, these grants should help to reduce the required tariffs.

Established markets have also taken different approaches to delivering the electrical export systems for offshore wind projects, with countries implementing public- or private-sector-led approaches, or a hybrid of these. Figure 3.3 provides a summary of the different processes that five established markets have employed to deliver offshore wind farms and their

FIGURE 3.2

A Schematic of an Offshore Wind Farm, Showing the Main Elements and their Typical Contribution to the Overall Capex



Source: *World Bank Group*

export systems. As the *Key Factors* report discusses, the reasons for choosing the approach to deliver the export systems will be influenced by the capacity and risk appetite of the transmission system operator (TSO; also referred to as transmission network operator, TNO). In the UK and Belgium, for example, the private sector developer is responsible for delivering the export system but at completion, in the UK the ownership of the system is transferred to a third-party private owner, whereas in Belgium the ownership of the system is transferred to the public TSO.[9] In the Netherlands, however, the public sector TSO and government are entirely responsible for the delivery, financing, and operation of the export system.

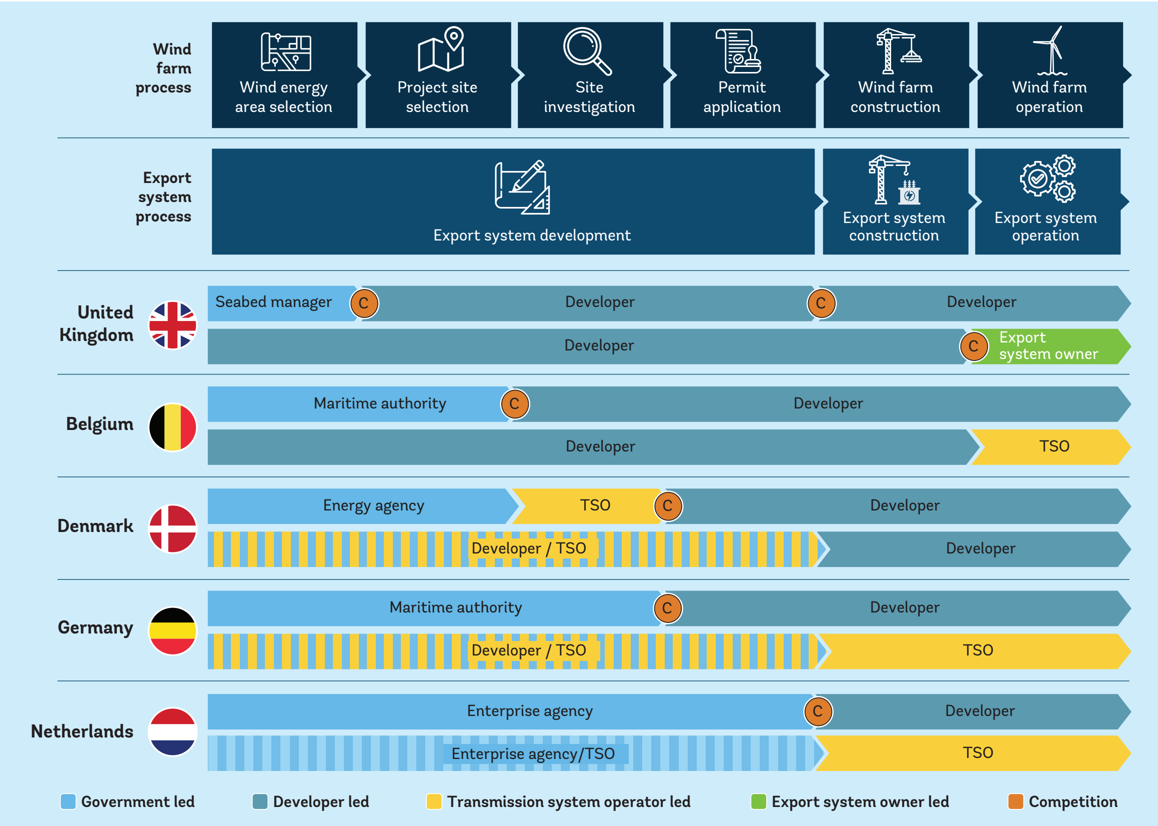
In the context of emerging markets and considering the stated objective of reducing the private developer's CapEx, there are three broad options for using public sector financing to achieve this:

i) A capital grant provided to the selected developer to bring the power tariff down to the desired rate, perhaps provided through a reverse auction;
ii) A public sector equity stake in the offshore wind project in exchange for public sector financing towards the CapEx costs; or
iii) Public sector financing and ownership of the export system and transmission assets, thus separating them from the offshore wind generation project.

[9] Only one case of this transfer of ownership has occurred—Belgium's 309MW Rentel project constructed an offshore substation and export system, and then transferred those assets to Belgium's transmission system operator, Elia (Windpower Monthly 2017).

FIGURE 3.3

Examples of Approaches to Offshore Wind and Export System Development, Construction, and Operation, In the UK, Belgium, Denmark, Germany, and the Netherlands



Source: (World Bank 2021b) *and* (Wind Europe 2019)

A capital grant would be simple to administer and would achieve the stated objective, but it has several disadvantages. First, it can be politically unpalatable at the scale required, especially during tight fiscal situations. Second, it may be hard for governments to raise this level of funding for a single project, especially since any MDB funding will flow in the form of loans. Furthermore, providing a capital grant to a private developer excludes the possibility of a direct return, unless accompanied by a requirement for annual concession payments. One possibility is to use a shadow carbon price to pay for emission reductions over the life of the project.

A public-sector equity stake in the offshore wind project would allow for a financial return to the government and possibly local communities, but this option is likely to be undesirable for many developers. This is due to the risk of political interference and potential delays in decision-making that could result from having a public sector investor, even one that holds a minority stake in the project.

Public-sector financing of the electrical export system infrastructure is an attractive option. This would effectively remove the burden of around 15 to 20 percent of the total project CapEx from the private developer and transfer it to the public sector. This also has the benefit of allowing a "shared infrastructure" approach, whereby the publicly-financed transmission and export system assets are developed to benefit multiple offshore wind projects within a single development zone: essentially creating a "transmission hub" that could be utilized by several different project developers. Although this would depend on the size of the proposed development zone, and would not be appropriate in all countries, it builds on concepts already discussed in developed country markets, including plans initially proposed by the Dutch transmission operator TenneT, and now being taken forward by the North Sea Wind Power Hub consortium, (TenneT 2016), (North Sea Wind Power Hub 2021). The shared infrastructure approach also has several precedents in emerging markets, for example in the development of solar PV in India, (World Bank 2017). In addition to reducing the CapEx on the private sector side of the project, this approach has the benefit of creating a publicly-owned capital asset with the potential for cost recovery over the life of the connected offshore wind project(s), in contrast to a capital grant where no public sector return is possible. This is likely to be more politically attractive, and easier to justify when discussing concessional finance support. Finally, public financing of a shared "over-built" export system yields benefits beyond the first projects, allowing for space-efficient planning and more effective consideration of cumulative environmental and social impacts.

In consultations carried out in the preparation of this study, it was found that the **private developers are generally agnostic as to who is responsible for the electrical export system infrastructure, so long as it is delivered on time and to the required specifications**. There are likely to be significant interface and delay risks if this work is the responsibility of a state-owned enterprise or other public agency, especially if the project represents their first foray into offshore wind. Hence a proposed solution is to require the selected developer to take on the responsibility of carrying out the installation work—and perhaps also the long-term operation and maintenance (O&M)—on a regulated return basis using public financing. If the assets are developed as shared infrastructure, then the developer awarded the first project could take on this role, or they may wish to set up a special-purpose vehicle with one or more of the other developers that would connect to the same assets. Either way, usage fees would be set as part of the bidding package to ensure public sector cost recovery and to pay for the cost of O&M where this becomes the responsibility of a public sector agency. The key for new markets will be to show that whoever builds and operates the export infrastructure has the right competencies and can provide a high degree of detail and transparency on their design, construction and operational activities.

Capital costs are also benefiting from improving offshore wind deployment in developed markets, as certain technologies continue to push out the technical frontier. With each new project in Europe, China, and the USA, the technological frontier of offshore wind is pushed a little farther out. Wind turbine capacity of European offshore wind farms has increased from an average rated capacity of 3 MW in 2010 to 8.2 MW in 2020

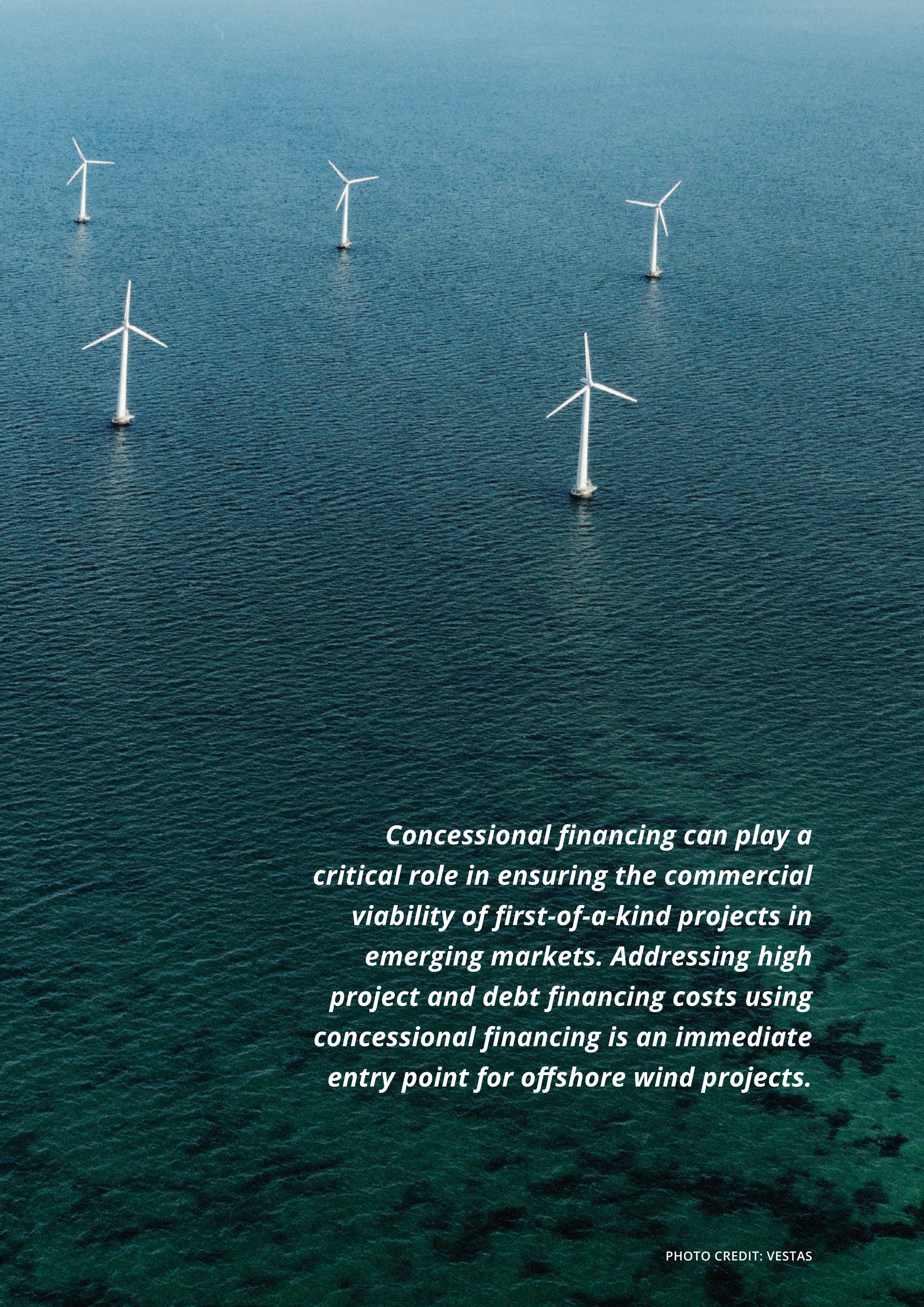
(Wind Europe 2020), and the current state-of-the-art turbines are 15 MW. Project scale has increased substantially; in 2010, projects were typically <250 MW, whereas in 2022, projects commonly exceed 1,000 MW, allowing large economies of scale and hence reductions in cost. The advance of foundation design has in effect increased the depth of water where wind farms can be deployed, and this is set to increase further as floating foundations enable deployment in deeper water. Also, the typical distance between shore and wind farm had by 2019 increased to more than 50 kilometers, on average, for European projects. Moving further offshore enables the possibility of covering larger areas of sea that benefit from more energetic and less variable wind conditions. The move further offshore, away from coastal areas, may also reduce the impact on environmental and social receptors. Naturally, these benefits must be traded off against higher transmission, construction, and operation costs (Wind Europe 2019). Furthermore, international financing for offshore wind requires environmentally and socially sustainable development, in line with good international industry practice, global goals for biodiversity conservation and carbon emissions reduction. Projects will therefore need to meet recognized environmental and social standards, such as those published by (World Bank 2018) and (IFC 2012).

3.4 Investing in Ancillary Infrastructure

Developing a successful offshore wind project is reliant on a number of ancillary infrastructure services, in particular suitably equipped ports that have the space needed to support staging, construction and O&M activities, and nearby power evacuation capacity, including the ability of the wider electricity grid to integrate the power generated. When one or both of these services is insufficient, project developers may be forced to bear some or all of the costs of necessary upgrades, or will factor in the risk that promised upgrades by third parties are not delivered on time.

Hence assessing the need for such investments and developing a plan for implementing them is a critical factor to bringing down costs and ensuring successful and timely project delivery. Ports and transmission infrastructure may be publicly or privately owned, and this will determine the investment strategy and responsibilities. For publicly-owned infrastructure, governments can either integrate the necessary upgrades into existing capital investment plans, or may wish to include them as part of a specific offshore wind facilitation project, which could then be eligible for concessional finance. For privately-owned infrastructure, governments can play a supporting role by bringing the key parties together and agreeing on an investment plan for private financing. In such cases, private entities may be eligible for government-provided fiscal incentives or for concessional finance from DFIs, as further described in the following subsection.

In larger markets there are also likely to be investments along the supply chain, for example in a blade-manufacturing facility or to establish cable-laying capacity. Such investments may also be eligible for concessional finance.



Concessional financing can play a critical role in ensuring the commercial viability of first-of-a-kind projects in emerging markets. Addressing high project and debt financing costs using concessional financing is an immediate entry point for offshore wind projects.

PHOTO CREDIT: VESTAS

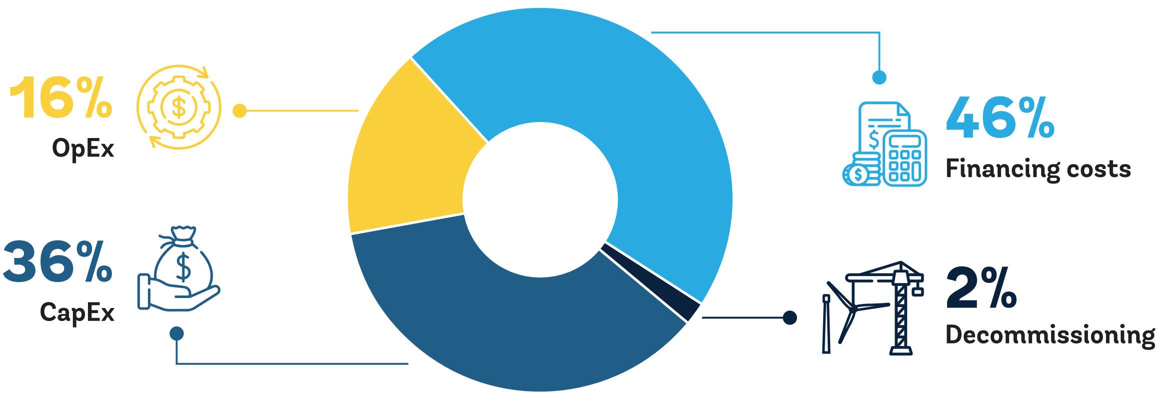
3.5 Lowering the Cost of Debt Financing

Over a project's lifetime, the cost of financing can have the largest impact on the cost of energy. Figure 3.4 provides an example of the breakdown of contributors to the LCOE of a typical 1 GW project in the early stages of an emerging market—this example is taken from the Offshore Wind Roadmap for Vietnam (World Bank 2021c). For this case, the cost of capital contributes 46 percent of the project's LCOE, therefore any reductions in the cost of capital would have a significant impact on the required tariff.

The large scale of offshore wind projects means that they typically need to be financed via non-recourse project finance structures as very few developers are able to raise the required volume of capital on a corporate finance basis. Europe provides valuable data for financing trends as it has fostered significant growth of its offshore wind industry. During the period 2011–2020, € 117 billion of financing was raised for offshore wind projects in Europe. These projects are expected to cumulatively provide 30.6 GW of energy. Of this € 117 billion, approximately 72 percent has been raised on a project finance basis (€ 84 billion) with the debt-to-equity ratios for each project depending on the specific risk profile. Typically for wind projects, debt accounts for 70–80 percent of financing. Accordingly, project finance debt has constituted fully 55 percent of total offshore wind financing during that period (roughly € 65 billion) (Wind Europe 2020).

European experiences with project financing demonstrate how risk premiums can fall as lenders become more familiar with the technology. Debt is typically preferred by sponsors as a cheaper method of financing than equity because debt provides a lower-risk investment with a fixed payout schedule. As lenders become more comfortable with the

FIGURE 3.4
Example of Typical Contributing Components to LCOE for Initial Projects in an Emerging Market



Source: (World Bank 2021c)

risk profile of offshore wind, an increasing supply of debt financing is expected to be made available as banks develop frameworks with which to price risks. In Europe, debt financing has continued to support construction on increasingly attractive terms; more than 67 lenders were active in 2020, including multilateral financial institutions, export credit agencies, and commercial banks (Wind Europe 2020). In addition to the underlying low interest rate environment, offshore wind projects are also benefiting from a reduction in risk premiums in Europe. Interest rates for offshore projects in Europe fell from approximately LIBOR + 275–325bps in 2011, to approximately LIBOR + 125bps in 2020. This serves as further evidence of increasing confidence in offshore wind technology as track records are established (Wind Europe 2020).

The cost of financing for the first projects in emerging markets will initially be higher. This is due to the first-of-a-kind risks that were summarized in Section 2.3 and, if the debt is locally sourced, the conventional macroeconomic and domestic risks associated with an emerging market will result in higher base interest rates. The interest rate environment is typically high or mixed across emerging markets, while debt, liquidity, and domestic lending are often limited. Accordingly, there is expected to be an initial price gap between offshore wind and alternative forms of power generation in emerging markets and the gap is greater for the first-of-a-kind projects (Wind Europe 2020).

The ensuing effects of higher interest rates on projects' LCOE directly impairs their commercial viability, and when compared to an often subsidized (or very low prevailing market) electricity price, offshore wind projects are uncompetitive, and investors remain on the sidelines. Higher costs of financing in emerging markets are also expected to result in higher volumes of interest during construction, given that these large projects can take five to ten years, or more, to build. This was affirmed by our analysis which found that the debt interest rate of a project has a significant influence on the tariff necessary to ensure the viability of the project in an emerging market setting. The study estimated that a 100bps interest rate increase would result in an eight percent increase in the tariff that would be required to ensure the viability of the project (that is, the LCOE).

Concessional financing can play a critical role in ensuring the commercial viability of first-of-a-kind projects in emerging markets. Addressing high project and debt financing costs using concessional financing is an immediate entry point for offshore wind projects. In emerging markets, a full-service package of concessional financing will need to be deployed in conjunction with public and private interventions for the first offshore wind projects.

Commercial debt could be blended with concessional financing to lower the cost of financing and reduce the tariff needed to ensure the commercial viability of projects in emerging markets. By providing the catalytic financing for first-of-a-kind or pathfinder offshore wind projects, concessional private debt finance could provide the initial support needed in developing countries to move them onto a trajectory informed by lessons from European markets. Such an approach would be aligned with previous blended finance initiatives, a prominent historical example being the scaling of solar investments in emerging markets. To give one specific case, in 2018, concessional financing was provided to a private sector company to develop a first-of-its-kind solar power plant in rural Mozambique. For Mocuba Solar, a total debt financing package of US$ 55 million was provided, which comprised: US$ 19 million of IFC own account lending; US$ 19 million of concessional financing from the Climate Investment Funds (CIF); and a US$ 17 million syndicated loan mobilized from the Emerging Africa Infrastructure Fund. The US$ 19 million of concessional financing was used to support an affordable end-user tariff for the 40 MW project and to de-risk the project for financiers over the long term. Mocuba Solar exemplified a strong concessional financing partnership by facilitating a pioneering project in a developing country that could become commercially viable and supported efforts towards a low-carbon future. Such projects create a demonstration effect for future similar investments and support developers looking to establish their track records.

Concessional finance blended with commercial debt will lower the overall effective interest rate, and it could also help to reduce the cost of financing through other debt terms. While the interest rate is an important factor, other debt terms (such as debt tenors, debt sizing criteria, or security requirements) also impact cost of financing and hence concessional debt is needed to not only lower interest rates, but also take the pressure off other required debt terms which will likely be more stringent due to higher perceived risks for first-of-a-kind projects.

In the case of offshore wind, project sizes will be significantly larger than historical initiatives. Hence, offshore wind projects will require strong and unwavering concessional financing commitments. These commitments will be critical to ensuring that other investors are confident in the overall financing and competitiveness of each project.

Using concessional financing to develop first-of-a-kind projects can create markets by establishing precedents. Pioneering projects also support the institutional and knowledge development of emerging markets. The lack of commercial viability due to high Engineering, Procurement and Construction (EPC) and borrowing costs can often be further undermined by the varying levels of market experience with project finance in emerging markets. If developing countries are to successfully deploy offshore wind, all market stakeholders must understand the relevant project risks. Pathfinder projects create such an understanding. Furthermore, there is limited access to affordable and flexible financing terms and instruments as commercial banks do not yet fully understand the array and complexity of risks associated with offshore wind projects. The risk-versus-reward balance for the private sector needs to be achieved with bankable Power Purchase Agreements (PPAs) and contractual arrangements.

By deploying concessional financing, the ambition would be to create a demonstration effect and establish market precedents that make domestic and international lenders feel more sanguine about offshore wind projects in developing countries. Over time, this could reduce lenders' risk premiums when considering investment in offshore wind projects in developing countries.

Concessional financing could also be deployed to optimally match the dynamic risk profile of offshore wind projects, given their long-term horizons. After construction, there is a meaningful change in the risk profile of offshore wind projects. Accordingly, it is not uncommon for wind projects to refinance or restructure debts upon commencing operation. Concessional financing could play a significant role in covering the higher costs associated with the construction phase for offshore wind projects in emerging markets.

3.6 Coordination and Structuring

As the analysis in Section 3.5 makes clear, multiple interventions may be required to accelerate the deployment of offshore wind in emerging markets, including potentially large contributions from concessional finance sources to reduce the CapEx requirement and the cost of debt. Bringing these interventions together will require a strong partnership between the host government, MDBs and other financiers, the private sector developers and lenders, and the providers of concessional finance so that the level and type of support can be tailored to the country's needs. The application process for concessional climate finance provides a good opportunity to outline this partnership and the related financing needs.

While the majority of the concessional climate finance required can be provided in the form of concessional public sector lending and concessional private debt, there is likely to be the need for grant funding to support project development work and capacity building within government agencies and regulators. It is also likely that both public and private sector financing will be required, necessitating close coordination between MDBs to ensure this is optimally structured.

In many emerging markets there is also strong interest in offshore wind from bilateral development partners and export credit agencies. While the support provided by these partners can be a critical part of the technical assistance and financial support package, it is also important that there is strong coordination to ensure that the whole is greater than the sum of its parts. It is also critical that bilateral partners support the objectives of competitive procurement to secure the lowest tariffs possible, and refrain from supporting negotiated deals.

FOUR
HOW MUCH CONCESSIONAL FINANCE MIGHT BE NEEDED?

PHOTO CREDIT: FRED OLSEN

4 How Much Concessional Finance Might be Needed?

The previous chapter outlined three primary roles for concessional climate finance to reduce project LCOE—public sector investment to remove certain CapEx items from private developer, concessional private debt to project developers to reduce the cost of debt, and direct grants to projects. This chapter attempts to quantify the concessional finance requirement, at an aggregate global level, by modeling the financing requirements for a representative 1 GW pathfinder project in a typical, large emerging market. The modeling helps to illustrate the impact of different concessional finance instruments on the tariff to be paid by the power off-taker, and the resulting quantum of concessional finance required to achieve a critical volume of capacity both within a typical country, and at an aggregate level.

The market characteristics of the 1 GW case study are described in Table 4.1.

It should be noted that this modeling is simplified and not exhaustive. It is intended to demonstrate a few of the main possible methods for reducing the tariff required for representative pathfinder projects. For example, it does not consider the potential impact of subordinated concessional debt on the overall financing costs, nor does it investigate possible risk mitigation instruments (World Bank 2007b); these, and many other options, should be studied in a future, more detailed modeling exercise, most probably for a country-specific scenario.

TABLE 4.1
Case Study Overview

CHARACTERISTIC	DESCRIPTION
Country size and energy demand	Large, with annual electricity production of >200,000 GWh
Income classification	Lower or upper middle-income
Electricity demand growth	High
Power market	Well-developed and with strong competition
Offshore wind potential	Excellent, with the possibility of >10 GW committed by 2030
Tariff expectations	Low, with significant sensitivity to cost comparison with other forms of power generation
Export potential	High, with desire to build export-oriented industries and capitalize on economic development opportunities
Assumed project characteristics	1 GW fixed offshore wind project 44% net capacity factor 25-year operational life (though this could be extended) CapEx US$ 2.93m/MW (including export system) OpEx US$ 25/MWh (initial cost, with 2% annual escalation)

4.1 Modeling Methodology

The financial model is set up using a scenario manager to conduct sensitivity analysis on the expected electricity tariff for a representative offshore wind pathfinder project using various amounts of concessional finance. The model includes a base case and a series of variables used to undertake scenario analysis at different levels of CapEx and concessional debt to assess the impact on tariff, the project's Internal Rate of Return (IRR), average rate of interest, and debt-service coverage ratio (DSCR). A full description of the variables and assumptions incorporated in the model can be found in Annex B.

4.2 Modeled Scenarios

The model was used to run three distinct scenarios to illustrate the impact of the key measures described in Chapter 3:

- **Scenario 1: Base case**, where the entire offshore wind project CapEx (including the wind farm, offshore substation, export cable and onshore substation) is financed by the private sector without explicit public sector financing support;
- **Scenario 2: Public financing of electrical export system and transmission**, as per Scenario 1, except that the CapEx associated with the offshore substation, export cable, and onshore cable and onshore substation, is financed by the public sector using concessional public debt, representing a transfer of roughly 16 percent of total CapEx from the private to the public sector; [10]
- **Scenario 3: Goal seek**, as per Scenario 2 but where the target tariff is set at a level lower than that achieved under Scenarios 1 and 2, to determine the additional public support (for example, capital grant) that would be needed to achieve this tariff, over and above the support provided under Scenario 2. This is included to provide an illustration of the likely cost of aiming for a lower tariff.

Within each of these scenarios, three sub-scenarios consider the impact of ***concessional private debt*** provided to the private sector developer as a percentage of the total debt financing requirement, at 0, 25 and 50 percent (that is, concessional private debt blended with other debt on commercial terms). The commercial debt is assumed to have a tenor of 20 years (including three years' grace during construction) and an effective interest rate of eight percent[11] (note that the project life is assumed to be 25 years). The concessional private debt is assumed to have the same tenor but with an effective interest rate of five percent. The scenarios and sub-scenarios are summarized in Table 4.2.

[10] To mitigate risks, the development and construction of the transmission could be undertaken or led by the project developer and then transferred to the public sector grid operator, as noted in Section 3.3.

[11] Typical interest rates for commercial debt in established offshore wind markets may be lower than five percent, however the risk premium associated with first projects in emerging markets will increase rates. Eight percent is assumed to be a representative rate that could be obtained, however rates from local financing markets may be even higher.

TABLE 4.2
Summary of Modeled Scenarios

SCENARIO	DESCRIPTION	SUB-SCENARIO	CONCESSIONAL PRIVATE DEBT*
1	Base case (no grants)	A	0%
		B	25%
		C	50%
2	Public funds cover electrical export system costs	A	0%
		B	25%
		C	50%
3	Goal seek to achieve a competitive tariff using publicly funded export system, concessional private debt, and grants	A	0%
		B	25%
		C	50%

*As a percentage of total private sector debt financing needs.

For Scenario 3, the goal seek tariff is set to US$ 70 per MWh which is taken to represent a reasonably competitive LCOE compared to new-build conventional generation. Note that in many emerging markets, new-build conventional thermal generation and onshore wind and solar will have a lower LCOE, often in the range of US$ 40 to US$ 50 per MWh. However, setting this as a target tariff would not recognize the following:

- Most projections assume that the LCOE of thermal generation will rise given rising input prices (copper, steel) and fuel price volatility; the latter being tied to long-term energy security;
- Offshore wind—with its higher capacity factors and lower variability—is considered to have a system value that is greater than onshore wind and solar (the IEA puts offshore wind in a category of its own, termed “variable base-load”); and
- The need for emerging markets to cover at least part of the incremental costs of offshore wind as they build up their domestic industry.

4.3 Results

Results of the modeling indicate that without any form of concessional finance support, a 1 GW pathfinder project will have an LCOE of around US$ 108 per MWh (see Table 4.3 and 4.4, and Figure 4.1). This is much higher than the cost of conventional generation in many emerging markets, meaning that interventions would be needed to lower the tariff to a competitive level to make it affordable.

TABLE 4.3

Modeling Results for a 1 GW Pathfinder Project

SCENARIO	GRANT (% OF TOTAL DEVELOPER CAPEX)	LEVEL OF CONCESSIONAL PRIVATE DEBT (%)	TOTAL DEVELOPER CAPEX (US$BN)	EFFECTIVE PRIVATE DEBT INTEREST RATE (%)	LCOE (US$/MWH)
Base Case: no grants; no concessional public finance of export system; varying levels of concessional private debt to offshore wind project					
1-A	0	0	2.93	8.0	108
1-B	0	25	2.93	7.3	93
1-C	0	50	2.93	6.5	91
Concessional public debt to finance the export system; no grants; varying levels of concessional private debt					
2-A	0	0	2.45	8.0	94
2-B	0	25	2.45	7.3	81
2-C	0	50	2.45	6.5	79
Concessional public debt to finance the export system, plus varying levels of grants and concessional private debt to achieve competitive tariff					
3-A	25	0	2.45	8.0	70
3-B	13	25	2.45	7.3	70
3-C	10	50	2.45	6.5	70

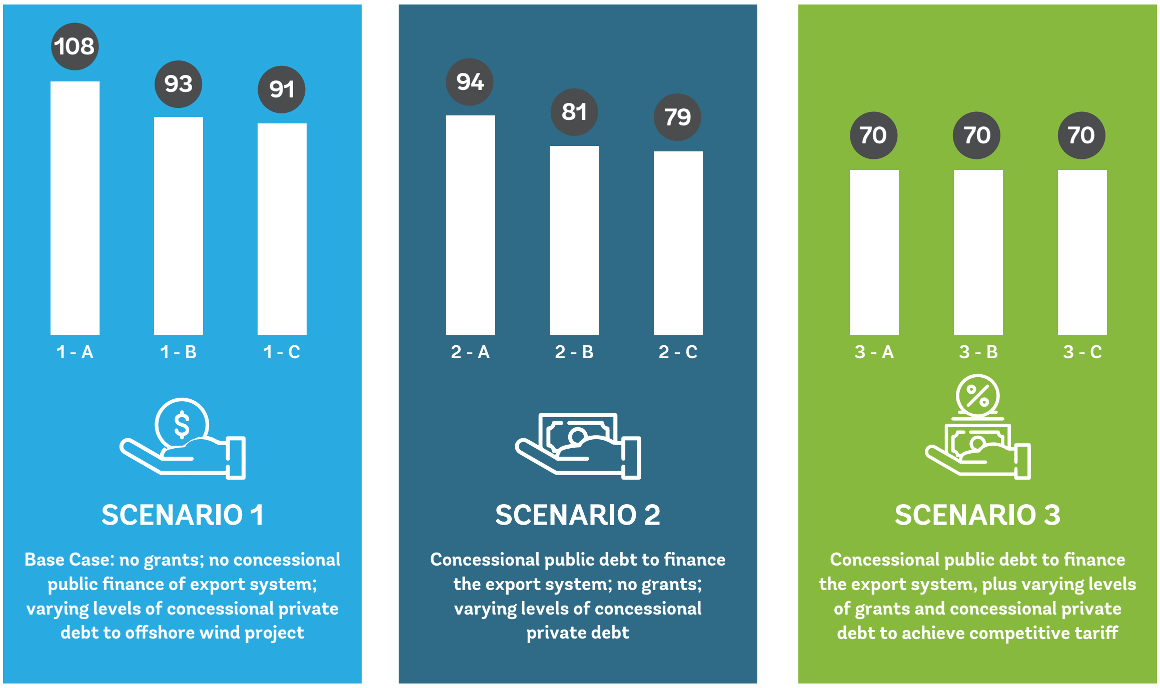
TABLE 4.4

Funding Sources for a Representative 1 GW Pathfinder Project Under Each Scenario

SCENARIO	FROM PUBLIC SOURCES			FROM PRIVATE SOURCES		TOTAL CAPEX ($M)
	CONCESSIONAL PUBLIC DEBT FOR EXPORT SYSTEM ($M)	GRANT FUNDING ($M)	CONCESSIONAL PRIVATE DEBT ($M)	COMMERCIAL DEBT ($M)	EQUITY ($M)	
1-A	–	–	–	2,198	733	2,930
1-B	–	–	549	1,648	733	2,930
1-C	–	–	1,099	1,099	733	2,930
2-A	480	–	–	1,838	613	2,930
2-B	480	–	459	1,378	613	2,930
2-C	480	–	919	919	613	2,930
3-A	480	613	–	1,378	459	2,930
3-B	480	319	400	1,199	533	2,930
3-C	480	245	827	827	551	2,930

FIGURE 4.1

Tariff Results (US$/MWh) Under Each Scenario



4.4 Discussion of Results

These results reveal the following insights:

- If concessional private debt is the only instrument used (Scenario 1B and 1C) then there is a relatively limited impact on the tariff. That is, even with 50 percent of a project's debt provided under concessional terms (Scenario 1C), the LCOE only falls by 16 percent, from US$ 108 per MWh to US$ 91 per MWh. It is assumed that the concessional debt is senior and pari passu with the commercial debt; the results for subordinated debt would be similar, however subordinated debt would have the benefit of enabling greater participation by providing a degree of downside protection to lenders;

- If the electrical export system is funded publicly (Scenario 2A) with no other concessional finance support, the impact is relatively limited, bringing the LCOE down by 13 percent from the baseline to US$ 94 per MWh. However, if 50 percent concessional private debt is added (Scenario 2C) then the LCOE drops to US$ 79 per MWh. Nevertheless, this LCOE is still above the LCOE in many emerging markets for both new-build thermal and renewable sources of generation. Therefore policy makers may require the cost of pathfinder projects to be lower;
- Adding grant funding is another way to further reduce the LCOE. In the case that the export system is covered by public funds, 50 percent of the debt is concessional and 10 percent of the remaining CapEx is covered by a grant (Scenario 3C), then the LCOE falls to $ 70 per MWh; and
- The levels of concessional financing required strongly favor DFIs as the lead financiers, but each DFI is likely to have a project exposure limit that they will want to observe. IFC, for example, typically finances no more than 25 percent of the total CapEx. Since concessional climate finance is usually blended with finance provided by DFIs on commercial terms, this may allow a single DFI to carry a 50 percent share of total financing (60 percent of total debt under an 80:20 debt:equity ratio), but another entity eligible to mobilize concessional financing would be needed to reach the 50 percent contribution of concessional private debt.

On its own, concessional private debt has a relatively low impact on the LCOE; however, if it is in the form of subordinated debt then it has the benefit of enabling greater participation by lenders who provide lower-cost debt, because it gives them a degree of downside protection. Concessional public debt to finance the electrical export system does have a substantial impact on the tariff although, due to the size of this cost item relative to the overall project CapEx, it is unlikely to reduce the LCOE enough on its own. Grants are the most effective tool for substantially lowering the tariff, by buying down a portion of the CapEx of the pathfinder projects for example, but they are the least attractive option to providers of concessional finance and are generally reserved for technical assistance activities and pathfinder projects.

The results are intended to illustrate the volume of concessional finance required for a single project in a single country. However, to achieve effects globally, multiple countries will need to be supported to deploy offshore wind, and support may be required for several projects within each country. We assume that 10 GW of offshore wind would need to be supported through 1 GW pathfinder projects across at least five countries to have a substantial, catalytic impact. This program of pathfinder projects would likely require a total of at least US$ 30 billion to finance the generation and transmission assets. Of this total amount, and assuming that a low LCOE is targeted, roughly US$ 2.5 billion would be required in the form of grants, US$ 4.8 billion of concessional public debt for export systems, and US$ 8.3 billion in the form of repayable concessional private debt. Importantly, this program of support would help to catalyze the establishment of those five new offshore wind markets, thereby accelerating the deployment of offshore wind, resulting in faster cost and emission reductions, followed by new pipelines of projects in each country.

If the grant portion of this concessional financing program is considered as an effective carbon price, and assuming an average electricity emission factor of 475 grams of CO_2 per kWh (EIA 2019), a project life of 25 years and an average capacity factor of 40 percent, then these projects would reduce emissions by 416 Mt of CO_2 over their lifetime. This level of emission reduction is equivalent to the total annual CO_2 emissions of Türkiye (World Bank 2019a). If the grant is assumed to effectively pay for these emission reductions, then the overall cost would be approximately US$ 5.90 per metric ton of CO_2.

FIVE RECOMMENDATIONS FOR STAKEHOLDERS

PHOTO CREDIT: VESTAS

5 Recommendations for Stakeholders

There is a clear, strong, potential role for concessional finance in launching and accelerating offshore wind deployment in emerging markets. To be effective, the following actions will be required by various stakeholders:

5.1 Developing Country Policy Makers

- Assess the potential for an aggressive expansion of offshore wind through a country roadmap study or equivalent strategic study, taking account of the scale impacts of different rates of deployment on the future tariff and on economic development opportunities;
- As described in *Key Factors*, formulate and announce offshore wind strategies along with policies, frameworks, and delivery mechanisms to bring offshore wind online through a realistic capacity procurement schedule;
- Generate credibility by moving forward with early-stage pathfinder projects, while continuing to build the medium- and long-term pipeline of projects;
- Scope out and agree on the role of the public sector, including public investment in shared infrastructure and other assets, to help reduce the tariff for the initial series of projects;
- Work with development partners to apply for available sources of concessional climate finance; and
- Engage with private sector developers to discuss plans, ensuring they share risk appropriately, and enable projects to be bankable.

5.2 Donor Countries and Climate Finance Providers

- Provide dedicated concessional finance of at least US$ 4.8 billion of concessional public debt, US$ 2.5 billion grant and US$ 8.3 billion private concessional debt, under existing mechanisms such as the GCF or CIF;
- Work with GCF and/or CIF to streamline the application process and ensure an appropriate balance between grants, concessional public sector debt, and concessional private debt finance for private sector developers and firms; and
- Refrain from tying funding and technical support to bilaterally negotiated deals.

5.3 Investors and Financiers

- State a willingness to finance offshore wind in emerging markets, and engage with governments and project sponsors at an early stage; and
- Work with climate finance providers and DFIs to refine the scope and design of the projects and instruments to be deployed.

5.4 Transmission System Operators

- Where governments follow the model of public investment in export system infrastructure, financed by concessional climate finance, TSOs will need to work with the government and private sector developers to examine the different options for the procurement, construction, and O&M of these assets; and
- TSOs may also need to assess ancillary infrastructure investments required to integrate the power generated from offshore wind projects into the country's electricity grid—such investments may also be candidates for concessional climate finance.

5.5 Private Sector Developers

- Broaden strategy to include emerging markets and develop early-stage project pipelines;
- Explore concessional financing options with partners who can help navigate the donor landscape and provide timely, effective support;
- Work with policy makers to identify cost reduction potential and set targets for future project tariffs that do not require concessional financing support;
- Push for competitive bidding rather than negotiated deals as a surer way of reaching financial close and securing the necessary finance (especially where MDBs are involved); and
- Help inform the scope and design of bidding packages to ensure that they reflect the needs of developers.

This program of support would help to catalyze the establishment of five new offshore wind markets, thereby accelerating the deployment of offshore wind, resulting in faster cost and emission reductions, followed by new pipelines of projects in each country.

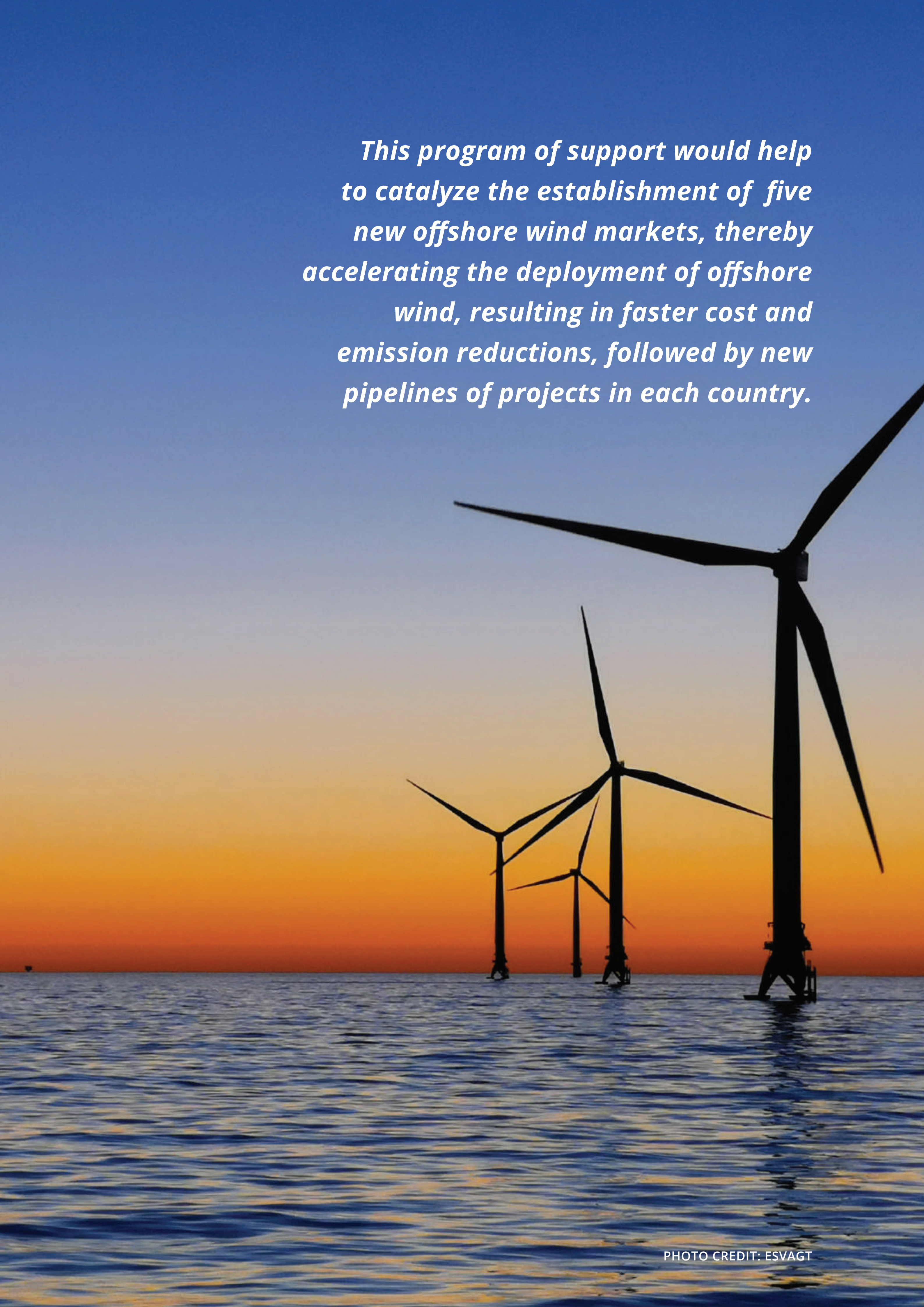


PHOTO CREDIT: ESVAGT

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ANNEX A

Climate Finance Landscape

The United Nations Framework Convention on Climate Change (UNFCCC) states that climate finance refers to financing that seeks to support mitigation and adaptation actions that will address climate change (UNFCCC 2020). In this context, the UNFCCC also recognizes that the contribution of countries to climate change and their capacity to prevent it and cope with its consequences vary enormously, stressing the Convention and the Paris Agreement's call for financial assistance from Parties with more financial resources to those that are less endowed and more vulnerable.

For the purpose of outlining the landscape and architecture of climate finance, this report adheres to the definition and scope of climate finance used by Climate Policy Initiative in its Global Landscape of Climate Finance 2019, which maps out primary capital flows directed toward low-carbon and climate-resilient development interventions with direct or indirect greenhouse gas mitigation or adaptation benefits (Climate Policy Initiative 2019b).

The landscape of climate finance can be broken down into two main groups—public and private sources—depending on the nature of the investors. Public climate finance includes funds provided by development finance institutions (DFIs),[12] governments and their agencies and national and multilateral climate funds; whereas private climate finance comprises funds contributed by commercial financial institutions, corporate actors, households, institutional investors and private equity, venture capital and infrastructure funds.

According to CPI (Climate Policy Initiative 2019a), annual tracked climate finance reached US$ 574 billion on average in 2017/2018, representing a 24 percent increase from 2015/2016, and public sources of climate finance have been the dominant source of overall climate financing in that period. Average annual public climate finance totaled US$ 300 billion in 2017/2018, representing 52 percent of average total climate finance flows. MDBs continued to provide the majority of public finance, contributing US$ 213 billion annually, or 71 percent of tracked public finance, up from US$ 194 billion in 2015/2016. They were followed by state-owned enterprises and financial institutions (US$ 49 billion) and governments and their agencies (US$ 32 billion).

[12] Encompassing National, Bilateral and Multilateral Development Banks

TABLE A.1

Key Multilateral Funds, Including Their Features, Size/Flows and Relevance to Renewable Energy Financing

NAME	UNFCCC / NON-UNFCCC[a]	DESCRIPTION	AREAS OF WORK RELATED TO RENEWABLE ENERGY	FUNDS RECEIVED	FUNDS COMMITTED	PROJECTS	CO-FINANCING RATIO	INSTRUMENTS
Global Environmental Facility (GEF), GEF-7[b]	UNFCCC	GEF provides new and additional grant and concessional funding to meet the agreed incremental costs of measures to achieve global environmental benefits in several areas, including climate change. The GEF also administers the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF)	GEF-7 Climate Change Focal Area objectives include the promotion of innovation and technology transfer for sustainable energy breakthroughs, (GEF 2017).	US$ 20 billion (World Bank 2022b)	US$ 17.5 billion	> 5,000	1:7.8 (GEF 2020)	Grants
Green Climate Fund (GCF)	UNFCCC	GCF aims for a 50:50 balance between mitigation and adaptation investments over time and for a floor of 50% of the adaptation allocation for particularly vulnerable countries. GCF offers a wide range of instruments to both the public and private sector, with a focus on vulnerable communities (Green Climate Fund 2022b).	GCF seeks to have an impact within eight mitigation and adaptation result areas, including energy generation and access.	US$ 15.2 billion (World Bank 2022c)	US$ 10.8 billion	>200	1:2.2 (Green Climate Fund 2022a)	Grants, loans, equity and guarantees
The Climate Investment Funds (CIF)	Non-UNFCCC	CIF are administered by the World Bank in partnership with AfDB, ADB, EBRD and IDB. CIF operate through various financing windows including the Clean Technology Fund (CTF) and the Special Climate Change Fund (SCF). These various funding programs provide financing to low- and middle-income countries.	CIF focal areas include: • Providing large-scale financing to low-carbon technology projects in developing countries through CTF; • Demonstrating the viability of renewable energy projects in low-income countries through SCF's Scaling up Renewable Energy in Low-income Countries Program (SREP).	US$ 10.3 billion (World Bank 2022a)	US$ 5.5 billion	>300	1:7.9 (CIF 2019)	Grants, concessional loans, equity and guarantees

[a] This column indicates whether the funds outlined here serve as operating entities of the financial mechanism of the UNFCCC or not.
[b] On April 25, 2018, almost 30 countries jointly pledged US$ 4.1 billion for the GEF's four-year investment cycle (known as GEF-7, it runs from July 1, 2018 to June 30, 2022).

Climate funds

Multilateral climate funds increased annual financing to US$ 3.2 billion in 2017/2018, up 43 percent from 2015/2016 levels, consolidating their role as an increasingly important source of climate finance. The major players in this context have been the Green Climate Fund (GCF), which provided 50 percent of total finance from these institutions, as well as the Global Environment Facility (GEF) and Climate Investment Funds, which provided 32 percent and 14 percent respectively (see Table A.1).

These institutions have deployed climate finance to help tackle the adverse environmental impacts of climate change, some as early as the 1990s. More recently, climate funds have provided targeted support for the pioneering, early development, and emergence of modern-day renewable energy technologies, with a goal to improve energy access, affordability and reliability in least developed and lower income countries.

Since its creation in 1992**,** the Global Environmental Facility (GEF) has invested more than US$ 1.1 billion in 249 stand-alone renewable energy projects, as well as US$ 277 million in 54 mixed projects with renewable energy components. These investments, which have been mostly channeled through grants, the main financing instrument used by GEF, have attracted additional investment of US$ 14 billion and resulted in emissions reductions of more than 580 Mt CO_2e (GEF 2022).

Meanwhile, through the US$ 720 Scaling Up Renewable Energy Program in Low Income Countries (SREP), the Climate Investment Funds (CIF) are demonstrating the economic, social, and environmental viability of renewable energy in the world's poorest countries (CIF 2022b). As of June 30, 2020, the SREP portfolio included 46 projects in 27 countries totaling US$ 542 million in SREP funding and US$ 674 million in co-financing, and funding had been committed to 33 projects. Among them, 25 projects, with US$ 289 million of SREP resources, are at various stages of implementation, and they expect to mobilize US$ 1.9 billion in co-financing from other sources. As of 2016, SREP funds had been channeled mainly through grants (80.1 percent), while other instruments such as loans (4.4 percent), guarantees (3 percent) or equity (3 percent), were used to a lesser extent (CPI 2016). The CIF Clean Technology Fund (CTF) is also at the forefront of financing promising renewable energy technologies, such as concentrated solar power (CSP), with over US$ 4 billion (75 percent of CTF resources) approved for implementation in renewable energy, energy efficiency, and clean transport (CIF 2022a).

Climate funds financing provides a demonstration effect and helps create a track record and solid precedents to the successful financing of these technologies in the market. This, in turn, increases the interest of private financiers and stimulates the entry of the local banking sector into the industry. A good example of this effect is the well-established track record of such funds in financing concentrated solar power (CSP) and geothermal energy projects. The role played by the Global Environmental Facility (GEF) and the Climate Investment Funds (CIF) is notable: they have become pioneers in the demonstration and deployment of these technologies. Some of the first projects of this kind in emerging markets include: the 20 MW Ain Beni Mathar CSP project, in Morocco, financed by a US$ 43.2 million GEF grant (GEF 2016) and co-financed by two AfDB loans amounting to US$ 371.8 million, and a US$ 129.19 million loan from Spain's State-owned financial agency, Instituto de Crédito Oficial (ICO) (World Bank 2014); the 100 MW KaXu CSP plant in South Africa, that became the first operational private sector utility-scale CSP plant with storage in the developing world (CIF 2022c), funded by a blended financing structure comprising US$ 125 million from IFC's own commercial funds and a US$ 26.5 senior concessional loan from CTF (IFC 2020); or the Menengai geothermal power plant, in Kenya, financed by a US$ 25 million SREP channeled through the AfDB as part loan (US$ 17.5 million) and part grant (US$ 7.5 million), and co-financed by the AfDB (US$ 120 million loan), the Agence Française de Développement (AFD), other development partners, and a local budget provided by the Government of Kenya up to a total estimated cost of US$ 847 million (World Bank 2011).

These projects helped scale down market entry barriers, soften perceived risks and reduce uncertainties, ultimately unlocking the markets, attracting financiers, and driving down costs. However, lessons learned from these experiences evidenced the difficulty for emerging markets of adopting technologies that are not fully commercialized; and the potential risk to the technology's wider credibility if developed countries fail to achieve market viability. In the case of the CSP plants mentioned previously, construction costs increased as the projects progressed, and host countries were burdened with both these additional costs and the risk that the projects might not produce the rated power on a firm basis. In this context, blending climate funds financing with loans and grants from the World Bank and other MDBs could help reduce the support provided by governments to an affordable level and thus contribute to easing the burden on governments' fiscal budgets.

ANNEX B
Financial Model Description

This annex provides further details on the modeling variables and assumptions used to generate the results provided in this report.

B.1 Variables

The following variables are incorporated in the model:

- **Objective**: The objective cell was equity internal rate of return (EIRR) which was set to the value of return on equity for each scenario to optimize the tariff level which is a dependent to the revenue flows in the equity free cashflows, consequently they are mutually dependent.
- **Optimal outcome variable**: Using goal seek function, the changing variable was set to tariff for getting optimized value, depending on the EIRR.
- **Constraints**: The constraints in the solver were mainly set as follows: (i) tariff level, not greater than the tariff cap pricing of each category: (ii) Debt Service Coverage Ratio, greater than and equal to 1.3, based on literature for offshore wind investments.
- **Output variables**: The model generates an output table that includes the following:

(i) ***Equity IRR***, which is at the rate of return on equity cash flows after tax that is equivalent to the sum of Net Income and Depreciation minus Loan Repayments. The Net Income is the sum of any forms of revenues such as tariff, carbon credits and generation-based incentives, minus taxes, and interest payments.

(ii) ***Project IRR*** is another output to demonstrate rate of return based on free cash flows, which comprise Earnings Before Interest and Tax (EBIT) and depreciation minus the net cash from investing cash flows.

(iii) ***Average Interest*** is used to indicate how various levels of debt instrument impact the average interest of the project. This is the average of the sum of interests from all types of debt, that is, concessional and commercial debt.

(iv) ***Levelized Cost of Electricity*** (LCOE) is the present value of expenditures over the present value of sum of electricity generation units over project life cycle. It represents the power tariff that might be offered to the public off-taker by a private developer under a competitive procurement process.

B.2 Assumptions

The general assumptions are those that are unchanged in the financial model across the different scenarios. They are summarized in Table B.1.

TABLE B.1

General Assumptions Used in the Financial Model

ASSUMPTIONS	UNIT	VALUE
Power Generation		
Net Capacity Utilization Factor	%	44.0 %
Useful Life	Years	25
Construction Period	Years	3
Costs		
CapEx (including electrical export system)	US$m/MW	2.93
OpEx (initial value)	US$30/MWh	0.03
Working Capital		
Payables	Days	45
Receivables	Days	60
Annual Escalation in OpEx	%	2.0 %
Spare & Maintenance (Inventory)	%	0 %
Interest on Working Capital	%	10.0 %
Interest on Long-Term Loan Outstanding	Days	30
Taxes		
Corporate Tax	%	20.0 %
Financial Assumptions		
Commercial debt – tenor	Years	15
Commercial debt – grace period	Years	3
D/E ratio	ratio	75/25
DSCR average	ratio	1.5
DSCR min	ratio	1.3
Commercial debt-interest rate	%	8.0 %
Blended (concessional & commercial) debt – tenor	Years	25
Blended (concessional & commercial) debt – grace period	Years	5
Concessional debt – interest rate	%	5.0 %

ANNEX C

List of Acronyms and Abbreviations

TERM	DESCRIPTION
ADB	Asian Development Bank
AfDB	African Development Bank
AFD	Agence Française de Développement
BPS	basis points (the unit is 0.01%)
CapEx	capital expenditures
CIF	Climate Investment Funds
CO_2	Carbon Dioxide
CSP	Concentrated Solar Power
CTF	Clean Technology Fund
DAC	Development Assistance Committee
DevEx	Development Expenditure
DFI	Development Finance Institution
DSCR	Debt Service Coverage Ratio
EBIT	Earnings Before Interest and Tax
EBRD	European Bank for Reconstruction and Development
EIRR	Equity Internal Rate of Return
EPC	Engineering, Procurement and Construction
ESMAP	Energy Sector Management Assistance Program
GCF	Green Climate Fund
GEF	Global Environment Facility
GGDP	Global Geothermal Development Plan
GHG	Greenhouse Gas
GREM	Geothermal Resource Risk Mitigation
GW	gigawatt
GWh	gigawatt hour
GWEC	Global Wind Energy Council
IBRD	International Bank for Reconstruction & Development
ICO	Instituto de Crédito Oficial

(*continues*)

TERM	DESCRIPTION
IDA	International Development Association
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
kWh	kilowatt hour
LCOE	Levelized Cost of Electricity
LDCF	Least Developed Countries Fund
LIBOR	London Inter-Bank Offered Rate
MDB	Multilateral Development Bank
MW	megawatt
MWh	megawatt hour
NDC	Nationally determined contribution
NGO	Nongovernmental Organization
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
OpEx	Operating Expenditures
O&M	Operation and Maintenance
OREAC	Ocean Renewable Energy Action Coalition
PPA	Power Purchase Agreement
PV	photovoltaic(s)
SCCF	Special Climate Change Fund
SREP	Scaling-up Renewable Energy in Low-income Countries Program
TSO	Transmission System Operator
TW	terawatt
UNFCCC	United Nations Framework Convention on Climate Change
WBG	World Bank Group

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