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RENEWABLE ENERGY

Evaluation of the World Bank Group's Support for Electricity Supply from Renewable Energy Resources, 2000–2017

Financial, Private Sector, and Sustainable Development Department

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Management Response

World Bank Group management welcomes the Independent Evaluation Group (IEG) evaluation, *Renewable Energy: Evaluation of the World Bank Group's Support for Electricity Supply from Renewable Energy Resources, 2000–2017.* The report assesses the Bank Group's contribution to helping remove barriers to investing in renewable energy, using its convening capacity to mobilize financing through partnerships, disseminating global knowledge and experiences, engaging with clients, and coordinating both within the Bank Group and with external partners. It provides a thorough review of the Bank Group's renewable energy portfolio over the 17-year period with helpful insights and relevant recommendations.

World Bank Management Comments

Management welcomes the three recommendations in the report. IEG's recommendations indicate the potential to strengthen the Bank Group's global impact in terms of (i) focus (grid stability); (ii) modalities (long term and integrated); and (iii) staff resources. The evaluative findings of the report identified areas where the Bank Group is already building internal capacity and a solid body of knowledge. On renewable energy integration, the Bank Group has been at the forefront of innovation, developing methodologies, protocols, and guidance, and facilitating international partnerships to build the capacity of system operators, regulators, and planning agencies.

The linear results chain presented as the theory of change does not fully capture the magnitude of the challenge in adopting renewable energy solutions. In practical terms, renewable energy development can only be achieved when technical and economic feasibility demonstrate a comparative advantage in relation to a range of cheaper and more readily available alternatives. Moreover, renewable energy may not always be the most cost-effective way to reduce carbon emissions or enhance energy security. The role of long-term planning goes beyond renewable energy integration as described in the report: it is a critical first step in any decision-making process at the sectoral level to achieve the most reliable, sustainable, affordable, and universal provision of electricity services.

Renewable energy supply depends on complex market dynamics, the state of the transmission and distribution infrastructure, capacity, and overall energy policy. Policy decisions on fossil fuel subsidies, coal mining or investment in coal-based capacity impact the volume of renewable energy installed. The theory of change appears to suggest that increased renewable energy capacity delivers development results under assumptions that may not always exist, for example, natural resource endowments,

political commitment, institutional capacity, regulatory infrastructure, macroeconomic stability, local renewable energy champions, and the dynamism of the private sector.

The report makes the unrealistic assumption that World Bank support for renewable energy, by itself, would reduce the global reliance on fossil fuels. The 66 percent increase of global power generation between 2000 and 2017 was almost entirely based on fossil fuels. The extent to which the deployment of renewable energy reduces the carbon intensity of developing economies depends on government decisions to reduce the use of fossil fuels. The success of World Bank renewable energy programs is related to policies that remove subsidies for fossil fuels and create a conducive environment for accelerating the energy transition.

The Bank Group's program to deploy renewable energy is also shaped by trade-offs among economic, social, and environmental objectives. There are trade-offs among the policy objectives to reduce greenhouse gases, ensure access to energy, protect consumers from high prices, and support private sector participation. Improved access to energy may not always translate into climate-friendly energy and vice versa. The World Bank focuses on win-win strategies that increase access to energy while taking advantage of rapidly falling prices for renewable energy.

The report's finding that the Bank Group had not met its commitment to translate nationally determined contributions (NDCs) into climate action in 31 countries is not supported by the strong pipeline of projects and ongoing activities. IEG evaluated the period between 2000 and 2017, but the Intended NDCs and NDCs were only introduced after the ratification of the Paris Agreement in November 2016 and the subsequent design of NDCs by 98 signatory countries, representing 70 percent of those with NDC. The Bank Group is committed to helping developing countries translate the NDCs into climate action. The World Bank is in fact preparing renewable energy projects or technical assistance in many of the 31 countries highlighted by the evaluation. The Bank Group works with other development partners on the implementation of NDCs and renewable energy targets at the country level. The division of labor across multilateral institutions should be factored into any evaluation of World Bank support to individual countries.

Renewable energy barriers vary across different segments. The report appropriately highlights the barriers to renewable energy, including the weak financial viability of some electricity utilities, inappropriate energy policy, low tariffs, inadequate institutional capacity, and the lack of an enabling environment for domestic financing. However, the impact of these factors on the renewable energy program differs substantially across the broad range of different renewable energy sources and technologies: conventional versus nonconventional, variable versus nonvariable , grid

versus off-grid, and mature versus emerging renewable energy technologies. The Bank Group program is tailored to the different challenges, barriers, policy or regulatory solutions, and concessional finance needs that characterize each of these distinct renewable energy segments. There is no single approach to the increased use of renewable energy.

Limited representativeness of the country case studies. The evaluation entailed a qualitative comparative assessment using empirical evidence from nine country case studies, complemented by a portfolio review, a literature review, and the observations of an external panel. The small sample of nine country case studies that exhibit stark differences among them limits a meaningful validation of the theory of change. Only one case study was selected from Sub-Saharan Africa, where the challenges to renewable energy deployment and financing are the most acute, and only two of the nine case studies were from low-income countries. More than half of case studies were from middle- and upper-middle income countries, where the barriers to renewable energy deployment and financing are different to those in low-income countries.

IEG Findings

The evaluation states that the Bank Group could do more to deliver cutting-edge knowledge. IEG rated the Bank Group's capacity to deliver innovative solutions in renewable energy integration and energy storage as moderate. The transfer of knowledge in emerging fields entails the production of new knowledge modules, tools, and guidance. It requires international consensus and partnerships in an environment where client countries are not always ready to adopt innovative practices. The World Bank is currently preparing two comprehensive reports on distributed energy resources. Bank technical experts have organized multiple workshops for clients on the themes of integration, new ways of planning and forecasting, and identification of flexibility options. This includes the use of demand-side resources, including the demand response and distributed energy generation, trade in electricity and pooling. The World Bank worked on delivering renewable energy policy and regulatory design. A robust quantitative assessment of electricity pricing for distributed generation and its impact on poor people was undertaken.

The report's assessment of World Bank support to renewable energy integration is incomplete. The evaluation states that "less than 7 percent of the project support in the period 2000–17 focused on renewable energy integration." This statement is misleading. The evaluation period covers 18 years, whereas renewable energy integration only became a significant issue in recent years and only in a few developing economies. The assessment of the World Bank's engagement should also factor in the division of labor among international development institutions. The World Bank delivers cutting-edge

assistance in the area of renewable energy integration through the Global Environment Facility, climate investment funds, trust funds, and partnerships. Management disagrees with the conclusion that the Bank Group's limited project-level experience on renewable energy integration posed a challenge in acquiring and maintaining knowledge, given the evolving nature of policy and regulatory requirements and the emergence of innovative solutions. The World Bank is at the forefront of variable renewable energy (VRE) integration. The World Bank's efforts have intensified in recent years despite the fact that the level of VRE in most developing countries is low and integration is not yet an operational challenge (as it is by contrast in Europe). The World Bank focused on helping clients develop (i) appropriate long-term modeling exercises, (ii) specific renewable energy integration assessments and forecasting protocols, and (iii) deployment of technologies to enhance flexibility, such as battery energy storage or demand response to prepare for higher VRE penetration levels. The World Bank also contributed significantly to global knowledge on VRE integration and delivered cutting-edge advice. The Energy Sector Management Assistance Program introduced dedicated technical assistance windows to support renewable energy integration. This included (i) renewable energy resource mapping, (ii) power systems planning, (iii) VRE integration and forecasting, and (iv) an Energy Storage Partnership. Other Trust Funds have also contributed to VRE integration activities in World Bank projects. As the penetration of VRE increased in developing economies in recent years (for example, over fiscal years [FY]17–20), Energy Sector Management Assistance Program supported 31 country activities and 5 Regional activities to address VRE grid integration issues and more than 60 countries with long-term planning modeling.

The World Bank entered into partnerships with various organizations to deliver timely and cutting-edge advice and training. In addition to the Energy Storage Partnership launched in 2018 and the partnership with the International Renewable Energy Agency to support project development, the World Bank signed a memorandum of understanding with the International Council on Large Electric Systems (known as CIGRE) to close gaps in power system expertise using a wide set of measures to ensure a robust integration of VRE.

Management welcomes IEG's efforts to highlight the specificities of the off-grid renewable energy portfolio. Although it welcomes the analysis, the chapter on off-grid solutions could have been more nuanced. In particular, the earlier sections on renewable energy scale-up did not allude to the potential or importance of off-grid renewable energy renewables. The section on the pathway for clean energy transition could have incorporated some analysis of the potential of off-grid renewables and the importance of these technologies for the clean energy transition in low-access countries. The findings could have similarly been more nuanced, reflecting trends in off-grid technology (for

example, a shift to solar), providing a better overview of the types of off-grid projects in the analysis (for example, minigrids versus off-grid solar), and whether successful projects share particular features that could be replicated in other countries. Finally, it would have been helpful to define "off-grid solutions to energy access" for the purposes of the report. The term "off-grid" is often used with different meaning in different contexts.

Other Comments

Although the report highlights the contribution of renewable energy to boosting economic growth, it could have included data and evidence on job creation and local industrial activity. That would have strengthened the case for a green fiscal stimulus in light of the COVID-19 crisis. It would have been worthwhile to learn which project components and approaches were more effective in ending extreme poverty and boosting shared prosperity. More information on the trade-offs among economic, social, and environmental goals would have helped the Bank Group to either focus on renewable energy in those economies with large carbon footprints to deliver on the global greenhouse gases reduction agenda or instead to emphasize off-grid renewable energy to support the energy access agenda in the poorest client countries with negligible impact on the global agenda. It would also have been helpful to learn whether the Bank Group had leveraged the appropriate mix of public and private sector resources to make an impact on greenhouse gases reduction. An assessment of the conflicting incentives within the Bank Group to improve the "bankability" of individual investments (that is, the "transaction view") or to support longer-term sector development (that is, the "sector view") would have been useful. The transaction view entails incentives, such as tariffs or the protection of private investors from risk, whereas the sector view recommends minimizing the subsidy provided to the private sector.

There could have been more information on renewable energy auctions. Auctions are defined as competitive tenders to assign development rights. The innovative feature of the renewable energy auction is the sophisticated design that awards power purchase agreements to bidders that offer the lowest purchase tariffs, thereby minimizing the volume and level of subsidies. The experience from the renewable energy auctions pioneered by several countries—Brazil, South Africa, and Turkey—and then applied in low-income countries (for example, Zambia) indicates that auctions facilitated renewable energy at incredibly low prices that compared favorably with low fuel prices.

International Finance Corporation Management Comments

Management of the International Finance Corporation (IFC) welcomes the report *Renewable Energy: Evaluation of the World Bank Group's Support for Electricity Supply from*

Renewable Energy Resources, 2000–2017 given the importance of the subject matter. Indeed, now more than ever, renewable energy stands at the core of IFC's energy strategy and has constituted the majority of its new financing commitments in the energy space in recent years.

Management notes and appreciates that the report recognizes that the evaluation period FY00–17 represents the early days of renewables deployment globally (even more so on a commercial basis) and that IFC investments experienced a substantial uptick in later years. Due to the fact that the majority of the evaluated period was in the early days of the renewable expansion, the assessment of IFC project performance is largely that of IFC's hydropower project performance. Wind and solar energy, the two technologies that represent the overwhelming share of renewable energy being deployed at scale today, were indeed nascent technologies in the early 2000s. Reflecting sustained efforts in this space, solar and wind represented only 6 percent of IFC's total power generation portfolio in 2007 but now represent 37 percent as of June 2020, with the total renewables' share reaching 62 percent. IFC has now invested in over 5.9 gigawatts of solar and 5.0 gigawatts of wind power globally, of which 59 percent of the total solar and wind gigawatts within the past 5 years alone. In IFC's latest fiscal year (FY20), renewables represented 54 percent of total new commitments in the power subsector. For the foreseeable future, IFC expects that this trend will continue and increase in both absolute and relative terms.

The report touches on IFC's important role in mobilizing commercial capital for renewable energy. Following IFC's catalytic role principle stipulated in its Investment Guidance and Practices (typically, not to provide more than 25 percent of the required financing), and as IFC usually plays a lead role in arranging the entirety of the required financing for its project, IFC's contributions to renewable energy deployments are best measured through total financing of the capital it generates. Indeed, IFC was credited with Core Mobilization for renewable energy projects of $5.3 billion between FY06 and FY17. In FY18–20 alone, IFC mobilized an additional $2.8 billion from its partner institutions.

Although the report illustrates that nearly a third of IFC investments included some form of institutional strengthening that addresses other barriers beyond the provision of financing, management would like to emphasize IFC's multifaceted contribution to the Bank Group's renewables scale-up effort:

- In many countries, IFC plays a significant role in enabling faster deployment of renewable energy sources by means that go beyond the mere provision of financing or scope of traditional advisory services projects. This includes (i) direct policy dialogue on private sector issues with governments and regulators,

focusing on the sharing of global best practices and key success factors; (ii) aggregating private sector views and using its convening power and honest broker role to foster a constructive public-private dialogue; (iii) targeted initiatives to fast track renewable energy deployment; and (iv) pioneering innovative approaches for financing renewable energy projects. Examples of such IFC interventions include the following: (i) IFC's contribution to structuring and mobilizing financing for merchant renewables—despite the complexity of doing so—in a number of emerging markets including in Chile, Mexico, the Philippines, Panama, and Turkey;[1] (ii) IFC catalyzing more than 3.4 gigawatts of renewable power generation in Argentina through its contribution to the structuring of the RenovAr renewable energy auction (and the financing of some of these projects); (iii) IFC's development of new standardized financing structures in Jordan,[2] the Arab Republic of Egypt,[3] and Pakistan;[4] and (iv) IFC's pioneering work (jointly with International Development Association (IDA) / International Bank for Reconstruction and Development (IBRD) and Multilateral Investment Guarantee Agency [MIGA]) to rollout the Scaling Solar program in countries requiring a different approach to scaling up solar photovoltaic (PV) technology. Going forward, these types of interventions will be emphasized even further due to IFC's new "upstream" focus and strategic directions (such as "creating markets").

- IFC's trailblazing role in financing the very first renewables projects in many countries. This signaling and demonstration effect has been key in opening many countries to renewables, showing the crucial role IFC has played in expanding renewables markets. Examples during the evaluation period include the first independent power producer (IPP) in Vietnam (hydro, FY07), the first grid-tied solar PV investment in India (FY09), the first concentrated solar power projects in Sub-Sahara Africa (Abengoa Khaxu and Khi, South Africa, FY13), and the first solar PV IPP in Mozambique (FY17). Examples for FY18–20 include the first solar IPP in Burkina Faso and the first utility-scale solar projects under the Scaling

[1] A merchant plant is a privately financed independent power producer without a long-term power purchase agreement.It sells electricity to a variety of customers based on the current wholesale market.

[2] The "Seven Sisters": a group of 7 solar photovoltaic projects totaling 102 megawatts.

[3] The International Finance Corporation financed 13 solar projects totaling 752 megawatts in the Arab Republic of Egypt in fiscal year (FY)18

[4] A group of six wind farms totaling 310 megawatts in Pakistan, financed by International Finance Corporation in FY20.

Solar program in Zambia and Senegal. Being a first-mover is typically associated with a steeper learning curve and substantial levels of technology and regulatory risk.[5] This is consistent with the report's findings that these early wind and solar PV projects performed unevenly, with earlier projects having a weaker performance than projects toward the later years of the evaluation.

Management acknowledges IEG's finding of some significant differences in performance of IFC's portfolio by industry subgroup (power versus nonpower) and subsector (wind, solar and hydro) in terms of IFC's work quality and development impact. Such differentiation is useful from the perspective of drawing relevant lessons and designing corrective actions. The review's findings would also have benefited from a more in-depth look at the evolution of IFC's work quality over the course of the review period since, as mentioned above, IFC has also gone through a learning curve in the earlier years of solar and wind deployment. However, such a granular analysis may not be feasible due to small sample sizes and insufficient historical information.

While IFC management agrees with most barriers identified in the report, the report could have benefited from a more detailed focus on key barriers to private investment in renewables. This is important given that the deployment of renewable capacity worldwide has been led predominantly by the private sector except hydropower. Given the magnitude of the climate challenge that the Bank Group is called to address and the limited amounts of official development assistance flows made available, the private sector is likely to continue leading investments in renewable capacities in emerging markets. This makes the proper identification and removal of barriers constraining private investment in renewables at a more granular level of critical importance. For instance, barriers to wind or solar renewable energy deployment are different from those for hydropower. Although the report mentions "significant investment risks" as one of six key barriers to renewable energy development, two major barriers to private sector investment could have been further explored in detail:

- **Offtaker credit risk and electricity sector financial sustainability.** Renewable energy projects require large upfront investments, and as such, are vulnerable to the credit risk of their offtakers in the long term. This issue must be urgently addressed to see the rapid increase in renewable energy the Bank Group is calling for, for example, through sound regulation of utilities, particularly when

[5] By way of illustration: (i) on the technology front, energy yield assessments for intermittent renewables have considerably improved since the mid-2000s (more accurate models, lessons learned from experience), and understanding impacts on the grid have progressed—and continue to do so; and (ii) on the regulatory front some feed-in tariffs regimes proved to be unsustainable and were rescinded or amended.

it comes to ensuring proper cost pass-throughs or through regulatory frameworks that allow investors to address demand from private off-takers.[6] While mentioning this aspect, the report does not give this topic the weight and attention it deserves.

- **Predictability and clarity on award processes.** To invest in renewable energy in emerging markets, private investors require predictability and clarity on the procurement front. Whether feed-in-tariffs, tenders, or auctions, private investors have been agile enough to play by the rules set for them by governments and regulators. Be it in Colombia, India, Senegal or Zambia, when clear rules for procuring renewable energy projects were announced, private investors flocked in, including in frontier economies with elevated levels of risk (thanks in part to instruments made available by the World Bank and MIGA).

IFC management agrees with IEG on the importance of alleviating transmission bottlenecks. The report identifies opportunities for scaling up and integrating renewable energy into the power system through means such as energy storage and distributed generation (which IFC agrees with), and the foundational role of solid transmission and distribution infrastructure for the integration of renewables cannot be stressed enough. In many emerging markets, the issue goes beyond the integration of renewables. In many instances, the main barrier is rather the lack of available interconnection options for renewables. Removing this barrier is achievable technically but requires planning from utilities and transmission companies to identify available interconnection points and make this information available to potential investors. IFC's newly operational upstream units, working closely with IDA/IBRD teams, can significantly contribute to resolving these transmission bottlenecks.

More differentiation and granularity in parts of the analysis and recommendations would be welcome. The renewable energy landscape is very diverse among Bank Group member countries and challenges can differ vastly from country to country, warranting a more granular and differentiated approach along some analytical dimensions. As an illustration, IFC's experience is that barriers to renewable energy differ considerably between more mature emerging markets and IDA and fragile and conflict-affected situation countries: for the latter, the balance between development needs and climate change mitigation imperatives, investor perception (and interest), regulatory, political economy, and energy sector challenges warrant a different response. IFC's strategy is to

[6] In several countries, utilities are not creditworthy enough to enter into power purchase agreements with independent power producers, but there are creditworthy private companies (typically in energy-intensive manufacturing sectors) that would be willing to enter in agreements with private renewable energy producers.

support the growth of renewable energy in all countries of operation: ramping up even more its efforts in more challenging markets and continuing to have a significant footprint in the renewable energy space in more mature emerging markets,[7] while adopting differentiated approaches for each country. Another analytical dimension that would benefit from more granularity relates to fossil fuels: the report discusses fossil fuels (coal, oil, and gas) as an aggregate, whereas there is now substantial data and evidence highlighting that gas merits a differentiated approach owing to the role it is expected to play in markets where it can contribute to displacing more carbon-intensive fuel sources (such as coal) and promoting renewable energy penetration, thereby enabling the energy transition.[8]

IFC management generally agrees with the recommendations put forth by the report. Consistent with the report's recommendations, management would like to flag that several actions have already been implemented to address some of the reasons for IFC project underperformance. These include the following:

- **Consistent decision-making at the global level.** In line with the findings of the report, in 2018, IFC management decided to take a unified approach to assessing projects across industries worldwide. Given the different pace of adoption of renewable energy across regions, this provides significant risk mitigation, allowing IFC to anticipate potential issues. All renewable energy projects are thus now approved by IFC global directors, and IFC's Global Energy team is required to provide guidance and inputs from the initial stages of projects. Details of these decision-making steps and procedures can be found in IFC's Accountability and Decision-Making ("ADM").

- **Global support infrastructure for Regional teams.** This includes, among other things, (i) the creation of global Renewable Energy Leads positions, available to support Regional teams on complex projects and providing relevant global knowledge and best practices; (ii) the establishment of subsector databases (wind, solar, hydropower) providing Regional teams with access to relevant benchmarks; (iii) increased support by industry and market specialists, and (iv) the codification of "project acceptance criteria" to better inform decision-making at early stages of projects.

- **Regular reviews of IFC's renewable energy portfolios.** IFC is regularly reviewing the performance of its renewable energy portfolio to identify trends,

[7] Which have historically been at the forefront of renewable energy deployment.

[8] For now, the technology to enable renewable-only electricity sectors is, though promising, not fully mature yet –except in countries with substantial hydropower or geothermal resources.

common issues, and best practices. In 2019, for example, two comprehensive reviews of IFC's wind and solar portfolios were conducted, with their results shared with relevant staff and the organization of a series of learning events to disseminate these findings.

- **Increased number of technical specialists.** Recognizing the need for more technical know-how, IFC has increased the number of technical specialists with expertise in the renewables space.
- **An increased focus on knowledge management and dissemination.** IFC's Global Energy unit has rolled out a comprehensive knowledge management effort ("Knowledge for Business"), which systemizes the dissemination of knowledge and lessons learned. This series, which includes written and audiovisual material as well as targeted events, aims at equipping IFC teams with the up-to-date information and lessons from experience needed to further enhance the quality of work in relation to renewable energy projects.

IFC's upstream focus: IFC's creating markets strategy emphasizes the importance of upstream work to help accelerate the prevalence of well-thought-out, balanced, public-private partnerships in the infrastructure space (among other things). With the operationalization of IFC's upstream units, this will add important capabilities to IFC's tool kit, helping grow IFC's renewable energy markets (particularly in challenging and complex contexts) and holistically addressing some of the constraints identified in the report (for example, transmission and distribution) where it is most needed.

IFC management agrees with and would like to reinforce the importance of a common and coordinated effort to implement the Bank Group Cascade approach to Maximizing Finance for Development and to jointly work with the World Bank on the upstream agenda. As experience has demonstrated, powerful and lasting impacts can be achieved when all Bank Group institutions coordinate their action in member countries and leverage each other to achieve better outcomes. IFC management would welcome more replication of the success stories, such as the 2017 "Nubian Suns" Program in Egypt, Nachtigal in Cameroon, and Upper Trishuli in Nepal, through early-stage coordination, open exchange of perspectives on the sequencing of public and private interventions (including suitable forums for resolving differences when they arise), support to Regional Bank Group teams (with clear, shared frameworks for enabling working-level cooperation), and the design of staff incentive structures that promote greater collaboration.

Multilateral Investment Guarantee Agency Management Comments

MIGA contributions in renewable energy. MIGA welcomes the report *Renewable Energy: Evaluation of the World Bank Group's Support for Electricity Supply from Renewable Energy Resources, 2000–2017*. MIGA finds the report useful and important. MIGA notes that development outcome success rate of evaluated MIGA guarantee projects during the report period was 86 percent (6/7), the highest within the Bank Group, although this was based on a smaller set of projects compared with World Bank and IFC. MIGA also appreciates the recognition accorded to MIGA in the report from BloombergNEF's 2018 Climate Scope Emerging Markets Outlook, which highlighted the Bank Group's prominence as a major long-standing "foreign investor" and political risk insurance issuer (through MIGA) for renewable energy development in emerging economies, with the widest overall global reach.

Addressing barriers to renewable energy investments. The report identified six barriers to renewable energy investments: (i) inadequate policies and regulations; (ii) inability to integrate renewable energy to power system; (iii) insufficient design and technical standards; (iv) inadequate institutional capacity; (v) significant investment risks; and (vi) constraints on mobilizing financing. The report found that MIGA focused on addressing investment risks. This is consistent with the Agency's mandate as an investment guarantee provider for facilitating foreign investment into emerging markets and developing economies by mitigating noncommercial risks.

Addressing barriers to renewable energy investments through the Cascade approach. The report underscores the importance of coordination across the Bank Group—leveraging the comparative advantages of the Bank Group institutions—for addressing barriers to renewable energy Investments. The report found that renewable energy development was more successful when the Bank Group engaged systematically over time, strengthening its relationships, and progressively and comprehensively helping countries implement the necessary reforms to remove barriers to renewable energy development. The report also found the evidence consistent with the Bank Group Cascade approach for Maximizing Finance for Development that prioritizes leveraging sustainable private sector financing and reserves scarce public financing for those areas where private sector engagement is not optimal or available. Therefore, the report recommends that the World Bank and IFC's upstream advisory work focus on renewable energy policies and integration, that IFC mobilize private capital while promoting adoption of environmental and social standards and mechanisms for scaling up, and that MIGA further extend its risk mitigation work to a wider range of renewable energy technologies.

MIGA agrees with these findings. MIGA notes that it is increasingly aiming to work alongside IFC and the World Bank to support the upstream work of our sister institutions to help reduce the barriers to private sector investment in the renewal energy sector. In addition, since the evaluation period, MIGA has been making substantial progress in working to support solar and wind projects, especially in Sub-Saharan Africa. MIGA will continue to expand its efforts to work with clients in derisking investments projects across a wide range of renewable technologies.

MIGA also notes that the findings are consistent with the evidence presented in IEG's FY15 electricity access evaluation regarding the efficacy and effectiveness of joint Bank Group projects in the power sector. The electricity access evaluation identified MIGA's value added in joint Bank Group projects in the electricity sector as (i) providing long-term political risk insurance for high-risk countries not available from international commercial insurers.

Management Action Record

IEG Findings and Conclusions	IEG Recommendations	Acceptance by Management	Management Response
World Bank Group to prioritize interventions that focus on integrating renewable energy sources into the power systems of client countries, to facilitate progress in their clean energy transitions	The envisaged growth of variable renewable energy (VRE) technologies in generation mixes requires prioritizing the "integration challenge" through investments (in addition to advisory services and analytics) by • Tackling key intermittency issues linked to VRE sources. • Enhancing power systems flexibility with specific attention to o Developing hydropower with storage that meets high environmental and social standards and o Accelerating the deployment of battery storage technologies (as viable). • Addressing key transmission bottlenecks,	Agreed.	Regarding the proposed areas of focus, management agrees that the World Bank should emphasize the integration challenge, where grid reinforcement and smart grid technologies will be a prime area of focus. Management concurs with the importance of system planning and focus on integrating renewable energy. This is an area where well-targeted technical assistance can be highly impactful, beyond supporting aggressive target-setting for renewable energy, to facilitate investment to address the challenge of intermittent renewable energy. It would be important to continue scaling up trust fund and lending resources in this area—for example, by expanding the existing system planning group in Energy Sector Management Assistance Program and by lending for transmission and distribution networks upgrades to better manage capacity constraints, variable dispatch, and system balancing. In recent years, the World Bank's efforts have intensified, and focused on helping clients (i) develop appropriate long-term planning modeling exercises; (ii) undertake specific renewable energy integration assessments and forecasting protocols; and (iii) deploy technologies to enhance flexibility (such as battery energy storage or demand response) to prepare for higher VRE penetration levels. The Energy Sector Management Assistance Program has introduced specific windows for technical assistance that contribute to renewable energy

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	including through distributed generation.		integration, including windows on renewable energy resource mapping, systems planning, and VRE integration and forecasting, and the Energy Storage Partnership. In addition, other Trust Funds, such as the nationally determined contributions Support Facility, have contributed funds to VRE integration activities in World Bank projects. A new initiative, the Sustainable Renewables Risk Mitigation Initiative, was recently launched to support sustainable renewable energy targets based on sound planning and least-cost studies covering integration of VRE. Management of the International Finance Corporation agrees with IEG on the importance of alleviating transmission bottlenecks. The report identifies opportunities for scaling up and integrating renewable energy into the power system through means such as energy storage and distributed generation (which IFC agrees with), and the foundational role of solid transmission and distribution infrastructure for the integration of renewables cannot be stressed enough. In many emerging markets, the issue goes beyond the integration of renewables. In many instances, the main barrier is rather the lack of available interconnection options for renewables. Removing this barrier is achievable technically but requires planning from utilities and transmission companies to identify available interconnection points and make this information available to potential investors. IFC's newly operational upstream units, working closely with International

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			Development Association and International Bank for Reconstruction and Development teams, can significantly contribute to resolving these transmission bottlenecks.
Bank Group to support renewable energy scale-up through comprehensive, long-term country engagements, with coordinated Bank Group solutions, based on the comparative advantages of each institution, to address barriers, aided by robust upstream diagnostics	Effectively addressing barriers to renewable energy requires the following: • Long-term comprehensive engagement with clients across the Bank Group, with a focus on addressing the rapidly evolving renewable energy technologies and markets, and more early-stage coordination and exchange across the Bank Group on the sequencing of public and private interventions. • A focus on the electricity sector financial viability and off-taker creditworthiness. • Conducting comprehensive upstream diagnostics and adequate risk assessments. • Exploiting the comparative advantages of the World	Agreed.	Bank Group management concurs with the need to support renewable energy expansion through comprehensive long-term country engagements. The Bank Group's approach to renewable energy development targets the wide spectrum of upstream actions, including policy and regulatory design, sector reforms, planning and operations, utility modus operandi, and transformation necessary to create the conditions for systematic cost-effective renewable energy deployment. Over the past few years, Bank Group institutions have gradually found ways to deliver their services in a complementary and coordinated way, including through the Cascade approach to Maximizing Finance for Development. The Bank Group supported a substantial scale-up of renewable energy investments, in step with global trends after the landmark Bonn commitment in 2004, with Bank Group investments covering all major renewable energy technologies. IFC management agrees with and would like to reinforce the importance of a common and coordinated effort to implement the Bank Group Cascade approach to Maximizing Finance for Development and to jointly work with the World Bank on the upstream agenda. As experience has demonstrated, powerful and lasting impacts can be achieved when all Bank Group

IEG Findings and Conclusions	IEG Recommendations	Acceptance by Management	Management Response
	Bank, IFC, and Multilateral Investment Guarantee Agency, with the World Bank (and potentially IFC's "upstream" advisory) focusing on renewable energy policies and integration, IFC mobilizing private capital while promoting adoption of environmental and social standards and mechanisms for scaling up, and the Multilateral Investment Guarantee Agency further extending its risk mitigation portfolio to cover a wider range of renewable energy technologies.		institutions coordinate their action in member countries and leverage each other to achieve better outcomes. IFC management would welcome more replication of the success stories, such as the 2017 "Nubian Suns" Program in Egypt, Nachtigal in Cameroon, and Upper Trishuli in Nepal, through early-stage coordination, open exchange of perspectives on the sequencing of public and private interventions (including suitable forums for resolving differences when they arise), support to Regional Bank Group teams (with clear, shared frameworks for enabling working-level cooperation), and the design of staff incentive structures that promote greater collaboration.
Bank Group to continually upgrade the pool of specialized skills to help clients address their pressing and rapidly evolving challenges to expand renewable energy	Helping clients address their scale-up needs and challenges requires a change in the Bank Group skills mix to include expertise on the following: • Systems planning, especially for integrating VRE.	Agreed.	The Bank Group has been agile in attracting talent in the area of clean energy in 2000–20, during which time the Bank Group mainstreamed renewable energy projects in its energy portfolio, representing about a third of total energy sector commitments in 2010–20. The Infrastructure Vice Presidency houses a group a specialized engineers and economists and deploys technical support and knowledge to Regional units, and all of the World Bank's Regional units have a diverse talent pool that includes renewable energy experts.

IEG Findings and Conclusions	IEG Recommendations	Acceptance by Management	Management Response
	• Policies, especially on transitioning from pricing (feed-in tariffs) to structuring renewable energy auctions and on transparent and predictable procurement processes. • Innovation, including energy storage and distributed generation.		Moreover, Bank Group staff needs are regularly reviewed through a strategic staffing exercise, of which the purpose is precisely to ensure that the Group has the specialized skills that it needs to help clients address their principal development challenges, including those related to scaling up renewable energy. IFC management has increased the number of technical specialists with expertise in the renewables space, recognizing the need for more technical know-how. In addition, IFC's Global Energy unit has rolled out a comprehensive knowledge management effort (called Knowledge for Business), which systemizes the dissemination of knowledge and lessons learned. This series, which includes written and audiovisual material, as well as targeted events, aims at equipping IFC teams with the up-to-date information and lessons from experience needed to further enhance the quality of work in relation to renewable energy projects.

Report to the Board from the Committee on Development Effectiveness

The Committee on Development Effectiveness met to consider the report entitled *Renewable Energy: Evaluation of the World Bank Group's Support for Electricity Supply from Renewable Energy Resources, 2000–2017,* and management's response.

The committee welcomed the evaluation, noting its timeliness and valuable insights to inform the upcoming Board of Executive Directors engagement on Sustainable Development Goal 7 (ensure access to affordable, reliable, sustainable and modern energy for all) and its complementarity to the Independent Evaluation Group's series of evaluations on energy. They appreciated management's broad agreement with the evaluation's recommendations and were pleased to learn that the World Bank Group is the single largest global contributor to renewable energy in developing countries. While acknowledging that the evaluation did not assess the most recent technological innovations and practices used by the Bank Group, members were encouraged to learn that the Bank Group has stepped up its engagements on solar power, wind and storage and the Bank Group has played a relevant convening and knowledge sharing role, including in supporting countries' efforts to meet their Nationally Determined Contributions targets.

Members stressed the key role of the Bank Group in promoting integration of renewable energy sources into the power systems of client countries to facilitate progress in their clean energy transition. Some members encouraged management to speed up investments in renewable energy and focus on addressing the bottlenecks in transmission and distribution. Some underscored that this needed to be a demand-driven agenda and encouraged management to also assist client countries in improving the effectiveness and efficiency of traditional sources of power generation, given that these sources continue to outpace the growth of renewable energy.

On the recommendation to scale up resources and upgrade staff skills through comprehensive long-term country engagement with coordinated Bank Group solutions to address multiple barriers to renewable energy scale-up, members referred to the need to reinforce partnerships and ensure early and continuous coordination across the Bank Group institutions and with other development agencies. Some highlighted that there was room to expand the role of institutional investors in climate change projects in client countries. Management underscored the importance of continuing to support sector policy reforms and of building strong partnerships to help countries achieve their goals.

Members highlighted that upgrading the pool of specialized staff was key to help client countries address rapidly evolving challenges in scaling up renewable energy. They appreciated the International Finance Corporation's efforts to recruit industry specialists and reinforce knowledge management to ensure dissemination of best practices, lessons learned, and expertise on renewable energy. Members also appreciated the World Bank's efforts to focus on next-generation technologies, policy and regulatory reforms, and operational solutions to build capacity for renewable energy integration, as well as the work with education specialists to create centers of excellence to build capacity in client countries. They were also pleased to learn about the upstream work being done by the Equitable Growth, Finance, and Institutions and the Sustainable Development Practice Groups to scale up and improve the macro fiscal framework to remove market distortions.

Abbreviations

- AS — Advisory services
- ASA — Advisory services and analytics
- ASTAE — Asia Sustainable and Alternative Energy
- CAS — Country Assistance Strategy
- CAO — Compliance Adviser/Ombudsman
- CBA — Cost-benefit analysis
- CCAP — Climate Change Action Plan
- CIF — Climate Investment Fund
- CO_2 — Carbon dioxide
- CPF — Country Partnership Framework
- CRESP — China Renewable Energy Scale-up Program
- CSP — Concentrated solar power
- CTF — Clean Technology Fund
- DG — Distributed generation
- DPF — Development Policy Finance
- E&S — Environmental and social
- EIA — Energy Information Administration
- EIB — European Investment Bank
- ESMAP — Energy Sector Management Assistance Program
- FY — Fiscal year
- GEF — Global Environment Facility
- GHG — Greenhouse gas emissions
- GWh — Gigawatt hour
- IBRD — International Bank for Reconstruction and Development
- IDA — International Development Association
- IEA — International Energy Agency
- IEG — Independent Evaluation Group
- IFC — International Finance Corporation
- IPCC — Intergovernmental Panel on Climate Change
- IRENA — International Renewable Energy Agency
- KPI — Key performance indicators
- kWh — Kilowatt hour
- M&E — Monitoring and evaluation
- MDB — Multilateral development bank
- MIGA — Multilateral Investment Guarantee Agency
- MW — Megawatt
- NaS — Sodium-sulphur
- NDC — Nationally determined contributions
- OECD — Organization for Economic Co-operation and Development
- PCF — Prototype Carbon Fund
- PV — Photovoltaic
- P4R — Program for Results
- QCA — Qualitative comparative analysis
- RE — Renewable energy
- REN21 — Renewable Energy Policy Network for the 21st Century
- SAS — Screening, appraisal, and structuring
- SDGs — Sustainable Development Goals
- TES — Thermal energy storage
- ToC — Theory of change
- TWh — Terawatt hours
- VRE — Variable renewable energy
- WCD — World Commission on Dams
- WB — The World Bank (IBRD/IDA)
- WBG — The World Bank Group (WB-IFC-MIGA)

All dollar amounts are U.S. dollars unless otherwise indicated

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The initial analysis for the evaluation was carried out by a team that included Migara Jayawardena (Lead Evaluation Officer and Thematic Coordinator for Energy and Infrastructure), Aurora Medina Siy (Senior Evaluation Officer), Ramachandra Jammi (Senior Evaluation Officer), Ihsan Kaler Hurcan (Consultant), Mari Noelle Lantin Roquiz (Evaluation Analyst), Joy Kaarina Butscher (Junior Professional Officer), Ebru Karamete (Evaluation Analyst), Shenghui Feng (Consultant), and Lalrinpari Sailo (Strategy Officer). The team was supported by Andrew H. W. Stone (Adviser), Jozef Leonardus Vaessen (Methods Adviser), Elena Bardasi (Senior Economist), Jacqueline Andrieu (Evaluation Officer), and subject matter experts and consultants. Richard Kraus, Romayne Pereira, Vibhuti Narang Khanna, and Emelda Cudilla provided administrative support.

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Summary

Key Takeaways

Developing Renewable Energy: The Context

Clean Energy Transition

The *Clean Energy Transition*—the pathway for decarbonizing global energy—is essential to foster inclusive and sustainable growth while addressing climate change.

Renewable energy scale-up

A **major scale-up of RE-generated electricity** to displace fossil fuel power generation is an imperative of the *Clean Energy Transition*.

The share of RE in global power generation will need to double by 2030 (from over 25% in 2017) to meet *Clean Energy Transition* targets.

Over 70% of the requisite RE scale-up is forecast to take place in **developing and emerging economies**.

Wind power, solar photovoltaic (PV), and hydropower are forecast to have the largest roles in the RE scale-up.

Challenges and opportunities

Based on EIA forecasts, IEG estimates that annual global financing for RE needs to double, from $300 billion to $600 billion (2017 US$) to meet the SDGs and allow the *Clean Energy Transition*.

Integrating larger shares of RE, especially solar PV and wind power that provide variable/intermittent supply (variable renewable energy—VRE), implies a **fundamental shift in design and operations of energy systems**, prioritizing their flexibility.

Energy storage—whether through hydro, thermal, or electro-chemical (battery)—presents opportunities for addressing integration of VRE.

RE distributed generation (RE DG) is fast gaining traction and can help reduce transmission constraints and integrate scaled-up RE.

WBG Renewable Energy Portfolio Performance

Overall RE performance

Based on 168 evaluated RE projects (101 WB, 60 IFC, 7 MIGA) during FY00–FY17, **the WBG overall had a 66% success rate**—varying across institutions (71% WB, 51% IFC, 86% MIGA).

Hydropower projects performed best, with sizable energy and climate benefits when developed in line with industry standards.

Wind power and solar PV performed unevenly. Other single-technology RE projects (geothermal, CSP, bio-power) were mostly successful.

Multi-technology RE project success varied (78% WB, 36% IFC), mostly meeting energy supply targets but less successful in avoidance of CO_2.

Evolution of WBG RE portfolio

The WBG's RE **investment portfolio of $22 billion** over the evaluation period, 2000–2017, included support across all major RE technologies.

The period 2006–11, following a major commitment by the WBG to scale-up RE, saw steady growth, with a peak of $2.7 billion of RE commitments in 2011. From 2012 onwards, **RE commitments plateaued at around $2.2 billion/year** while the annual number of projects increased.

The WBG's financial commitments are a fraction of total global RE investments. However, **the WBG is the single largest global contributor to RE in developing countries** and helps clients address key barriers to scaling-up RE technologies through its investments.

Hydropower and multi-technology projects dominate the WBG RE portfolio, although there has been a surge in the share of wind and solar PV projects, emulating global trends.

Recommendations

*WBG to prioritize interventions that focus on **integrating** RE sources into the power systems of client countries, to facilitate progress in their clean energy transitions.*

*WBG to support RE scale-up through **comprehensive**, long-term country engagements, with **coordinated** WBG solutions, based on the comparative advantages of each institution, to address barriers, aided by robust upstream diagnostics.*

*WBG to continually upgrade the pool of **specialized skills** to help clients address their pressing and rapidly evolving challenges to scale-up RE.*

What has worked

The adequacy of WBG's identification of, and interventions to overcome, **RE-specific barriers,** broadly corresponded to the success of project outcomes. Such barriers include policy and regulatory constraints, limited integration of RE in power systems, meeting industry standards, institutional capacity, investment risks, and financing of RE.

The quality of the WBG's contributions to RE (**doing things right**) depended on quality of project design, due diligence and screening, appraisal, structuring, and implementation performance, including M&E.

The WBG's core contributions in RE (**doing the right things**) were helping remove barriers to RE, using convening capacity to mobilize financing through partnerships, disseminating global knowledge and experiences, systematically engaging with clients, and effectively coordinating within the WBG and with external partners.

Context, Scope and Approach

Development Context

Energy and climate are inextricably linked: the Clean Energy Transition—a pathway for decarbonizing the global energy system—is therefore imperative to foster inclusive and sustainable growth and limit climate change.

A major scale-up of RE to displace fossil fuels for power generation is vital to the Clean Energy Transition, with a majority of the requisite scale-up forecast to take place in developing countries.

Clean energy: key to sustainable growth and climate action

The context that frames this evaluation is the importance of renewable energy (RE) to the *Clean Energy Transition*: a pathway for transforming the global energy system from fossil fuel dependence to one powered by low carbon-emitting renewable resources.

Global energy production is still dominated by fossil fuels (coal, oil, gas) and accounts for over 60% of overall greenhouse gas (GHG) emissions. The levels of climate-altering carbon dioxide (CO_2) emitted from RE technologies (hydro, solar, wind, biomass, geothermal) for producing electricity are nominal compared with those from fossil fuels.

The *Clean Energy Transition*—in which the global share of RE-based electricity would need to quadruple by 2040 with over 70% of that increase in developing countries (IEA)—is therefore vital to achieving the UN's sustainable development goals (SDGs) and targets in the 2016 Paris Agreement on climate change:

a) Ensure access to affordable, reliable, clean electricity to alleviate poverty and foster economic growth, as articulated in SDG 7 for energy; and

SDG 7 is an explicit and interdependent goal that underpins all other SDGs (UN).

b) Take urgent action to combat climate change and its impacts in line with SDG 13 for climate action and the Paris Agreement, whereby the international community committed to limit global temperature rise to no more than 2°C and "make best efforts to limit [it] to 1.5°C" by 2100.

This clean energy framework also aligns with the WBG's *Forward Look 2030* for the acceleration of inclusive and sustainable economic growth to realize the twin goals: boost shared prosperity and eliminate extreme poverty by 2030. It is also relevant to increase fiscal benefits and enhance security of power supply, as the use of indigenous resources can cushion against the volatility of fossil fuel prices in international markets.

"The SDGs and the Paris Agreement create the framework for the coordination and further acceleration of global efforts to advance the energy transformation" (IRENA)

Purpose and Scope

This evaluation assesses the performance of the World Bank Group (WBG) in its support to electricity production from RE resources in client countries over the period 2000 to 2017.

The evaluation's findings and analysis aim at informing and enhancing the ways the WBG can best add value to support client countries' transitions to more sustainable and cleaner energy systems.

The evaluation primarily focuses on the ability of RE to increase electricity supply and realise global environmental benefits from avoiding GHG emissions.

The evaluation was designed to answer two main questions based on the ToC:

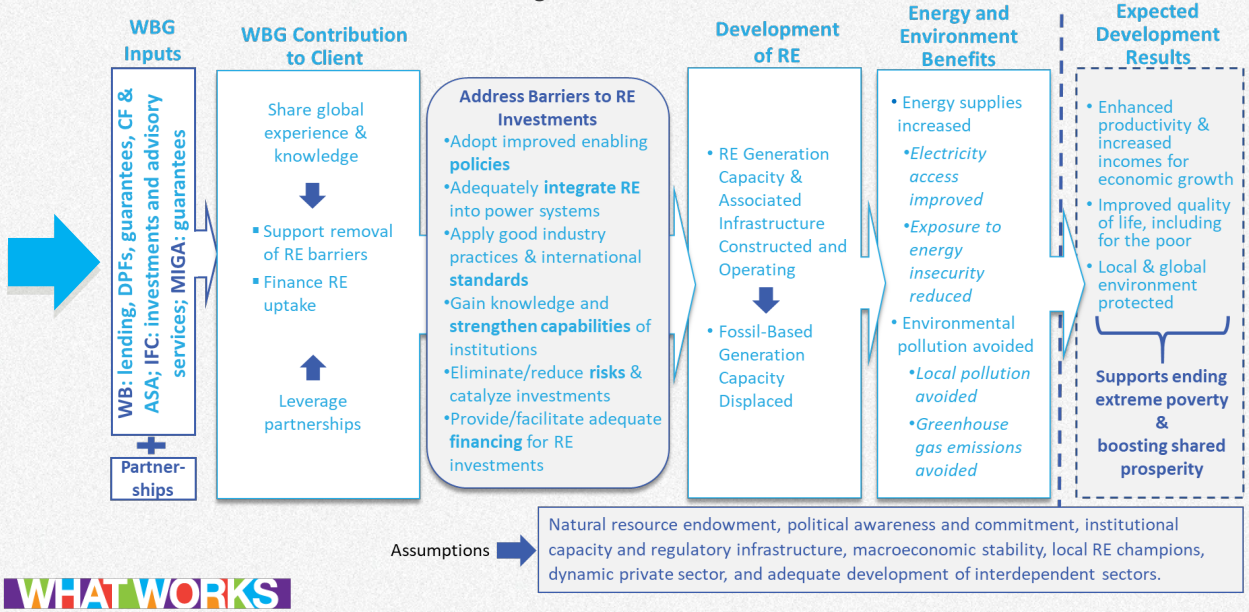
i) In what ways—and how well—has the WBG contributed to addressing the evolving RE needs of its clients?

ii) What lessons from experience can be identified to strengthen the role of the WBG in helping clients achieve RE goals?

In line with the WBG's energy sector directions, the evaluation recognizes that the institution's financial commitments to RE account for a small fraction of the global investments needed to meet sustainable development and climate goals. Its overarching aim, therefore, is to illuminate where and how, with the resources it has, the WBG can use its core strengths—maximizing its global reach in sharing knowledge and leveraging partnerships—to help clients address key barriers to developing RE to meet energy needs and transition to a more sustainable future locally and globally. The acceleration and scaling-up of RE in developing countries is paramount to achieving this *Clean Energy Transition.*

The evaluation focuses on the electricity supply and global climate benefits as the primary motivations for RE development over the evaluation period 2000–2017. But it also acknowledges RE's important role in increasing access, particularly through off-grid means; enhancing energy security, by using indigenous resources; and reducing local pollution.

The Theory of Change (ToC) of the RE evaluation *considers that the WBG's investment and advisory support for RE mobilizes global knowledge and leverages additional finance and partnerships to address key barriers to investments in RE and associated infrastructure. The resulting increase in generation capacity displaces fossil-based capacity, facilitating the energy and environmental outcomes needed to achieve development impacts.*



IEG Independent Evaluation Group | WORLD BANK GROUP World Bank • IFC • MIGA

WHAT WORKS

Approach

*The evaluation used a **multi-method approach** to collect data and triangulate various sources of evidence.*

The approach takes into account the inherent complexities and contextual specificities of energy sector development, particularly during a period of rapid and dynamic expansion of RE, and in view of the emerging challenges and opportunities presented by the *Clean Energy Transition*.

The evaluation recognizes that the dynamic evolution of the RE markets renders only some lessons from experience relevant to future developments, and that the energy and development needs of each client country necessitate a broad menu of options and tailored solutions.

Key aspects of the evaluative structure were therefore to identify key **barriers** commonly faced when expanding RE; to validate and map them against the WBG's RE experience and performance; and to assess the institution's position and capacity to support clients' emerging RE development needs.

The portfolio review and country case studies provide examples of what worked and what didn't and reveal gaps and opportunities to inform the WBG's future strategic and operational approach, particularly for maximizing the different strengths and complementarities within the institution (i.e., between WB, IFC, and MIGA).

Multi-Method Evaluation Approach

Evaluation Method	Description
Structured Literature Review	*An assessment of the evolution of RE markets; a literature review of barriers to developing RE, the energy and environment impacts of electricity produced from RE; and, a review of the development impacts of RE.*
Portfolio Review & Analysis	*A review of 546 investment projects in the Bank Group's RE portfolio (investment lending, Development Policy Finance (DPF), Program for Results (P4R), guarantees, and carbon finance transactions); select Bank Advisory Services and Analytics (ASAs) and IFC Advisory Services (AS) from a portfolio of 245 activities; 19 Project Performance Assessment Reports (PPARs); and, an in-depth review of hydropower applying cost-benefit analyses (CBA), among other methodological techniques.*
Comparative Case Studies	*Nine purposefully selected, in-depth country case studies, and a Qualitative Comparative Assessment (QCA) of the case study results. Countries selected: China, India, Jordan, Kenya, Mexico, Morocco, Nicaragua, Sri Lanka, and Turkey.*
Semi-structured Interviews	*Interviews with public and private stakeholders, and development partners, during case study preparation; interviews with key Bank Group managers who oversee the RE portfolio; and a survey of a purposive sample of Bank Group staff working on RE.*
IEG Global Expert Panel on RE	*A structured, iterative Delphi process with a set of global experts who helped identify and prioritize emerging RE opportunities and challenges and provided views on the Bank Group's position and capacity to help clients scale-up RE.*

Source: IEG

*The evaluation included a **qualitative comparative assessment (QCA)** to analyse the causal relationship between RE-specific barriers and outcomes and identify distinct pathways to scaling-up RE.*

*It also involved an innovative structured, iterative **Delphi process** with a **global expert panel on RE** convened by IEG to validate and prioritize the identified barriers and provide views on the WBG's role and capacity to deliver in the global RE scale-up.*

RE Scale-Up

The Evolution of Markets and Current State of Play

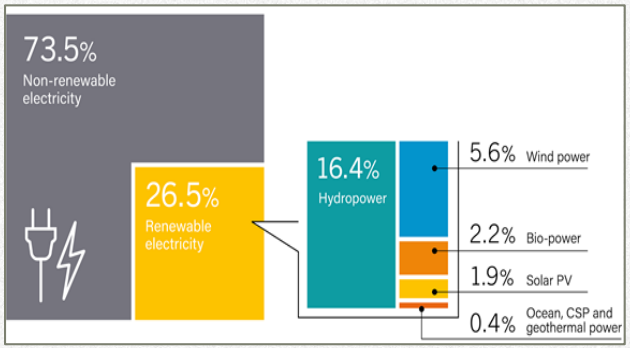
Pathway for the Clean Energy Transition

Emerging Challenges

Emerging Opportunities

RE Scale-up: The Evolution of Markets & Current State of Play

***Over a quarter of global electricity in 2017 came from RE resources**. The RE share in global power generation will need to double by 2030, and further increase to 63% by 2040, to meet the Clean Energy Transition targets (IEA).*



Source: REN21. Renewables 2018. Global Status Report

Global RE development, 2000-2017

The period covered by this evaluation saw the global deployment of multiple RE technologies rapidly expand, with total annual investments in RE increasing from $57 billion in 2000 to nearly $280 billion in 2017 (US$ 2017).

Since 2000, the global RE landscape has evolved from one in which hydropower was the only major RE technology of scale to one that has mainstreamed technologies such as wind and solar photovoltaics (PV). The expansion, which originated in the developed world, has spread to developing countries, which experienced a similar share of global investments in RE by 2017.

Hydropower remains the largest RE technology, generating over 60% of global electricity from RE in 2017. However, the global share of hydropower in RE has steadily declined as other technologies have expanded, in some cases at a rapid pace.

Wind power and **solar PV** have grown from negligible levels in 2000 to producing approximately 21% and 7%, respectively, of total global RE electricity in 2017.

The significant expansion of wind power and solar PV over the evaluation period was primarily due to declining technology costs derived from self-reinforcing cycles of innovation, manufacturing efficiencies, and economies of scale.

Other RE technologies—such as bio-power, concentrated solar power (CSP), and geothermal—have also expanded during this period, albeit more modestly. However, these technologies can play significant roles in diversified generation mixes in specific countries.

Despite these advances, to meet increasing global demand, electricity produced from fossil fuels (coal, gas and oil) has also continued to grow, outpacing the overall expansion of RE over the same period. This was further compounded by subsidies to fossil fuels, which still outweighed those to renewables in 2016 (IEA, 2017).

Therefore, to realize the positive impacts of the *Clean Energy Transition*, the immediate global scale-up of RE must be accelerated and sustained over several decades.

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* IRENA (2018) estimates that RE needs to be scaled up at least six times faster than current rates for the world to meet the goals in the Paris Agreement

RE Scale-up: Pathway for the Clean Energy Transition

Any pathway to achieving the goals in the Clean Energy Transition involves an ***unprecedented global scale-up in RE****.*

Wind power, solar PV, and hydropower *are forecast to have the largest roles in the global RE scale-up.*

A Pathway to Achieving the Clean Energy Transition

RE Technology	Installed Capacity			Average Annual Increase (%)	Average Capacity Addition (GW/year)	Electricity Produced		
	2016 (GW)	2030 (GW)	2040 (GW)			2016 (TWh)	2030 (TWh)	2040 (TWh)
Hydropower	1241	1723	2060	2.1%	34	4070	5688	6928
Wind	466	1706	2629	7.5%	90	981	4193	6950
Solar PV	299	1846	3246	10.4%	123	303	2732	5265
Bio-Power	127	243	347	4.3%	9.2	570	1209	1807
Geothermal	13	44	82	8.0%	2.9	86	292	563
Solar CSP	5	92	328	19.0%	13.5	11	287	1066

Note: 2030 represents target consistent with meeting SDGs

Source: Based on IEA forecasts for its Sustainable Development Scenario cited in *IPCC Special Report on Global Warming of 1.5°C* (2018) https://www.ipcc.ch/sr15/download/#full

Several studies propose different pathways to the *Clean Energy Transition*, and all call for a momentous expansion of RE. The International Energy Agency (IEA) forecasts that the largest RE expansions will be in wind power, solar PV and hydropower.

Wind power installed capacity is forecast to increase more than fivefold, from 466 GW in 2016 to over 2,600 GW by 2040, and **solar PV** more than tenfold, from 299 GW in 2016 to nearly 3,250 GW by 2040. This would result in the share of wind and solar PV in total installed variable renewable energy (VRE) capacity being 30% and 27%, respectively, by 2040, with a combined increase in electricity production from 1,284 TWh in 2016 to 12,215 TWh by 2040.

Hydropower's installed capacity is forecast to nearly double and to remain a mainstay in power supply. The increase would be from 1,240 GW in 2016 to an estimated 2,060 GW by 2040, with 83% of that expansion expected in developing countries. The resulting overall electricity produced from hydropower would increase from 4,000 TWh in 2016 to approximately 7,000 TWh by 2040.

Based on IEA's forecasts, the Inter-governmental Panel on Climate Change estimates that the RE share in the global generation mix will need to more than double by 2030 (as per SDGs) and almost quadruple by 2040 (to stay on course with Paris Agreement targets), with a majority of the expansion in developing countries. Overall, RE would need to produce 63% of the total global electricity by 2040.

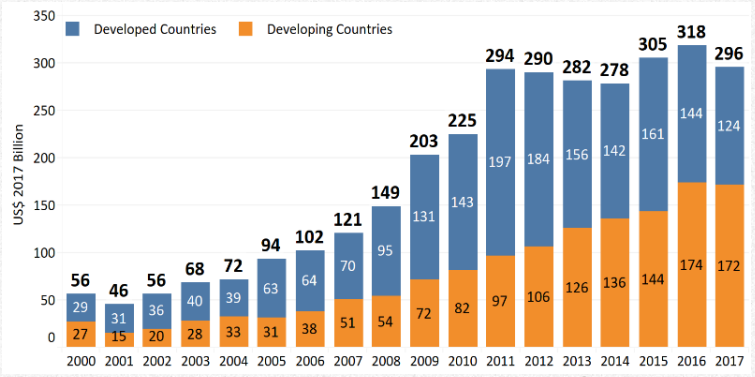
Emerging Challenges: *Mobilizing Financing for RE*

Annual global financing levels for RE will need to ***double, from $300 billion to $600 billion*** *(2017 US$), to meet the Clean Energy Transition targets; but recent RE investment trends indicate that the world is not on track to achieve these.*

Mobilizing the needed scale of financing will require a combined effort to enhance the investment climate, including ***enabling policy, regulatory and institutional reforms.***

This in turn will require a ***multi-dimensional, long-term approach, with coordinated and continuous efforts*** *at transforming the energy sectors in countries.*

Rising Global RE Investments have Levelled-Off



Source: IEA

The unprecedented scale-up in RE in the *Clean Energy Transition* – the transition from fossil-based energy to zero-carbon by the second half of the century – will require mobilizing significant funds, especially since most RE investments must be financed up-front. Despite the substantial scale-up in global funding for RE, there is broad consensus (IEA, IRENA) that annual global financing levels will need to double, from about $300 billion (2017 US$) to $600 billion, requiring both public and private sector contributions.

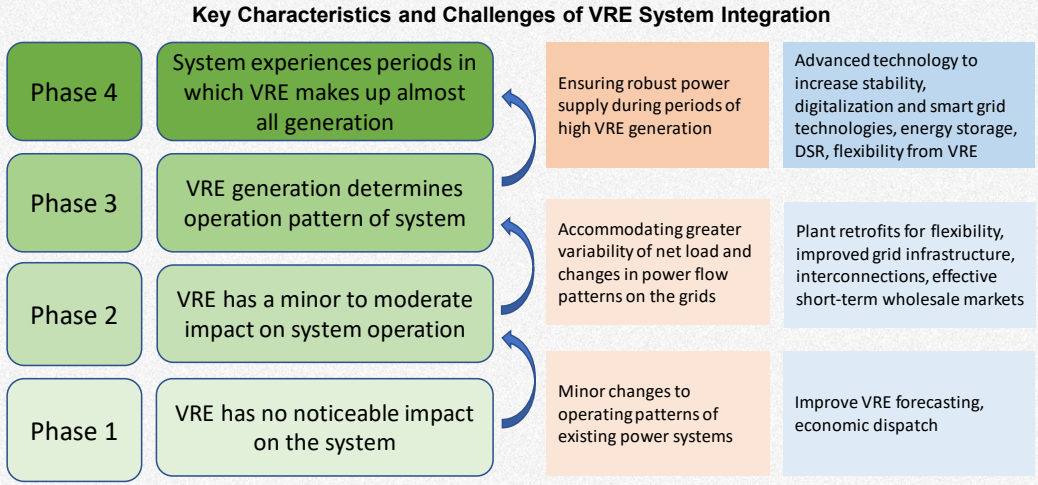
However, overall RE investments in recent years have plateaued, and the 2018 SDG Global Tracking Framework report indicates that the world is not on track to achieve the SDG target for RE (IEA, World Bank, 2017). If RE expansion continues along its current trajectory, the *Clean Energy Transition* will not be fully achieved.

Since a majority of the forecast RE expansion is expected in developing countries, significant reforms will be required to overcome vested interests and enhance the investment climate to mobilize the required financing in emerging markets. This requires continued improvements to the **legal and policy** framework for RE, strengthening **planning and institutional capabilities** to follow good practices and standards, and innovative ways to mobilize financing for 'bankable' investments in an evolving RE market.

"Transforming the global energy system …requires long-term energy system planning and a shift to more holistic policy-making and more co-ordinated approaches across sectors and countries." (IRENA)

Emerging Challenges: *Integration of RE in Power Systems, Especially VRE*

Integrating increasing shares of RE into power systems, particularly variable renewable energy (VRE) such as solar and wind due to their supply intermittency, necessitates "a fundamental shift in the way energy systems are conceived and operated" (IRENA).



Source: Adapted from IEA *World Energy Outlook 2018*

Penetration of RE in Developing Countries (2015)

% RE in Generation	# of Countries	% Share of Countries
0% - 20%	61	46%
21% - 40%	19	14%
41% - 60%	22	16%
61% - 80%	11	8%
81% - 100%	22	16%

% share of VRE	# of Countries	% Share of Countries
0% - 5%	126	93%
6% - 10%	6	4%
11% - 15%	1	1%
16% - 35%	2	2%

Source: based on IEA data

Greater power system flexibility is required to integrate increasing shares of RE, especially variable renewable energy (VRE) such as wind power and solar PV. The reliability and efficiency of VRE technologies cannot be predictably dispatched in a power system because they depend on the availability of wind and sunlight. Therefore, the flexibility needed in power systems to integrate VRE presents technical, economic and regulatory challenges to overcome.

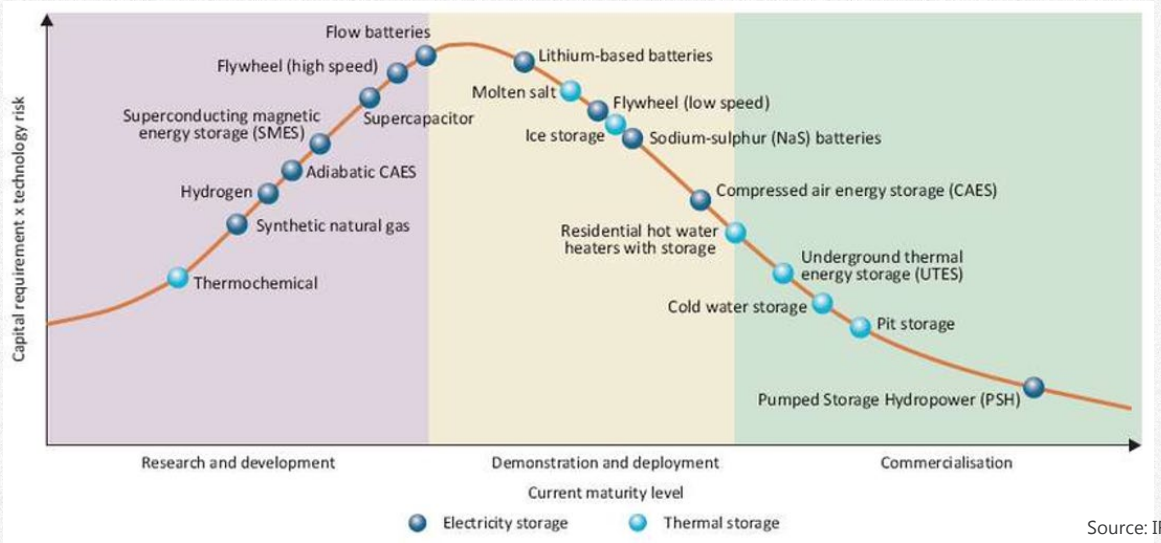
Most developing countries have yet to face acute integration challenges, because few have significant shares of VRE in their power systems. (The few exceptions are mainly in Phases 1 or 2 of integration as per IEA.)

To more smoothly integrate increasing shares of VRE into power systems, it will be necessary to undertake various actions depending on the 'phase' in question. The actions can include **robust systems planning** (based on improved forecasting)**, priority dispatch requirements** (ensuring system integrity), **extending or rehabilitating energy infrastructure** to access RE resource sites and evacuate power, and **facilitating power trade and pooling**. These options will also add to the costs of operating power systems and the financing required for developing RE.

Emerging Opportunities: *for Scaling-Up & Integrating RE in Power Systems*

Energy storage and distributed generation from RE are emerging as options for integrating VRE by enabling control over electricity dispatch from generation sources to provide greater system flexibility. Yet many solutions are not mature enough to be commercially deployable or economically viable in many markets.

Limited Commercially Viable Options for Storage in 2017



Source: IRENA

Energy storage is a key option for increasing system flexibility to integrate VRE. This is typically accomplished by storing the fuel to be used when needed through a dispatchable technology. Outside of fossil-based generation technologies, **hydropower** with reservoirs for storage (including pumped storage) is the only RE option that can presently produce commercially viable balancing power to integrate VRE. It does so by providing balancing power that can offset the impact of increasing shares of variable in power systems. It made up 96 percent (169 GW) of all installed storage capacity (not counting conventional hydro) by 2017, (IRENA). It will play an important function in the *Clean Energy Transition*.

Direct storage of electricity (rather than the fuel) for dispatch when needed is fast emerging as a potential solution for integrating VRE. While most technologies were not commercially viable at utility scale during the evaluation period, **thermal storage** and **battery storage** are rapidly advancing and costs decreasing. Battery storage capacity is expected to double or triple by 2030 (IRENA), provided the decreasing cost of storage and expansion of VRE create the market conditions for such a scale-up. The Bank recently established a community of practice for energy storage and launched a US$5 billion initiative to "finance 17.5 GWh of battery storage by 2025", more than tripling installed capacity in client countries.

Distributed generation (DG) refers in this report to electricity produced from RE sources at the consumer level and fed directly into the distribution network.

DG is gaining traction in the global RE scale-up. Its benefits include modular flexibility and improved energy efficiency and reliability. Given that RE DG is primarily solar PV and wind power, it can help integrate VRE by bypassing transmission bottlenecks (because it feeds directly to the distribution grid). However, as the share of RE DG increases, it can create its own VRE integration challenges. While DG is still nascent in most developing countries, China and India have recently set ambitious targets for DG expansion.

WBG RE Experience

WBG RE Investments Over Time

WBG RE Investments by Technology

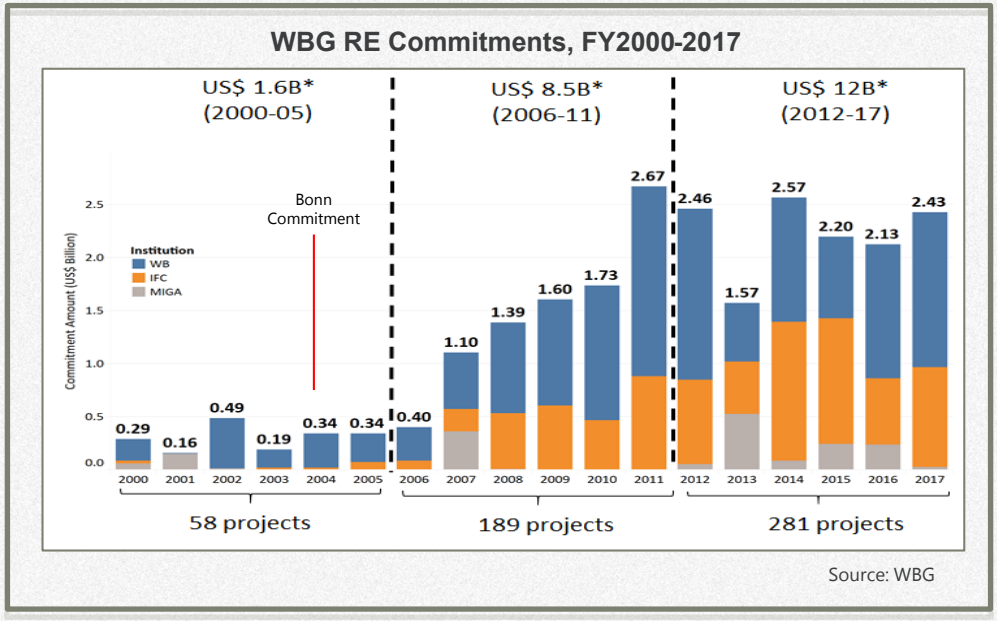
RE & CC in WBG Strategies

Geographical Coverage of WBG RE Investments

WBG Prioritized RE and Scaled-Up Investments

The WBG progressively mainstreamed its commitment to support RE in corporate strategies as a major solution to meeting energy needs while addressing the growing threat of climate change.

The WBG followed with a substantial scale-up of RE investments, in-step with global trends, following the landmark 'Bonn commitment' in 2004.



The WBG's RE investment portfolio scaled-up from 2000 to 2017 for total commitments of $22 billion, reflecting its strategic priority at the corporate level*. However, even the new scale represents a modest 1.5–2.5% of total global investments in RE on average.

A review by IEG found that the WBG's **corporate-level strategies** shifted over the evaluation period so that RE became more prominent. Initially, RE was primarily a means to contribute to poverty alleviation by increasing access to electricity, followed by greater concern for environmental sustainability. In the latter part of the evaluation period, influenced by global climate action, successive corporate strategies mainstreamed climate change as a major corporate priority and RE as a key mitigation solution.

The WBG's **investment portfolio** responded reflecting global trends and its evolving corporate strategy. There was a substantial uptick in support to RE by the WBG following a major commitment made at the International Renewable Energy conference in Bonn, Germany in 2004. The WBG surpassed its commitment to increase RE lending by 20% annually from 2005 to 2010, through public and private means.

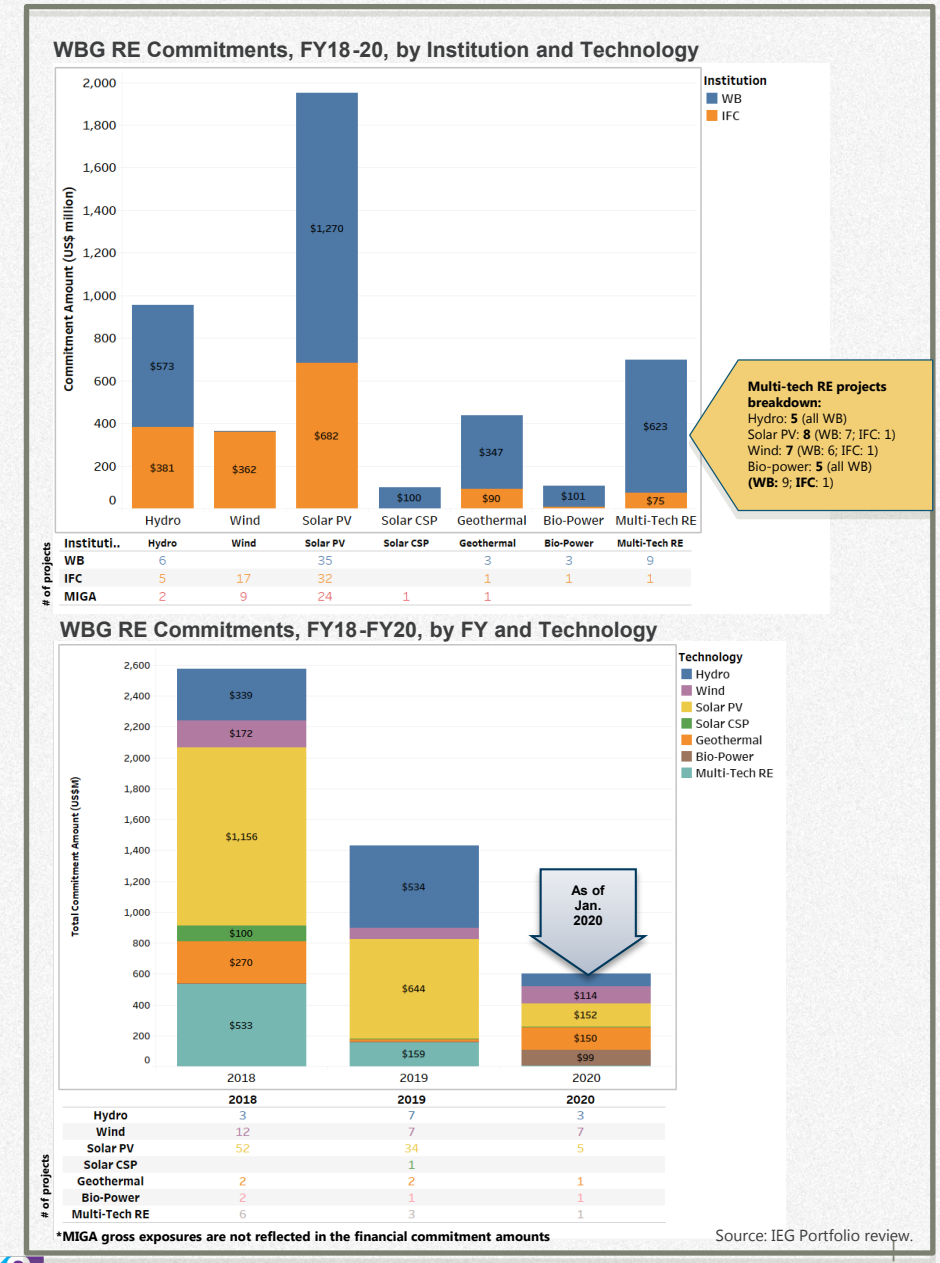
IEG found that the primary motivations for supporting RE in the WBG's portfolio were: to increase the supply of electricity (63% of projects) and to avoid GHG emissions to mitigate climate change (58% of projects). Of projects with electricity supply goals, 64% also targeted the avoidance of GHGs, emphasizing the interdependence of the two goals in developing clean energy. A 19% share of RE projects included increasing access to electricity as an objective.**

* The evaluated portfolio included financing projects that were closed or evaluated between 2000 and 2017. The portfolio includes a few projects that were approved prior to 2000, but were evaluated after 2000. Most projects approved after 2014 were still under implementation at the time of the evaluation and therefor their performance could not be ascertained through the portfolio review. **Given the highly dynamic nature of the RE market, the current state of the WBG RE work has evolved rapidly since this evaluation was conducted.**

** IEG did an evaluation on electricity access in 2016.

RE Portfolio Since FY18-20: Scale-Up in Solar PV, Hydro Remains a Mainstay, Less Multi-Tech

The total RE portfolio during FY18, FY19 and until Jan FY20 is over $4.5 billion through 150 investment projects. **Solar PV** continued to surge in terms of number of projects (n=91) and total commitment (US$2 billion) + 24 guarantees (up to US$424 million in gross issuance) across all WBG institutions since FY17. **Hydropower** remained a mainstay with a commitment of nearly $1 billion supported by the WB, IFC and MIGA. The portfolio share of **multi-tech RE** projects was considerably lower than in the evaluation period, with investments of about $700 million mainly by the WB. IFC and MIGA have continued to support **wind power,** while the lion's share of **geothermal** investments were supported by the WB. Other RE technologies such as **bio-power** and **solar CSP** have considerably fewer activities since FY17. MIGA appears to be diversifying its portfolio away from hydropower into more guarantees for wind and solar PV.



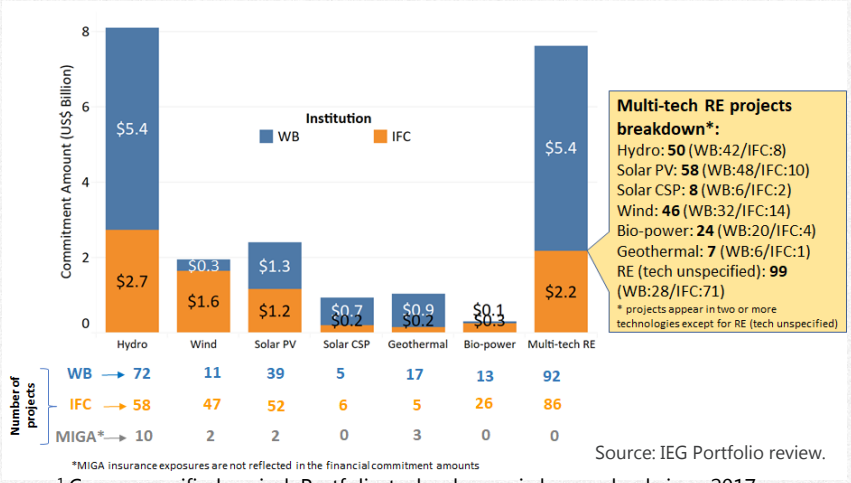
Source: IEG Portfolio review.

WBG Investments Covered All Major RE Technologies

Hydropower: the WBG's single-tech hydropower portfolio accounts for more than a quarter of RE projects (140/546) and 36% of the lending volume ($8.1 billion/ $22.4 billion). Single-tech hydropower projects account for 40% of overall WB and IFC RE commitments and 70% of the value of MIGA guarantees. The sizeable WB hydropower portfolio reflects historical commitment to the technology but also a reengagement following guidance from the World Commission on Dams (WCD) in 2000, which addressed the environmental and social concerns that had led to a slow-down in hydropower investments.

However, there was a marked shift in the type and size of hydropower projects supported by the WBG. There was a decreasing numbers of large-scale projects with storage (which can enhance system flexibility), particularly those involving the private sector (two-thirds of IFC and MIGA hydropower projects were for non-storage, run-of-the-river projects); just over half of WB hydropower projects included storage, but of a smaller scale compared to the larger dams with reservoirs supported pre-2000. The increase in run-of-the-river projects reflect IFC strategy to provide clients with least-cost energy solutions.

WBG RE Commitments, FY 2000-2017, by institution and technology[1]



Source: IEG Portfolio review.

[1] Covers specified period. Portfolio technology mix has evolved since 2017.

Wind Power and Solar PV: the installed capacities of these two VRE technologies experienced the fastest growth globally over the evaluation period, due to significant decreases in technology costs (the result of technological innovation, production efficiencies, increased competition and economies of scale). Most of the WBG's commitments for wind power (94% of $2 billion) and solar PV (80% of $2.4 billion) were made after the global market expansion had begun, in around 2008 and 2011, respectively. The IFC contributed to opening RE markets in several client countries, including Chile, India and Zambia, among others.

Multi-Tech Projects: mostly included a combination of hydropower, wind and solar PV, with projects (DPFs or Financial Intermediaries – FIs) designed to include two or more specific RE technologies, or technologies that focus on RE in general. There were two types: those where funds were directly allocated to developing multiple technologies, and others, mostly DPFs or through financial intermediaries, supporting RE in general without specifying the technology. Multi-tech projects represented 33% of the projects (178/546) and 34% ($7.6 billion) of the commitments.

Other RE technologies:. WBG projects also supported **geothermal**, **concentrated solar power (CSP),** and **bio-power**.

Off-grid solutions to energy access

Given the declining cost of some key RE technologies, and the Bank Group's performance and strong focus in Africa, off-grid solutions provide the opportunity to serve those who are unlikely to be served in the near-term through electricity grid extension. Off-Grid Distributed Generation (DG) can be the least-cost option for providing access to some of the one billion people who presently do not have the benefit of electricity.

Solar PV, wind and other RE technologies at times played a key role in helping expand off-grid access to electricity through multi-technology projects. Micro hydropower projects can supply electricity for an isolated industry, or small remote community. Mini or micro schemes are sometimes part of a suite in multi-tech projects.

There are scale up opportunities for countries in most need of electricity access	
The WBG Portfolio	• RE based projects contributed significantly to access efforts, but the extent of WBG coverage in the neediest countries was limited. • One fifth of the Bank Group RE portfolio (105 projects) aims to increase access, with 74 projects utilizing off-grid or combined off-grid/on-grid solutions. • Over half of the off-grid access projects are in lower-middle income countries and 34 percent of projects are in low income countries where the access challenge is most acute. • In the top 20 least-electrified countries, only 14 of 74 off-grid RE projects were implemented over a 17 year period. • Example: In Nicaragua, the Off-Grid Rural Electrification for Development project utilized GEF grants to lower the cost of solar home systems through private dealers and, by reducing the cost of financing, it incentivized microfinance institutions to serve the poor living in rural and remote areas. • IFC and the World Bank's Lighting Africa program, and its successor, the Lighting Global program, pioneered targeted technical assistance for improving quality assurance and service delivery.
Portfolio Effectiveness	• The thirty-two validated off-grid access projects achieved their targets and performed better than the overall RE portfolio. • Key performance indicators (KPIs) found that just under three quarters of the projects either met or exceeded their access target. • Results indicate the Bank Group's support to addressing key barriers include capacity strengthening (70 percent of projects), finance mobilization (60 percent) and policy and regulatory reforms (nearly 45 percent).
Gaps / opportunities	• Gender considerations are not consistently incorporated in RE access projects. • There is an opportunity to accelerate access through off-grid solutions to those who are unlikely to be served in the near-term through electricity grid extension.

https://www.flickr.com/photos/worldbank/6286557816/in/album-72157624611744452/

WBG Reconciled Global Climate Goals with Local Energy Needs

Over time, RE became mainstreamed in WBG's corporate strategies, country-level strategies and investment programs..

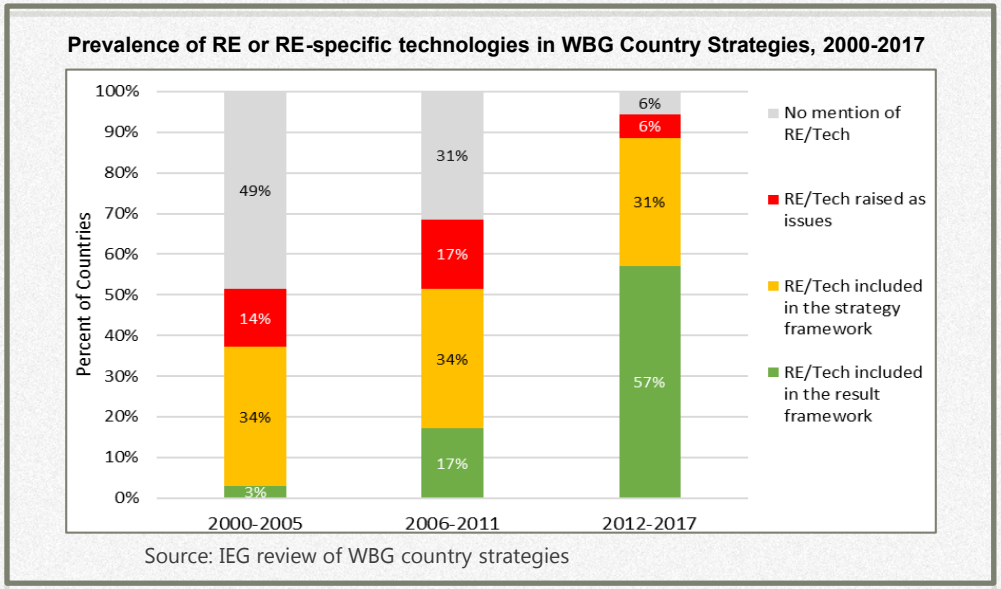
However, the primary driver for country-level investments in RE was to meet local energy needs rather than global climate goals.

WBG Country-Level Strategies

94% **Included RE**

25% **Included CC**

IEG reviewed 123 Country Assistance Strategies and Country Partnership Frameworks for 35 selected countries during the evaluation period (2000-2017). The selection was based on a random stratified sampling of all WBG client countries.



Source: IEG review of WBG country strategies

IEG reviewed WBG strategies at the corporate and country levels to assess whether RE and climate change were prioritized. As previously noted, the WBG mainstreamed both objectives in its corporate priorities. The analysis also found that RE progressively became mainstreamed at the country level, being included in 94% of the strategies (which determine WBG investment programs) to help clients meet their energy needs (for energy supply in most middle income countries and for access in lower income ones). In contrast, climate change progressively increased to become a priority in only 25% of the country-level strategies. Given that the actual investment levels for RE did increase, it can be concluded that the WBG contributed to reconciling global environment priorities with country development needs.

The WBG helped 'internalize' at the local level global 'externalities'. This will continue to be important as RE faces new challenges and costs to enhance power system flexibility to smoothly integrate greater shares of RE, as noted by IEG's Global Expert Panel on RE.

Developing Country Coverage is Wide, but Gaps Remain

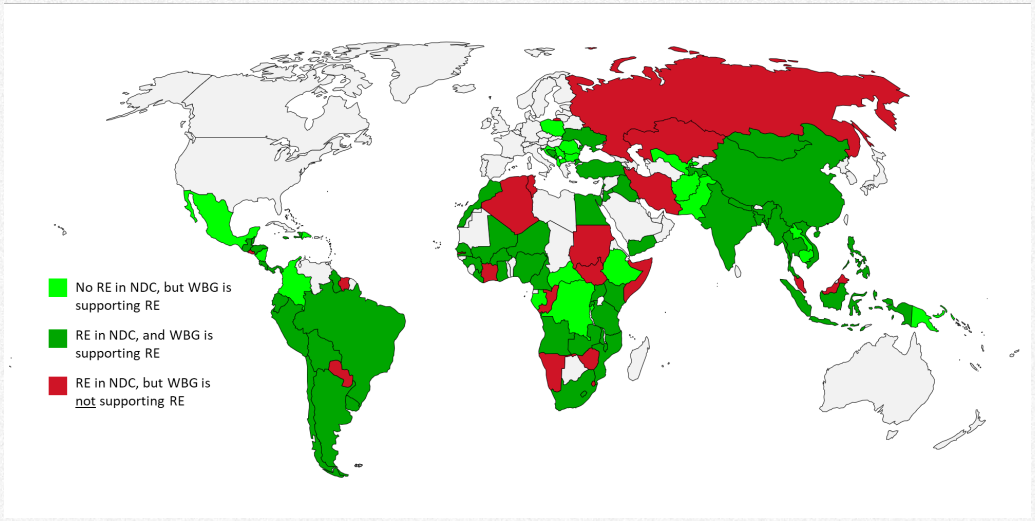
The WBG supported RE in all developing regions in the world, covering 98 countries over the evaluation period, representing 70% of those with Nationally Determined Contributions (NDCs).

However, this falls short of the WBG's commitment to "translate" the remaining countries NDCs into "climate action."

31

Countries that have NDCs with RE targets where the WBG is not yet active

WBG Support for RE in Countries with and without RE in NDCs



Source: NDC Database (2018), Institute for Global Environmental Strategies (IGES); IEG Portfolio Review (2000-17)

The WBG supported RE investments in a wide range of developing countries, including 70% of those targeting the sector in nationally determined contributions (NDCs). Coverage include 2/3 of the top 30 CO_2 emitting countries, and 17 of the 30 countries where GHG emissions growth is the fastest. The WBG also helped develop RE in 31 countries that did not have a specific RE target in their NDCs. The WBG had two or more RE-related activities in 20 of the top 30 countries with the highest CO_2 emissions. It should be noted that six of the 10 countries that had negligible or no RE-related activities were not active in borrowing from the WBG during the evaluation period.

The WBG is not active in the RE space in 31 countries that do have RE targets in their NDCs. The WBG committed to "expand its support, *on demand*, to more countries." Countries may not have asked for WBG support as they may have other (more pressing) energy priorities (e.g., African countries), or due to macro and debt exposure reasons.

"The WBG will support countries to translate their NDCs into climate actions"
WBG Climate Change Action Plan 2016-20

WBG RE Performance

Performance of Public Sector Support to RE

Performance of Private Sector Support to RE

Performance by RE Technology

Pathways to Addressing Key Barriers to RE Development

Mobilizing Additional Finance and Leveraging Partnerships

Knowledge Sharing

Coordination Effectiveness

Performance of Public Sector RE is Consistent with that of the Overall Energy Sector, but with some Risks to Outcomes

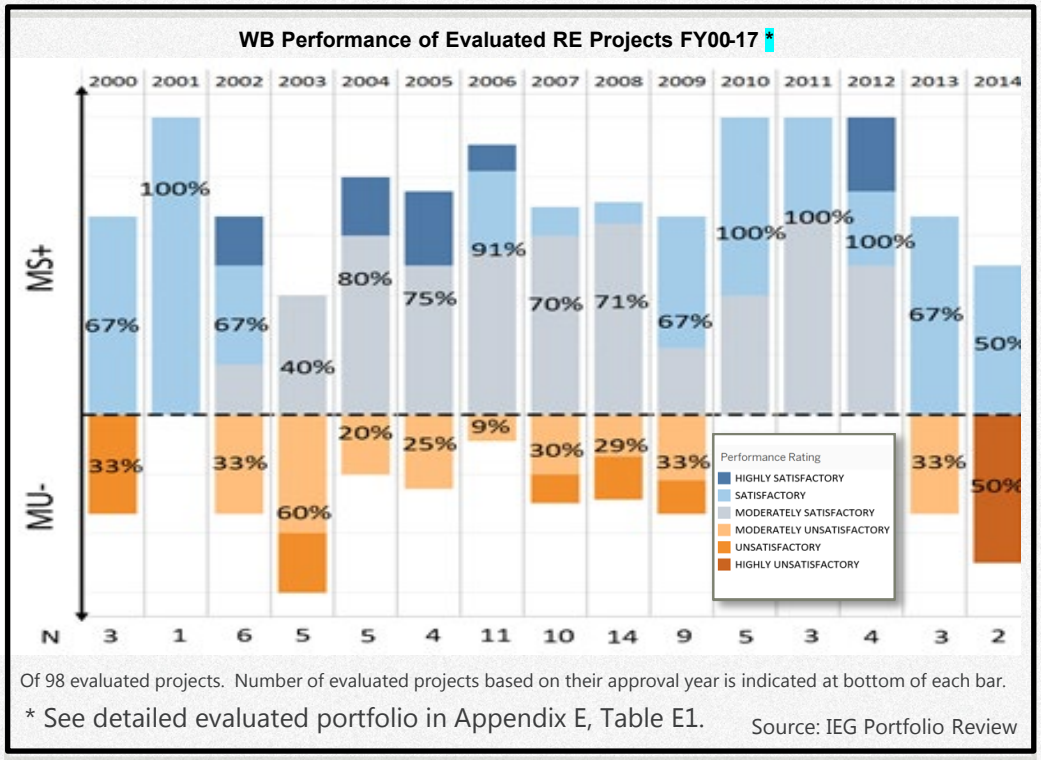
The consistency with the overall energy sector was achieved despite many RE projects operating in nascent and evolving markets.

Unaddressed barriers are the primary reason for a quarter of the successful projects being at risk to achieving their objectives.

WB performance rating of 98 RE evaluated projects:

71%

Moderately Satisfactory or better



Of 98 evaluated projects. Number of evaluated projects based on their approval year is indicated at bottom of each bar.

* See detailed evaluated portfolio in Appendix E, Table E1.

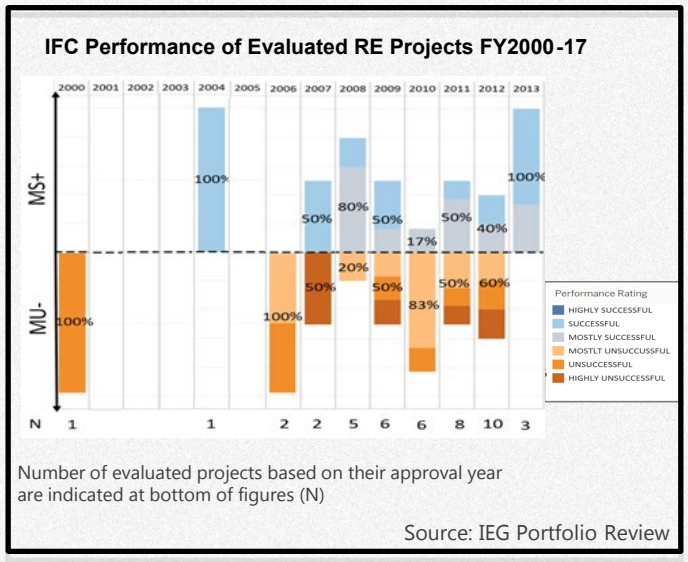
Source: IEG Portfolio Review

World Bank: 71% of the 98 evaluated WB RE projects had an outcome rating of "moderately satisfactory" or better (MS+). This is consistent with the performance of WB energy sector projects overall (73% rated MS+), notwithstanding that many of the RE projects required countering nascent sectors and evolving markets.

However, a quarter of the well-performing RE projects had "significant" or "high" ratings for their risk to achieving development outcomes.

These risk ratings stemmed from a range of unresolved barriers to RE development, such as the weak financial condition of utilities, adverse changes in policy, low tariffs, inadequate implementing agency capacity, and limited domestic financing options.

Private Sector Investments Faced Barriers that Affected Performance



Number of evaluated projects based on their approval year are indicated at bottom of figures (N)

Source: IEG Portfolio Review

IFC performance rating of 47 RE evaluated projects:

51%

Mostly successful or better

While IFC scaled-up its financing for RE investments, it had less success in achieving development outcomes in-line with its own objectives. Limited availability of sector expertise and poor risk assessment likely contributed to uninformed investment decisions. MIGA directly addressed specific risks and achieved successful outcomes in most investments.

IFC: 51% of the 47 evaluated IFC RE investments were rated "mostly successful" or better (MS+). After the evaluation period, IFC discarded its target corporate success rate of 65% in favor of the target "improving trend".

Unresolved barriers were key contributors to IFC's poorer performance. Barriers included under use of credit facilities lacking 'bankable' investments; environmental and social issues; insufficient RE data for resource risks for robust assessments; poor financial viability of off-takers; low contractor capability contributing to high cost overruns (especially in hydropower); and unfavourable regulatory environments for private participation, including unclarity of procurement rules and of the award process.

IFC's performance varied significantly between industry groups. The Electric Power sub-group (of the Infrastructure Industry Group) that undertook the bulk of the investments (60%) had a MS+ rating of 59%. The remaining investments (40%) dispersed across several industry (sub) groups had a combined rating of MS+ for 40% of the projects. This lower rating likely reflects the limited availability of sector expertise in groups where financing RE is not a mainstay*.

An overall work quality study of IFC found a shortage of industry specialists limiting access to requisite expertise that would be essential in a technical sector such as RE. It also found investment officers were unable to keep up with market developments, which could well be the case in a sector such as RE that has rapidly evolved. Poor risk assessments were also cited, which, combined with insufficient sector expertise to identify barriers in advance in a dynamic market, can lead to uninformed project design and due diligence. The evaluation found that 70% of IFC investments with low-quality screening, appraisal, and structuring (SAS) had poor development outcomes, while over 85% with high quality SAS achieved MS+ ratings.

MIGA: Six of the seven evaluated MIGA projects were rated 'Satisfactory,' as its political risk insurance directly addressed a specific barrier to private investments.

* For a more detailed description of performance by industry and technology, see Appendix E, Figure E.14 (and related text).

RE by Tech: Hydro Provided Sizable Benefits when Developed to Standards

57

Hydropower projects financed from 1976 to 2015

25 GW

of hydropower capacity

$498 billion

Net economic benefits from avoided costs

$335 billion

Net global environmental benefits from avoided CO2

The best performing single-tech RE projects evaluated were hydropower with 71% rated Moderately Satisfactory or better (MS+).

The investments are delivering sizable net economic and climate benefits by displacing fossil fuels.

The WBG portfolio is shifting towards support for hydropower without storage, especially through private participation, possibly due to complexity and environmental and social requirements.

Overall, 90% of the evaluated WBG hydropower projects from 2000 to 2017 (24 of 26) complied with the WBG's environmental and social policies

Hydropower: 71% of the 40 single-tech hydropower projects evaluated 2000-17 were rated MS+. The success rate was 61% for hydropower projects without storage and 77% for those with storage, even though the latter are typically more complex to develop and can have greater environmental and social challenges. Both WB (70% MS+) and IFC (68% MS+) had relatively successful outcomes supporting hydropower, as did MIGA (all 3 evaluated project were MS+).

An additional analysis of 57 investments totalling 25 GW of capacity dating back to 1976 found sizable net economic benefits ($498 billion) despite average cost overruns of 25% and time overruns of 14 months. The same portfolio of projects was estimated to avoid over one billion tons of CO2 valued at $335 billion due to the displacement of fossil fuel based power generation.

The more recent portfolio of 26 hydropower projects evaluated from 2000-17 was evaluated against the WCD recommendations that called for a more comprehensive approach to hydropower development that went beyond energy sector needs to include planning, environmental and social considerations, leveraging financing, and promoting regional development. It revealed a correlation between projects that successfully incorporated key WCD recommendations being more likely to achieve development outcomes.

Over 90% of the WBG's evaluated hydropower investments complied with the applicable environmental and social safeguards and performance standards. A desk review of 26 evaluated hydropower projects found two cases where compliance was rated less than satisfactory.

RE by Technology: Wind, Solar PV & Multi-Tech had Mixed Performance

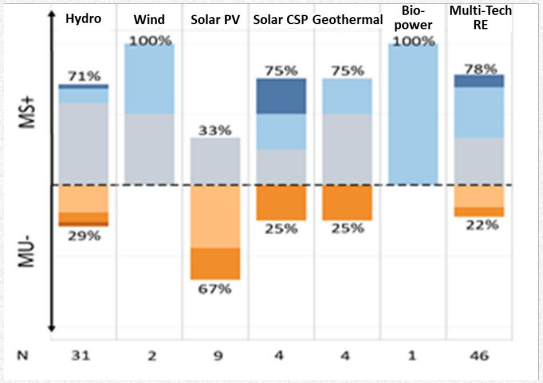
Wind power and solar PV projects performed unevenly.

Other niche single-tech RE projects (geothermal, CSP, bio-power) were mainly successful.

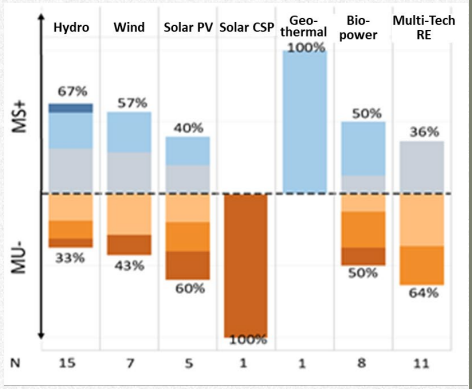
Multi-tech project performance was uneven between public and private interventions.

WBG Evaluated RE Project Performance, 2000-2017, by Technology

WB RE Project Performance



IFC RE Project Performance



MIGA performance (7 projects): hydro (2 MS+), wind (2 MS+), geothermal (2 MS+, 1 MU-).

Wind power: WBG support to wind power was primarily with private participation through IFC and MIGA, with some impactful public sector exceptions.

IEG evaluated two WB and two MIGA-guaranteed single-tech wind power projects. All were rated satisfactory. However, four of the seven evaluated IFC wind power investments were rated MU-. Issues underlying the less successful projects included environmental and social issues; lower than expected plant factors; insufficient expansion of connections; and unpredicted regulatory changes made by government.

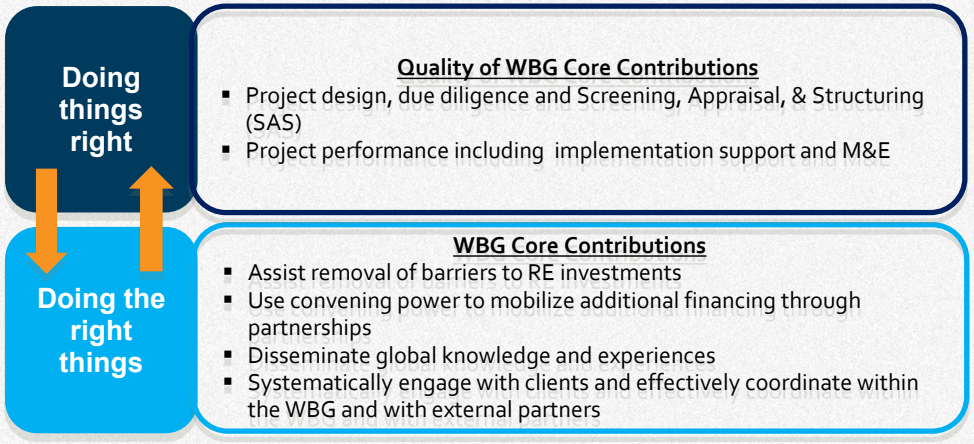
Solar PV: Only five of the 14 evaluated single-tech solar PV projects, were rated MS+ (36), with the majority of the less successful projects funded by the WB.

WB underperformance was due to a range of issues, including slow implementation; government subsidization of alternate energy sources such as kerosene or diesel, the inability of private dealers to borrow from domestic banks; and affordability constraints on consumers. For IFC, challenges included sponsors lacking market competitiveness; and inadequate monitoring indicators for measuring development impacts.

Multi-Tech: Of the 57 evaluated projects, 78% of the 46 funded by the WB and 36% of the 11 IFC investments were rated MS+. In the evaluated portfolio, 81% of projects with electricity supply objectives were rated MS+ while only 61% that set targets to avoid CO_2 achieved similar outcomes. Multi-tech RE projects were successful when they were well designed, barriers were addressed, and their purpose was clear. However, they can be , challenging to manage and perform poorly if a robust pipeline of investments is not clearly identified. They may be better suited for meeting energy needs than achieving climate objectives.

What worked? Performance Analysis Overview

The WBG's performance is based on the success with which it delivers on its core contributions that reflect the institution's global comparative advantages.



As outlined in the Approach section of this report, the various and competing complexities of RE development render the appraisal and extraction of lessons from the WBG's performance challenging, particularly in view of the dynamic global expansion of the sector seen over the evaluation period (2000-2017), and in anticipation of the much greater scale-up to come.

While the WBG's financial commitments in RE are globally modest, its far reaching influence working with the public and private sectors has led to it being recognized as the single largest contributor to the RE sector in developing countries.* This, combined with the complementary capabilities of its three institutions (WB, IFC, MIGA), uniquely positions the WBG to add value to clients.

To identify the impact of the WBG's support to RE, the evaluation explored what worked, particularly in increasing RE-generated electricity supply and in realizing associated global climate benefits. First, the evaluation explores how well the support provided by the WBG delivered results. It then assesses the underlying factors that determined the results with a view to evaluating the WBG's 'readiness' to help clients address emerging challenges and seize future opportunities.

1. **The *quality* of the WBG's contributions** – as reflected by the WBG's project design, due diligence including SAS, the performance of RE investment projects in achieving its objectives including the support provided during implementation and the monitoring and evaluation (M&E). **["doing things right"]**

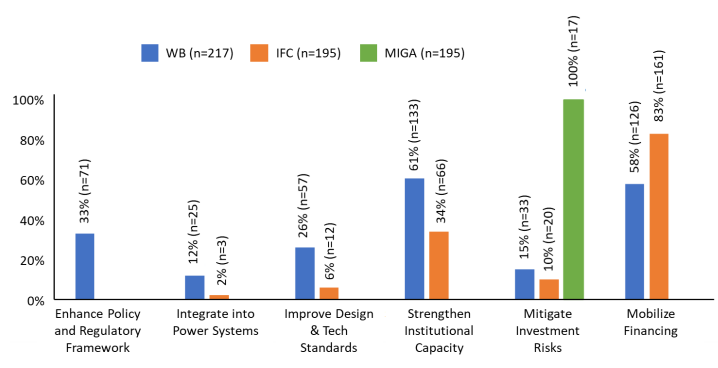
2. **The WBG's '*core contributions*'** – supporting the removal of barriers to RE development, convening partnerships and mobilizing additional finance, dissemination of global knowledge and experiences, and systematic engagement with clients and partners to effectively coordinate with them. **["doing the right things"]**

* Bloomberg NEF's *Climate Scope Emerging Markets Outlook 2018* highlight's the WBG's prominence as a major longstanding "foreign investor" and political risk insurance issuer (through MIGA) for RE development in emerging economies, with the widest overall global reach.

WBG is Addressing All Key Barriers to RE Development to Varying Degrees

The key barriers identified in the ToC were validated through a QCA confirming its causal link to mobilizing investments in RE.

The three WBG institutions address different barriers to varying degrees based on their comparative advantages.



Major Barriers to RE Development

Inadequate Policies & Regulations	Policy & regulatory environment established by governments and the opportunities/incentives created are a major factor that can facilitate or hinder public and private investments in RE.
Inability to Integrate RE to Power System	Increasing share of VRE requires flexible power systems to smoothly and efficiently integrate RE into grid (via systems planning, strengthening transmission networks, and developing storage and dispatchable capacity, power trading, and pooling).
Insufficient Design & Technical Standards	To construct high-quality RE infrastructure, the designs and developments should meet industry and international standards.
Inadequate Institutional Capacity	In many developing countries, various institutions involved in the development of RE do not have the capability to undertake new investments or operate ongoing projects.
Significant Investment Risks	Even with improved policies and institutional capabilities, there may be residual risks, either on a transitional basis or permanently that are outside the control of developers, and which may discourage investments (i.e., commercial/off-taker risks, political risks, RE resource risks).
Constraints on Mobilizing Financing	In addition to above barriers, the typically high up-front investments make it more challenging to mobilize financing for RE. This can occur when RE is new to certain markets, at a scale that exceeds capacity of domestic capital markets, or in small markets where financial institutions are not well developed.

Source: IEG

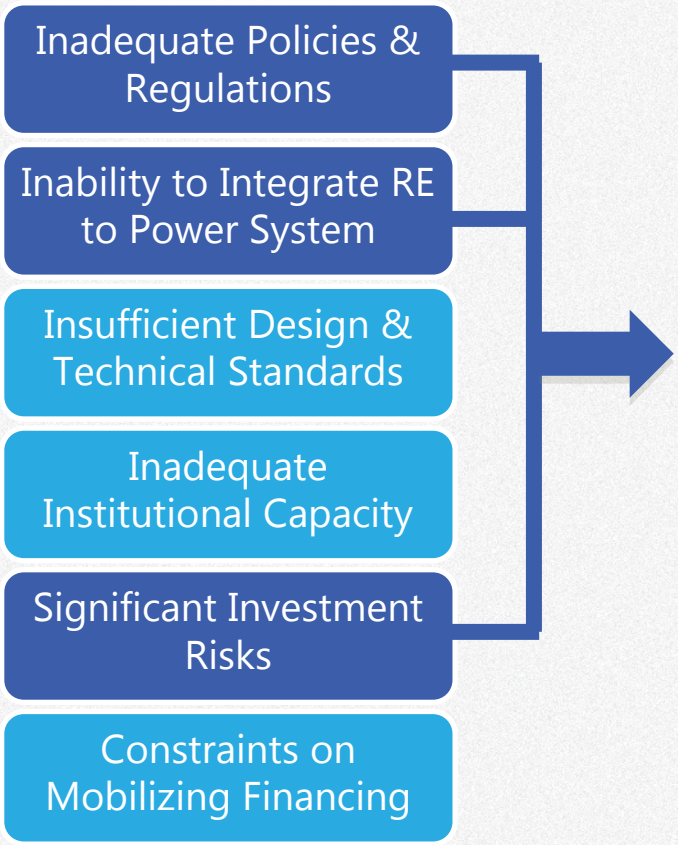
IEG verified the ToC by confirming a causal link between each of the six barriers identified and energy and environment outcomes. The evaluation carried out a QCA using empirical evidence from nine country case studies underpinned by theory to validate the ToC. The causal relationship was reinforced by project portfolio evidence, a structured literature review, and the views of IEG's Global Expert Panel on RE.

The WBG has made efforts to address all six of these barriers, to varying extents based on the comparative advantages and mandates of the WB, IFC, and MIGA. Nearly 80% of the WBG's RE investment portfolio addressed one or more of the barriers.

The WB covered all six barriers within its RE portfolio (and was the only institution to address policy, and most of integration). The IFC's mobilized private sector finance, enhanced sponsor capacity and reduced risks, supported improvement of design and technical standards and institutional capacity. MIGA mitigated political risks, catalyzing investments. All three institutions involved development partners to disseminate knowledge, address key RE barriers, and mobilize financing.

The analysis revealed that projects addressing three or more barriers were significantly more successful (81% MS+) compared with those that addressed two or fewer (67% MS+). This does not imply that projects should maximize the barriers addressed. It rather emphasizes that, when significant barriers do exist, it is essential they are clearly identified and addressed to scale-up RE.

Addressing *Policies, Integration,* and *Risks* Provide a Pathway to Scaling-Up RE



Enhancing the policy and regulatory framework and facilitating the integration of RE into power systems are essential elements for any successful scale-up of RE.

Residual shortcomings could be addressed through the mitigation of investment risks especially when mobilizing private participation.

While the QCA confirmed a causal link and validated the ToC, it also found specific pathways to scaling-up RE.

The QCA identified adequate ***policies and regulations*** and the ***integration of RE into power systems*** to be necessary pre-conditions for improving the investment climate under any successful development scenario. All countries that successfully developed RE improved their regulatory frameworks and took action to facilitate greater integration of RE.

Where the *policy* environment is improved and *integration* issues mostly addressed, measures are needed to ***mitigate investment risks*** to expand RE.

Taken together, addressing these three barriers presents an important pathway to scaling-up RE, especially through private sector participation.

These findings were further validated by *IEG's Global Panel of Experts on RE*. The Panel concluded that "unstable and untenable policy and regulatory" frameworks and "difficulty integrating RE (especially VRE)" were two of the top three challenges facing the development of RE. Two-thirds of the Panel identified mitigating investment risks as 'highly important'.

A 2019 report by the IEA also highlighted the exact same pathway to "accelerate" RE growth "to meet long-term sustainable energy goals" as per the *Clean Energy Transition*. The IEA prescribed governments to address "policy and regulatory uncertainty; high investment risks in many developing economies; and system *integration of wind and solar PV* [VRE] in some countries."

While many countries that were successful in developing RE also addressed the other three barriers, the analysis implies that these can be augmented with external support to some extent even if domestic capabilities are limited.

Global Experience Removing Policy and Regulatory Barriers

The enabling policy and regulatory environment and the opportunities and incentives it creates are key factors in facilitating or hindering investments in RE.

1/3

of WB RE projects have activities to address policy barriers

The WB was the primary WBG institution that helped clients improve their policy and regulatory frameworks in 39 countries.

A third of the WB investments in RE portfolio included activities to improve the policies and regulations.

RE policies will need to continue to evolve with changing markets such as assigning development or concession rights to RE through auctions.

They were complemented with analytical work of major platforms such as ESMAP.

Barrier to RE Development: Inadequate Policy & Regulatory Frameworks	
Typical activities to address barrier	• Issue laws and regulations. • Implement pricing reforms and policy-based incentives. • Assign development rights for RE.
Scope of WBG interventions	The WB helped prepare laws or regulations to improve the investment climate through 71 projects covering 39 countries. The WB helped establish feed-in tariffs (FITs) or minimum renewable portfolio standards (RPS) through 31 projects in 23 countries to create incentives for scaling-up RE.
Examples of what worked	• **Kenya** credited the WB explicitly for its support in preparing the country's revised FiT regulations. • WB support for wind power legislation in **Jordan** was timely in developing RE to offset fossil fuel import shocks. • A DPF in **Turkey** helped adjust FiT for RE technologies by amending the law, which led to an expansion of RE. • IFC and WB support in **Zambia** for its Scaling Solar initiative helped structure deals and competitively tender RE development rights. • In **Jordan**, IFC deployed its structuring expertise, syndication platform, legal advice, and specialist advisers to establish uniform financing terms and common project documents, laying the groundwork for financing the Seven Sisters Solar Project (2014)
Gaps / opportunities	While **China** found success with its FiT policy helping scale-up RE, an inadequate phase-out strategy resulted in untenable surcharges; the WB is supporting a shift to more competitive tenders for future RE developments in China, which may inform efforts in other countries. Assigning development or concession rights for RE through auctions offering financially structured deals is an area where the WB has more limited project-level experience and needs to build expertise, according to interviews with WBG staff. Nonetheless, in Morocco (CSP), Egypt (wind), Mexico (hybrid solar-thermal), and (advisory support) in Zambia (Scaling Solar initiative), the Bank Group helped with structuring deals and competitively tendering the rights to develop RE.

Experience Integrating RE into Power Systems

Increasing shares of RE, particularly VRE, requires flexible power systems to integrate RE to the grid

Less than

7%

of WB RE 2000-2017 projects focus on integration of RE

Only a small portion of the RE portfolio in the evaluation period has included activities for integrating RE into power systems. These limited interventions were mostly undertaken by the WB, given the broader sectoral role it plays and have been increasing over time.

According to IEG's Global Expert Panel on RE, integration is expected to be one of the top challenges as VRE penetration increases in developing countries in the future.

The WBG will need to gear up by developing its capacity and experience (i.e., integrated planning, power storage, and RE DG).

Barrier to RE Development: Inadequacy of Energy Systems to Integrate RE	
Typical activities to address barrier	• Robust power system planning to integrate RE. • Issue adequate grid codes and standards for grid-friendly equipment. • Strengthen and expand transmission infrastructure. • Reduce system congestions with distributed generation (DG).
Scope of WBG interventions	Only 28 of 429 WBG-supported RE projects explicitly aimed at addressing this barrier, reflecting the limited experience within the institution in addressing this critical barrier over the evaluation period. 25 of the projects that addressed system integration were funded by the WB, primarily focusing on extending transmission lines to locations with RE resources (8 projects), integrated systems planning (6 projects), and establishing standards for RE equipment (6 projects). More recently, support to on-grid DG (9 projects by WB and 3 by IFC). In recent years, the WB has supported client planning models, forecasting protocols and Renewable Energy Integration Assessments. Also, ESMAP introduced a window to provide TA to projects on VRE integration, and a RE Resource Mapping window to map countries' RE resource potential. Other TF resources have also been used to support integration.
Examples of what worked	• The WB provided system planning support to **Egypt** as part of wider support to develop wind power in the country. • 7 (of 13) on-grid DG projects aim to help ease integration of RE in multiple countries as it can overcome transmission bottlenecks.
Gaps / opportunities	Ambitious wind power expansion without the requisite system flexibility (inadequate planning and insufficient transmission access) has resulted in curtailment in **China** and **Nicaragua**. The WB is helping both countries address this issue, and lessons from experience should help guide similar challenges in other countries. In anticipation of the growing significance of this barrier, there is a **global** effort underway by the Energy Sector Management Assistance Program (ESMAP) to provide more analytical support in this area.

A Suite of Options for Mitigating Risks to Mobilizing Investments

RE development is complex and capital intensive. It presents risks, which may deter investors, either on a transitional basis while sector reforms are underway or risks that are outside of developers' control.

66%

of countries where RE risks mitigated are low or lower middle income

When most policies are in place and integration issues are mostly addressed, then mitigating residual risks can be important to mobilizing investments in RE.

RE resource risks were primarily addressed by WB through the public sector because they typically exceed private sector risk tolerance.

The WB and IFC helped address commercial and market risks while MIGA insured against political risks faced by RE investments.

Barrier to RE Development: RE-specific investment risks	
Typical activities to address barrier	• Undertake RE resource assessments. • Mitigate commercial and market risks. • Address country political risks.
Scope of WBG interventions	RE resource risks were primarily addressed by the WB with early capital (through 13 projects + ESMAP support for mapping RE resources); commonly undertaken by public sector as it typically exceeds private risk tolerance. The WB and IFC supported efforts to address commercial and market risks and provided credit enhancements to financial intermediaries, including several projects supported by IFC's Blended Finance instrument. MIGA provided political risk insurance for 17 RE investments.
Examples of what worked	• The WB helped **Jordan** assess solar and wind resources, which helped develop markets for both technologies. • A WB guarantee for geothermal off-take in **Kenya** was cancelled as the long-term engagement by developer (with WBG support) provided sufficient comfort, with additional assurances not needed. • The IFC contributed to mitigating risk by structuring merchant risk on RE projects (e.g. Turkey, Philippines.) • Country political risks were mitigated through MIGA guarantees for geothermal (**Kenya** and **Nicaragua**) and wind (**Nicaragua**). Developers found the assurances essential for investing in RE. • A biomass developer in **Nicaragua** reported that IFC financing served as a "soft guarantee," perceived to reduce risks. • Auctions are emerging as a feasible option due to greater awareness and decreasing costs of RE technologies. In **Morocco** (CSP), **Egypt** (wind), **Mexico** (hybrid solar-thermal), and Zambia (*Scaling Solar* initiative), the WBG helped with structuring deals and competitively tendering the rights to develop RE.
Gaps / opportunities	Insufficient resource data, such as hydrological data and wind maps, was a reason for several of IFC's less successful projects. For example, in **Nicaragua**, initial drilling for geothermal was only partially successful, with additional drilling needed to maintain operating capacity.

Innovation Experience, Barriers and Skills

Niche RE technologies face barriers to expansion due to high risks, cost that are considered high, and markets that are still nascent.

In geothermal, the WBG is undertaking a global effort to catalyze investments in resource confirmation to help unlock the technology's potential, with some successful examples. It has supported 25 geothermal projects during the evaluation period (commitments close to US$1.05 billion dollars and US$57 million in MIGA guarantees), in 11 countries; including 4 where the technology was introduced for the first time. The Bank Group's focus has shifted from primarily extending financing to addressing up-front resource risks.

In CSP, the WBG was one of the first institutions supporting the technology when there was little installed capacity in developing countries. In Solar CSP, the Bank and IFC supported 11 projects for a total commitment of $934 million in 5 countries, all of which had nascent markets at the time the Bank Group mobilized its support. In countries such as Egypt, Morocco, Mexico, South Africa and India, the Bank Group was one of the first institutions to support CSP development.

Keeping up with evolving RE markets requires cutting-edge knowledge	
The Challenge: Knowledge for Innovation	The Bank Group's limited project-level experience with integration of RE, the evolving nature of policy and regulatory requirements, and the emergence of innovative new solutions such as energy storage, distributed generation, and new financing mechanisms pose challenges in acquiring or maintaining relevant knowledge. In RE integration and in energy storage, the IEG Global Expert Panel rated the Bank Group as being only moderately well positioned to assist clients. It rated its capacity to support potential solutions in these areas as moderate.
Skill Development Areas	Key areas for skills development include*: • System planning that incorporates dispatch models to optimally utilize variable/intermittent energy; • Battery, hydro, and other storage solutions for enhancing system flexibility; • Approaches to RE Distributed Generation for scaling-up and overcoming transmission bottlenecks; • Auctions for setting prices and allocating RE development rights; • Financing mechanisms better suited for scaling-up RE; and • Other skills that may emerge in importance going forward.
Gaps / opportunities	• Going forward the Bank Group has the opportunity to address knowledge and specialized skills gaps through training, by augmenting teams with external expertise, and by progressively learning from the emerging experiences in its client countries.

* Identified through interviews of WBG staff and management, and the evaluation expert panel

Addressing Other Barriers: Technical Standards, Institutional Capacity, Mobilizing Finance

Most countries that addressed all barriers have developed RE successfully.


*While the critical pathway to scaling-up RE requires an adequate policy framework and smooth integration of RE complemented by the mitigation of residual risks, addressing other barriers remains important. Thus, enhancing **technical standards**, and **institutional capacity** and mobilizing **finance** remain essential, even if domestic capabilities are limited. The evaluation found that the WBG provided significant support to address such barriers.*

Technical Standards

High-quality RE infrastructure developments necessitate compliance with industry and international design and technical standards. The WB and IFC supported activities for improving design and technical standards mainly through the preparation of feasibility studies that meet industry standards and safeguards documentation that complies with WBG policies. In **China**, establishment of country-level standards led to wind manufacturers being certified in this leading market; standards for solar PV contributed to a boom in manufacturing and exports. In **Kenya**, equipment standards established under the joint WB-IFC initiative Lighting Africa were being applied in an estimated 65% of the market.

Institutional Capacity

The capacity of various institutions involved in RE development may need to be strengthened so they can effectively undertake new and ongoing projects. In total, 199 WBG projects included activities for bolstering the institutional and human capacity of clients, two thirds of which were WB and one-third of which was IFC. Nearly half of the Bank projects included activities to improve technical design and implementation capacity, and to strengthen governance and fiduciary capabilities. Nearly 60 percent of the IFC projects aimed to improve the ability to comply with environmental and social performance standards. In **India**, long-term engagement through a series of projects helped strengthen institutional capacity to access finance and develop RE. In **Kenya**, officials appreciated the WB's assistance with designing projects in-line with international standards, although long-term impact is uncertain due to lack of ownership and limited retention of trained staff.

Mobilizing Finance

Mobilizing finance for RE can remain a challenge, especially in developing countries, due to barriers that include high up-front costs with RE investments when RE markets are not mature for a specific technology, if the scale of RE expansion exceeds the capacity of domestic capital markets, or in small markets where financial institutions are not well developed. Of the total RE projects that addressed barriers, 83 percent of IFC investments (162) and 57 percent of World Bank projects (72) mobilized financing from other partners (i.e., brought additional funds* through grants, co-financing, and parallel financing). IFC syndicated loans with other private financiers for 71 percent of these investments while the WB mobilized grants and concessional financing in 60 percent of these projects and funding from multilateral and bilateral partners in 43 percent of the projects. In **Jordan**, IFC helped aggregate a solar PV initiative by standardizing documentation to create a common platform for financing multiple investments. In **Tajikistan**, IFC and the WB helped financially structure the Pamir hydropower project by reconciling financial viability with affordability.

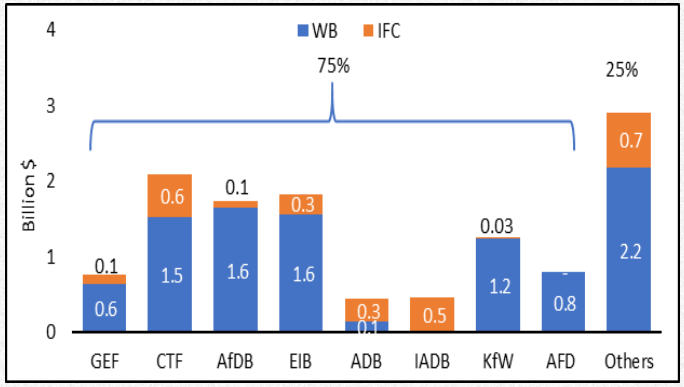
* The definition of *mobilizing finance used* includes indirect financing through co-financing and parallel financing partnerships, and direct mobilization through syndication.

WBG Mobilized Additional Financing through Partnerships to Address Barriers

The WBG used its global position to mobilize grants, concessional finance, and co-funding to address funding gaps and other barriers to RE development.

The more than $12 billion (excluding syndicated financing) in partnership funds mobilized in support of RE represent nearly 60% in additional financing associated with the $22 billion WBG RE portfolio.

$12 billion mobilized by WBG Development Partners for RE projects, 2000-2017



IEG Portfolio Review

In the RE portfolio from 2000-17, 125 of 246 WB RE projects included partnerships, more than one-third of which were with climate- or environment-related funds – the Global Environment Facility (GEF) and Climate Investment Funds (CIFs). IFC was often the lead financier syndicating RE loans with other financiers. Around 30% of the 280 IFC RE projects partnered with climate- or environment-related funds as well as with MDBs and bilateral agencies. Six of 17 MIGA RE projects contributed to mobilizing financing, mostly from MDBs and bilateral partners. A majority of WBG staff surveyed by IEG indicated that investment projects they oversaw used substantial development partner support for disseminating global knowledge, helping to address key RE barriers, and mobilizing financing for RE.

Grants by partners served to transfer global knowledge through RE investment projects supported by the WBG and helped address enhancements to RE policies, strengthen domestic capacity, reduce costs, and mitigate risks to facilitate financing.

GEF was a major provider of grants to environmentally concerned investments. The WB utilized $631 million in GEF funds through 63 projects primarily to create an enabling regulatory environment, establish technical standards, strengthen institutional capacity and reduce project costs. IFC used GEF funds totalling $137 million in nine investments primarily to provide first-loss cover in risk sharing facilities.

Concessional loans extended by partners played a critical role in risk mitigation and improving the financial viability of RE projects to make them "bankable." For example, the WB utilized the Clean Technology Fund (CTF) to leverage non-concessional financing for major RE projects with transformational potential in six countries. IFC, under its Blended Finance operations, used CTF funds to benefit from concessional terms and to cover first-loss risk in credit-lines in countries. With contribution from the Government of Canada, IFC also established the IFC-Canada Climate Change Program (IFC-CCCP) to cover the early entrant costs in new lines of business, lowering electricity tariffs and shortening investment pay-back periods.

MDBs and bilateral partners co-funded projects to help bridge financing gaps and address financing barriers. The WBG mobilized US$8.2 billion from MDBs such as AfDB and the EIB, and bi-lateral organizations, such as KfW and AFD. These funds supported investments in hydropower, CSP, geothermal, and multi-tech projects.

Sharing Global Knowledge to Help Address Barriers

The WBG uses its investment projects as vehicles for addressing key financial and other barriers to developing RE through the transfer of knowledge based on its global experience. The evaluation found that the WBG has shared global experiences to influence RE development in 98 countries – more than double the coverage of the next leading MDB. Knowledge is disseminated through multiple means.

There are numerous examples of effective and timely knowledge sharing, leading to improved RE initiatives:

- **China** off-grid PV experience served as the basis for. . . → . . . Key design elements of rural electricity access in **Mongolia.**
- **Morocco** CSP projects informed the design of and approach to. . . → . . . several similar successful CSP projects, including one in **South Africa.**
- The design of a solar PV project in **Sri Lanka** was the precursor to. . . → . . . the design of **Bangladesh**'s flagship solar PV program.

Knowledge exchanges were also facilitated between countries through dialogue, workshops, and study tours, such as between China and several other countries prior to implementing China's RE law; or indigenous communities from Chile visiting Nicaragua to learn about addressing E&S impacts of geothermal development.

Advisory Services: The WB undertook 146 Advisory Services and Analytics (ASA) and IFC supported 99 Advisory Services (AS) related to RE from 2000-17. They provided direct analytical support and technical assistance to clients. The general areas covered by the WB ASA's were RE policies, institutional capacity, resource risks, and planning and development of RE technologies. IFC's AS primarily focused on institutional capacity and financing.

Knowledge Sharing through Experience: This includes knowledge sharing of similar technologies or experiences. IEG found that over 70% of the WB lending projects (covering 72 countries) and 44% of IFC investments (covering 31 countries) utilized global knowledge and experience in their design and approach.

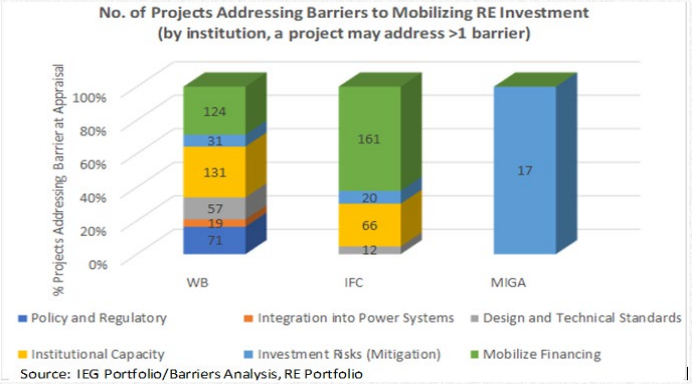
Global Knowledge Platforms: The WBG employed several RE-related global knowledge platforms. These include the flagship **Energy Sector Management Assistance Program (ESMAP)**, a major multi-partner funded knowledge platform within the WB that has progressively prioritized RE; the **Carbon Finance Group**, which facilitated knowledge sharing and carbon off-set financing; and the **Asia Sustainable and Alternate Energy Program (ASTAE)** (now merged with ESMAP), which served as a preparation facility for multiple RE projects.

ESMAP also funded several distinct **global knowledge initiatives**. These include the **Global Geothermal Development Plan** (GGDP), a technology-specific knowledge exchange forum for facilitating financing and knowledge sharing amongst a group of international stakeholders; the **RE Resource Mapping** to inform planners and developers; and, **Integration of Variable Renewables** providing advisory support.

The innovative approach of the WBG **Scaling Solar** initiative that "brings together a suite of WBG services to create "viable markets for solar power" is being replicated in several countries.

Systematic, Comprehensive and Coordinated Efforts Succeed in Addressing RE Barriers

RE development proved more successful when the WBG engaged systematically over time, strengthening its relationships, and progressively and comprehensively helping countries implement the necessary reforms to remove barriers to RE development.



Source: IEG Portfolio/Barriers Analysis, RE Portfolio

The WBG's support for RE in Sri Lanka shows the importance of a long and sustained engagement. While systematic and successful during the earlier part of the evaluation period, the WBG has since struggled to gain a foothold at a time when the country is attempting to develop larger scale RE after largely withdrawing from major activities in the sector.

Sustained engagement also allows for more comprehensively addressing barriers, as shown earlier. For example, in China's RE Scale-up Program (CRESP) a series of projects in a long-standing relationship made major contributions to the country's globally leading position in RE.

The evaluation points to the importance of strategic internal coordination to capture synergies within the WBG (as well as with external partners). One example is the joint IFC-WB hydropower project in Tajikistan, which successfully mobilized private finance and partnership support to supply affordable electricity to remote areas. In contrast, in Nicaragua, all three WBG institutions were coincidentally supporting several RE investments without an explicit coordination strategy.

As the barrier analysis confirmed, the WB has a comparative advantage in guiding policy and integration (albeit there is limited activity in the latter) and build public institutional capacity, while IFC is better placed to mobilize private financing and can also use its advisory services to build private institutional capacity. MIGA is entirely focused on mitigating FDI risks.

This is also consistent with the MF These intra-institutional synergies should be captured for maximum impact. WBG's maximizing finance for development (MFD) approach. However, staff interviews identify conflicting incentives within the WBG, between improving the "bankability" of individual investments ("transaction view") and the longer-term sector development ("sector view"), which can lead to divergent approaches for public and private sectors.

Unresolved barriers to RE are a major reason that a quarter of public sector projects face substantial or high risk to development outcomes. A majority of projects cited the weak financial viability of the electricity utilities as a major risk for the sustainability of development objectives, while other main risk factors included changes in energy policy, low tariffs, institutional capacity, and the lack of enabling environment for domestic banks.

The lower success rate for many private sector RE projects was primarily due to the existence of unresolved barriers. Some key reasons cited for 55 percent of the evaluated IFC RE projects performing mostly unsuccessful or below are strongly correlated with RE barriers.

Recommendations

Based on the findings of this evaluation and the challenges facing WBG country clients to scale-up RE, IEG proposes the following recommendations:

Recommendations	Action areas
1 *WBG to prioritize interventions that focus on the integration of RE sources into the power systems of client countries, to facilitate progress in their clean energy transitions.*	The envisaged growth of VRE technologies in generation mixes requires prioritizing the 'integration challenge' through investments (in addition to ASA) by: • Tackling key intermittency issues linked to VRE sources. • Enhancing power systems flexibility with specific attention to: – Developing hydropower with storage that meets high E&S standards and – Accelerating the deployment of battery storage technologies (as viable). • Addressing key transmission bottlenecks, including through distributed generation.
2 *WBG to support RE scale-up through comprehensive, long-term country engagements, with coordinated WBG solutions, based on the comparative advantages of each institution, to address barriers, aided by robust upstream diagnostics.*	Effectively addressing barriers to RE requires: • A long-term comprehensive engagement with clients across the WBG, with a focus on addressing the rapidly evolving RE technologies and markets. More early stage coordination and exchange across the WBG on the sequencing of public and private interventions. • Focus on electricity sector financial viability and off-taker creditworthiness. • Conducting comprehensive upstream diagnostics and adequate risk assessments. • Exploiting the comparative advantages of the WB, IFC and MIGA, with the WB (and potentially IFC's "upstream" advisory) focusing on RE policies and integration, the IFC mobilizing private capital while promoting adoption of E&S standards and mechanisms for scaling-up, and MIGA further extending its risk mitigation portfolio to cover a wider range of RE technologies.
3 *WBG to continually upgrade the pool of specialized skills to help clients address their pressing and rapidly evolving challenges to scale-up RE.*	Helping clients address their scale-up needs and challenges requires a change in the WBG skills mix to include expertise on: • Systems planning, especially for integrating VRE. • Policies, especially on transitioning from pricing (FiTs) to structuring RE auctions and on transparent and predictable procurement processes. • Innovation, including energy storage and distributed generation.

Glossary of Key Terms

Glossary

Auctions (or Competitive Tenders) refers to the process whereby governments and financial institutions invite bids for large projects that must be submitted within a finite deadline.

Bank Group – The World Bank Group consists of the World Bank (the International Bank for Reconstruction and Development [IBRD] and the International Development Association [IDA]), the International Finance Corporation (IFC) and the Multilateral Insurance Guarantee Agency (MIGA).

Base-load power- *Base load power* sources are the plants that operate continuously to meet the minimum level of *power* demand. They are only turned off during periodic maintenance, upgrading, overhaul or service, or due to an unplanned disruption.

Bio-Power - *Bio-power technologies convert biomass fuels into electricity primarily through burning, bacterial decay or conversion to gas/liquid fuel.*

Cascade approach – Recently adopted by the World Bank Group, the "cascade framework" to "maximize finance for development" prioritizes leveraging sustainable private sector financing and reserves scarce public financing for those areas where private sector engagement is not optimal or available.

CAS or CPF – Country Assistant Strategies or Country Partnership Frameworks, which are country-level strategies that provides the strategic basis for the World Bank Group assistances to different countries.

Capacity Factor – The ratio of actual electrical energy output over a given period of time to the maximum possible electrical energy output over that period. For example, a 1MW power plant with a capacity factor of 0.70 will produce 6,132 MWh of electricity in a year (1MW X 8,760 hours X 0.70 = 6,132 MWh).

Clean Energy Transition – A conceptual term used to describe pathways for transitioning from fossil fuels to cleaner energy including through the increased use of renewable energy. In this evaluation, the term is used to describe low carbon pathways that will help achieve the SDG targets by 2030 and be on track by 2040 for meeting the goals of the Paris Agreement anchored around a forecast from the International Energy Agency (IEA) that was considered as an option by the Inter-Governmental Panel on Climate Change (IPCC).

CO_2 – Carbon dioxide, which is a greenhouse gas that is emitted when producing electricity from fossil fuels, and to a lesser extent when utilizing renewable energy technologies, which contributes to climate change.

Compliance Adviser/Ombudsman (CAO) - The CAO is the independent accountability mechanism for the IFC and MIGA, which responds to complaints from project-affected communities with the goal of enhancing social and environmental outcomes of investments supported by the two institutions.

Concentrated Solar Power (CSP) or concentrated solar thermal, and CSP systems generate electricity by using mirrors to concentrate (focus) the sun's energy and convert it into high-temperature heat. Since Solar CSP is typically developed together with thermal storage for the generated heat, it is a dispatchable technology because it can shift its time-of-use.

Dispatchable generators - Generation sources used to meet demand at a given moment. Dispatchable generators can be turned on or off, or can adjust their power output according to an order. These include fossil fuel power plants, renewable energy power plants using biomass, geothermal, and variable renewable energy power plants with storage.

Distributed or Decentralized Generation – Generators that are usually privately owned and operated that are connected to the medium or low voltage (customer) side of the distribution network that supply power to the grid under a power purchase agreement. These plants usually supply electricity when able and not actively controlled by the system operators. They include, for example, roof-top solar, or small (for example under 10 MW), mini-hydro, solar PV fields or wind farms.

DPF – Development policy finance, formerly referred to as development policy lending, *which* provides IBRD loan, IDA credit/grant and guarantee budget support to governments or a political subdivision for a program of *policy* and institutional actions to help achieve sustainable, shared *growth* and poverty reduction.

ESF – or the Environmental and Social Framework, launched on October 1, 2018, enables the World Bank and Borrowers to better manage environmental and social risks of projects and to improve development outcomes. The ESF offers broad and systematic coverage of environmental and social risks.

Feed-in-Tariff (FIT) – An agreed electricity tariff within a power purchase agreement that a utility will purchase electricity from a third-party generator.

Geothermal Power - Geothermal power, the term derived from the Greek words geo (earth) and therme (heat), refers to electricity generated from the natural heat of the earth through several different types of technologies that include dry steam, flash steam, and binary cycle.

Global environmental impacts – refers to the rapidly increasing greenhouse gases such as carbon dioxide that is causing global warming leading to climate change as rising temperatures disrupt the ecological balance of the planet. Fossil fuel use in producing electricity is one key factor in the emission of greenhouse gases and the use of renewable energy for the same purpose can help mitigate the impacts on the climate, which is a major focus of this evaluation.

Glossary (2)

Guarantees - The World Bank Group offers several types of guarantees. This includes MIGA guarantees, which offer political risk insurance (PRI) coverage to foreign direct investors, as per its mandate. The World Bank (IBRD or IDA) guarantees for RE considered in this evaluation are project-based guarantees that are designed to better allocate risks and mobilize private investments. This includes loan guarantees that cover loan-related debt service defaults caused by Government failure to meet specific payment and/or performance obligations arising from contract, law or regulation, in relation to a project; or, payment guarantees that cover payment obligations, to private entities and foreign public entities arising from contract, law or regulation. *IFC* offers partial credit *guarantees* (PCGs) and full credit *guarantees* (FCGs) as credit enhancement mechanisms for debt instruments (bonds and loans) issued by its mostly private sector clients.

Green Field Project – In energy projects it is a project that is developed on unused lands where there is no need to remodel or demolish an existing structure.

Hydropower with storage commonly referred to as conventional hydropower, is typically a large power system that uses a dam to store water in a reservoir. Electricity is produced by releasing water from the reservoir through a turbine, which runs a generator. Storage hydropower provides base load as well as the ability to be shut down and started up at short notice according the demands of the system (peak load). It can offer enough storage capacity to operate independently of the hydrological inflow for many weeks or even months. Hydropower presently represents the largest capacity and power generation from renewable energy.

IFC – the International Finance Corporation, the private sector arm of the World Bank Group.

InfraSAP – a diagnostic and planning exercise carried out by the World Bank Group aimed at informing how a country can improve infrastructure access and performance.

Inspection Panel - The Inspection Panel is an independent complaints mechanism for people and communities who believe that they have been, or are likely to be, adversely affected by a World Bank-funded project.

Installed Capacity – The production capacity of a power plant based either on its rated (nameplate) capacity or actual (practically determined) capacity.

Intergovernmental Panel on Climate Change or IPCC - An intergovernmental body of the United Nations, dedicated to providing the world with an objective, scientific view of climate change and its political and economic impacts.

Investment Lending – in this evaluation refers to IBRD loans, IDA credits/grants and guarantee financing to governments, Program-for-Results; financing, direct investment and guarantees are provided by MIGA and IFC to the private sector; and trust funded loans and grants through all Bank Group institutions.

Key Performance Indicators (KPIs) – Indicators used in World Bank Group projects to measure how well the project is meeting its objectives during implementation.

Local environmental impacts in this evaluation primarily refers to airborne substances caused by emissions from combustion-generated exhaust gases and smoke particles such as sulfur dioxide (SO2), Nitrogen Oxide (NOx) and particulate matter (PM) that leads to adverse impacts om human health. It should be noted that broader definition is applied at times for local environmental impacts to include noise, surface transport, energy, waste, water and land quality, water use, and biodiversity; in addition to air quality.

MFD or Maximizing Finance for Development (MFD) is the World Bank Group's approach to systematically leverage all sources of finance, expertise, and solutions to support developing countries' sustainable growth.

MIGA is an institution within the World Bank Group that provides political risk insurance (guarantees) for cross-border private sector investors and lenders in a broad range of sectors in developing member countries, covering all regions of the world.

Multi-Tech RE A World Bank Group supported investment project (or operation) that includes two or more of the renewable energy technologies considered in this evaluation.

Nationally Determined Commitments (NDCs) - Term used under the United Nations Framework Convention on Climate Change (UNFCCC) for reductions in greenhouse gas emissions that all countries committed to as part of the Paris Climate Change Agreement. They are non-binding agreements.

Non-dispatchable generators – Generation sources where output depends on the availability and level of input energy resources. While operators can turn these power plants on and off, their output is not modulated to meet demand at any given moment. These include run-of-river hydro, solar and wind.

Off-grid (stand-alone) solar – Solar PV systems with batteries that provide electricity to an installation that is part of a grid network. Small systems are also referred to as Solar Home Systems .

Paris Agreement - A landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. Its central aim is to maintain global temperature rise below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to increase the ability of countries to deal with the impacts of climate change, and at making finance flows consistent with a low GHG emissions and climate-resilient pathway.

RE resource risks is the uncertainty surrounding the availability of a given RE resource in sufficient amounts to operate a specific power generation operation. Hydrological information, geothermal resource data, and wind and solar irradiation maps are typically developed to ascertain such information to the extent possible so that it can inform the investment decision and design of a RE project.

Glossary (3)

SDGs - The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. Of the 17 SDGs, the one on energy (SDG#7) includes the aim to provide universal access to affordable and clean energy, where a mainstay is renewable energy. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another. According to the UN, SDG#7 is "crucial for achieving almost all [16 other] SDGs"

Single-Tech RE A World Bank Group supported investment project (or operation) that includes a single renewable energy technology of the ones considered in this evaluation, although it may include multiple installations of the selected technology.

Solar PV *or solar photovoltaic* (*PV*) is a technology that converts sunlight (*solar* radiation) into direct current electricity by using semiconductors. When the sun hits the semiconductor within the *PV* cell, electrons are freed and form an electric current. It is considered a variable renewable energy (VRE) since typical installations at greater levels than individual households that do not include battery storage is only available when there is sunlight.

PAPs *or project affected persons* refers to a *people* or households *affected* by direct economic and social impacts caused by an investment that results in adverse impacts on the livelihoods, including from relocation, or loss of incomes associated with *project*-changes in use of land, water and other natural resources.

P4R *or Program for Results is a* World Bank financing instrument that uses a country's own institutions and processes linking disbursement of funds to the achievement of specific program results and supporting clients in enhancing the effectiveness and efficiency of their development programs to achieve tangible and sustainable results. For the purpose of this evaluation, P4R is classified as investment lending.

Peak demand – The highest power demand typically in a 24-hour period in power network.

Performance Standards or the Environmental and Social Performance Standards define IFC and MIGA clients' responsibilities for managing their environmental and social risks.

Political risks include currency inconvertibility and transfer restrictions, expropriations, and war, terrorism and civil disturbances, which are insured within the World Bank Group by MIGA.

Pumped Storage (hydropower) or pumped-storage hydropower (PSH) or pumped hydroelectric energy storage (PHES), is a type of hydroelectric energy storage used by power systems for load balancing among other things. The technology stores energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to a higher elevation. Low-cost surplus off-peak electric power is typically used to run the pumps. During periods of high electrical demand, the stored water is released through turbines to produce electric power. Although the losses of the pumping process make the plant a net consumer of energy overall, the system increases revenue by selling more electricity during periods of peak demand, when the value of electricity is higher. The reservoirs used with pumped storage are quite small when compared to conventional hydroelectric dams of similar power capacity, and generating periods are often less than half a day.

Qualitative Comparative Assessment (QCA) – Qualitative Comparative Analysis (QCA) is an approach to analyzing causal contribution of different "pre-conditions" (e.g. aspects of an intervention such as barriers to RE development) to an outcome of interest (e.g. energy and environment benefits). The methodology uses Boolean algebra to identify "pre-conditions" that account for the observed outcomes

Renewable (Energy) Portfolio Standards (RPSs) – Specifies the amount of the energy a power utility must generate/buy or sell from renewable sources.

Run-of-the River Hydropower is a type of hydropower technology that channels flowing water from a river through a canal or penstock to spin a turbine. Typically, a run-of-river project will have little or no storage facility. Run-of-river typically provides a continuous supply of electricity (base load), with some flexibility of operation for daily fluctuations in demand and possible seasonal variations.

Safeguards The term "Environmental and Social Safeguards (or Standards)" is used by development institutions, international treaties and agencies to refer to policies, standards and operational procedures designed to first identify and then try to avoid, mitigate and minimize adverse environmental and social impacts that may arise in the implementation of development projects. ESS also have a pro-active dimension to try to increase chances that development projects deliver better outcomes for people and the environment.

Storage in this evaluation applies to energy or fuel storage for later producing electricity. In the case of hydropower, storage implies that there is a reservoir developed along with the hydropower dam, which enables the water to be stored and utilized for generating electricity when the system operations call for it (i.e. dispatchable). This flexibility enables load balancing for system operations including the integration of VRE as it can address the intermittency of these technologies. In the case of solar PV or wind batteries are used to storage electricity which is then dispatched when needed.

Theory of Change or ToC – A theory of change is a method that explains how a given intervention, or set of interventions, are expected to lead to a specific development change, drawing on a causal analysis based on available evidence.

Thermal Storage Technology (TES) is a technology that stores thermal energy by heating or cooling a storage medium so that the stored energy can be used at a later time for power generation. Solar SCP power plants are typically developed with TES.

VRE technologies include those that are interruptible in availability due to factors beyond direct control such as solar (available when the sun shines) and wind power (available when the wind blows) when storage that can smooth out its use during the day is not available. VRE can also include technologies where availability fluctuates, such as hydropower without storage, due to seasonal variations.

Wind Power or *wind energy* refers to the process of creating electricity using the *wind*, or air flows that occur naturally in the earth's atmosphere. Modern *wind turbines* are used to capture kinetic *energy* from the *wind* and generate electricity.

RENEWABLE ENERGY

Evaluation of the World Bank Group's support for electricity supply

from Renewable Energy resources, 2000–2017

APPENDICES

- **Appendix A:** Key Renewable Energy-Related Global Initiatives
- **Appendix B:** Country Classification by RE Penetration & CO2 Emissions (target vs progress)
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Appendix A. Key RE-related Global Initiatives

1) Sustainable Development Goals (SDGs) and Sustainable Energy for All (SEforALL)

The UN Sustainable Development Goals (SDGs)[i], otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The SDGs, endorsed by 194 signatory countries as well as the WBG,came into effect in January 2016.

The 17 Goals build on the successes of the Millennium Development Goals (MDGs), while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another.

The SDGs work in the spirit of partnership and pragmatism to make the right choices now to improve life, in a sustainable way, for future generations. They provide clear guidelines and targets for all countries to adopt in accordance with their own priorities and the environmental challenges of the world at large. The SDGs are an inclusive agenda. They tackle the root causes of poverty and unite us together to make a positive change for both people and planet. **Table A1. List of SDG**

GOAL 1: No Poverty	GOAL 10: Reduced Inequality
GOAL 2: Zero Hunger	GOAL 11: Sustainable Cities and Communities
GOAL 3: Good Health and Well-being	GOAL 12: Responsible Consumption and Production
GOAL 4: Quality Education	GOAL 13: Climate Action
GOAL 5: Gender Equality	GOAL 14: Life Below Water
GOAL 6: Clean Water and Sanitation	GOAL 15: Life on Land
GOAL 7: Affordable and Clean Energy	GOAL 16: Peace and Justice Strong Institutions
GOAL 8: Decent Work and Economic Growth	GOAL 17: Partnerships to achieve the Goal
GOAL 9: Industry, Innovation and Infrastructure	

Source: https://sustainabledevelopment.un.org/

SDG 7: Affordable and Clean Energy

Ensuring access to affordable, reliable and modern energy for all has come one step closer due to recent progress in electrification, and improvements in industrial energy efficiency. However, national priorities and policy ambitions still need to be strengthened to put the world on track to meet the energy targets for 2030. The key indicators for SDG 7, developed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs), is as follows:

- By 2030, ensure universal access to affordable, reliable and modern energy services

- By 2030, increase substantially the share of renewable energy in the global energy mix
- By 2030, double the global rate of improvement in energy efficiency
- By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossilfuel technology, and promote investment in energy infrastructure and clean energy technology
- By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

Energy is central to nearly every major challenge and opportunity the world faces today. Be it for jobs, security, climate change, food production or increasing incomes, access to energy for all is essential. Working towards this goal is especially important as it interlinks with other Sustainable Development Goals. Focusing on universal access to energy, increased energy efficiency and the increased use of renewable energy through new economic and job opportunities is crucial to creating more sustainable and inclusive communities and resilience to environmental issues like climate change.

Figure A1. Energy is Essential for Achieving All SDGs

Source: The United Nations

At the current time, there are approximately 3 billion people who lack access to clean-cooking solutions and are exposed to dangerous levels of air pollution. Additionally, slightly less than 1 billion people are functioning without electricity and 50% of them are found in Sub-Saharan Africa alone. Fortunately, progress has been made in the past decade regarding the use of renewable electricity from water, solar and wind power and the ratio of energy used per unit of GDP is also declining.

However, the challenge is far from being solved and there needs to be more access to clean fuel and technology and more progress needs to be made regarding integrating renewable energy into end-use applications in buildings, transport and industry. Public and private investments in energy also need to be increased and there needs to be more focus on regulatory frameworks and innovative business models to transform the world's energy systems.

SEforALL is a global platform that aims to help meet the dual challenge of reducing the carbon intensity of energy while making it available to everyone on the planet. It is designed to empower leaders to broker partnerships and unlock finance to achieve universal access to sustainable energy, as a contribution to a cleaner, just and prosperous world for all. SEforALL has three objectives:

- ensure universal access to modern energy services;
- double the global rate of improvement in energy efficiency; and
- double the share of renewable energy in the global energy mix.

SEforALL builds and supports partnerships that can deliver tangible action toward our sustainable energy goals. Some partnerships focus on knowledge and evidence needed to inform action, while others focus on delivering concrete action and results on the ground.

2) Global Climate Accords (Kyoto Protocol and Paris Agreement)

Kyoto Protocol[ii]

The Kyoto Protocol[iii] (KP) is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC), which **commits** its Parties by setting internationally binding emission reduction targets.

Recognizing that developed countries are principally responsible for the current elevated levels of greenhouse gas (GHG) emissions in the atmosphere because of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities".

The KP was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords". Its first commitment period started in 2008 and ended in 2012.

Doha Amendment

In Doha, Qatar, on 8 December 2012, the "Doha Amendment to the Kyoto Protocol[iv]"was adopted. The amendment includes:

- New commitments for Annex I Parties to the KP who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the KP which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

On 21 December 2012, the amendment was circulated by the Secretary-General of the United Nations, acting in his capacity as Depositary, to all Parties to the KP in accordance with Articles 20 and 21 of the Protocol.

During the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of Parties in the second commitment period is different from the first.

The Kyoto mechanisms

Under the Protocol, countries must meet their targets primarily through national measures. However, the Protocol also offers them an additional means to meet their targets by way of three market-based mechanisms[v].

The Kyoto mechanisms are:

- International Emissions Trading[vi]
- Clean Development Mechanism (CDM)[vii]
- Joint implementation (JI)[viii]

The mechanisms help to stimulate green investment and help Parties meet their emission targets in a cost-effective way.

Monitoring emission targets

Under the Protocol, countries' actual emissions must be monitored and precise records have to be kept of the trades carried out.

Registry systems[ix] track and record transactions by Parties under the mechanisms. The UN Climate Change Secretariat, based in Bonn, Germany, keeps an international transaction log[x] to verify that transactions are consistent with the rules of the Protocol.

Reporting[xi] is done by Parties by submitting annual emission inventories and national reports under the Protocol at regular intervals.

A compliance[xii] system ensures that Parties are meeting their commitments and helps them to meet their commitments if they have problems doing so.

Adaptation[xiii]

The KP, like the Convention, is also designed to assist countries in adapting to the adverse effects of climate change. It facilitates the development and deployment of technologies that can help increase resilience to the impacts of climate change.

The Adaptation Fund[xiv] was established to finance adaptation projects and programs in developing countries that are Parties to the KP. In the first commitment period, the Fund was financed mainly with a share of proceeds from CDM project activities. In Doha, in 2012, it was decided that for the second commitment period, international emissions trading and joint implementation would also provide the Adaptation Fund with a 2 percent share of proceeds.

The road ahead

The KP is seen as an important first step towards a truly global emission reduction regime that will stabilize GHG emissions, and can provide the architecture for the future international agreement on climate change.

In Durban, the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) was established to develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention, applicable to all Parties. The ADP is to complete its work as early as possible, but no later than 2015, in order to adopt this protocol, legal instrument or agreed outcome with legal force at the twenty-first session of the Conference of the Parties and for it to come into effect and be implemented from 2020.

Paris Agreement[xv]

At COP[xvi] 21 in Paris, on 12 December 2015, Parties to the UNFCCC reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The Paris Agreement builds upon the Convention and – for the first time – brings all nations into a common cause to undertake take ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above preindustrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to increase the ability of countries to deal with the impacts of climate change, and at making finance flows consistent with a low GHG emissions and climate-resilient pathway. To reach these ambitious goals, appropriate mobilization and provision of financial resources, a new technology framework and enhanced capacity-building is to be put in place, thus supporting action by developing countries and the most vulnerable

countries, in line with their own national objectives. The Agreement also provides for an enhanced transparency framework for action and support.

The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs[xvii]) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts. There will also be a global stocktake every 5 years to assess the collective progress towards achieving the purpose of the agreement and to inform further individual actions by Parties.

The Paris Agreement opened for signature on 22 April 2016 – Earth Day – at UN Headquarters in New York. It entered into force on 4 November 2016, 30 days after the so-called "double threshold" (ratification by 55 countries that account for at least 55% of global emissions) had been met. Since then, more countries have ratified and continue to ratify the Agreement. To this date, 179 Parties have ratified of 197 Parties to the Convention[xviii].

In order to make the Paris Agreement fully operational, a work program was launched in Paris to develop modalities, procedures and guidelines on a broad array of issues. Since 2016, Parties work together in the subsidiary bodies (APA, SBSTA and SBI) and various constituted bodies. The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) met for the first time in conjunction with COP 22 in Marrakesh (in November 2016) and adopted its first two decisions. The work programme is expected to be completed by 2018.

The Paris Agreement, adopted through Decision 1/CP.21[xix], addresses crucial areas necessary to combat climate change. Some of the key aspects of the Agreement are set out below:

- **Long-term temperature goal** (Art. 2) – The Paris Agreement, in seeking to strengthen the global response to climate change, reaffirms the goal of limiting global temperature increase to well below 2 degrees Celsius, while pursuing efforts to limit the increase to 1.5 degrees.

- **Global peaking and 'climate neutrality'** (Art. 4) –To achieve this temperature goal, Parties aim to reach global peaking of greenhouse gas emissions (GHGs) as soon as possible, recognizing peaking will take longer for developing country Parties, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of the century.

- **Mitigation** (Art. 4) – The Paris Agreement establishes binding commitments by all Parties to prepare, communicate and maintain a nationally determined contribution (NDC) and to pursue domestic measures to achieve them. It also prescribes that Parties shall communicate their NDCs every 5 years and provide information necessary for clarity and transparency. To set a firm foundation for higher ambition, each successive NDC will represent a progression beyond the previous one and reflect the highest possible ambition. Developed countries should continue to take the lead by undertaking absolute economy-wide reduction targets, while developing countries should continue enhancing their mitigation efforts, and are

encouraged to move toward economy-wide targets over time in the light of different national circumstances.

- **Sinks and reservoirs** (Art.5) –The Paris Agreement also encourages Parties to conserve and enhance, as appropriate, sinks and reservoirs of GHGs as referred to in Article 4, paragraph 1(d) of the Convention, including forests.

- **Voluntary cooperation/Market- and non-market-based approaches** (Art. 6) – The Paris Agreement recognizes the possibility of voluntary cooperation among Parties to allow for higher ambition and sets out principles – including environmental integrity, transparency and robust accounting – for any cooperation that involves internationally transferal of mitigation outcomes. It establishes a mechanism to contribute to the mitigation of GHG emissions and support sustainable development, and defines a framework for non-market approaches to sustainable development.

- **Adaptation** (Art. 7) – The Paris Agreement establishes a global goal on adaptation – of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change in the context of the temperature goal of the Agreement. It aims to significantly strengthen national adaptation efforts, including through support and international cooperation. It recognizes that adaptation is a global challenge faced by all. All Parties should engage in adaptation, including by formulating and implementing National Adaptation Plans, and should submit and periodically update an adaptation communication describing their priorities, needs, plans and actions. The adaptation efforts of developing countries should be recognized

- **Loss and damage** (Art. 8) – The Paris Agreement recognizes the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage. Parties are to enhance understanding, action and support, including through the Warsaw International Mechanism, on a cooperative and facilitative basis with respect to loss and damage associated with the adverse effects of climate change.

- **Finance, technology and capacity-building support** (Art. 9, 10 and 11) – The Paris Agreement reaffirms the obligations of developed countries to support the efforts of developing country Parties to build clean, climate-resilient futures, while for the first time encouraging voluntary contributions by other Parties. Provision of resources should also aim to achieve a balance between adaptation and mitigation. In addition to reporting on finance already provided, developed country Parties commit to submit indicative information on future support every two years, including projected levels of public finance. The agreement also provides that the Financial Mechanism of the Convention, including the Green Climate Fund (GCF), shall serve the Agreement. International cooperation on climate-safe technology development and transfer and building capacity in the developing world are also strengthened: a technology

framework is established under the Agreement and capacity-building activities will be strengthened through, inter alia, enhanced support for capacity building actions in developing country Parties and appropriate institutional arrangements. Climate change education, training as well as public awareness, participation and access to information (Art 12) is also to be enhanced under the Agreement.

- **Climate change education, training, public awareness, public participation and public access to information** (Art 12) is also to be enhanced under the Agreement.

- **Transparency** (Art. 13), **implementation and compliance** (Art. 15) – The Paris Agreement relies on a robust transparency and accounting system to provide clarity on action and support by Parties, with flexibility for their differing capabilities of Parties. In addition to reporting information on mitigation, adaptation and support, the Agreement requires that the information submitted by each Party undergoes international technical expert review. The Agreement also includes a mechanism that will facilitate implementation and promote compliance in a non-adversarial and non-punitive manner, and will report annually to the CMA.
- **Global Stocktake** (Art. 14) – A "global stocktake", to take place in 2023 and every 5 years thereafter, will assess collective progress toward achieving the purpose of the Agreement in a comprehensive and facilitative manner. It will be based on the best available science and its long-term global goal. Its outcome will inform Parties in updating and enhancing their actions and support and enhancing international cooperation on climate action.

- **Decision 1/CP.21** also sets out a number of measures to enhance action prior to 2020, including strengthening the technical examination process, enhancement of provision of urgent finance, technology and support and measures to strengthen high-level engagement. For 2018 a facilitative dialogue is envisaged to take stock of collective progress towards the long-term emission reduction goal of Art 4. The decision also welcomes the efforts of all nonParty stakeholders to address and respond to climate change, including those of civil society, the private sector, financial institutions, cities and other subnational authorities. These stakeholders are invited to scale up their efforts and showcase them via the Non-State Actor Zone for Climate Action platform[xx] . Parties also recognized the need to strengthen the knowledge, technologies, practices and efforts of local communities and indigenous peoples, as well as the important role of providing incentives through tools such as domestic policies and carbon pricing.

[i] http://www.undp.org/content/undp/en/home/sustainable-development-goals.html [ii] https://unfccc.int/process/the-kyoto-protocol [iii] The full Kyoto Protocol can be found at https://unfccc.int/sites/default/files/kpeng.pdf

[iv] https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment [v] https://unfccc.int/process/the-kyoto-protocol/mechanisms [vi] Parties with commitments under the KP (Annex B Parties) have accepted targets for limiting or reducing emissions. These targets are expressed as levels of allowed emissions, or assigned amounts, at over the 2008-2012 commitment period. The allowed emissions are divided into assigned amount units (AAUs). Emissions trading, as set out in Article 17 of the KP, allows countries that have emission units to spare - emissions permitted them but not "used" - to sell this excess capacity to countries that are over their targets. Thus, a new commodity was created in the form of emission reductions or removals. Since carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon. Carbon is now tracked and traded like any other commodity. This is known as the "carbon market". https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

[vii] CDM, defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the KP (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one ton of CO2, which can be counted towards meeting Kyoto targets. https://unfccc.int/process-and-meetings/the-kyotoprotocol/mechanisms-under-the-kyoto-protocol/the-clean-development-mechanism

[viii] The mechanism known as "joint implementation", defined in Article 6 of the KP, allows a country with an emission reduction or limitation commitment under the KP (Annex B Party) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one ton of CO2, which can be counted towards meeting its Kyoto target. Joint implementation offers Parties a flexible and costefficient means of fulfilling a part of their Kyoto commitments, while the host Party benefits from foreign investment and technology transfer. https://unfccc.int/process/the-kyoto-protocol/mechanisms/joint-implementation

[ix] https://unfccc.int/process/the-kyoto-protocol/registry-systems

[x] https://unfccc.int/process/the-kyoto-protocol/registry-systems/international-transaction-log [xi] https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-kyoto-protocol/overview/guidelines-under-articles-5-7-and-8-methodological-issues-reporting-and-review-under-thekyoto-1

[xii] https://unfccc.int/process/the-kyoto-protocol/compliance-under-the-kyoto-protocol [xiii] https://unfccc.int/adaptation/items/4159.php

[xiv] https://unfccc.int/cooperation_and_support/financial_mechanism/adaptation_fund/items/3659.php [xv] https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement

[xvi] The COP is the supreme decision-making body of the Convention. All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.
https://unfccc.int/process/bodies/supremebodies/conference-of-the-parties-cop [xvii] NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions. https://unfccc.int/process/the-parisagreement/nationally-determined-contributions/ndc-registry [xviii] https://unfccc.int/process/the-paris-agreement/status-of-ratification [xix] https://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf [xx] http://climateaction.unfccc.int/

Appendix B. RE Penetration and CO2 Emissions

		RE Capacity (GW) 2015							Electricity Generation (TWh) 2015							CO2 Emissions			Access	WBG	
Country	Lending Group	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Capacity	Installed Capacity	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Generation	Total Electricity Generation	Total CO2 per Country (kt) 2014	per kwh electricity - heat output (gCO2 per kWh) 2014	CO2 Average 2000-2014	Access to electricity (% of population) 2016	WBG RE Investment Projects FY00-17	WBG Total RE Commitment
Afghanistan	IDA	0.33	0.00	0.00	-	-	0.33	0.60	0.89	-	-	-	-	0.89	1.03	9,809	-	4,821	71.50	1	58.10
Albania	IBRD	1.80	-	0.00	-	-	1.80	1.90	5.87	-	-	-	-	5.87	5.87	5,717	-	4,321	100.00	4	88.87
Algeria	IBRD	0.28	0.01	0.08	-	-	0.36	17.12	0.14	0.02	0.06	-	-	0.22	64.68	145,400	508	109,444	99.34	0	-
Angola	IBRD	0.92	-	0.01	-	-	0.93	1.70	5.14	-	-	-	-	5.14	9.44	34,763	363	22,670	42.00	1	-
Antigua and Barbuda	IBRD	-	-	0.00	-	-	0.00	0.09	-	-	-	-	-	-	0.33	532	-	456	96.83	0	-
Argentina	IBRD	9.10	0.28	0.01	0.66	-	10.04	38.19	33.67	0.60	0.02	2.14	-	36.42	133.82	204,025	394	169,387	100.00	5	669.63
Armenia	IBRD	1.30	0.00	0.00	0.00	-	1.30	4.07	2.18	0.00	0.00	-	-	2.19	7.39	5,530	200	4,447	100.00	6	124.66
Azerbaijan	IBRD	1.08	0.00	0.02	0.04	-	1.15	7.42	1.62	0.01	0.01	0.18	-	1.81	23.30	37,488	477	32,989	100.00	0	-
Bangladesh	IDA	0.23	0.00	0.17	-	-	0.40	11.70	0.56	0.00	0.15	-	-	0.71	55.50	73,190	587	48,788	68.20	2	357.26
Belarus	IBRD	0.04	0.00	0.01	0.04	-	0.08	10.08	0.11	0.03	0.01	0.19	-	0.33	32.06	63,498	404	59,622	100.00	0	-
Belize	IBRD	0.05	-	0.01	0.03	-	0.09	0.19	0.24	-	-	-	-	0.24	0.25	495	-	473	91.80	1	15.00
Benin	IDA	0.00	-	0.01	-	-	0.01	0.21	0.00	-	0.01	0.00	-	0.01	0.31	6,318	697	3,878	40.03	0	-
Bhutan	IDA	1.61	-	-	-	-	1.61	1.63	7.73	-	-	-	-	7.73	7.73	1,001	-	522	98.42	0	-
Bolivia	IBRD	0.50	0.00	0.01	0.15	-	0.66	2.36	2.44	0.01	0.01	0.19	-	2.65	8.15	20,411	414	13,904	91.52	3	27.23
Bosnia and Herzegovina	IBRD	2.05	-	0.01	-	-	2.06	4.24	5.50	0.00	-	-	-	5.50	14.97	22,233	859	18,360	100.00	2	5.35
Botswana	IBRD	-	-	0.00	-	-	0.00	0.13	-	-	0.00	-	-	0.00	2.79	7,033	1,587	4,362	58.53	0	-
Brazil	IBRD	92.06	8.72	0.02	13.30	-	114.10	155.55	356.15	21.63	0.06	48.80	-	426.64	568.65	529,808	160	388,852	99.71	17	757.96
Bulgaria	IBRD	2.21	0.69	1.03	0.05	-	3.98	10.91	5.60	1.45	1.38	0.27	-	8.71	46.27	42,416	505	46,099	100.00	3	115.52
Burkina Faso	IDA	0.03	-	0.01	-	-	0.04	0.31	0.09	-	-	-	-	0.09	0.94	2,849	-	1,728	18.47	2	21.00
Myanmar	IDA	3.15	-	0.01	-	-	3.16	4.78	9.31	-	-	-	-	9.31	15.48	21,632	279	12,002	60.50	1	70.00
Burundi	IDA	0.06	-	0.00	-	-	0.06	0.07	0.20	-	-	-	-	0.20	0.23	440	-	228	7.25	2	100.80
Cambodia	IDA	0.93	-	0.01	0.02	-	0.96	1.54	1.98	-	0.00	0.04	-	2.02	4.24	6,685	397	3,801	47.57	1	14.72
Cameroon	Blend	0.72	-	0.01	-	-	0.73	1.55	5.02	-	-	0.08	-	5.09	6.61	7,004	175	5,076	58.87	3	161.57
Cabo Verde	Blend	-	0.03	0.01	-	-	0.04	0.16	-	0.14	-	-	-	0.14	0.46	491	-	430	90.24	1	1.00
Central African Republic	IDA	0.03	-	-	-	-	0.03	0.04	0.15	-	-	-	-	0.15	0.17	301	-	260	13.38	1	4.80
Chad	IDA	-	-	-	-	-	-	0.05	-	-	-	-	-	-	0.22	730	-	443	7.70	0	-
Chile	IBRD	6.50	0.91	0.62	0.47	-	8.49	21.64	23.40	2.11	1.24	5.62	-	32.37	72.33	82,563	402	67,859	99.71	17	640.89
China	IBRD	296.00	129.00	43.20	10.30	0.03	478.53	1,518.56	1,103.33	185.77	45.25	63.73	0.13	1,398.21	5,581.74	10,291,927	680	6,974,412	100.00	42	1,574.38
Colombia	IBRD	11.50	0.02	-	0.24	-	11.76	16.66	44.39	0.06	-	2.20	-	46.65	67.26	84,092	186	67,719	98.19	5	201.39
Comoros	IDA	0.00	-	-	-	-	0.00	0.03	0.00	-	-	-	-	0.00	0.05	154	-	133	75.38	0	-
Congo, Dem. Rep.	Blend	0.21	-	-	-	-	0.21	0.55	0.92	-	-	-	-	0.92	1.68	4,672	266	1,894	16.42	2	145.93
Congo, Rep.	IDA	2.59	-	-	-	-	2.59	2.62	8.83	-	-	0.01	-	8.84	8.85	3,095	1	1,601	60.40	0	-
Costa Rica	IBRD	1.94	0.27	0.01	0.04	0.22	2.47	3.13	7.99	1.08	0.00	0.18	1.38	10.62	10.72	7,759	73	7,178	99.41	2	110.00
Cote d'Ivoire	IDA	0.60	-	-	-	-	0.60	1.82	1.34	-	-	0.11	-	1.44	8.26	11,045	454	#N/A	64.09	0	-
Croatia	IBRD	1.92	0.43	0.05	0.08	-	2.47	4.92	6.33	0.80	0.06	0.27	-	7.45	10.89	16,843	195	20,782	100.00	4	74.21
Djibouti	IDA	-	-	-	-	-	-	0.13	-	-	-	-	-	-	0.41	722	-	468	52.03	2	10.00
Dominica	Blend	0.01	0.01	-	-	-	0.01	0.03	0.02	0.00	-	-	-	0.02	0.09	136	-	124	99.90	0	-
Dominican Republic	IBRD	0.60	0.09	0.02	0.02	-	0.72	3.73	0.93	0.73	0.23	0.02	-	1.91	15.64	21,540	548	20,577	98.56	3	42.85
Ecuador	IBRD	2.39	0.02	0.03	0.14	-	2.58	5.99	12.97	0.10	0.04	0.41	-	13.51	24.97	43,920	353	32,258	98.83	3	4.38

		RE Capacity (GW) 2015							Electricity Generation (TWh) 2015							CO2 Emissions			Access	WBG	
Country	Lending Group	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Capacity	Installed Capacity	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Generation	Total Electricity Generation	Total CO2 per Country (kt) 2014	per kwh electricity - heat output (gCO2 per kWh) 2014	CO2 Average 2000-2014	Access to electricity (% of population) 2016	WBG RE Investment Projects FY00-17	WBG Total RE Commitment
Egypt, Arab Rep.	IBRD	2.85	0.81	0.05	-	-	3.71	38.88	13.30	1.35	0.25	-	-	14.90	171.83	201,894	421	179,020	100.00	5	329.80
El Salvador	IBRD	0.47	-	0.02	0.20	0.20	0.89	1.85	1.35	-	-	0.57	1.54	3.46	5.92	6,285	264	6,413	95.40	0	-
Equatorial Guinea	IBRD	0.15	-	-	-	-	0.15	0.33	0.20	-	-	-	-	0.20	0.43	5,346	-	4,639	67.47	0	-
Eritrea	IDA	-	0.00	0.00	-	-	0.00	0.14	-	0.00	0.00	-	-	0.00	0.38	697	858	620	45.51	0	-
Ethiopia	IDA	2.15	0.32	0.02	-	0.01	2.50	2.70	9.58	0.76	-	-	0.00	10.34	10.34	11,599	1	6,511	33.42	6	311.39
Fiji	IBRD	0.13	0.01	0.00	0.07	-	0.21	0.33	0.41	0.01	-	-	-	0.41	0.89	1,170	-	1,070	97.12	1	2.50
Gabon	IBRD	0.33	-	-	-	-	0.33	0.67	0.91	-	0.00	0.01	-	0.92	2.05	5,192	460	4,691	90.31	1	11.40
Gambia, The	IDA	-	-	-	-	-	-	0.11	-	-	-	-	-	-	0.24	513	-	357	46.49	0	-
Georgia	IBRD	2.73	-	-	-	-	2.73	4.28	8.37	-	-	-	-	8.37	10.61	8,988	109	5,894	99.99	4	211.82
Ghana	IDA	1.58	-	0.01	-	-	1.59	2.84	5.79	-	0.00	-	-	5.79	11.09	14,466	243	9,292	75.72	1	6.22
Grenada	Blend	-	0.00	-	-	-	0.00	0.05	-	-	-	-	-	-	0.20	242	-	236	91.87	0	-
Guatemala	IBRD	1.04	0.05	0.09	0.87	0.05	2.10	3.68	3.84	0.11	0.15	2.30	0.25	6.64	10.76	18,328	306	12,177	90.51	6	37.67
Guinea	IDA	0.37	-	0.00	-	-	0.37	0.74	0.50	-	-	-	-	0.50	1.00	2,450	-	2,123	30.96	3	5.49
Guinea-Bissau	IDA	-	-	-	-	-	-	0.03	-	-	-	-	-	-	0.03	271	-	216	14.00	0	-
Guyana	IDA	0.00	0.01	0.00	0.04	-	0.06	0.44	-	-	-	-	-	-	1.00	2,010	-	1,656	83.57	1	5.32
Haiti	IDA	0.06	-	0.00	-	-	0.06	0.32	0.08	-	-	-	-	0.08	0.98	2,860	783	2,110	38.22	1	7.83
Honduras	IDA	0.63	0.18	0.39	0.16	-	1.36	2.50	2.32	0.67	-	0.79	-	3.77	8.63	9,472	446	7,687	89.98	9	181.54
India	IBRD	46.77	24.76	5.50	5.60	-	82.63	324.91	120.27	42.79	5.64	26.54	-	195.24	1,294.50	2,238,377	813	1,498,346	88.00	75	3,057.21
Indonesia	IBRD	5.41	0.00	0.01	1.74	1.40	8.56	57.35	13.60	0.00	0.01	1.13	10.05	24.80	221.31	464,176	736	404,602	97.54	16	1,118.61
Iran, Islamic Rep.	IBRD	10.16	0.12	0.02	0.01	-	10.30	72.94	13.95	0.22	0.00	0.01	-	14.18	264.97	649,481	567	511,623	99.98	0	-
Iraq	IBRD	2.51	-	0.02	-	-	2.53	31.37	2.55	-	-	-	-	2.55	64.92	168,444	1,177	110,376	99.86	1	41.30
Jamaica	IBRD	0.03	0.05	0.01	0.03	-	0.11	0.99	0.13	0.13	-	0.17	-	0.42	3.90	7,422	615	9,349	97.28	3	25.20
Jordan	IBRD	0.01	0.12	0.03	0.00	-	0.16	4.38	0.05	0.12	0.00	0.01	-	0.18	17.88	26,450	656	20,713	100.00	8	285.05
Kazakhstan	IBRD	2.68	0.06	0.06	-	-	2.79	20.08	9.18	0.13	0.05	-	-	9.36	100.56	248,315	515	199,943	100.00	0	-
Kenya	Blend	0.82	0.03	0.02	0.09	0.61	1.57	2.30	3.75	0.06	0.02	0.12	4.48	8.44	9.57	14,287	168	10,564	41.60	10	219.77
Kiribati	IDA	-	-	0.00	-	-	0.00	0.01	-	-	-	-	-	-	0.02	62	-	51	90.56	1	1.00
Kosovo	IDA	0.05	-	-	-	-	0.05	1.57	0.14	-	-	-	-	0.14	5.76	-	1,019	-	100.00	0	-
Kyrgyz Republic	IDA	3.09	-	-	-	-	3.09	3.89	10.99	-	-	-	-	10.99	12.80	9,608	50	6,707	99.91	0	-
Lao PDR	IDA	4.46	-	0.00	0.03	-	4.49	4.54	11.06	-	-	-	-	11.06	11.46	1,955	-	1,335	89.70	7	65.26
Lebanon	IBRD	0.29	0.00	0.01	0.00	-	0.30	2.34	0.47	0.01	-	-	-	0.48	17.32	24,070	713	18,294	100.00	3	8.90
Lesotho	IDA	0.08	-	-	-	-	0.08	0.08	0.60	-	-	-	-	0.60	0.60	2,468	-	2,130	27.92	1	0.30
Liberia	IDA	0.00	-	-	-	-	0.00	0.13	-	-	-	-	-	-	0.30	935	-	691	13.84	1	1.84
Libya	IBRD	-	-	0.01	-	-	0.01	9.46	-	-	-	-	-	-	35.45	56,996	660	51,968	98.53	0	-
Macedonia, FYR	IBRD	0.63	-	0.02	-	-	0.65	1.73	1.85	0.12	0.02	-	-	1.99	6.07	7,510	805	9,976	100.00	1	2.00
Madagascar	IDA	0.16	0.00	0.01	-	-	0.17	0.67	0.90	0.00	-	-	-	0.90	1.51	3,077	-	2,031	19.04	2	1.98
Malawi	IDA	0.35	-	0.01	0.02	-	0.37	0.38	2.10	-	-	-	-	2.10	2.12	1,276	-	1,002	10.80	3	31.47
Malaysia	IBRD	4.67	-	0.26	1.04	-	5.97	33.34	13.79	-	0.27	0.75	-	14.81	141.87	242,821	666	185,601	100.00	0	-
Maldives	IDA	-	-	0.00	-	-	0.00	0.10	-	-	-	-	-	-	0.35	1,335	-	801	99.99	2	17.55
Mali	IDA	0.18	-	0.01	-	-	0.19	0.59	1.17	-	0.01	-	-	1.18	2.18	1,412	-	959	37.60	5	56.65

		RE Capacity (GW) 2015							Electricity Generation (TWh) 2015							CO2 Emissions			Access	WBG	
Country	Lending Group	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Capacity	Installed Capacity	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Generation	Total Electricity Generation	Total CO2 per Country (kt) 2014	per kwh electricity - heat output (gCO2 per kWh) 2014	CO2 Average 2000-2014	Access to electricity (% of population) 2016	WBG RE Investment Projects FY00-17	WBG Total RE Commitment
Mauritania	IDA	0.10	0.03	0.02	-	-	0.15	0.41	0.18	0.10	0.02	-	-	0.30	1.28	2,710	-	1,899	39.50	0	-
Mauritius	IBRD	0.06	0.00	0.02	0.28	-	0.36	1.06	0.12	0.00	0.03	0.53	-	0.68	2.86	4,228	828	3,520	98.74	0	-
Mexico	IBRD	12.22	3.27	0.17	0.75	0.91	17.33	67.43	30.61	8.45	0.25	1.79	6.00	47.10	294.82	480,271	457	461,218	99.00	18	1,049.91
Moldova	Blend	0.06	0.00	0.00	0.00	-	0.07	0.48	0.31	0.00	0.00	0.02	-	0.32	5.74	4,932	492	4,585	100.00	2	3.83
Mongolia	Blend	-	0.05	0.01	-	-	0.06	1.11	-	0.17	-	-	-	0.17	5.19	20,840	1,295	14,438	81.19	3	16.95
Montenegro	IBRD	0.67	-	-	-	-	0.67	0.89	1.48	-	-	-	-	1.48	2.90	2,211	469	2,322	100.00	1	1.35
Morocco	IBRD	1.31	0.80	0.04	0.00	-	2.15	8.04	1.87	2.52	0.01	-	-	4.39	27.97	59,864	708	48,994	99.59	7	721.13
Mozambique	IDA	2.19	-	0.01	-	-	2.20	2.56	17.04	-	-	-	-	17.04	19.58	8,427	41	2,716	24.00	4	71.03
Namibia	IBRD	0.33	0.00	0.03	-	-	0.36	0.51	1.49	-	-	-	-	1.49	1.52	3,755	9	2,557	50.70	0	-
Nauru	IBRD	-	-	-	-	-	-	0.01	-	-	-	-	-	-	0.03	48	-	55	99.00	0	-
Nepal	IDA	0.75	0.00	0.03	-	-	0.79	0.84	3.46	-	0.03	-	-	3.49	3.49	8,031	29	4,107	87.21	13	241.80
Nicaragua	IDA	0.12	0.19	0.01	0.13	0.15	0.60	1.47	0.29	0.87	-	0.45	0.68	2.29	4.44	4,862	331	4,424	81.16	6	73.36
Niger	IDA	-	-	0.01	-	-	0.01	0.18	-	-	0.00	-	-	0.00	0.50	2,127	676	1,065	16.60	1	41.87
Nigeria	Blend	2.04	0.00	0.02	-	-	2.06	10.48	5.66	0.00	-	-	-	5.66	29.83	96,281	416	94,295	52.50	2	8.50
Pakistan	Blend	7.26	0.26	0.21	0.31	-	8.04	22.83	33.66	0.84	-	-	-	34.50	104.58	166,298	425	143,753	93.50	17	1,735.90
Panama	IBRD	1.73	0.27	0.05	0.01	-	2.06	3.20	6.19	0.42	0.02	0.03	-	6.67	10.02	8,801	352	7,794	92.55	2	144.00
Papua New Guinea	Blend	0.27	-	-	0.00	0.06	0.33	0.88	0.86	-	-	-	-	0.86	3.62	6,318	-	4,678	22.19	1	7.30
Paraguay	IBRD	8.81	-	-	0.04	-	8.85	8.87	55.19	-	-	-	-	55.19	55.19	5,702	0	4,492	99.33	0	-
Peru	IBRD	4.15	0.15	0.10	0.18	-	4.58	12.26	23.47	0.60	0.23	0.91	-	25.21	46.65	61,745	254	42,121	93.85	5	88.13
Philippines	IBRD	3.60	0.22	0.13	0.19	1.92	6.06	21.21	8.58	0.75	0.14	0.37	11.04	20.88	78.64	105,654	604	79,844	89.08	13	525.41
Poland	IBRD	0.59	4.89	0.11	0.97	-	6.56	37.32	1.81	10.73	0.06	10.01	-	22.61	155.29	285,740	755	304,767	100.00	1	189.47
Romania	IBRD	6.73	2.98	1.30	0.12	-	11.13	24.03	16.47	7.06	1.98	0.52	-	26.03	63.02	70,003	320	89,964	100.00	2	101.22
Russian Federation	IBRD	50.17	0.02	0.06	1.40	0.08	51.73	263.53	166.31	0.15	0.34	2.82	0.46	170.08	1,008.36	1,705,346	380	1,657,852	100.00	0	-
Rwanda	IDA	0.10	-	0.01	0.00	-	0.11	0.15	0.30	-	-	-	-	0.30	0.60	840	-	600	22.80	2	3.85
St. Kitts and Nevis	IBRD	-	0.00	0.00	-	-	0.00	0.06	-	0.01	-	-	-	0.01	0.21	231	-	209	99.93	0	-
St. Lucia	Blend	-	-	0.00	-	-	0.00	0.09	-	-	-	-	-	-	0.36	407	-	378	97.16	1	1.17
St. Vincent and the Gren	Blend	0.01	-	0.00	-	-	0.01	0.05	0.03	-	-	-	-	0.03	0.16	209	-	215	99.46	0	-
Samoa	IDA	0.01	-	0.00	-	-	0.02	0.05	0.04	0.00	-	-	-	0.04	0.13	198	-	173	99.94	0	-
Sao Tome and Principe	IDA	0.00	-	-	-	-	0.00	0.02	0.01	-	-	-	-	0.01	0.07	114	-	#N/A	64.51	1	9.10
Senegal	IDA	0.08	-	0.01	0.03	-	0.11	0.97	0.34	-	0.00	0.07	-	0.41	3.67	8,856	616	5,980	60.50	3	36.68
Serbia	IBRD	2.32	-	0.01	0.01	-	2.34	7.32	9.98	0.00	0.01	0.03	-	10.02	35.46	37,667	695	47,392	99.98	1	3.50
Seychelles	IBRD	-	0.01	0.00	-	-	0.01	0.09	-	0.01	-	-	-	0.01	0.35	495	-	563	99.68	0	-
Sierra Leone	IDA	0.05	-	-	-	-	0.05	0.08	0.11	-	-	-	-	0.11	0.18	1,309	-	753	16.47	0	-
Solomon Islands	IDA	-	-	0.00	-	-	0.00	0.04	-	-	-	-	-	-	0.09	202	-	178	55.10	1	28.59
Somalia	IDA	-	-	0.00	-	-	0.00	0.08	-	0.01	-	-	-	0.01	0.35	609	-	586	28.29	0	-
South Africa	IBRD	0.66	1.05	1.19	0.14	-	3.04	47.28	0.79	2.27	2.18	0.31	-	5.55	230.59	489,772	1,009	444,191	85.50	9	781.67
South Sudan	IDA								-	-	0.002	-	-	0.002	0.310	1,496	854	1,425	7.94	0	-
Sri Lanka	IBRD	1.665	0.127	-	0.021	-	1.813	4.056	5.909	0.340	0.021	0.057	-	6.327	12.711	18,394	545	13,016	93.89	8	220.63
Sudan	IDA	2.250	-	0.008	0.191	-	2.449	3.736	8.336	-	-	-	-	8.336	12.685	15,365	177	12,349	38.01	0	-

		RE Capacity (GW) 2015							Electricity Generation (TWh) 2015							CO2 Emissions			Access	WBG	
Country	Lending Group	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Capacity	Installed Capacity	Hydro	Wind	Solar	Biomass	Geothermal	Total RE Generation	Total Electricity Generation	Total CO2 per Country (kt) 2014	per kwh electricity - heat output (gCO2 per kWh) 2014	CO2 Average 2000-2014	Access to electricity (% of population) 2016	WBG RE Investment Projects FY00-17	WBG Total RE Commitment
Suriname	IBRD	0.189	-	0.006	0.002	-	0.197	0.435	1.342	-	-	-	-	1.342	2.190	1,991	375	1,922	87.74	0	-
Swaziland	IBRD	0.060	-	0.001	0.120	-	0.181	0.281	0.231	-	-	-	-	0.231	0.431	1,203	-	1,090	62.99	0	-
Syrian Arab Republic	IDA	1.500	0.001	-	-	-	1.501	9.6096	0.409	-	-	-	-	0.409	16.829	30,704	537	51,689	99.64	0	-
Tajikistan	IDA	5.130	-	-	-	-	5.130	5.448	16.731	-	-	-	-	16.731	16.977	5,189	7	2,749	100.00	2	233.70
Tanzania	IDA	0.562	-	0.009	0.070	-	0.641	1.187	2.087	-	0.021	0.021	-	2.129	6.025	11,562	389	6,301	18.50	6	85.59
Thailand	IBRD	3.640	0.220	1.425	3.230	0.000	8.515	40.9733	4.692	0.330	2.380	7.731	0.001	15.134	167.961	316,213	531	253,141	99.60	6	21.31
Timor-Leste	Blend	-	-	-	-	-	-	0	-	-	-	-	-	-	-	469	-	242	67.28	0	-
Togo	IDA	0.067	-	0.002	-	-	0.069	0.229	0.055	-	-	0.005	-	0.060	0.079	2,622	135	1,861	45.03	0	-
Tonga	IDA	-	-	0.003	-	-	0.003	0.017	-	-	-	-	-	-	0.050	121	-	112	96.18	1	0.63
Trinidad and Tobago	IBRD	-	-	0.003	0.005	-	0.008	2.117	-	-	-	-	-	-	9.682	46,274	620	39,528	100.00	0	-
Tunisia	IBRD	0.066	0.245	0.022	-	-	0.333	5.028	0.068	0.450	0.040	-	-	0.558	18.328	28,830	476	24,114	100.00	0	-
Turkey	IBRD	25.867	4.503	0.249	0.299	0.624	31.613	73.146	65.856	11.591	0.191	1.349	2.924	81.911	248.863	345,981	497	268,332	100.00	27	2,168.35
Turkmenistan	IBRD	0.001	-	-	-	-	0.001	4.001	0.003	-	-	-	-	0.003	21.185	68,423	890	52,505	100.00	0	-
Uganda	IDA	0.706	-	0.020	0.060	-	0.786	0.922	2.615	-	-	-	-	2.615	3.235	5,229	-	2,957	18.50	9	610.74
Ukraine	IBRD	5.883	0.514	0.840	0.050	-	7.287	56.915	5.343	1.080	0.480	0.145	-	7.048	152.122	227,299	448	306,392	100.00	3	117.70
Uruguay	IBRD	1.538	0.850	0.065	0.425	-	2.878	4.408	8.183	2.065	0.050	1.788	-	12.086	13.564	6,747	43	6,477	99.71	1	0.00
Uzbekistan	Blend	1.760	-	-	-	-	1.760	12.927	11.700	-	-	-	-	11.700	54.423	105,214	548	117,200	100.00	1	9.00
Vanuatu	IDA	-	0.003	-	0.003	-	0.006	0.033	-	0.005	-	-	-	0.005	0.055	154	-	97	44.67	1	2.00
Venezuela, RB	IBRD	15.140	0.030	0.003	-	-	15.173	32.173	74.150	0.090	-	-	-	74.240	114.370	185,220	243	176,684	99.46	0	-
Vietnam	IBRD	16.600	0.135	0.004	0.255	-	16.994	40.494	55.562	0.120	-	0.060	-	55.742	146.902	166,911	355	110,571	100.00	6	505.31
Yemen, Rep.	IDA	-	-	0.015	-	-	0.015	1.534	-	-	-	-	-	-	5.006	22,699	737	20,133	70.21	2	23.30
Zambia	IDA	2.320	-	0.003	0.040	-	2.363	2.37	12.905	-	-	-	-	12.905	13.285	4,503	18	2,594	31.10	4	13.95
Zimbabwe	Blend	0.790	-	0.004	0.100	-	0.894	2.129	4.940	-	-	0.129	-	5.069	9.384	12,020	675	10,129	33.70	0	-

Source: U.S. Energy Information Administration, 2018*; OECD, 2018**; World Development Indicators, 2018.

* EIA data not available for Marshall Islands, Micronesia, Palau and Tuvalu

** OECD data not available for 49 developing countries

Appendix C: Methodology

Evaluation Questions

The purpose of the evaluation was to obtain evidence-based findings on the performance of the World Bank Group (WBG) as it helped clients integrate renewable energy (RE) in their overall power generation mix in order to meet energy and environment needs. In line with this objective, two overarching evaluation questions[1], with corresponding sub-questions, guided the collection of data:

1. In what ways and how well has the WBG contributed to addressing its clients' evolving RE needs within the context of their overall energy sector development objectives? in which these sub-questions were raised:
    - How well aligned are the WBG's interventions with the clients' priority RE needs as they navigate changing RE markets and expanding global initiatives?
    - How has the WBG performed in addressing barriers and mobilizing finance for advancing RE development in meeting client's energy and environment needs?
    - How has the WBG positioned itself at global and country levels through its RE engagements by leveraging experience and partnerships?
2. What lessons can be learned from experience that could inform the WBG's role in helping clients achieve emerging goals in RE?
    - What does evaluative evidence indicate about the WBG preparedness to assist clients in meeting their future RE development goals in consideration of SDGs and climate agreements?

Theory of Change (ToC)

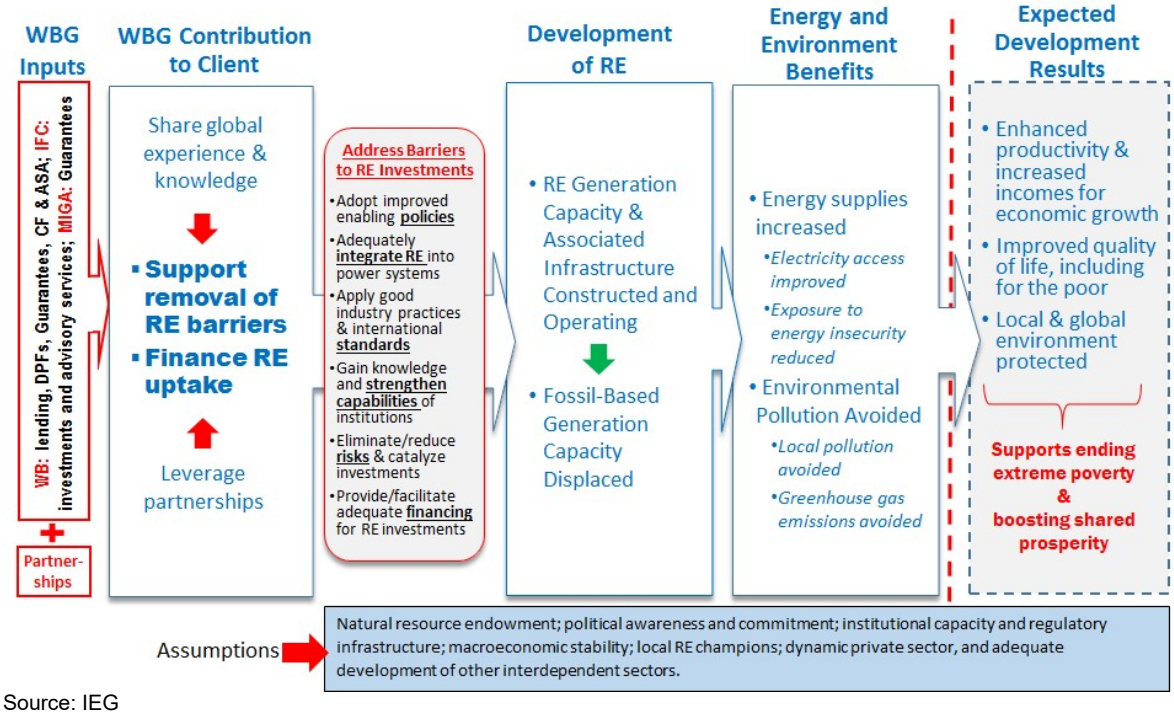
The Theory of Change (ToC) presents a stylized representation of WBG along the following causal linkages: (a) WBG support contributes to RE development by helping clients address financing, policy and technical barriers to renewable energy (RE) investments; (b) WBG interventions motivate clients to improve investment climate and scale-up investments in RE generation capacity; and (c) development of RE leads to energy and environmental benefits, which ultimately contribute to economic growth, improved quality of life and protected the local and global environment. (refer to Figure C1).

The ToC maps the different types of WBG instruments and products (inputs) and in partnership with donors, government and public partners, allow the WBG to contribute its global experience and knowledge to help remove key barriers to RE investments and uptake (core contribution). In

[1] Approach Paper

turn, support by the WBG and its partners are expected to influence client countries to improve the investment climate for RE development, mobilize adequate funding, follow good industry practices, effectively implement RE investments, mitigate risks, facilitate the integration and strengthen institutional capacity (intermediate outcomes). These reforms would result in the successful deployment of RE generation capacity and associated infrastructure (development of RE) to meet client countries' energy needs. In countries where RE sources displaces fossil-based alternatives, these countries gain from the resulting energy and environmental benefits such as a) increased power supplies, which improves electricity access and reduced energy insecurity and b) avoided environmental pollution including avoided local pollution, and greenhouse gas emissions. The realization of these energy and environment benefits are interdependent on other *assumed* developments in different sectors and, when applied in combination, can lead to a number of development impacts. These impacts include: a) the promotion of economic growth; b) the improvement to quality of life, especially for the poor; and c) the protection of the local and global environment. The impacts support WBG's twin goals of ending extreme poverty and boosting shared prosperity through sustainable and inclusive economic growth, consistent with the WBG's *Forward Look 2030* strategy.

Figure C1. Theory of Change



Source: IEG

Data Collection and Analysis

Evaluating the WBG's support to RE can be complex given the multiple technologies and their respective technical characteristics, and therefore, the need for an in-depth assessment of WBG interventions in addressing key barriers in the sector, and for placing them in the context of

evolving external global and country level market influences is necessary. To sort through these complexities and bring different perspectives together in answering the evaluation questions and the corresponding lines of analytical inquiry, the evaluation adopted a multi-level and mix evaluation methods. The evaluation is multi-level, assessing at the global, country, project and intervention levels. Finally, the evaluation applied a mixed methods approach that combined an array of methods for data collection and analysis and triangulated to ensure robustness of findings. The methods applied include Structured Literature Review (SLR), Portfolio Review and Analysis (PRA) including Cost-Benefit Analysis (CBA) and evolution of hydropower projects, Qualitative Comparative Analysis (QCA), Comparative Case Studies, Delphi global expert panel, Project Performance Assessment Reports (PPARs), Semi-Structured Interviews with various stakeholders, WBG staff and Management and Country and Sector Strategy reviews. Table C1 summarizes the alignment of the different methods used to the evaluation questions.

Table C1. Overview of Methodological Design

Evaluation Method	Description
Structured Literature Reviews (SLR)	Three (3) SLRs on a) RE Market Review, b) Barriers to RE, and c) Benefits/Impacts of RE were completed
Portfolio Review and Analysis (PRA)	Systematic desk-review and assessment of 543 RE Lending/Investment projects, 245 RE ASA/AS projects across 100 countries. Two (2) new PPARs were also completed in addition to the 16 existing PPARs reviewed. A separate analysis of the hydropower portfolio was performed including a cost benefit analysis.
Case Studies	Nine (9) in-depth country studies (5 field-based, 4 desk-based) were analyzed across 3 time periods within the overall evaluation period (FY00-17) to , QCA/Comparative Analysis
Semi-Structured Interviews	Interviews with WBG staff and management as well as public and private stakeholders were implemented
Structured survey of purposive sample of WBG staff	A Survey Monkey survey was administered to 37 RE specialists to obtain WBG staff views and experience related to supporting WBG clients with RE issues specifically on integration, distributed RE generation and WBG staff experience on institutional coordination and collaboration
Global Expert Panel	An 8-member high level RE global expert panel using a Delphi technique was convened to identify emerging opportunities and challenges in developing RE and whether the WBG is well-positioned and has the capacity to assist client countries.
Country Strategy Reviews	A review of WBG institutional and country assistance strategies (CAS/CPF) were completed on a stratified sample of 35 countries in which resulted in 123 CAS/CPF covering the evaluation period. In addition, case study countries were also added to the sample which included an additional 43 CAS/CPF for the review for a total of 166 CAS/CPF reviewed.

A. **Structured Literature Reviews (SLR)**

i) **RE Market Review:** IEG conducted a literature review of the evolution of RE market and the changes that occurred in the last 17 years (FY2000-17) focusing on the selected RE technologies mainly hydropower, wind, solar, geothermal, biomass, included in the evaluation. The main areas covered in the research include the evolution of RE in the context of the overall power sector, the evolution of each of the five technologies included in the evaluation, the influence of climate change and climate action on the development of RE, and the identification of emerging opportunities and issues that could catalyze and hinder respectively the development of RE around the world.

ii) **Barriers to RE:** A SLRs were carried out to identify and confirm the different barriers to RE development and RE energy and environmental benefits. The SLR focused on literature published during the period FY2000-17. The literature search was undertaken at the global

level, regional level, and country level. The resulting literature included: (i) publications from major global and regional organizations involved in RE development; (ii) articles in academic and trade journals, (iii) private sector publications and (iv) articles by general news sources. Multiple literature searches were conducted, using keywords denoting barriers to RE development. The search results d was filtered to focus on the most reputable and relevant sources for answering the evaluation questions. The selected documents were structured in a matrix, according to global, regional and country-specific categories, by year. The results of the research formed the basis for identifying RE barriers, benefits, and RE development impacts in the evaluation.

iii) **Benefits/Impacts of RE:** Two SLRs were carried out to review and validate: a) the energy and environmental benefits, and b) the development impacts that the energy and environmental benefits contribute to, including economic growth, improved quality of life, especially for the poor, and achieving local and global environmental goals. The SLR focused on literature published during the period FY2000-17. The literature search was undertaken at the global level, regional level, and country levels. The resulting literature included: (i) publications from major global and regional organizations involved in RE development; (ii) articles in academic and trade journals, (iii) private sector publications and (iv) articles by general news sources. The selected documents were structured in matrices, according to global, regional and country-specific categories. The results of the research, in addition to the QCA, helped validate the ToC for supporting RE development by the Bank Group.

B. **Portfolio Review and Analysis**

An extensive review of all identified RE projects from FY2000-17 using a data recording template (see Figure C5) that was designed to align to the evaluation questions was conducted. The PRA exercise covers the overall mapping and description of the global RE portfolio, as well as some depth and breadth analysis on hydropower sub-sector.

iv) **RE Investment Portfolio:** Analysis was performed at the global portfolio level starting with the mapping of selected type of interventions from FY2000-17 and their potential contribution in addressing key barriers and risks to help clients to meet their RE needs for increased electricity access, energy security and their environmental objectives as well as an in-depth review of the evaluated projects in the portfolio. The diversity and levels of WB, IFC and MIGA collaboration at the global portfolio level and the use of partnerships were also considered in the mapping exercise. The review was based on a set of protocols that were developed specifically for the evaluation to extract the information from the 543 projects reviewed. The evaluated projects provided results and lessons to the Appendix E which describes the portfolio review analysis process and findings in detail.

The PRA validated the working hypothesis of the ToC to identify key contributions made by the WBG in helping clients address key barriers to developing RE. Contributions through RErelated projects including the behavioral changes it helped influence and the specific barriers that the contributions helped address, determined the effectiveness of achieving this end, assess whether the output was successfully attained (i.e. efficacy), and evaluate whether the contribution helped produce the intended outcomes. Key performance indicators (KPI) were also analyzed for the evaluated WB investment projects based on the development objectives that were designed to measure project performance in addition to the review of the Implementation Completion Report Review (ICRRs) and Project Performance Assessment Report (PPARs) for WB projects, Evaluations Notes on Expanded Project Supervision Report (XPSRs) and Project Completion Report (PCRs), Project Evaluation Summary (PES) for IFC and Project Evaluation Report (PERs) for MIGA. A detailed performance analysis of RE projects across all WB institutions is discussed in Appendix E.

v) **Review of WB ASA and IFC AS:** A total of 245 WBG ASA/AS (146 ASA and 99 IFC AS) were identified and tabulated using the same identification methodology as the lending portfolio. Of these, only 10 IFC AS projects have self-evaluations that were validated by IEG. The WB does not yet have a self-evaluation system for WB ASAs and therefore IEG did not review the WB ASA results and performance. Appendix E. Portfolio Review and Analysis describes the role and performance of ASA and advisory services analysis which includes detailed examples. To supplement the limited sample of evaluated ASA/AS projects, a review was undertaken for ESMAP and ASTAE, which were two multi donor-supported trust fund programs that supported RE in particular through various programs. An in-depth review of ASA/AS projects, both active and closed were also undertaken as part of the country case studies. Annex H. Partnerships provides a summary of this review.

vi) **Review of Hydropower Portfolio:** Given the significance of hydropower (stand-alone and combined with other technologies) as a share of RE (43%) in project volume, and its prominence across all three WBG institutions, IEG carried out additional assessments to assess the results and performance of the WBG in supporting the technology over a long period of time.

   a. **Cost Benefit Analysis**: A cost-benefit analysis was carried out on 60 hydropower dams (57 conventional dams and 3 pumped storage) supported by the Bank Group since 1976, which approximates to about 25 percent of all hydropower projects financed by the institution. The evaluation assessed the efficiency of Bank Group supported projects by ascertaining the impact on cost and time overruns on the overall results of the portfolio of projects, which reflects the complexities often associated with developing the technology. The evaluation used avoided costs to estimate the benefits from the hydropower. The analysis valued the net economic benefits resulting through the provision of electricity

from the portfolio, and also the global external benefit contribution from the avoided CO_2 emissions. Details about the methodology and results are presented in Appendix G.

b. **Review against criteria established in *Directions in Hydropower*:** In 2009, the WBG decided to scale-up the support to hydropower, but focus beyond the direct energy benefits, to ensure that the projects also achieve additional benefits in several priority areas (Water Working Note 21, 2009). They included scaling up finance by addressing barriers, promote good practices in governance, safeguards and technical analysis, strengthen planning capacity, leverage regional benefits, and build partnerships at country and global levels to maintain focus on sustainability. A portfolio of 41 evaluated projects/investments (from the overall hydropower portfolio of 140 projects/investments) were reviewed against the above criteria to ascertain how well and to what extent the WBG supported hydropower projects met the stated objectives that were established at approval. Details about the methodology and results are presented in Appendix G.

vii) **Review of WBG Country Strategies:** WBG strategies at the corporate and country levels were reviewed to assess whether the three institutions transitioned over time in a manner consistent with the evolving market conditions as well as client needs.

a. The WBG-wide and each WBG institution energy and climate related strategies were reviewed and mapped for the evaluation period to identify the strategic focus placed by the energy sector of the WBG institutions including identifying any placement of RE or related subjects.

b. To confirm whether the institutional-level strategies were being reflected at the country level, a stratified (based on RE penetration in the country) sample of 35 countries were randomly selected from 140 developing countries that are eligible to borrow from the WBG. The Country Partnership Strategies (CPFs) or Country Assistant Strategies (CASs) that covered the evaluation period (FY2000-17) for the 35 countries were reviewed. A total of 123 CPFs/CASs were reviewed to assess whether RE in general or specific RE technologies were included in the country-level strategies. The review identified the degree to which RE or RE technologies were included in the CPFs/CASs, whether RE was a part of the results framework (RF) indicating a specific project/investment (indicating RE is a strategic priority), one of the strategic pillars for client support (inclusion in strategy is less firm than if it was included in the RF), or if RE was only mentioned as an issue in the strategy documents (least significant indicator in terms of leading to a specific project/investment engagement). The results were then analyzed over time to identify whether RE or specific RE technologies are being mainstreamed within the WBG's country-level strategies as an area of engagement. Finally, a cross check of the list of projects/investments mentioned in the strategies was performed against the overall identified RE portfolio for validation.

viii) **In-Depth Country Case Studies:** Nine (9) purposefully selected country case studies were carried out to further analyze the different approaches to developing RE over the evaluation period; evaluate the WBG's project/investment and ASA/AS activities to confirm its contribution in helping clients address barriers to RE development and impact on achieving energy and environmental results; assess the extent to which there was coordination within the WBG institutions and with other development partners, and provide input to the QCA exercise. Of the 9 country cases selected, five involved field-based case studies with country visits while four involved desk-reviewed studies. Country cases benefited from interviews from field-level staff, government officials, beneficiaries, local experts, NGOs, academia and other stakeholders.

The case studies were purposefully selected shown in Figure C2 based on the nature of the WBG RE portfolio including the different RE barriers addressed (based on PRA review), the number of completed and evaluated projects/investments, share of IBRD, IDA, IFC and MIGA, and overall geographical spread (including income group level and lending groups) covering most WBG designated regions. In each case study shown in Table C2, an in-depth portfolio review provided the initial basis as to how the country utilized WBG's activities and contributions and how it aligned to the government and WBG country and sector strategies. Field missions were used to further validate and gather more evidence to support the narrative and to fill in information gaps required to fully understand how the barriers to RE development were addressed through WBG interventions. The results were utilized as evidence to triangulate with examples to the overall conclusions of the evaluation.

Figure C2. Case Study selection criteria summary

Source: IEG

Table C2. List of Countries for Case Studies by Regions and Selection Criteria

Country Case Studies		WBG Institution			PRA-flagged barriers						Units of Analysis						
Region	Country	IBRD/ IDA	IFC	MIGA	Policy	Integration	Design & Standards	Inst. Capacity	Inv. Risk	Mob. Financing	RE %	RE Technology					
												H	S-PV	W	B	G	S-CSP
EAP	China	x	x		x	x	x	x	x	x	25	x	x	x	x		x
ECA	Turkey	x			x	x		x	x	x	33	x		x	x	x	
LAC	Mexico	x	x		x	x	x	x	x	x	16		x	x	x		X
LAC	Nicaragua	x	x	x	x	x		x	x	x	52	x	x	x	x	x	
MNA	Jordan	x	x	x	x	x		x	x	x	5		x	x			
MNA	Morocco	x	x		x	x	x	x	x	x	16	x	x	x			x
SAR	India	x	x		x	x	x	x	x	x	15	x	x	x	x		x
SAR	Sri Lanka	x	x		x	x	x	x	x	x	50	x	x	x	s		
AFR	Kenya	x	x	x	x	x	x	x	x	x	88	x		x		x	

Sources: IEG portfolio review and EIA statistics. Technology: H=hydropower, S-PV=solar PV, W=wind, B=biomass, G=geothermal and SCSP=solar CSP

ix) **Qualitative Comparative Analysis (QCA):** is "a new analytic technique that uses Boolean algebra to implement principles of comparison used by scholars engaged in the qualitative study of macro social phenomena. integrative … examining how the different parts of a case fit together, both contextually and historically."[2] As a case-oriented and set theory-based method, rather than variable-oriented and statistics-based method, the QCA technique begins by establishing qualitative descriptors for group membership in each precondition and outcome variable. For this evaluation, the nuances and complexities of RE growth are distinctive to the country contexts in which RE is being developed. It was determined that a qualitative approach to assess the validity and comprehensiveness of the TOC was most appropriate. QCA was therefore undertaken to achieve two primary objectives: (a) the first being to validate the TOC for RE investments, developed during the evaluation; and (b) the second, to identify the pathways used by countries to grow RE capacity, depending on contextual factors within the case countries.

By validating the TOC, the QCA analysis contributed to determining if the approach to RE development applied over the past almost-two decades has been addressing the appropriate barriers (equivalent to preconditions in QCA terminology) to achieve RE growth, and thereby potential energy and environmental benefits, within the contexts in which the WBG is operating. In addition to validating the TOC, the QCA technique was used to identify pathways to RE growth (i.e., differing combinations of addressing preconditions that led to RE capacity) that are consistent with the sometimes-unique experiences of countries. Appendix J describes the process and results of the analysis in detail.

[2] fuzzy set/Qualitative Comparative Analysis. www.socsci.uci.edu/~cragin/fsQCA/

x) **Project Performance Assessment Reports (PPARs)[3][i]:** Eighteen 18 PPARs were reviewed for the evaluation, including two new PPARs that were completed during the evaluation. These additional PPARs, included a hydropower project in China and an off-grid rural electrification project in Nicaragua, both of which served as inputs to the country case studies. Appendix F describes the objective, components and ratings of the eighteen (18) RE PPARs included in the portfolio.

C. Semi-Structured Interviews/Surveys

xi) **Public and Private Stakeholders:** Purposefully selected key stakeholders that include government officials, state-owned enterprise officers, private sector players, development partners and civil society representatives were interviewed during the preparation of the indepth country case studies. In addition, select WBG staff that worked on the specific country were also interviewed. Their input and views are reflected in the final case-study assessment. xii) **WBG Management:** Management from IFC, MIGA, and the WB who oversee RE development were interviewed to seek their input as to the opportunities and challenges they see in supporting the development of RE. Their inputs are reflected in the evaluation report.

xiii) **WBG Staff Survey:** An electronic survey was carried with a purposefully selected group of WBG specialists who work on RE. There were 34 survey responses (18 WB, 16 IFC) out of 37 selected staff (92% response rate). The survey solicited perspectives from the WBG specialists on select emerging issues and solutions in RE development, providing WBG perspective. The survey results are reflected in the evaluation report.

D. **IEG Global Expert Panel on RE** xiv) IEG convened a RE global expert panel to (a) identify emerging opportunities and challenges in developing RE and (b) whether the WBG is well-positioned and has the capacity to help clients identify opportunities and address the emerging challenges to developing RE. The expert panel is comprised of eight individuals who are internationally recognized as thought/business leaders in energy, environment, and development. The panel members went through a Delphi exercise involving a structured, iterative process utilized for forecasting based on the collective knowledge and experience of a highly qualified group of experts on a given subject. two iterative rounds where each of the panel member provided their input to validate the findings of the evaluated. The resulting information was then used

[3] PPARs serve both accountability and learning functions, and may be conducted at any point after a selfevaluation (ICR) has been completed. Though they formally follow the same rating criteria as the ICRR, PPARs are evaluations rather than a validation exercise, and they rely on a broader set of evidence. For World Bank operations, the instrument has evolved over time; IEG began to conduct PPARs for IFC operations in FY16. Each PPAR conducts an independent field-based evaluation of one or more lending operations. PPARs use different evaluation methods which include (but is not limited to) a literature review, portfolio analysis, and a country mission involving site visits and semi-structured interviews with different stakeholders

to validate the findings of the evaluation. Details about the participants and the results from the Delphi exercise is presented in Appendix I.

Sampling Considerations Summary

The evaluation encompassed data collection and analysis activities at four levels: global/total portfolio level, country level (for selected countries), intervention level (for selected interventions in selected countries), and the level of individual stakeholders or stakeholder groups. The criteria for selection and sampling are described below:

- Selection of countries for in-country data collection and analysis used the following screening criteria:

  a. adequate number and sufficient diversity of types and levels of WBG interventions in the country, including use of partnership programs;

  b. sufficient diversity of country contexts along important dimensions such as, geographic/regional, technology type, country income classification, etc.;

  c. pragmatic considerations such using desk reviews for country experience that have been extensively studied instead of country visits;

  d. countries that were not selected as case studies by other on-going IEG evaluations that have some relevance to RE such as the respective evaluations of WBG support for Carbon Finance and Pollution Management;

  e. level of WB, IFC and MIGA internal collaboration and coordination with external partners in identifying public and private opportunities to scale up WBG engagement in RE; and

  f. countries highlighted by key actors/stakeholders such as WBG institutions' management and sector leaders.

- Purposive sampling of interventions for the QCA.
  The comparative case study analysis focused on the effectiveness of a purposive representative sample of RE interventions. The purposive sample was determined by the following three main criteria:

  a. Stratification of the portfolio according to the major barriers/risks in RE addressed by the intervention. The purposive sample included sufficient interventions relating to specific barriers and risks to adequately reflect the overall diversity.

  b. Overall representativeness. The purposive sample of interventions reflected the overall (regional, technological, policy instrument, etc.) of the global RE portfolio.

  c. Alignment with country selection (see above) ensured the efficiency of the analysis in the light of resource and time constraints.

- Diversity and minimum number of intra-WBG collaboration and external partnerships.
- Purposive selection of key stakeholders for interviews at the global, country and specific intervention (in selected countries) levels covered relevant stakeholder groups, including WBG management and staff, for each interview exercise. The number of interviewees was optimized to allow for large diversity in coverage while being mindful of cost and time implications. In addition to diversity, principles of triangulation and reaching the 'point of theoretical saturation' was considered in deciding about the number of interviews.

Limitations

The evaluation design came with several limitations and challenges including (i) use of findings and lessons from evaluations of past Bank Group projects approved under different contexts and data availability on a fast moving sector; (ii) the highly contextual nature of REs based on countryspecific resource endowments and varying institutional landscapes that made generalizations difficult; (iii) lack of evaluative evidence on the effectiveness and outcomes of the Bank's RErelated ASAs and stand-alone Project-Based Guarantees (PBGs) left a large knowledge gap; (iv) differences in IFC, MIGA and the Bank project evaluation methodologies limited comparability and aggregation; (v) data collection and analysis pertaining to the case studies required consistent and rigorous application to yield modest and generalizable findings (external validity); (vi) limited selection bias in the case study design; and (vii) the Bank Groups's effectiveness in utilizing partnerships for helping deploy RE were assessed at the country level only through case studies.

Ensuring Validity of Findings

To address these limitations and to ensure a consistent approach across evaluation team members, the evaluation team undertook continuous and extensive triangulation from different data sources. To ensure internal validity of findings, templates for the case study analysis, incountry visits and the semi-structured interviews of key stakeholders were prepared in consultation with IEG's Methods Adviser. Team specialists assigned to conduct the case study analysis and stakeholder interviews underwent orientation regarding the data requirements and the expected outputs. Quality control was consistently applied on the information gathered at different stages of the evaluation.

Evidence and conclusions from interviews were checked against information arising from documents, ICRRs, PPARs, and quantitative data from external sources, and vice versa.

The evaluation team also used external validation at various stages of the evaluation process. In particular, the team consulted its senior advisors throughout the evaluation process. The team maintained a dialogue with key Management counterparts of the World Bank Group institutions at several points throughout the evaluation to validate hypotheses, approaches, impressions, and

preliminary conclusions. Three peer-reviewers provided feedback at the approach paper and one-stop stages.

ATTACHMENT 1: Form for Extraction and Recording of Data for RE Portfolio Evaluation

The Power to RE new: Evaluation of the World Bank Group's Support to Renewable Energy (RE) Development

Form for Extraction and Recording of Data for RE Portfolio Evaluation

The Independent Evaluation Group (IEG) is conducting an evaluation of the performance of World Bank Group's (WBG) support to Renewable Energy (RE) development in the period 2000-2017. **This form is used to extract and record data that will be used for the evaluation.**

========== **Reviewer's Name:** _____ **Date Reviewed:** _____

Validated by: _____ **Date Validated:** _____

I. Documents Reviewed

	World Bank (Check all That Apply)	IFC (Check all That Apply)	MIGA (Check all That Apply)
WBG Appraisal	Project Appraisal Document (PAD) OR Project Paper ☐	Board Document ☐	President's Report ☐
WBG Self-Evaluation	Implementation Completion Results (ICR) Report ☐	Expanded Project Supervision Report (XPSR) ☐	Project Evaluation Report (PER) ☐
IEG Validation OR Independent Evaluation	Implementation Completion Results Report Review (ICRR), ☐ OR Project Performance Assessment Report (PPAR)* ☐	Evaluative Note (EvNote) OR Project Evaluation Summary (PES) ☐ OR Project Performance Assessment Report (PPAR)* ☐	PER Validation Note OR Project Evaluation Report (PER) ☐

(*) A PPAR is a more in-depth review of a Project performance conducted by IEG, for select projects. Where there is a completed PPAR, it supersedes the assessment of an ICRR.

If other documents were reviewed, please specify here:

II. Basic Information about Project

Name of Project	Project ID	Country	FY Approved

Region of Project/Investment (Please check one)

☐ AFR ☐ EAP ☐ ECA ☐ LAC ☐ MNA ☐ SAR ☐ World

Note: We are using the World Bank regional classification for this exercise. Please note that for IFC, Pakistan and Afghanistan are in the MNA region but will need to be coded as SAR for consistency.

Type of RE technologies covered under project (Check all that Apply)

☐ Hydro (Storage) ☐ Hydro (No Storage) ☐ Geothermal ☐ Solar PV ☐ Solar CSP ☐ Biomass ☐ Wind

☐ Other (Please Specify): _____

Were any financial intermediaries (other than the WBG) involved?

☐ YES ☐ NO

If Yes, please specify FIs: _____

Is the Project IEG Validated?

☐ YES ☐ NO

If Yes, what is the year of IEG Validation? _____

III. Evaluation Questions/Lines of Inquiry

What are the inputs to the project/investment (please note that the definition of a project/investment includes a clientimplemented (i.e. client-executed) activity that is related to developing RE through assistance by the WBG via loans, grants, technical assistance, development policy financing, guarantees (including political risk insurance), program for results (P4R) or carbon finance)?

Question 1: Please fill in the following Project Cost Table (add rows and columns as necessary)* (US$M)

Project Component/Source of Funding	**PROJECT COSTS**	***FINANCING SOURCES***						TOTAL
		WB	***IFC***	***Owner's Funds /Equity***	***GEF***	***Other Source (please revise name)***	***Other Source (please revise name)***	

Title of Project Component 1 (Copy-Paste all Subcomponents from Detailed project description in Annex)								Sum
Title of Project Component 2 (Copy-Paste all Subcomponents from Detailed project description in Annex)								Sum
Title of Project Component n (Copy-Paste all Subcomponents from Detailed project description in Annex)								Sum
Directly Enter Sum if Sub-Components are not available		Sum	Sum	Sum	Sum	Sum	Sum	**Total Cost**
Renewable Energy Total								

*Use ICR(R) (actuals) for evaluated projects, otherwise from the PAD. When needed, convert all amounts to US$ using the conversion rates provide in the beginning of the document under review.

Project Cost/Financing Notes (please copy and paste direct evidence from project documents):

Does the project involve any guarantees?
☐ YES ☐ NO

If Yes, by which institution? ☐ World Bank ☐ IFC ☐ MIGA

And in what amount in millions of USD: _____

Question 2: What is the project's development objective (DO)? Check all that apply.

☐ Derived from PAD (WB)

☐ Derived from Development Impact (IFC Board Doc)

☐ Derived from Development/Project Impact (MIGA's President's Report) **Please copy and paste PDO:**

Which PDO category does it belong? (check ALL that apply)

☐ Increase in access to electricity ☐ Increase in electricity supply

☐ Reduction in energy insecurity ☐ Local environment (pollution such as SOx, NOx, PM) ☐ Global environment (GHG)

Question 3: Does the project/investment allocate some or all of the funds for technical assistance for various activities (i.e. policy, capacity building, transaction advice) as contrasted with support for development of physical RE infrastructure?

☐ YES ☐ NO

If Yes, how much is allocated for this purpose in terms of US$? _____

Question 4: Is the project on-grid or off-grid electrification (including household level and mini-grid solutions) [Check all that Apply]?

☐ On-Grid ☐ Off-Grid/Mini Grid ☐ Not specified

Please copy and paste direct evidence and references from the documents reviewed. Insert evidence

Question 5: Does the project/investment have linkages with other projects/investments in portfolio?

☐ YES ☐ NO

If Yes, which ones (**list project codes if explicit**)? _____

If Yes, what is the nature of the link? (**Provide details**) _____

Question 6: Was the project/investment related to or influenced by Advisory Services & Analytics (ASA) (ESW or TA) or IFC Advisory Services (i.e. WBG-executed activities)?

☐ YES ☐ NO

If Yes, which ones (**list project codes if explicit**)? _____

If Yes, what is the nature of the link? (**Provide details**) _____

Was the contribution from these activities during project preparation or project implementation (Check all that apply)

☐ Project Preparation ☐ Project Implementation

ADDRESSING BARRIERS TO DEVELOPING RE

What are the RE related barriers (directly or indirectly impacting RE significantly) that the WBG helped address through the project (refer to Attachment 2 of PRA protocols for more details)?

Question 7: Did WBG project/investment's design aim to help address any of the following RE related barriers: (Check all that apply)? (This information should come from WBG appraisal documents: usually at the end of sector context or in the project description)

☐ **Policy and Regulatory**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Integration into Power Systems**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Improve Technical Design & Standards**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Strengthen Institutional Capacity**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Mitigation of Investment Risks**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

Mobilizing Financing

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Other**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

Question 8: For evaluated projects, identify the direct client-based action (issuance of improved law, better design of projects, actions that mitigated risks, provision of finance, etc.) and results that was influenced by the WBG project support? (This information should come from WBG evaluated documents)

☐ **Policy and Regulatory**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Integration into Power Systems**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Improve Technical Design & Standards**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐

☐ **Strengthen Institutional Capacity**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Mitigation of Investment Risks**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Mobilizing Financing**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

☐ **Other**

Provide Specifics (summarize in your own words)	Cut & Paste Evidence from Docs (provide references)

Question 9: Were there any Partnership Funds (i.e. other development partner funds either entrusted with the WBG, such as ASTAE, ESMAP, GEF etc., or syndicated financing – CTF, GEF, SREP, bi-lateral funds, MDBs) that supported the client's efforts to address specific barriers that were preventing investments in RE from being mobilized? If Yes, please list them and provide details.

Please copy and paste direct evidence and references from the documents reviewed

Were the Partnership Funds Bank-Executed) (i.e. directly utilized by WBG to provide support to client) or ClientExecuted (i.e. funds provided to client to secure the necessary support)?

☐ Bank-Executed ☐ Client-Executed

GLOBAL EXPERIENCE AND PARTNERSHIPS

Question 10: Is there evidence indicating WBG contribution from global experience (related experiences/expertise/solutions applied in similar circumstances in other countries/regions i.e. South/South) to any of the project solutions?

☐ YES ☐ NO

If Yes, please explain briefly what the specific global experiences were? **Insert details**

Please copy and paste direct evidence and references from the documents reviewed **Insert evidence**

Did any of them include addressing one or more of the following types of barriers to developing RE (Check all that apply)?

☐ Policy and Regulatory ☐ Integration into Power Systems ☐ Improve Technical Design and Standards

Strengthen Institutional Capacity ☐ Mitigation of Investment Risks ☐ Mobilizing Financing

☐ Other

Please list the other Barriers, if any: _____

Question 11: Did the WBG engagement significantly influence (i.e. cause the WBG client to do something differently) project design/structure of project/investment? **(Evaluated projects only)**

☐ YES ☐ NO

If Yes, was it supported with Partnership Funds (i.e. other development partner funds either entrusted with the WBG, such as ASTAE, ESMAP, GEF etc., or syndicated financing – CTF, GEF, SREP, bi-lateral funds, MDBs)?

☐ YES ☐ NO

☐

Question 12: What Partnership Funds/Development Partners were utilized in the project/investment?

Please Fill Table Below.

Name of Partnership/Fund	Type/Nature of Support	Amount of Funding Provided	Support During Project Preparation or Project Implementation	Client Executed or Bank Executed
(please provide name) …#1				
(please provide name) …#2				
(please provide name) …#n				

Were the Partnership Funds utilized to secure any global expertise?

☐ YES ☐ NO

If Yes, please describe the nature of the global expertise as part of the project? **Insert details**

Please copy and paste direct evidence and references from the documents reviewed **Insert evidence**

Were the partnership support/funds secured during project preparation or during project implementation? (Check all that apply)?

☐ Project Preparation ☐ Project Implementation

Did any of them include addressing one or more of the following types of barriers to developing RE (Check all that apply)?

☐ Policy and Regulatory ☐ Integration into Power Systems ☐ Improve Technical Design and Standards

☐ Strengthen Institutional Capacity ☐ Mitigation of Investment Risks ☐ Mobilizing Financing

☐ Other

Please list the other Barriers, if any: _____

KEY PERFORMANCE INDICATORS (KPIs) – OUTPUTS AND OUTCOMES *What are the RE related outputs and outcomes from the project (refer to key performance indicators when appropriate)?*

Question 13: Which of the energy related outcomes resulted from the RE project/investment? (Check and complete all that apply)

	Provide Specifics/ Indicator Value		**KPI? Y/N**
☐ Increase in access to electricity	***# of people***	***# connections***	☐ **YES** ☐ **NO**
Cut & Paste Evidence from Docs			
☐ Increase in electricity supply	***MWs***	***MWh/year***	☐ **YES** ☐ **NO**
Cut & Paste Evidence from Docs			
☐ Reduction in energy insecurity (increase in indigenous RE resource)	***Insert indicator***	***Insert indicator***	☐ **YES** ☐ **NO**
Cut & Paste Evidence from Docs			

What is the source for the information above?

☐ Appraisal Documents (PAD, Board Doc) ☐ Self-Evaluation Documents (ICR,XPSR, PER)

☐ Evaluation Documents (ICRR, XPSR, PER, PPAR) ☐ Other, please specify

_____

Question 14: Is there evidence in documents of objectives to displace or actual displacement of fossil-based alternate generating sources as a result of RE project/investment?

☐ YES ☐ NO

If Yes,

(1)

Capacity Displaced	**Electricity Displaced**	**KPI? Y/N**
MWs	***MWh/year***	☐ **YES** ☐ **NO**

☐

Cut & Paste Evidence from Docs

(2) Is it displacing existing capacity or potential future investments in fossil based alternatives?

Existing Capacity ☐ Potential Future Investments

Insert evidence

Question 15: Are there any estimates/evidence (if evaluated) of environmental benefits in KPIs or elsewhere (Check and complete all that apply)

	Provide Specifics/ Indicator Value	**KPI? Y/N**
☐ Avoided local pollution	***Health, SOx, NOx, PM***	☐ **YES** ☐ **NO**
Cut & Paste Evidence from Docs		
☐ Avoided global pollution	***GHG, CO_2***	☐ **YES** ☐ **NO**
Cut & Paste Evidence from Docs		

Question 16: Were there any energy or environment impact evaluations (survey, interviews etc., related to the development impacts) implemented under project/investment? **(Evaluated projects only)** ☐ YES ☐ NO

Insert evidence

COORDINATION/LEVERAGE/CONVENING *To what extent has the project/investment been coordinated between IFC/WB (and potentially MIGA)?*

Question 17: Is this a co-funded or joint project/investment that includes two or more of the WBG institutions (i.e. IDA/IBRD, IFC, and MIGA)?

☐ YES ☐ NO

If Yes, what is the nature of the collaboration **Insert details**

Please copy and paste direct evidence and references from the documents reviewed **Insert evidence**

Question 18: For projects, not co-funded within the WBG (i.e. supported by only one WBG institution), is there evidence of an effort to coordinate the project activities (i.e. strategies, policies, sequencing of activities) with any other WBG institution's other ongoing or future activities?

☐ YES ☐ NO

☐

If Yes, what is the nature of the coordination? **Insert details**

Please copy and paste direct evidence and references from the documents reviewed **Insert evidence**

To what extent has the WBG utilized partnerships to support project/investment?

Question 19: Is there an association between the project/investment and activities supported by specialized partnership programs such as ESMAP, ASTAE, Lighting Solar, GPOBA or others WBG trust funded program?

☐ YES ☐ NO

Question 20: According to the documents, is the project/investment the beneficiary of any activities undertaken in another past project/investment by the WBG?

☐ YES ☐ NO

Please explain these activities **Insert details**

Please copy and paste direct evidence and references from the documents reviewed **Insert evidence**

[i] PPARs are in-depth project level evaluations carried out on a proportion of World Bank projects following the World Bank's self-evaluation (Implementation Completion Report or ICR) and IEG's validation (Implementation Completion Report Review or ICRR) process. The PPARs are carried out by IEG, and involves in-depth review with in-country validation of the findings from the ICR/ICRR as well stakeholders interview.

Appendix D. Sector and Country Strategies and Diagnostics

Introduction

This section attempts to present how well aligned are the evolving WBG institutional strategies and country assistance strategies with the changing sector dynamics and client needs for

renewable energy (RE) and diagnose to what extent has the shift in WBG's intentions trickled down to client-level engagements (investments/projects).

Based on the objective above, the **specific questions** underpinning the analysis are:

- How did global RE market change over the evaluation period (2000-2017), along with the influence from Climate Actions and significant reduction in technology costs?
- How did the WBG shift its institutional strategy to better reflect RE as development priority?
- Was the institutional strategic shift represented in Country Assistance Strategy or Country Partnership Framework (CAS/CPF)?

Overview of Country Assistance Strategy (CAS, also called CPF)

CAS/CPF is the central tool of Management and the Board for reviewing and guiding the WBG's country programs and gauging their effectiveness. [1] It sets out WBG's strategy for specific time period supporting development goals of client countries based on importance of issues, development priorities, WBG's comparative advantage, and resource availability.

The country strategy diagnostics is based on analyzing three major areas comprising a CAS/CPF: Issue, Strategy and Result Framework.

- Firstly, a CAS/CPF starts from a section addressing the challenges shaping the development agenda of a country, which is referred as "Issue" in the analysis.
- Next, the following section proposes WBG's strategy framework in supporting a country to achieve its development goals, which is referred as "WBG strategy" in the analysis. Usually the strategy framework clarifies the development objectives and WBG engagement areas.
- Lastly, the concluding section of CAS/CPF, usually in the form of a matrix in the annex, lays out the Result Framework for WBG assistance, along with a brief review of ongoing and indicative WBG interventions. This section is referred as "WBG Result Framework" in the analysis.

Methodological Design

1. Country Sampling Process

1.1 Group of stratified sample countries

- The initial data included more than 200 countries, territories and regions with information on the percentage of renewable energy (RE) use out of total energy.
- 140 WBG lending countries remain in the sample after removing developed countries (countries with no CAS reports), and non-sovereign territories.

- From the 140 countries, a stratified sample of 35 countries were randomly selected from seven strata based on renewable energy penetration level (percentage of RE usage out of total energy) from high to low. For each of the 35 countries, a total of 123 CAS reports (also called CPF, CPS) covering evaluation period (2000-2017) were collected and reviewed.

1.2 Group of case study countries

For the purpose of validating the result of analysis on sample countries, 43 CAS reports of nine case study countries - China, India, Jordan, Kenya, Mexico, Morocco, Nicaragua, Sri Lanka, and Turkey covering the evaluation period (2000-2017) were also selected for review.

2. CAS Review Method

The whole CAS review is based on the dataset containing all the renewable energy contents for each CAS document of each country (123 CAS documents of sample countries, and 43 CAS documents of case study countries) covering the evaluation period (2000-2017).

The data collection on CAS begins with RE-related content searching within CAS/CPF documents. A CAS is considered including renewable energy agenda in country assistance strategies if related contents are found, and the terms used for searching can be categorized into two groups:

- **Climate change pertaining to renewable energy**. Key words have been used for searching were: climate change, global warming, climate mitigation.
- **Renewable Energy in general terms**. Key words have been used for searching were: green energy, clean energy, sustainable energy, alternative energy, non-conventional renewable energy, non-conventional energy, NCRE.

After collecting the general renewable energy terms above, specific RE technologies terms are used for searching to see whether a country addressed a specific technology in country-level strategies during different time periods. The terms for searching specific RE technologies are: Hydro/Hydropower, Wind/Wind Power, Solar/Solar PV/Solar CSP/Solar Power, Geothermal, and Biomass/Biofuel/Biogas/Bioenergy. After the first-round collection, CAS documents including bioenergy not related to electricity production were eradicated from the dataset.
Finally, in order to see the shifts in RE significance and the prioritization of different RE technologies at country level, RE in general terms and specific RE technologies in a CAS documents are grouped into specific CAS areas.

The analysis uses a Gantt Chart to show the evolving RE focuses included in WBG country strategy framework for 35 sample countries. The analysis divided the entire time frame is divided into three periods to show the shift in strategies over different phases of RE development:

2000-2005: This is the period when WBG initiatives for most RE were sporadic.

2006-2011: This is the period when WBG began to scale up the penetration of RE as climate change became a priority for development.

2012-2017: This is the period representing the last evaluation period of WBG initiatives for RE.

A "traffic-light" color coding is applied to the Gantt Chart showing the extent to which RE or technology was positioned in country strategies. The method for coding CAS/CPF is cascading, which shows the most advanced inclusion of RE or technology in CAS/CPF.

- "Red" - RE or technology included in CAS/CPF as an issue raised.
- "Yellow" - RE or technology included in CAS/CPF as a part of WBG strategy. This also includes conditions when RE or technology was included in CAS/CPF both as an issue and a part of WBG strategy.
- "Green" - RE or technology included in CAS/CPF as a part of WBG result framework. This also includes conditions when: RE or technology was included in CAS/CPF as an issue, a part of WBG strategy and WBG result framework; RE or technology was included in CAS/CPF as an issue and a part of WBG result framework; and RE or technology was included in CAS/CPF as a part of WBG strategy and WBG result framework.
- "Grey" is used for marking CAS periods when no RE or technology was mentioned in CAS/CPF documents.

An overview of the shift in WBG country strategies divided is in the graph below. The abbreviated texts on bars refer to RE or technologies that were mentioned in CAS/CPF in the most advanced phase: H- Hydropower; W- Wind Power; S-Solar Power; G- Geothermal Power; B-Biomass Energy; RE: RE term in general.

Figure D.: CAS/CPF Overview: Evolving CAS during 2000-2017

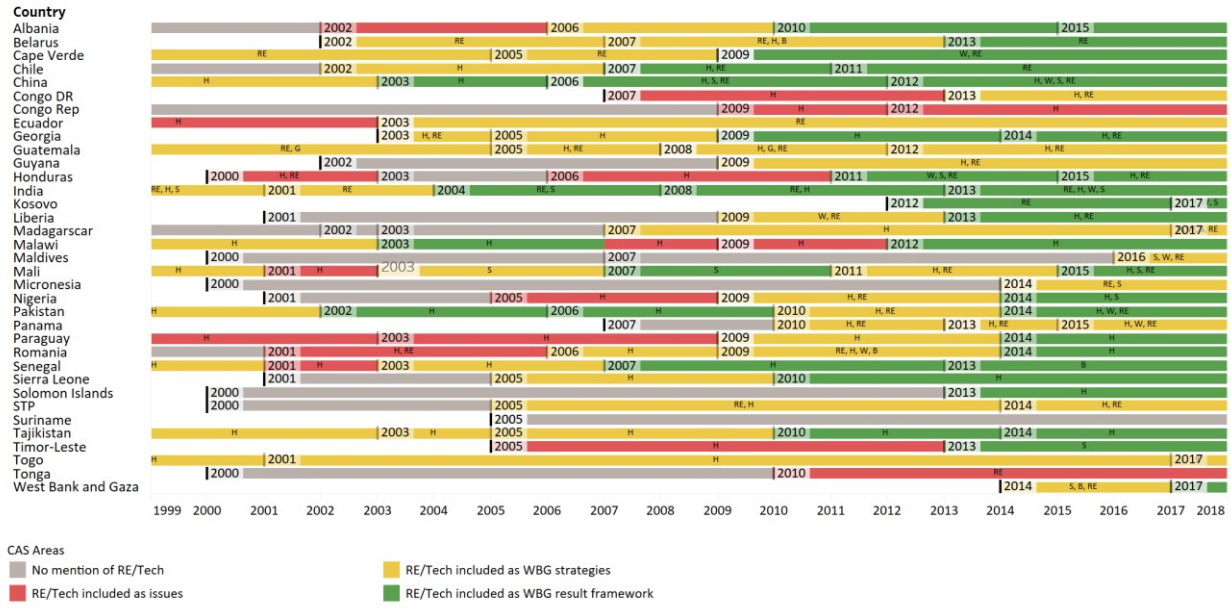


Figure D2. Shifts in strategic relevance of RE and specific technologies in CAS/CPF

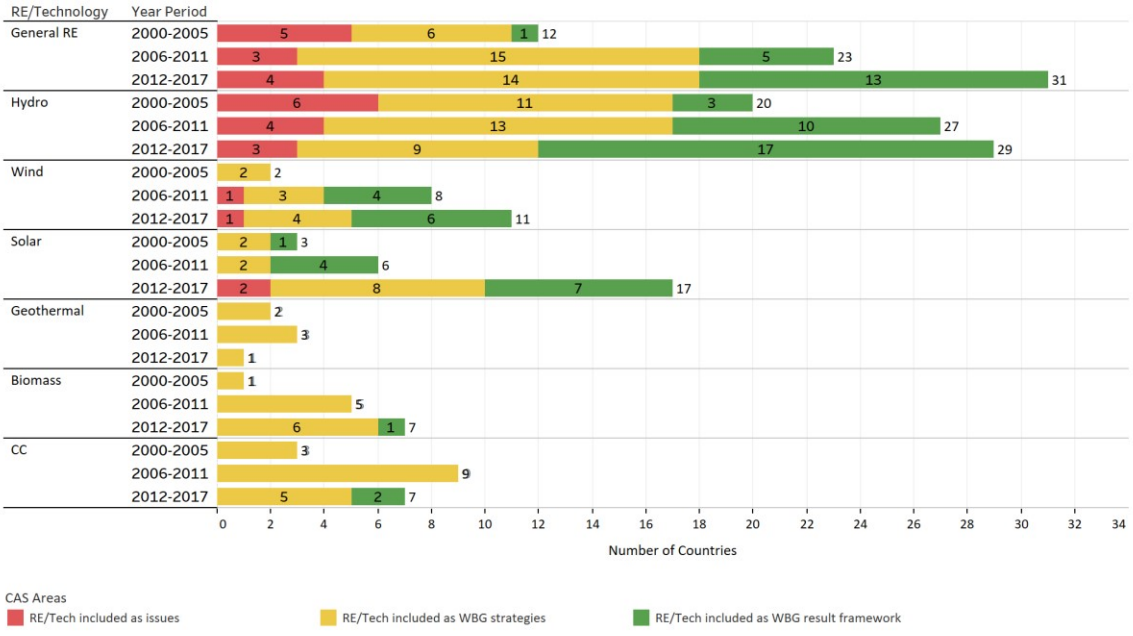


Figure D3. Shifts in strategic relevance of RE in CAS/CPF by income group


Year Period
Income Group
2000-2005
Low Income
Lower Middle Income
Upper Middle Income
High Income
2006-2011
Low Income
Lower Middle Income
Upper Middle Income
High Income
2012-2017
Low Income
Lower Middle Income
Upper Middle Income
High Income
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Number of Countries
CAS Areas
RE/Tech included as issues
RE/Tech included as WBG strategies
RE/Tech included as WBG result framework

Appendix E. Portfolio Review and Analysis

Table E1. WBG Renewable Energy (RE) related projects approved FY2000-17

WBG Institution and Type of Lending Instrument	Approved, Committed or Issued Projects, FY2000-17		Number of Evaluated Projects from Portfolio
	Amounts (in US$b)	Number of Projects	
World Bank (IBRD/IDA/Trust Funds)			
Investment lending[1]	10	182	85
Program for Results (P4R)	0.8	3	-
DPFs	2.0	20	12
Guarantees[2]	0.9	9	-
Carbon offset financing	0.4	35	1
World Bank ASAs[3]	0.05	146	*
IFC			
Power sector RE Investments[4]	5.7	164	29
RE-investments in other sectors	2.7	116	20
Advisory Services	0.1	99	10
MIGA Guarantees[5]	1.5	17	6
TOTAL	**	**791**	**163**

Sources: IEG Preliminary Portfolio Review; World Bank Business Intelligence (BI), IFC Management Information System (MIS) and Advisory Services Operational Portal (ASOP), and MIGA Portal.
Notes: (1) inclusive of recipient-executed technical assistance (TA); (2) refers to partial risk guarantees and other types of IBRD and
IDA guarantee products; (3) WB Advisory Service and Analytics (ASA) include economic and sector work (ESW) and Technical Assistance (TA); (4) broad classification includes loans, equity, credit guarantees (partial credit guarantees, full credit guarantees and risk-sharing facilities); (5) political risk insurance only.
*WB ASAs are not evaluated at the project level. **Total commitments and gross exposures cannot be combined as a total due to the inherent differences between financing instruments and guarantees.

1. Defining and identifying the portfolio between the evaluation period

A multi-stage process was used to identify the renewable energy (RE) portfolio using the following institutional datasets: 1) WB Lending Portfolio (BI); 2) WB Non-Lending ASA Portfolio (BI); 3) IFC Investment Portfolio (MIS); 4) IFC Advisory Services (ASOP); and 5) MIGA Guarantees (MIGA Portal). The combined portfolio was verified by respective units of WB, IFC and MIGA. Table E1 above shows the summary of the final RE portfolio with corresponding commitment/gross exposure amounts and project volumes for each institution.

Table E2 below describes the sources and methodology used to identify the RE portfolio for the FY2000-17 evaluation period. A total of 546 WB lending/guarantee projects and 245 ASA/AS were included in the portfolio.

Table E2. Summary of RE Database and Sources

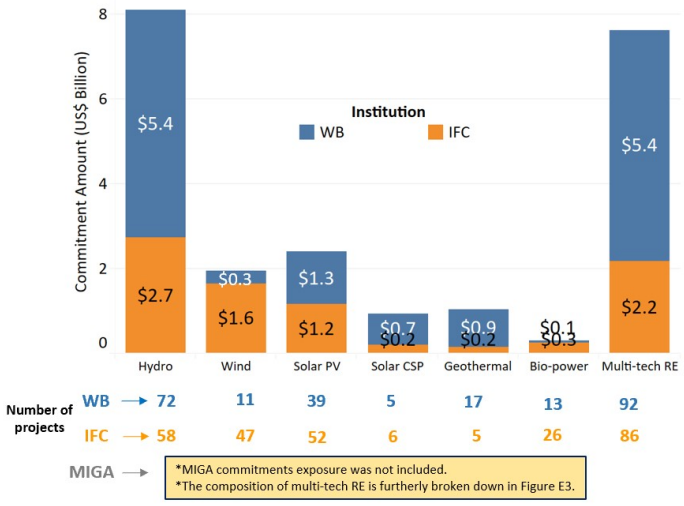
Sources:	**OPCS Sector and Theme Codes:** http://www.worldbank.org/projects/sector?lang=en&page= http://www.worldbank.org/projects/theme?lang=en&page= File from World Bank Business Intelligence (BI) Portal and Analysis for Office (AO) Application.
WB	**Sector Codes within Energy and Mining** • Hydropower (LH) (PH for ASA) • Wind (LW)
(Lending and ASA)	• Biomass (LB) • Geothermal (LI) • Solar (LU) • Power (LD) • Renewable Energy (LE) • Public Administration – Energy and Extractives (LP) • Other Energy & Extractives (LZ)
IFC **(Investment and AS)**	**Primary Sector Name** • Electric Power (V) **Secondary Sector Name** • Renewable Energy Generation (V-B) • Electric Power Other (Including Holding Companies) (V-I) **Tertiary Sector Name** • Bio-Mass - Renewable Energy Generation (V-BD) • Geothermal - Renewable Energy Generation (V-BE) • Small Hydro (<10MW) - Renewable Energy Generation (V-BB) • Large Hydro - Renewable Energy Generation (V-BA) • Wind Power - Renewable Energy Generation (V-BC) • Solar - Renewable Energy Generation (V-BF) • Renewable Energy Holding Companies (V-BJ) • Renewable through Financial Intermediaries – Renewable Energy Generation (VBH) • Electric Power Other (Including Holding Companies) (V-IA) **Non-RE Sectors** • Climate Change flag • Industry Group Codes: 1) Finance & Insurances 2) Collective Investment Vehicles 3) Industrial & Consumer Products 4) Chemicals 5) Nonmetallic Mineral Product Manufacturing 6) Utilities, Professional, Scientific and Technical Services, 7) Information 8) Wholesale and Retail Trade 9) Health Care 10) Education Services 11) Accommodation & Tourism Service 12) Agriculture & Forestry 13) Pulp & Paper 14) Food & Beverages

MIGA	**Sector** • Infrastructure (INFRA) **Sub-Sector** • Power

Source: IEG Portfolio review and consultations with the WBG Energy GP, IFC and MIGA counterparts.

2. Portfolio distribution by WBG and Global Practices

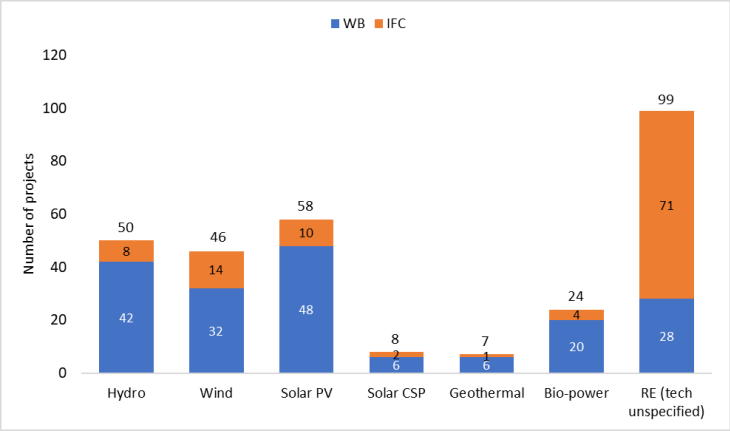
Figure E1. WBG RE Portfolio by Institution and RE Technology FY00-17 (# of projects, $ commitments)



Source: IEG Portfolio review.

Figure E1 presents the WBG RE portfolio between FY2000-17 separated by RE technologies supported through each of the WBG institutions. The data is presented by commitment amounts (for WB and IFC only) and number of projects (for all three institutions). In addition to single-technology (single-tech) projects, the WBG has supported a significant number of projects that included multiple RE technologies (multi-tech) within each intervention.

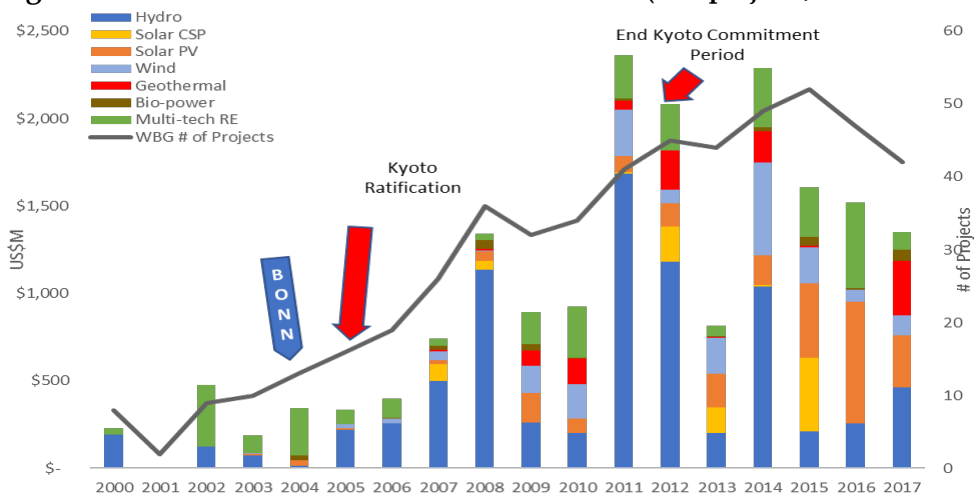
Figure E2. Breakdown of Technologies within Multi-Tech RE projects supported by the WBG FY00-17 (# of projects)



Source: IEG Portfolio review.

Figure E2 provides a breakdown of the technologies included in the multi-tech RE projects supported by the WBG by its institutions. The projects are counted two or more times depending on the number of RE technologies supported within each project interventions. The RE (tech unspecified) designation implies projects that include lines of credit through financial intermediaries or support to RE in general where specific technologies are not specified in project design documents. The figure only presents the number of multi-tech projects, since it is not possible to consistently isolate the commitment amounts by specific RE technologies in these types of projects.

Figure E3. WBG RE Portfolio Evolution FY00-17 (# of projects, $ commitments)

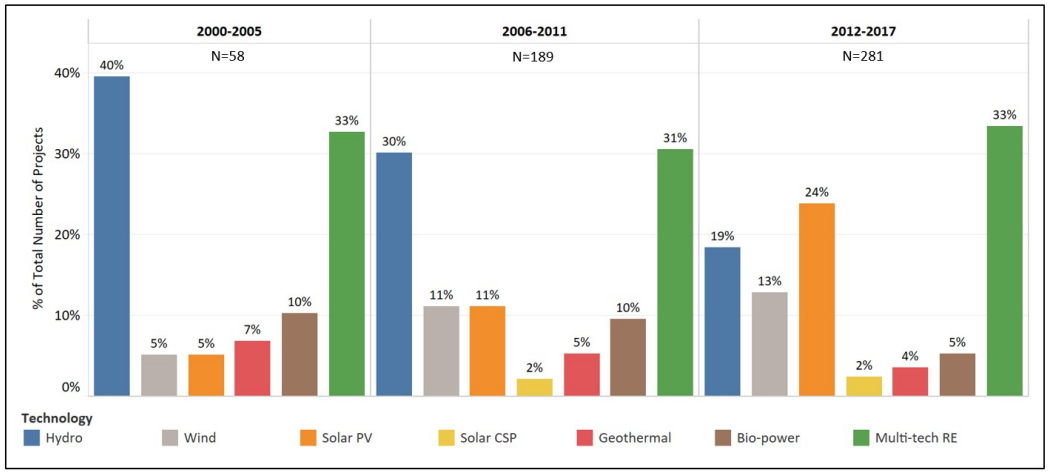


Source: IEG Portfolio review.

Figure E3 illustrates the scale-up in WBG RE related projects and commitments over time by different RE technologies. Much of the expansion followed the 2004 Bonn commitment by the WBG to, among other things, increase RE lending by 20 percent annually for five years. The evaluation period also includes the ratification of the Kyoto protocol and the subsequent end of

its commitment period, which raised global awareness and supported climate action including the scale-up of RE.

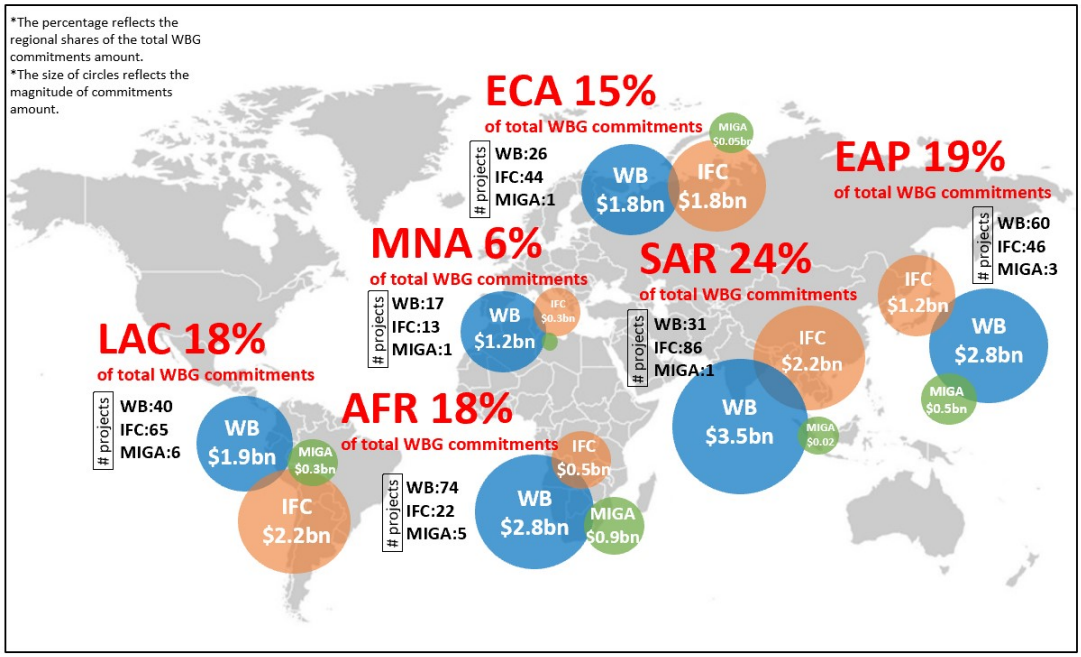
Figure E4. WBG RE Portfolio Evolution by Technology (Periods 2000-05, 2006-11, 2012-17, by # of projects)



Source: IEG Portfolio review.

Figure E4 illustrates the evolution of the WBG RE portfolio by technology over three time periods during the overall evaluation period (2000-05, 2006-11, 2012-17). The number of projects increased from 58 during 2000-05 to 189 within 2006-11 (following the Bonn commitment and the ratification of the Kyoto protocol), with 281 in the subsequent period 2012-17. While the number of single-tech hydropower projects have declined as a percentage over the three periods, the share of VRE technologies (solar PV and wind) in the WBG portfolio has increased matching global trends.

Figure E5. RE Investment Portfolio Geographical Dispersion of WBG Support FY00-17



Source: IEG Portfolio Review.

Figure E4 breaks down the WBG portfolio of RE projects and commitments by the WBG operational regions during the period FY2000-17. It illustrates commitment volumes and # of projects by each of the three WBG institutions.

Table E3. Top 10 countries for WBG RE Portfolio by # of Projects

Country	# Proj	RE Cmt (US$B)	CO_2 Emission Ranking (2014)
India	75	$3.1	2
China	42	$1.6	1
Turkey	27	$2.2	9
Mexico	18	$1.1	7
Brazil	17	$0.78	5
Chile	17	$0.64	26
Pakistan	17	$1.8	20
Indonesia	16	$1.3	8
Nepal	13	$0.25	67
Philippines	13	$0.52	22

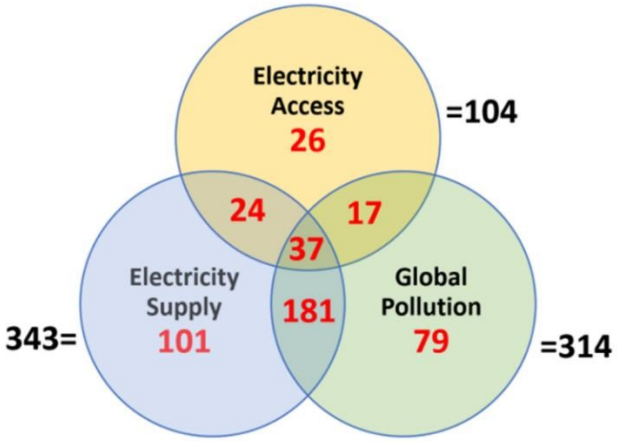
Source: IEG Portfolio Review.

Note: South Africa, Morocco and Argentina in the top 10 countries in terms of RE commitment amount.

Table E3 indicates the top 10 countries with the most number of projects in the WBG RE portfolio, with the corresponding commitments and their respective global ranking in terms of CO_2 emissions. The RE portfolio covers the period FY2000-17.

4. Portfolio by Development Objectives

Figure E6. Major Project Development Objectives (PDOs) of WBG RE FY00-17



Source: IEG Portfolio Review.

Figure E6 presents the primary objectives of the portfolio of WBG RE projects. 85 percent of the 546 projects aim to achieve one or more of the following goals: increase electricity supply, avoid global pollution, and increase access to electricity. Other objectives such as avoiding local pollution and reducing energy insecurity are less frequent in the formal development objectives of projects in the portfolio. Of the three common focuses of investment projects, the predominant objectives in RE projects are the increase of electricity supply and avoidance of global pollution; with half of the projects in the two categories having both objectives given the linkage between the two goals. Less prominent, but nevertheless significant is the utilization of RE to advance electricity access.

Table E4. RE Portfolio Distribution by Client Country Income Level FY00-17

	Electricity Access	Electricity Supply	Energy Insecurity	Avoid Local Pollution	Avoid Global Pollution	Total Projects
High Income	9% (2/23)	52% (12/23)	13% (3/23)	0% (0/23)	52% (12/23)	23
Upper Middle Income	7% (14/210)	54% (114/210)	17% (36/210)	7% (15/210)	66% (139/210)	210
Lower Middle Income	19% (55/295)	59% (175/295)	20% (59/295)	4% (12/295)	50% (148/295)	295
Low Income	38% (33/88)	48% (42/88)	1% (1/88)	2% (2/88)	20% (18/88)	88

Source: IEG Portfolio review.

Table E4 indicates the breakdown of the RE Portfolio project objectives by income-levels of the countries implementing them. The results indicate that the higher income countries tend to place greater emphasis on increasing electricity supply for the grid and avoiding global pollution, whereas the low-income countries place greater emphasis on increasing access through RE as

well as increasing electricity supply. The lower income countries place less emphasis on developing RE for avoiding global pollution as a means to mitigating climate change.

5. Technical Assistance (TA)

TA within investment projects: Over 34% of the investment projects in the RE portfolio have a technical assistance component (beyond project management support) that is supported through WBG funding. This figure is substantial for the WB as specific TA activities are present in 68% of all WB RE investment projects. In addition, the WB has seven (7) stand-alone TA projects in the RE portfolio. IFC provides far less TA support within its investments, likely due to existing capacities of pre-selected project sponsors (clients). In instances where IFC does provide TA support, it is typically to enhance client capabilities; or where it participates jointly with the WB in a single investment project (i.e. Kabeli in Nepal and Pamir in Tajikistan).

WB ASA/IFC AS Portfolio: The IEG team identified ASA by the WB and AS by the IFC, which represent activities where the institutions provide support through its knowledge and experience to disseminate knowledge directly to WBG to clients in RE. The WBG ASA/AS portfolio was extracted as follows:

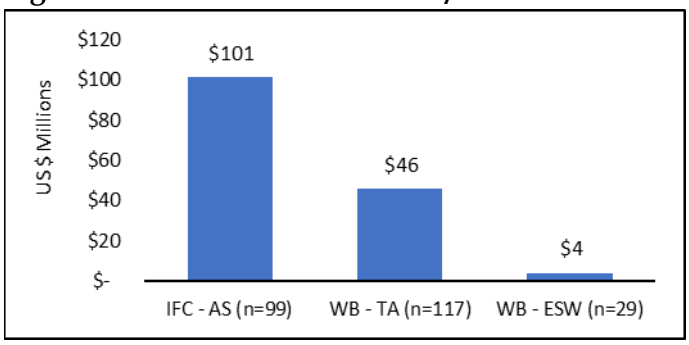
- For WB ASAs, an extraction of over 2,000 ASAs that had an RE sector coding from BI portal. These ASAs were filtered through the same 5 sector classifications as the lending portfolio. Each eligible ASA has at least one RE sector[i] classification. These projects were then screened for RE component percentages in terms of focus allocations. This exercise produced 600 ASAs, including TAs and ESWs with sectoral percentage tags. A project filter of 5%[ii] was used as a threshold for RE commitment to narrow the coverage of the portfolio.

- Similar to the portfolio identification steps used to identify IFC RE investment projects, IFC Advisory Services RE projects were also selected using "Electric Power" sector code to filter the Primary Sector Name and then as second filter "Renewable Energy Generation" in the Secondary Sector Name of the IFC AS database. A third filter was also applied to determine the types of RE technology and other modalities (Sector Codes V-BA to V-BJ). At the end of FY2017, there were 5,563 IFC AS projects. Of these, 2,517 are either closed or active and the rest are in the pipeline. After screening for relevant "V" sector projects and the rest of the "excluding-V" portfolio with a CAS-Energy business area classification, the result was 126 projects. Since IFC's Advisory Services Operations Portal (ASOP) does not identify specific funding percentages for RE under the Climate Change theme, the additional projects (RE Interventions in Other Sectors) for Advisory Services are further identified manually through the Business Area CAS-Energy.

Both project identification exercises resulted in 464 WB ASAs (both technical assistance (TA) and economic sector work (ESW)) and 126 IFC AS between FY00-17. A further in-depth screening of

ASA/AS project activities based on their attempt to address specific barriers to RE resulted in 146 WB ASAs and 99 IFC AS in the final RE portfolio, as illustrated in figure E7.

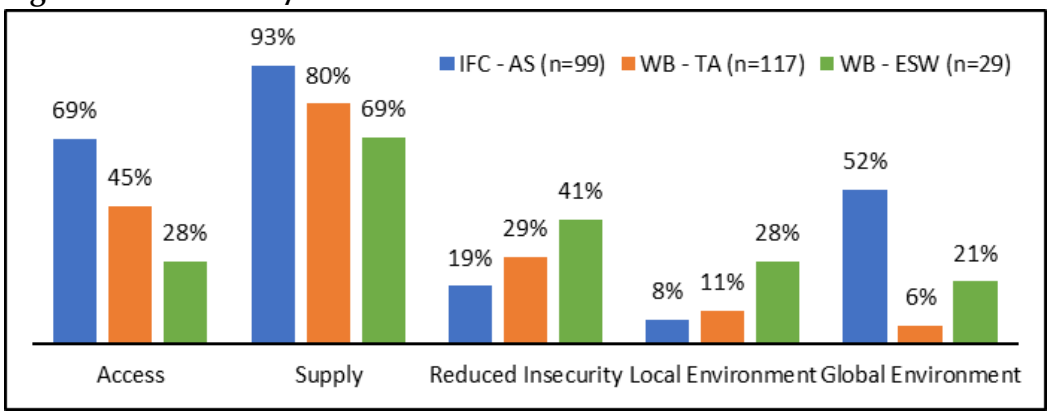
Figure E7. WBG RE-Related ASA/AS Commitment and # of Activities FY00-17



Source: IEG Portfolio review.

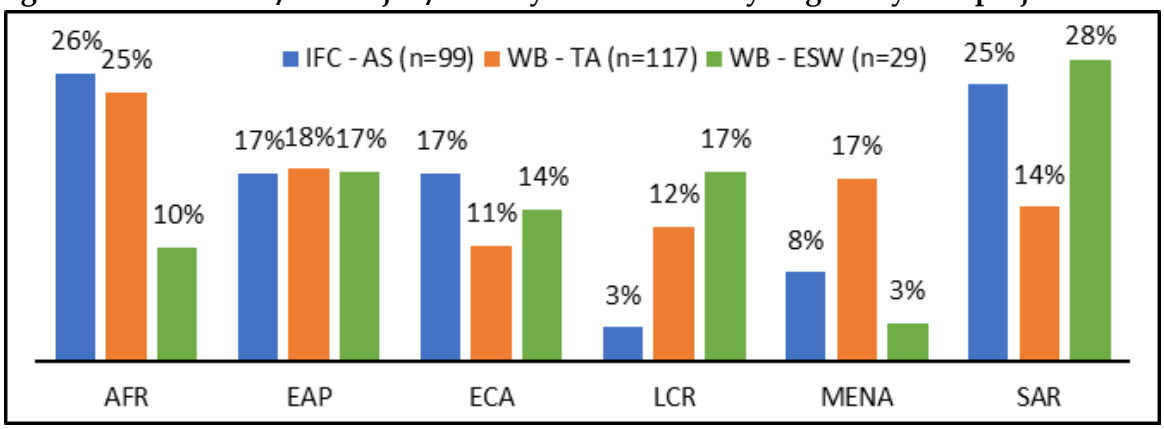
Figure E8 illustrates the ASA/AS activities by the breakdown of its development objectives. Over the evaluation period, the primary objective within WBG ASA/AS related to RE were to help increase energy supply from RE. For IFC, increasing electricity access and global environmental benefits appear to be other important objectives within its AS portfolio related to RE. For the WB, other important factors are increasing access (especially with TA) and reducing energy insecurity (in especially with ESW). The WB ASA over the evaluation period focused significantly less on addressing global environmental benefits, much lower than its corporate strategies and investment project objectives indicate.

Figure E8. WBG ASA/AS based on PDO Distribution



Source: IEG Portfolio review.

Figure E9. WBG ASA/AS Project/Activity Distribution by Region by # of projects



Source: IEG Portfolio review.

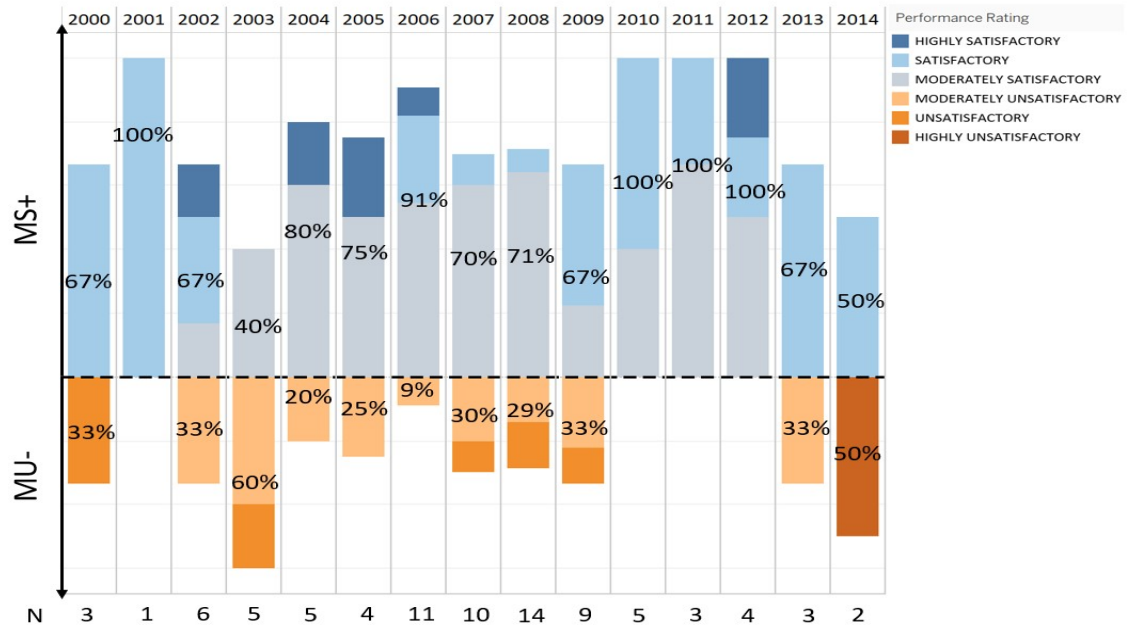
Note: Global ASA/AS are not shown, distribution is as follows: IFC 3%, WB-TA 4%, WB-ESW 10%.

Figure E9 indicates the regional distribution of the WBG ASA/AS activities. There was a greater focus by the WBG in the Africa and South Asia regions.

6. Overall Investment Project Portfolio Performance

Performance by WBG Institutions during Evaluation Period

Figure E10. WB Performance over Time

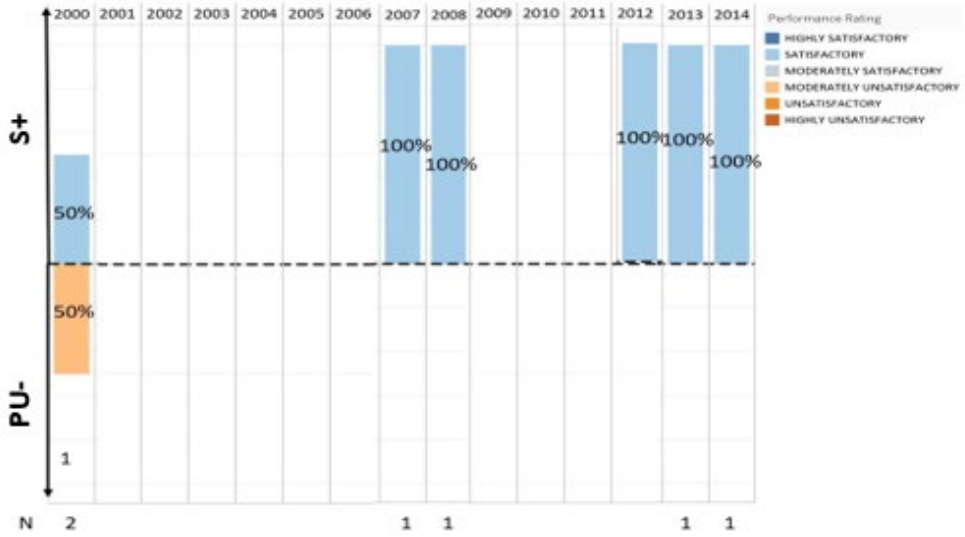


WB: Of the 98 evaluated WB projects in the RE portfolio, 71 percent performed moderately satisfactory or better, consistent with the 73 percent performance of the overall energy sector portfolio. The number of evaluated projects based on their approval year are indicated at bottom of figure (N).

Figure E11. IFC Performance over Time

IFC: Of the 49 evaluated IFC projects in the RE portfolio, 51 percent performed mostly successful or better, which falls below the IFC corporate scorecard goal of 65 percent. The number of evaluated projects based on their approval year are indicated at bottom of figure (N).

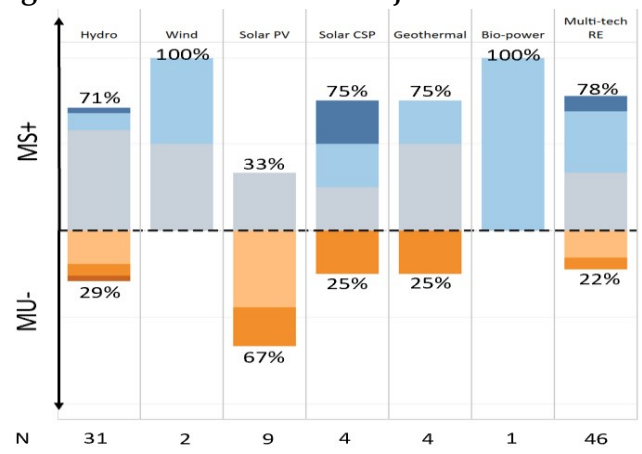
Figure E12. MIGA Performance over Time



MIGA: Of the seven (7) evaluated MIGA projects in the RE portfolio, six (6) were rated moderately satisfactory or better. The number of evaluated projects based on their approval year are indicated at bottom of figure (N).

Performance by RE Technology during Evaluation Period

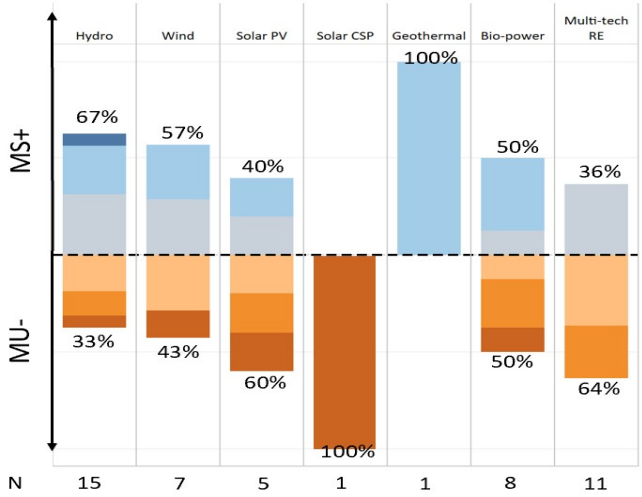
Figure E13. WB Evaluated Project Performance by Technology FY2000-17



Source: IEG ratings data, as of FY2018

Figure E13 illustrates the overall performance of the WB evaluated RE portfolio for FY2000-17 by different RE technologies. The total number of evaluated projects for each technology is indicated at bottom of figure (N).

Figure E14. IFC Evaluated Project Performance by Technology FY2000-17



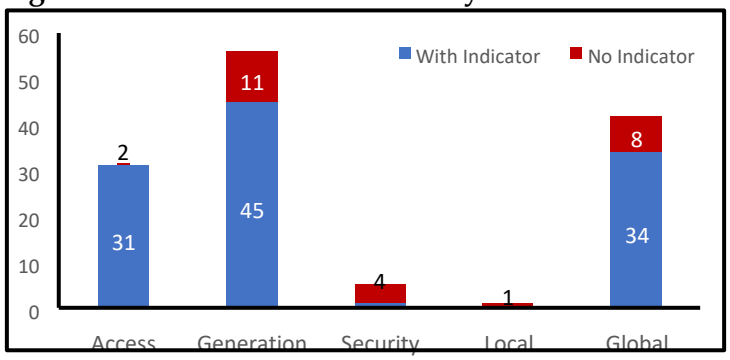
Source: IEG ratings data, as of FY2018

Figure E14 illustrates the overall performance of IFC's evaluated RE portfolio for FY2000-17 by different RE technologies. The total number of evaluated projects for each technology is indicated at bottom of figure (N).

Monitoring and Evaluation (M&E) of WBG RE Portfolio

An assessment was carried out for the WB and IFC to evaluate whether there were adequate indicators in the results framework for monitoring the key development objectives, as stated in project documents.

Figure E15. M&E Indicators for Key WB DOs

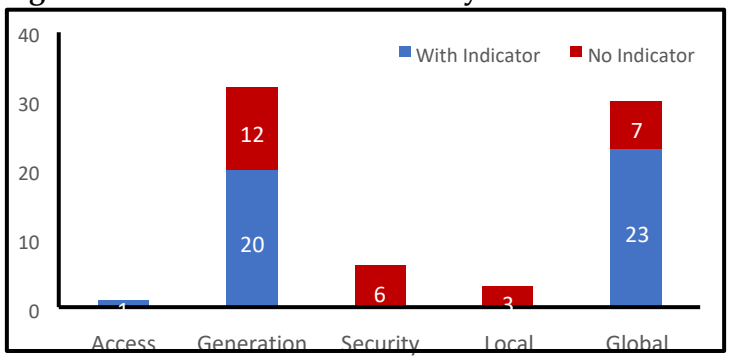


Source: IEG Portfolio review.

Figure E15 illustrates the occurrences of the five major development objectives (i.e. increase in access, electricity generation/supply, reduction of energy insecurity, avoidance of local pollution, and avoidance of global pollution), and the inclusion of corresponding M&E indicators in the results framework. The key gaps are in electricity generation/supply, which is primarily due to DPF operations (10 out of 11 projects); and in the avoidance of global greenhouse gases, which is mainly in older projects within the evaluation period.

Figure E16 shows that IFC is not sufficiently measuring its development impact. In nearly 40% of the projects, electricity supply benefits are not captured and in 25% of the projects, GHG benefits are also omitted.

Figure E16. M&E Indicators for Key IFC DOs



Source: IEG Portfolio review.

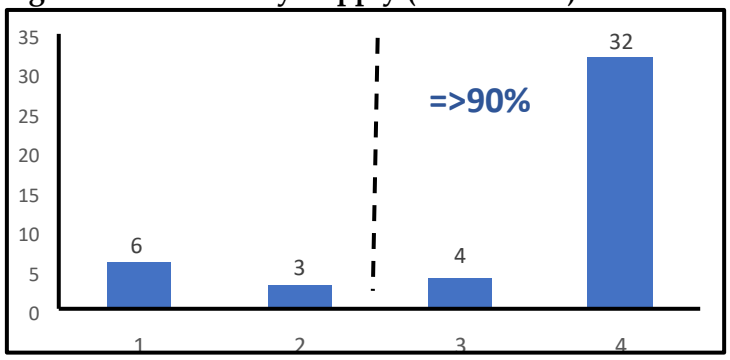
Assessment of Key Performance Indicators in WB RE Portfolio

Overall, 71 percent of the WB RE projects achieve a rating for achieving its development objective of moderately satisfactory or better. An analysis was carried out to assess the extent to which the key performance indicators (KPIs) for the specific development objectives in evaluated projects achieve. The effort mapped all the project indicators to the development objectives. In order to measure the achievement of what was set at appraisal stage (PAD), a 4-point rating was implemented to the evaluated project sample's objective achievement with the following parameters: 4= 100% achieved target, 3= 90% achieved target, 2= 75% achieved target and 1= less

than 75% achieved target. The aim was to determine whether the self-selected objectives in projects are largely met (i.e. 90% or more).

The KPI analysis found that 78 percent of the projects which aimed to increase electricity supply, and 74 percent of the projects which aimed to increase access to electricity achieved these objectives. However, for the projects with the objective to reduce the amount of GHG emissions, evidence of achievement was lower, at 58 percent.

Figure E17. Electricity Supply (Generation) Indicators (n=45)



Source: IEG Portfolio review.

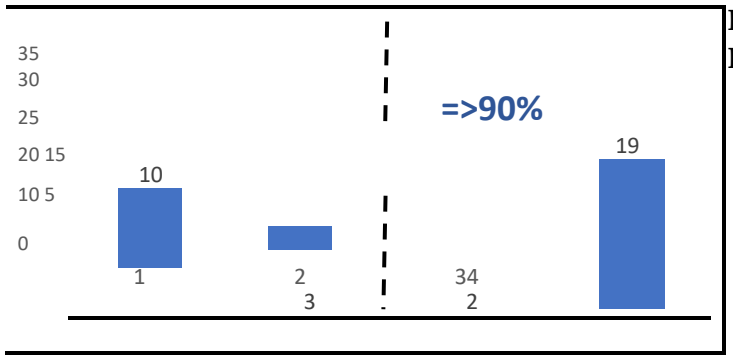
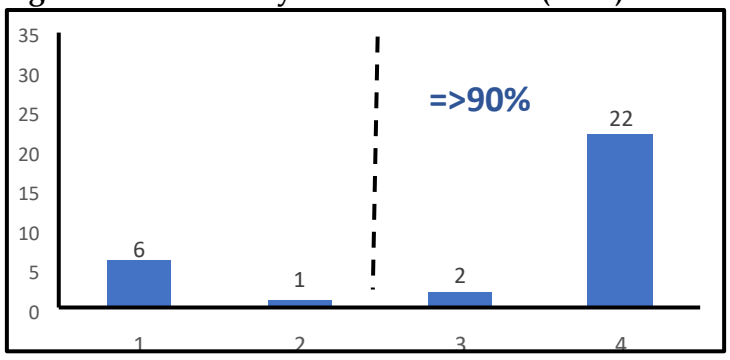


Figure E18. Avoidance of Global Pollution Indicators (n=34)

Source: IEG Portfolio review.

Figure E19. Electricity Access Indicators (n=31)



Source: IEG Portfolio review.

7. Key Barriers to RE Development

WBG client countries face various critical barriers to initiating, expanding, and scaling-up RE technologies in respective countries, which often constrain the mobilization of investments for utilizing RE resources to produce electricity. While there are many barriers that a WBG RErelated activity could help clients address depending on the given context and challenges facing the deployment of RE, this evaluation, based on an initial structured literature review, specialist opinions, and subsequent further validation through a Qualitative Comparative Assessment (QCA), broadly categorized them as follows:

- *Inadequate policy and regulatory framework*. The policy and regulatory environment established by governments and the opportunities/incentives they create are a major factor that can facilitate or hinder public and private investments in RE;
- *Integration of RE into power systems.* The greater share of variable/intermittent sources, such as wind and solar, will require power systems to invest in greater flexibility so that they can smoothly and efficiently integrate RE into the grid (through integrated systems planning, strengthening transmission networks to access RE sites, developing storage and dispatchable capacity, power trading and pooling);
- *Shortcomings in technical designs and standards*. To construct high-quality infrastructure the RE technologies must be designed and developed in line with industry and international standards;
- *Weak institutional and human capacity.* In many developing countries, various institutions involved in the development of RE do not have sufficient capabilities to successfully undertake new investments or efficiently operate ongoing projects;
- *Existence of investment risks.* Even with improved policies and enhanced institutional capabilities for RE, there may be residual risks that investors face, either on a transitional basis while reforms are ongoing or permanent risks that are outside the control of developers (such as commercial risks, political risks, RE resource risks), which may discourage investments.
- *Inability to mobilize adequate financing.* Furthermore, financing requirements for RE can be substantial, often because it includes high up-front investments, which can be challenging especially with technologies that are new to certain markets, at a scale that exceeds the capacity of domestic capital markets, or in small markets where financial institutions are not well developed.

The broad categories of barriers can be more systematically analyzed by further defining activities that can be undertaken to overcome these barriers (i.e. sub-barrier categories). These subcategories were selected through structured literature review, suggestions from the Global Expert Panel on RE, and discussions with sector specialists. The list of sub-categories is given in Table E5 below:

Table E5. Definition of Sub-Categories of Barriers to RE Development

	Enhance Policy and Regulatory Framework	Integration into Power Systems	Improve to Design & Tech. Standards	Strengthen Institutional Capacity	Mitigate Investment Risks	Mobilize Financing
1	Laws: Energy Law, Electricity Law, RE Law	Power systems planning (G&T)	Good industry practice for feasibility & safeguards studies	Improve planning capacity for RE expansion	Enhanced RE resource assessment	Grants and concessional financing mobilized to sustain subsidy schemes (GEF, CTF, ESMAP/ASTAE)
2	Policies and regulations related to the above	Adequate grid code	Enhanced standards for project design	Enhance technical capabilities for design and implementation of RE investments	Financial/investment risks related to pricing, off-take and timely payments (i.e. specific risks that underlie financing constraints)	Mobilize other development partner support (Other MDBs, local banks, DFID, KfW, CAF, other bilateral)
3	Pricing: Pass through, FIT, sustainable subsidization schemes	Standards for grid friendly RE equipment	Development and/or Introduction of improved/ international RE standards (country-wide, institution)	Expand capacity to secure financing for RE	Credit enhancements for financial intermediaries to extend funding to RE	Attracted or facilitated private financiers for financing RE
4	Mandatory offtake with pass through and/or subsidies	Strengthening of transmission to facilitate RE		Strengthen the governance, procurement and financial management practices and capacity	Political risks such as expropriations	
5	Concessioning: Policies that clarify approaches to assigning development rights for RE	Requirements for priority dispatch with regulation to ensure integrity of the system		Improve the ability to meet environmental and social safeguard needs		

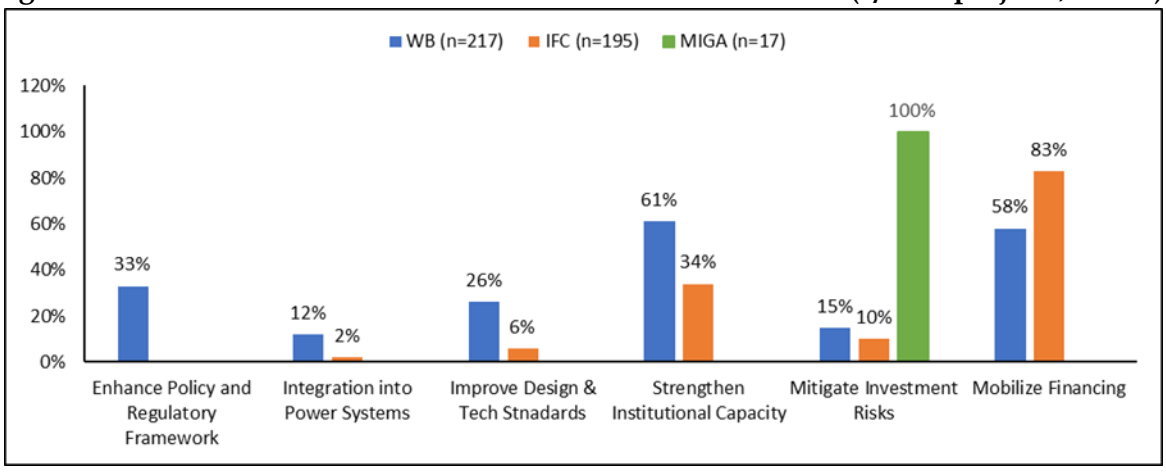
Source: IEG Portfolio review

Addressing Barriers to RE through the WBG Investment Project Portfolio

The primary focus of the barrier analysis was the portfolio review of active or closed investment projects from FY2000-17 (including 18 projects approved between FY1990-2000 that were validated during FY2000-17). Of the 543 total investment projects in the RE portfolio, the review identified 429 addressing one or more of the identified barriers. Figure E18 illustrates the degree

to which the WBG has aimed to address different barriers through its investment projects separated by WBG institution.

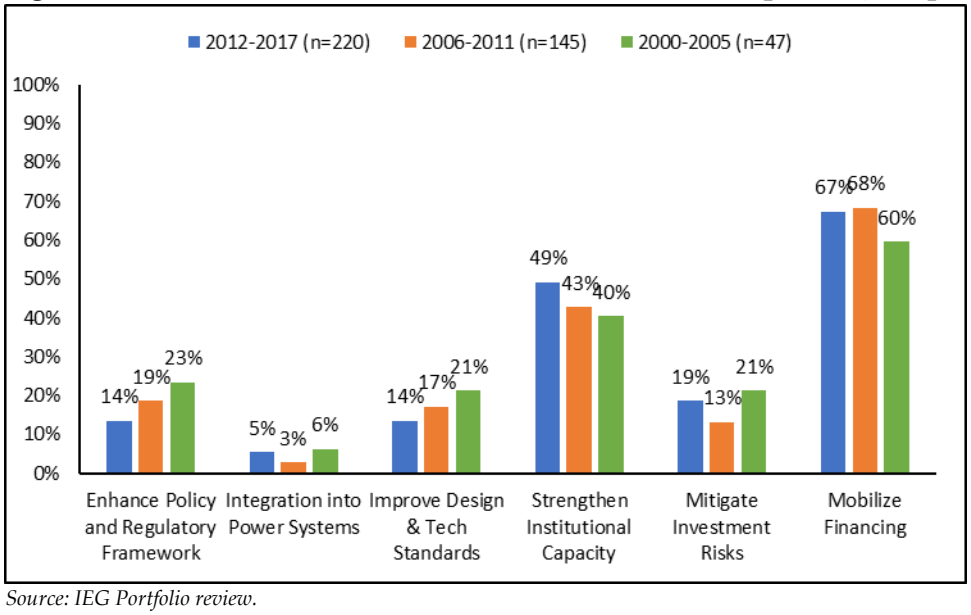
Figure E20. WBG RE Investment Portfolio Barriers Distribution (#/% of projects; n=429)



Source: IEG Portfolio review.

Figure E21 illustrates the evolution of the barriers to RE development over the evaluation period divided into three time periods (FY2000-05, FY2006-11, and FY2012-17) and shifts within the WBG RE portfolio.

Figure E21. The Evolution of WBG Barriers to RE Development (# of projects)



Source: IEG Portfolio review.

The focus of WBG activities to address various categories of RE barriers are analyzed to better ascertain the types of solutions and the extent to which support is provided by the institution to help clients address specific barriers.

Table E6: Solutions Supported by the WB to Address RE Barriers through Investment Projects

Policy and Regulatory (n=71)		Integration into Power Systems (n=25)		Improvements to Design & Tech Standards (n=57)		Strengthen Institutional Capacity (n=133)		Mitigate Investment Risks (n=33)		Mobilize Financing (n=126)	
Laws	44%	Integrated Planning	24%	Feasibility & Safeguards	**44%**	Planning Capacity for RE Expansion	16%	RE Resource Risk	**39%**	Grants & Concessional	**60%**
Regulations	**70%**	RE Grid Code	16%	Project Design Standards	37%	Technical Design & Implementation	**47%**	Commercial & Market Risks	18%	MDBs/Bilaterals	43%
Pricing & Offtake	44%	Standards for RE Equipment	24%	Development of Improved RE Standards	25%	Financing RE capacity	5%	Credit Enhancement	36%	Financing	17%
Concessioning	0%	Strengthening Transmission	32%			Governance	**47%**	Political Risk	9%		
		Reducing Congestion w/ DG	**36%**			Environmental & Social Safeguards	16%				

Source: IEG Portfolio review.

Table E6 illustrates the extent to which the WB is supporting various solutions to help address specific RE barriers, with highlights for where such focus is highest. Table E7 presents a similar assessment for IFC. Table E8 covers MIGA, which singularly focuses on risk mitigation by nature of its political risk insurance.

Table E7: Solutions Supported by the IFC to Address RE Barriers through Investment Projects

Policy and Regulatory (n=0)		Integration into Power Systems (n=3)		Improvements to Design & Tech Standards (n=12)		Strengthen Institutional Capacity (n=66)		Mitigate Investment Risks (n=20)		Mobilize Financing (n=161)	
Laws	0%	Integrated Planning	0%	Feasibility & Safeguards	33%	Planning Capacity for RE Expansion	0%	RE Resource Risk	0%	Grants & Concessional	17%
Regulations	0%	RE Grid Code	0%	Project Design Standards	**58%**	Technical Design & Implementation	15%	Commercial & Market Risks	30%	MDBs/Bilaterals	25%
Pricing & Offtake	0%	Standards for RE Equipment	0%	Development of Improved RE Standards	17%	Financing RE capacity	8%	Credit Enhancement	**35%**	Financing	**71%**
Concessioning	0%	Strengthening Transmission	0%			Governance	23%	Political Risk	**35%**		
		Reducing Congestion w/ DG	**100%**			Environmental & Social Safeguards	**58%**				

Source: IEG Portfolio review.

Table E8: Solutions Supported by MIGA to Address RE Barriers through Investment Projects

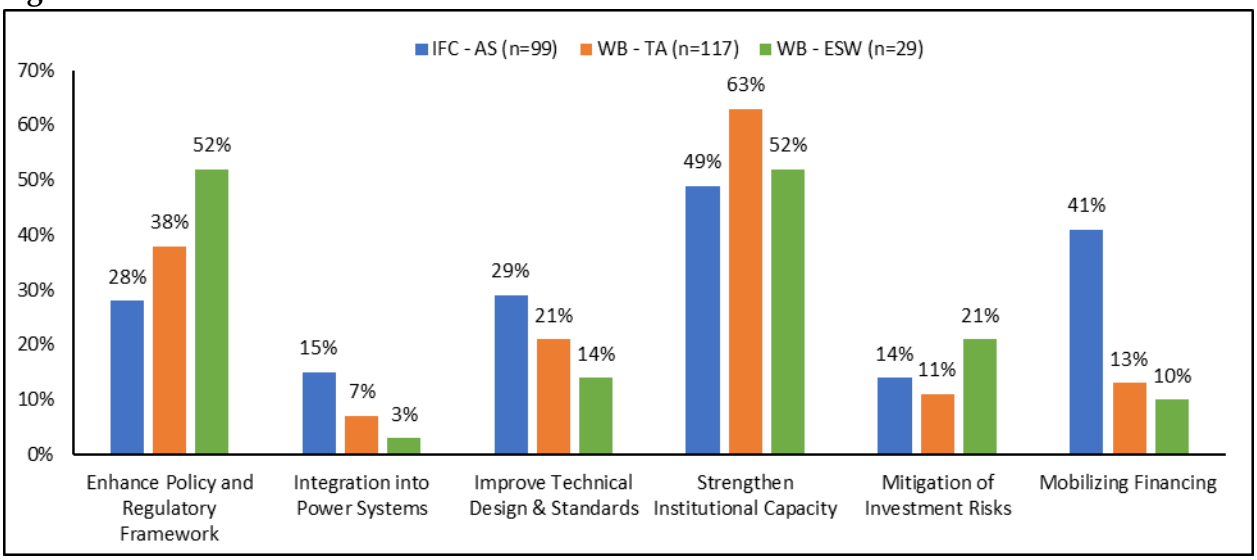
Policy and Regulatory (n=0)		Integration into Power Systems (n=0)		Improvements to Design & Tech Standards (n=0)		Strengthen Institutional Capacity (n=0)		Mitigate Investment Risks (n=17)		Mobilize Financing (n=0)	
Laws	0%	Integrated Planning	0%	Feasibility & Safeguards	0%	Planning Capacity for RE Expansion	0%	RE Resource Risk	0%	Grants & Concessional	0%
Regulations	0%	RE Grid Code	0%	Project Design Standards	0%	Technical Design & Implementation	0%	Commercial & Market Risks*	24%	MDBs/Bilaterals	0%
Pricing & Offtake	0%	Standards for RE Equipment	0%	Development of Improved RE Standards	0%	Financing RE capacity	0%	Credit Enhancement	24%	Financing	0%
Concessioning	0%	Strengthening Transmission	0%			Governance	0%	Political Risk	**65%**		
		Reducing Congestion w/ DG	0%			Environmental & Social Safeguards	0%				

Source: IEG Portfolio review. Note: MIGA only provides guarantees for non-commercial risks through its Political Risk Insurance (PRI) and Non-Honoring (NH) credit enhancement instruments.

Addressing Barriers to RE through the WBG ASA/AS Portfolio

As previously noted, the WBG mobilizes a sizable volume of ASA/AS alongside its investment project support, also aimed at addressing various barriers to RE. Figure 22 breaks down the various barriers that the ASA/AS by the WBG are attempting to address.

Figure E22. WBG ASA Barriers Distribution



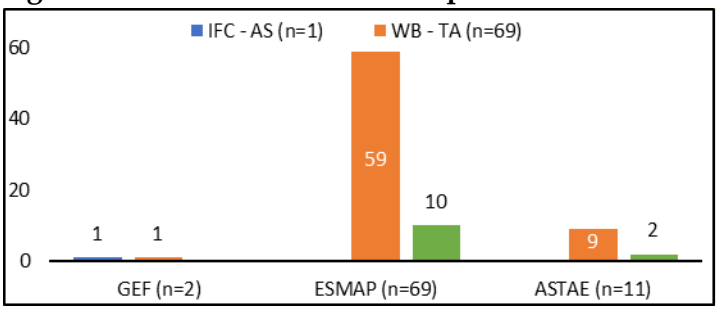
Source: IEG Portfolio review

Similar to the investment project portfolio, the WB ASA places considerable focus on policies and regulations, while both the WB and IFC emphasize capacity building through ASA/AS. IFC places far more emphasizes on mobilizing finance through its AS, while neither institution has placed a

high level of emphasis on issues related to integration of RE. MIGA does not undertake advisory services.

A significant number of these ASA/AS activities related to RE were supported by two key multidonor trust funds, the Energy Sector Management Assistance Program (ESMAP) and the Asia Sustainable and Alternative Energy program (ASTAE). The contribution of these two trust funds is illustrated in Figure E23.

Figure E23. WBG ASA Partnership Distribution

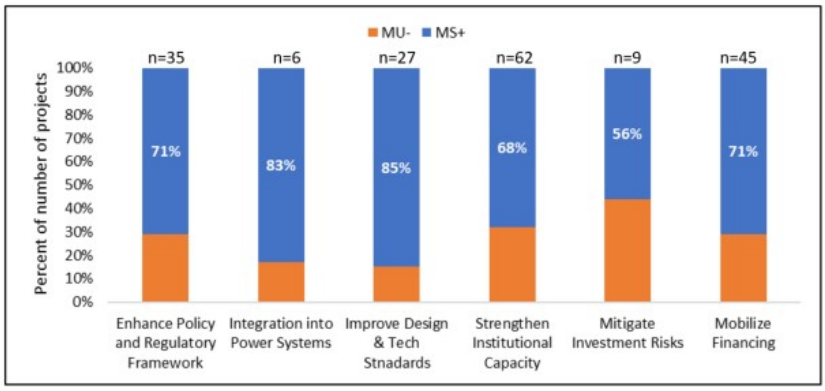


Source: IEG Portfolio review.

Performance of Investments Projects while Addressing Barriers to RE

For the limited sample of evaluated investment projects in the WBG RE portfolio, the overall performance of the projects in achieving its development objectives and the corresponding mapping with the various barriers they were attempting to address were assessed.

Figure E24. Performance Outcome of WB Investment Projects By Barriers Addressed



Source: IEG Portfolio review.

Out of 85 validated projects addressing at least one barrier, WB has a higher ratio for MS+ with 74% of total RE projects, as illustrated in figure E24. In general, WB has a significantly higher share satisfactorily performing projects each barrier. IFC has a closer distribution in terms of performance, in line with overall performance distribution for their portfolio shown in Figure E25.

Figure E25. Performance Outcome of IFC Investment Projects By Barriers Addressed

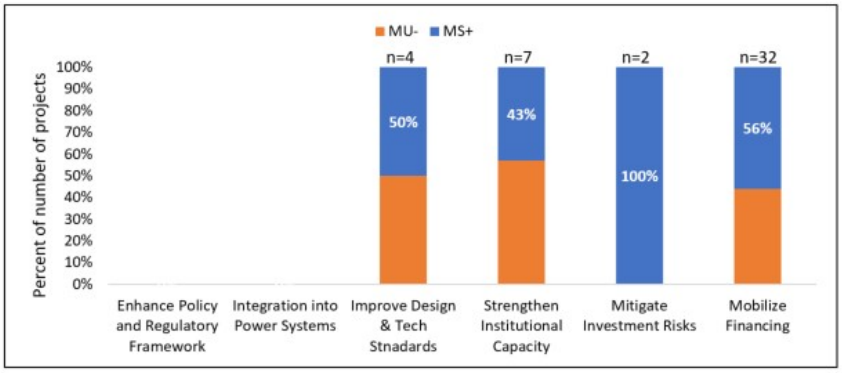
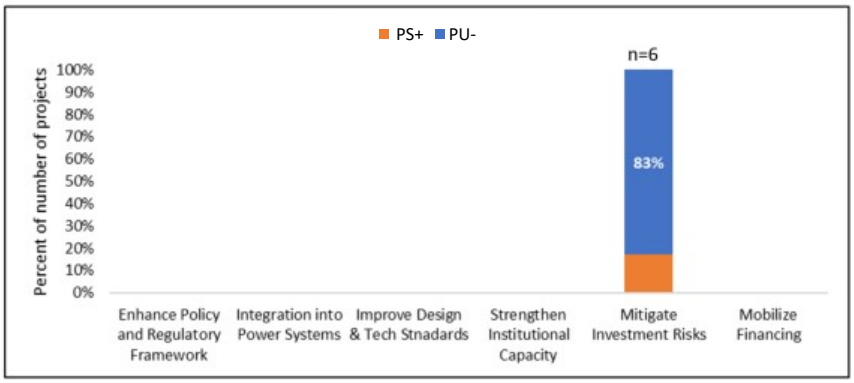


Figure E26. Performance Outcome of MIGA Investment Projects By Barriers Addressed

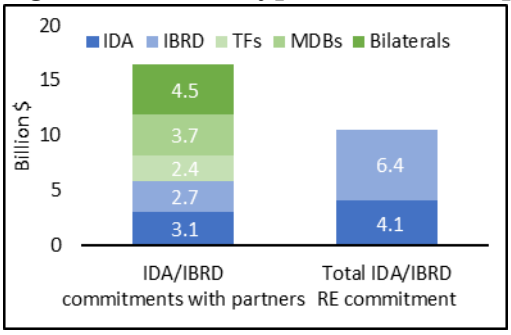


Source: IEG Portfolio review.

8. Partnerships, Coordination and Co-Funding

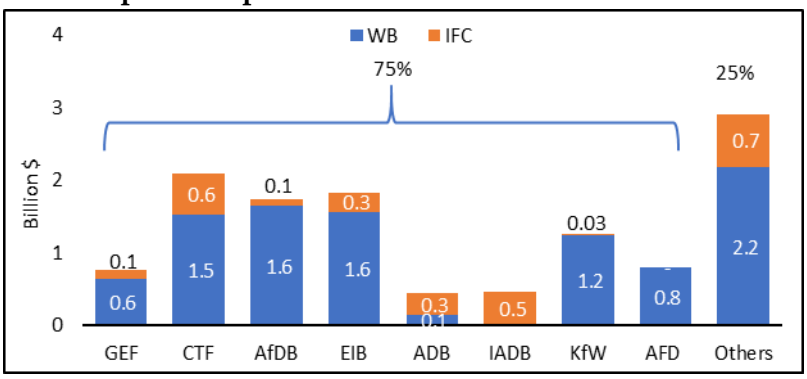
WBG utilizes its convening power to develop partnerships through which it mobilized resources for addressing barriers including financing shortfalls. Upon review of the RE portfolio for partnership support, much of the sources of partnership funds can be categorized into three distinct groups: Climate Funds (GEF, CTF, SREP, CCCP), Multilateral Development Banks (ADB, AfDB, EBRD, IADB, IsDB, UNDP) and bilateral organizations (such as AFD, DFID and KfW). As illustrated in figure E27, these partnership funds exceed the total IBRD/IDA commitments made for RE during the evaluation period.

Figure E27. WBG Types of Partnership Distribution



Source: IEG Portfolio review.

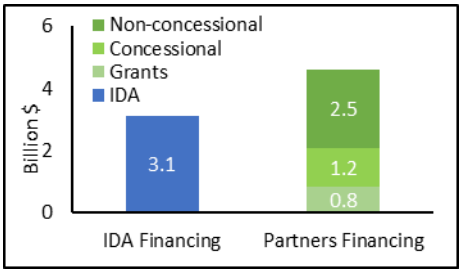
Climate funds provide grants and concessional funds for investment projects and cover 52% of partnered investment project portfolio. MDBs and bilateral organizations provide both concessional and non-concessional loans for high risk and high cost investment projects, mostly directed towards low income countries. Figure E28 shows the highest contribution levels for investment projects come from bilateral organization, followed by MDBs. WBG has partnered with 96 different development financial institutions for the RE investment portfolio. Shown in Figure E30, WB has mobilized more funding from partnerships than IFC projects for the top 8 partners. IFC, on the other hand has collaborated more with the ADB for RE investments, although the number of projects with a partnership is the same for both institutions. **Figure E28. WBG Top Development Partners for RE**

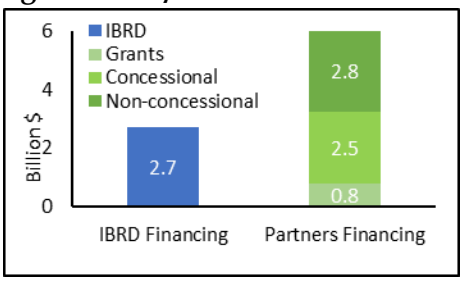


Source: IEG Portfolio review.

Grants and Loans

Figure E29. and E30. Partner Financing for IBRD/IDA





Source: IEG Portfolio review.

9. Portfolio Data and Documentation Limitations

ASA Portfolio Limitations

Due to data limitations, ASA portfolio covers mainly FY2005-2017. ASAs prior to FY05 have two major restrictions for data extraction. First, the definition of renewable energy for WBG evolved over time. Secondly, although WBG has been actively involved in technical assistance since its inception, most of the early ASA documentation is not available or not updated in the operations portal. About 13% of the captured ASA portfolio was inaccessible due to this limitation.

PRA Portfolio Limitations

One of the main challenges for investment portfolio analysis is the changing RE investment market, as well as emerging new technologies. Due to the changing environment, definition problems for ASA are also present in the investment portfolio. Adding to this issue, portfolio review relied heavily on the IEG team's efforts to best map project components under each given analysis method. However, data availability and reporting structure in both operations portal, documents used from past investment projects and business intelligence portal has provided sufficient evidence for the overall portfolio analysis.

[i] As reported in the system, 6 captured renewable energy sectors from BI portal are: Renew Energy Wind, Renewable energy, Renewable Energy Bio, Renewable Energy Geo, Renewable Energy Hyd, and Renewable Energy Sol.

[ii] ASAs report their sectors based on the percentage distribution of their components. Sector 1 is given to the highest percentage sharing sector of the ASA. Excluding RE sectors, list of captured 55 different 1st sectors are listed as reported in BI system: Agric ext & research, Agricultural markets, Agro-industry, Aviation, Banking Institutions, Capital Markets, Central Government, Crops, Energy Trans & Distr, Fisheries, Forestry, Health, Housing Construction, ICT Services, Insurance & Pension, Irrigation & drainage, Law and Justice, Media, Micro- & SME finance, Mining, Non-Renewable Energy, Oil and Gas, Oth Energy&Extrative, Oth Water, Sani&Wast, Other Agri, Forestry, Other Education, Other Industry,Trade, Other Info & Commuca, Other Non-bank Finan, Other Public Adminis, Other Transportation, PA Agri,Fish&Forest, PA Energy&Extratives, PA Financial Sector, PA Health, PA Ind, Trade & Serv, PA Info Commu Tech, PA Social Proctectn, PA Water, Sanitation, Ports/Waterways, Power, Primary Education, Railways, Roads & highways, Rural and Inter-Urba, Sanitation, Social Protection, Sub National Governm, Tourism, Trade, Urban Transport, Waste Management, Water Supply, Work Develop/Voca.

Appendix F: Project Performance Assessment Reports (PPAR) related to Renewable Energy

#	Project ID	Project Name	Country	App FY	Exit FY	IEG Rating
1	P002929	UG POWER III	Uganda	1991	2002	UNSATISFACTORY
2	P010410	RENEWABLE RESOURCES	India	1993	2002	SATISFACTORY
3	P010498	ENERGY SERVICES DLVY	Sri Lanka	1997	2003	HIGHLY SATISFACTORY
4	P044973	LA-SOUTHERN PROVINCE RE	Lao PDR	1998	2005	MODERATELY SATISFACTORY
5	P046829	CN-Renewable Energy Development	China	1999	2007	SATISFACTORY
6	P071794	BD: Rural Elect. Renewable Energy Dev.	Bangladesh	2002	2013	HIGHLY SATISFACTORY
7	P066396	VN-SYSTEM ENERGY, EQUITIZATION & RENEWAB	Vietnam	2002	2013	MODERATELY UNSATISFACTORY
8	P067828	CN-Renewable Energy Scale-up Program	China	2005	2009	HIGHLY SATISFACTORY
9	P071464	RENEW ENERGY RES (GEF)	Croatia	2005	2010	MODERATELY UNSATISFACTORY
10	P096158	CN-Renewable Energy II (CRESP II)	China	2006	2011	HIGHLY SATISFACTORY
11	P090116	PE Rural Electrification	Peru	2006	2013	SATISFACTORY
12	26016	Enerjisa Enerji Uretim S.A.	Turkey	2008	2016	MOSTLY SUCCESSFUL
13	P105279	SN-En. Sec. Recov. Dev Policy Financing	Senegal	2008	2011	UNSATISFACTORY
14	P095205	BR 1st Prog. DPL for Sust. Env Mgmt	Brazil	2009	2011	UNSATISFACTORY
15	P110643	Programmatic Electricity Sector DPL	Turkey	2009	2010	SATISFACTORY
16	P121651	ESES DPL 3	Turkey	2012	2012	SATISFACTORY
17	P068049	CN-Hubei Hydropower Dev in Poor Areas	China	2002	2018	SATISFACTORY
18	P073246	NI Offgrid Rural Electrification (PERZA)	Nicaragua	2003	2012	SATISFACTORY
19	P099321	MN-Renewable Energy for Rural Access	Mongolia	2007	2012	MODERATELY SATISFACTORY

Uganda - Third Power Project and Supplemental Credit (P002929)

a. Objectives: The project supported a major part of the sectoral development program implemented by the Uganda Electricity Board (UEB), the physical component being specific to Extension of the Owen Falls Dam (OFE) and associated generation and transmission facilities. The objectives according to the SAR were: 1. To provide least-cost capacity additions to Uganda's power generation and prevent power supply bottlenecks which would otherwise hinder economic development. 2. Increase the safety of the Owen Falls Dam. 3. Enhance the Utility's operating and management capability and improve its financial performance through policy reforms and institutional strengthening, including establishment of realistic tariffs and agreement on a sector investment program.

b. Components: 1. OFE (70.3%) - civil works and spillway, electrical and mechanical equipment and engineering supervision . 2. Technical Assistance (3.0%) - to UEB and Ministry of Energy and Mineral Development (MEMD.) 3. Next major site study and repayment of project

preparation facility (.6%.) 4. Dam Remedial Works (3.1%.) 5. Transmission and Distribution (21.9%.) 6. Power Sector Reform (1.1%.)

Ratings for the Third Power Project and Supplemental Credit for Uganda are as follows: outcome was unsatisfactory, risk to the development outcome was significant, the Bank performance was unsatisfactory, and the Borrower performance was rated as moderately unsatisfactory. Some of the lessons learned from this project are: 1) power sector reforms need to be very country-specific in order to produce improved sector performance and increased access to electricity by the poor. The Bank's power sector policy and lending strategies of the 1990s, with their strong emphasis on unbundling and privatization, did not lead to better performance of the sector and increased access, because they were not applied with due consideration to the country's characteristics; 2) private sector participation in major power projects can create significant contingent liabilities for the governments. Therefore, the Bank needs to encourage and help governments to develop an appropriate framework for risk sharing with the private sector; 3) the Bank needs to carefully scrutinize contractor prequalification. In some cases, the Bank might be better off using the services of outside consulting firms instead of relying on its own expertise; and 4) timely midterm reviews (and project restructuring if warranted) are particularly important in infrastructure projects with long implementation periods during which the original objectives and project design are more likely to require changes. **India – Renewable Resources (P010410)**

a. Objectives: (a) Promote commercialization of renewable resources technologies by strengthening the Indian Renewable Energy Development Agency's (IREDA) capacity to promote and finance entrepreneurial investments in alternate energy; (b) create marketing and financing mechanisms for the sale and delivery of alternate energy systems based on cost-recovery principles; (c) strengthen the institutional framework for encouraging entry of private sector investments in non-conventional power generation; and (d) promote environmentally sound investments to reduce the energy sector's dependence on fossil fuels . GEF's objectives were to demonstrate commercialization and catalyze wind energy and solar photovoltaic (PV) investments by strengthening IREDA's capacity to promote private investments in the sector. The GEF grant was used to help reduce the project cost to a level comparable to that of conventional alternatives.

b. Components: (i) irrigation-based small hydro projects with an aggregate capacity of 100 MW; (ii) aggregate capacity of 85 MW of wind farms; and (iii) a marketing and financing program to support the solar PV market and installation of 2.5 to 3.0 Megawatt Peak (MWp) of PV systems. Technical assistance to strengthen IREDA's capacity to promote renewable energy technologies and attract private sector interest; provide technical support and training for IREDA staff, investors and other stakeholders engaged in renewable energy market development and investment.

The ratings for the Project are as follows: the outcome is rated satisfactory. The project achieved its physical objectives, and in the case of small hydro power and wind farms components,

exceeded its targets. The project's institutional development impact is rated modest. Renewable Resources Development Project (RRDP) strengthened Indian Renewable Energy Development Agency (IREDA) and enabled it to mobilize greater private participation and attract additional multilateral and bilateral support for commercializing renewables. The sustainability of RRDP is rated likely, but only marginally so. There are high risks, as commercialization of renewables continues to be threatened by regulatory instability, and have many constraints, notably its continued dependence on incentives, grants, and subsidies. IREDA itself continues to face important financial issues that threaten the sustainability of the project's achievement. Overall, the Bank's performance is rated satisfactory, at least at the project level. As explained in the remainder of this PPAR, the main risks to the project stem from the lack of an integrated renewables and power sector strategy. Borrower performance is rated satisfactory. However, during project implementation, project supervision records show that the government was weak in supporting the rationalization of lending rates, and in coordinating various agencies involved with renewable energy development. The main lessons from this evaluation are as follows: Power sector reforms and renewable energy commercialization should be part of an integrated strategy. The Bank and its client countries should incorporate provisions to level the playing field between conventional and renewable energy technologies while legal/regulatory and other sector-level reforms are being designed and implemented. Monitoring and evaluation systems should be developed for both project and sector-level outcomes, which should distinguish between efficiency and equity indicators. GEF and other grant support operate in a power sector reform setting, and thus should also be keyed to sector outcome indicators. Much "learning-by-doing" is involved in non-conventional projects such as renewable energy development and commercialization, which underlines once more the importance of monitoring and evaluation systems

Sri Lanka – Energy Services Delivery (P010498)

a. Objectives: The ESDP's main objectives were to: (a) promote the provision of grid-connected and off-grid energy services by the private sector, NGOs, and cooperatives, using environmentally sustainable renewable energy technologies; (b) strengthen the environment for implementing demand side management; and (c) improve public and private sector performance to deliver energy services through renewable energy and demand side management.

b. Components: The ESDP had three principal components: (a) The ESD Credit Component was designed to provide private sector firms, nongovernmental organizations, and cooperatives with medium- and long-term financing for off-grid solar home systems and village hydro projects, and grid-connected mini-hydro, wind, and other renewable energy investments. In addition to the IDA credit, the Global Environment Facility (GEF) provided grant cofinancing to dealers and developers of solar home systems and off-grid village hydro schemes. (b) The Pilot, 3-MW GridConnected Wind Farm Component to demonstrate the technical and commercial viability and long-run economic potential of wind power in Sri Lanka, and to catalyze future private sector wind farm development. The component was implemented by the Ceylon

Electricity Board (CEB). (c) The Capacity-Building Component to provide training and technical support for renewable energy and energy efficiency initiatives by both the public and private sector, that is, CEB and energy service entrepreneurs.

The audit on these two operations gives mixed results, for although it concurs with the Implementation Completion Report (ICR) ratings of likely sustainability, and satisfactory Bank performance concerning the Second Power Distribution and Transmission Project (PDTPII), it downgrades the project outcome to moderately satisfactory, institutional development impacts to modest, and the Borrower performance to unsatisfactory; whereas, regarding the Energy Services Delivery Project (ESDP), the audit upgrades the ICR ratings of outcome, and Bank performance to highly satisfactory, yet concurs on its likely sustainability, high institutional development impacts, and highly satisfactory performance by the Borrower. The main lessons from the Second Power project concern the importance, prior to Board approval, of addressing procurement policies, and procedures that could create problems, and delays later; the need for a truly independent regulatory regime to govern tariff determination, in order to help safeguard the sector's financial viability; and, the importance of rigorously assessing risk, and identifying exit mechanisms for project components, in areas of civil unrest. Conversely, the ESDP yielded the following lessons of broad applicability, as the Bank expands its assistance for renewable energy, as part of its 2001 Energy Business Renewable Strategy, and 2003 Infrastructure Plan. These lessons can be clustered around three important areas: a) building-up the business and policy environment, addressing in particular the key barrier of access to capital; b) scaling-up the market, including a reliable after-sales service system, and end-user training; and, c) establishing strong project, and financial management systems, including monitoring and evaluation.

Lao PDR – Southern Province Rural Electrification (P044973)

a. Objectives: The objectives were to (i) expand rural electricity service in 7 central and southern provinces where economically justified, through grid extension and off -grid electrification; and ii) strengthen the electric company's (EDL) capacity to plan and implement electrification investments and to operate on a commercial basis.

b. Components: The project consisted of 3 components: i) Distribution Extension to increase electricity service in 7 provinces and thus reach 520 villages, benefiting 50,000 households, through the construction of voltage lines, transformer capacity, distribution transformers and consumer meters, and pilot low -cost single wire earth return (SWER) systems in rural areas. ii) Off-Grid Rural Electrification to pilot small-scale, standalone electricity systems, including the renewable energy technologies of micro -hydro, and solar battery charging stations, and diesel mini-grids, on a financially sustainable basis to provide electricity to 4,600 households in 46 villages. 3) Institution Building to improve EDL's efficiency by building its project management capability, improving its technical management and enhancing its commercial focus; and to assist the Ministry of Industry and Handicraft (MIH) in conducting hydropower planning studies and implementing the Electricity Law.

The overall outcome rating is moderately satisfactory, because of EdL's unsatisfactory financial performance for most of the project's duration and the technical problems. Bank performance was satisfactory, and that of the borrower moderately satisfactory (again reflecting EdL's poor financial performance). The risk to development outcome is modest since measures implemented toward the end of, and subsequent to, project completion have addressed the financial sustainability issue, and technical issues are being addressed under the follow-on Rural Electrification Project. The main lessons from this review are as follows: (i) the consumers are willing to pay tariffs at cost recovery levels, and the willingness to pay analysis shows that consumers are willing to pay for electricity at levels exceeding supply costs. Lao PDR has been able to implement sizeable tariff increases in a short space of time with no adverse social impact or notable demand reductions (indeed it can be argued that any reduction in usage by already connected customers would help extend supply to new locations); (ii) but poorer households remain unconnected, even after the grid has been in a village for more than 10 years, some 20 percent of households remain unconnected. Smart (i.e. efficiently targeted) connection subsidies for late connectors will help achieve government's 90 percent coverage target; and (iii) explicit attention needs to be paid to technical efficiency, and technical problems of system losses and outages reduce financial performance and undermine project benefits. Explicit components are needed to tackle such issues.

China – Renewable Energy Development (P046829)

a. Objectives: The PAD and Loan Agreement stated that the objective of the Renewable Energy Development Project (REDP) was to establish sustainable markets for wind and photovoltaic (PV) energy technologies in order to (i) supply electricity in an environmentally sustainable manner; and (ii) increase access of isolated rural populations to electricity services. The objectives of the grant cofinancing from the Global Environment Facility (GEF) were to (a) reduce greenhouse gas emissions by producing electricity from renewable energy; (b) reduce costs of renewable energy to permit long-term financial sustainability; and (c) remove barriers to the large-scale commercialization of the technologies. The project was restructured between approval by the Board and signature of the Loan, Grant and Project Agreements. Because the Loan Agreement was signed after the restructuring of the project, it is considered as the latest legal document capturing the objective and key associated outcome targets of the restructured project.

b. Components: 1. Wind Farm Component (12%) was to construct two wind farms in Shanghai totaling 21MW and to provide technical assistance to support the management of the wind farms and preparatory work on large coastal sites. 2. Photovoltaic (PV) Component (75.9%) for off-grid electrification. The component had three subcomponents: a) Investment (70.6%) that provided grants for 10MW peak (MWp) of PV systems to households and institutions in Qinghai, Gansu, Inner Mongolia, Xinjiang, Tibet and Sichuan. Subsidies of $1.50 per Wp of PV capacity, per system (with a capacity of 10 Wp or greater) would be provided to participating PV companies to improve PV product quality, to improve warranties and after -sale services, to

strengthen business capabilities, and to increase marketing efforts. b) Market development (3.4%) to overcome barriers and developing PV markets through public information campaign, capacity building for PV companies etc. c) Institutional strengthening (1.9%) to improve product quality, certification and standards, and project management and monitoring. 3. Technology Improvement (TI) Component (12.1%) for wind and solar technology to improve quality and reduce costs. The component had two subcomponents: a) Investment (11.4%). Cost-shared grants were available to participating TI companies through Competitive Grant Facility (CGF) to improve quality or reduce costs of products; a quick response fund for small and urgent costshared projects was provided through Quick Response Facility (QRF); and a Production Investment fund provided commercial loans to companies for purchase of production equipment, follow-up investment to grant-financed activities, or other investment activities. b) Institutional strengthening (0.7%) was to support program management and to improve the capacity of staff in manufacturing companies, and carry out special studies to facilitate project implementation.

Ratings for the China: Renewable Energy Scale-Up Program Phase 1 project are as follows: Outcome was highly satisfactory, Risk to development was low, Bank performance was satisfactory, and Borrower performance was satisfactory. The main lessons that emerge from the experience of this complex project are: (i) Combining institutional development and investments in one package can help overcome difficult challenges. (ii) Adequate time and resources for preparation and consultations should be planned and allowed. (iii) Cost-shared grants can enhance selectivity and efficiently leverage knowledge transfer, technology improvement, and counterpart funding. (iv) A long-term, predictable price signal can provide an effective stimulus for continuing investments in renewable energies.

Bangladesh – Rural Electrification and Renewable Energy Development (P071794)

a. Objectives: The Project's aim is to support Bangladesh's efforts to raise levels of social development and economic growth by increasing access to electricity in rural areas, where 85 percent of the country's nearly 63 million poor people live. The detailed objectives include: (i) assisting the Rural Electrification Board to expand the reach, capacity and reliability of rural grids and to improve the operational and financial performance of the rural electricity cooperatives Palli Bidyut Samities or PBSs); (ii) promoting the use of solar home systems in remote rural areas; (iii) facilitating development of small power projects, using renewable energy sources where feasible, to be owned and operated by the private sector or by NGOs/community-based organizations; and (iv) supporting initiatives in rural areas for productive use of electricity to increase household income and improve the delivery of such social services as health and education.

b. Components: 1): Rural Electrification System Expansion, Intensification and Rehabilitation 2) REB Technical Assistance 3) REB Solar Program 4) REB Solar Technical Assistance 5) IDCOL Renewable Energy Sub loans 6) IDCOL Technical Assistance

Ratings for the Rural Electrification and Renewable Energy Development Project for Bangladesh were as follows: outcome was highly satisfactory, risk to development outcomes was moderate, Bank performance was satisfactory, and Borrower performance was highly satisfactory. Ratings for the Power Sector Development Technical Assistance Project were as follows: outcome was unsatisfactory, risk to development outcomes was high, Bank performance was moderately satisfactory, and Borrower performance was unsatisfactory. Some lessons learned included: public-private partnership model can efficiently deliver large-scale and dispersed off-grid electricity services, by deploying public funding through private sector stakeholders. Flexibility to adapt to market conditions and signals are the hallmarks of this model, while quality assurance and after-sales and maintenance service mechanisms are a necessity for acceptance by beneficiaries. One-off technical assistance or credit support operations should be highly strategic, selective and practical in supporting policy and institutional issues of a complex nature. The PSD technical assistance project took on an ambitious agenda covering power sector policies, regulation, industry structure and private sector participation, and struggled to get traction on any of these matters. Achieving broader social and economic outcomes from electricity access provision will primarily depend upon the pursuit of a least cost path for grid expansion backed by appropriate sector policies, complemented by off-grid electricity in the interim or permanently as needed.

Vietnam – System Efficiency Improvement, Equitization & Renewables (P066396)

a. Objectives: is to assist the Borrower to: (a) enhance electricity system efficiency in Vietnam; (b) provide electric power in selected rural areas of Vietnam; and (c) sustain reform and institutional development of the Borrower's energy sector.

b. Components: Project Component 1 The component is designed to improve the transmission system efficiency and performance. It would include the following elements: 1.1 Upgrading of the 500 kV and 220 kV transmission networks and 1.2 DSM Phase 2. Subcomponent 1.1: Upgrading of the 550 kV and 220 kV transmission systems. Subcomponent 1.2: Demand-Side Management Phase 2. Project Component 2 This component would consist of three main subcomponents (2.1) Upgrading 110 kV sub transmission networks supplying rural areas; (2.2) Rehabilitation of existing small hydropower plants and new wind-diesel power plant for Phu Quoc Island and (2.3) Community-based hybrid renewable energy grids. Subcomponent 2.1. Upgrading 110 kV sub transmission networks supplying rural areas; Subcomponent 2.2. Rehabilitation of existing small hydro plants and a wind-diesel power plant system for Phu Quoc Island; Subcomponent 2.3. Community-based hybrid renewable energy grids. Project Component 3 This consists of five subcomponents: (3.1) Improvement of information system management; (3.2) Creation of district and commune-level joint-stock distribution companies; (3.3) Strengthening regulations, planning and Implementation capacity for Renewable Energy Projects in MOI; (3.4) EVN staff training program; and (3.5) Technical Assistance. Subcomponent 3.1. Improvement of management information system Subcomponent 3.2. Creation of District or commune-level Joint-Stock Distribution Companies. Subcomponent 3.3. Strengthening

regulations, planning and implementation capacity for Renewable Energy Projects. Subcomponent 3.4. EVN staff training program. Subcomponent 3.5. EVN Technical Assistance.

Ratings for the Transmission, Distribution, and Disaster Reconstruction Project for Vietnam were as follows: outcome was moderately satisfactory, risk to development outcome was significant, Bank performance was moderately unsatisfactory, and Borrower performance was moderately satisfactory. Ratings for the Rural Energy Project for Vietnam were as follows: outcome was satisfactory, risk to development outcome was significant, Bank performance was satisfactory, and Borrower performance was moderately satisfactory. Ratings for the System Efficiency Improvement, Equitization, and Renewables Project for Vietnam were as follows: outcome was moderately unsatisfactory, risk to development outcome was significant, Bank performance was moderately unsatisfactory, and Borrower performance was moderately unsatisfactory. Some lessons learned included: in supporting the sector to move towards long-term financial viability and fiscal sustainability, the Bank should lay primary emphasis on broader institutional and policy measures for cost recovery. In contrast, specific target-oriented and time-bound measures in the form of tariff or financial performance covenants carry excessive political implementation risks and are prone to noncompliance by the Borrower. A national push for universal electricity access provision will primarily depend upon the pursuit of a least cost path for grid expansion backed by appropriate sector policies, complemented by off-grid electricity in the interim, or for the long-term as needed. Rapid growth in electrification can be accompanied by sub-optimal use of electricity especially in a situation of relatively low or subsidized tariffs. The Bank should work to develop an understanding with client countries over the role of key institutions before embarking on full-fledged support for them. In a rapidly evolving sector environment, a de facto flexible approach should be adopted to adjust to changing priorities as well as new institutional and on-the-ground developments. The project monitoring and evaluation (M and E) framework should focus on identifying the direct causal links between project interventions and outcomes to the maximum extent possible. This is particularly important, albeit challenging, in large and rapidly evolving sector context in which Bank-supported interventions only partially influence but do not determine overall outcomes.

China – Renewable Energy Scale-Up Program (CRESP) (P067828)

a. Objectives: The projects under review supported the first phase of a three-phase Renewable Energy Scale Up Program, partly financed by a proposed Adaptable Program Loan (APL) series. The program objective was to enable commercial renewable electricity suppliers to provide energy to the electricity market efficiently, cost-effectively, and on a large scale. Phase 1 was to contribute to the program's global objective through development and implementation of the legal and regulatory framework to create and gradually increase the share of renewable energybased electricity generation. Phase 2 was to continue supporting the program's global objectives through institutional development and capacity building to further decrease cost, and to improve the financing framework and provide assistance for implementation in about 10

provinces. Phase 3 was to contribute to the full achievement of the program's global objective through support to the remaining less developed provinces.

b. Components: The project comprises two components: institutional development and capacity building and support for wind and biomass in pilot provinces

Ratings for the China: Renewable Energy Scale-Up Program Phase 1 project are as follows: Outcome was highly satisfactory, Risk to development was low, Bank performance was satisfactory, and Borrower performance was satisfactory. The main lessons that emerge from the experience of this complex project are: (i) Combining institutional development and investments in one package can help overcome difficult challenges. (ii) Adequate time and resources for preparation and consultations should be planned and allowed. (iii) Cost-shared grants can enhance selectivity and efficiently leverage knowledge transfer, technology improvement, and counterpart funding. (iv) A long-term, predictable price signal can provide an effective stimulus for continuing investments in renewable energies. **Croatia – Renewable Energy Resources (P071464)**

a. Objectives: To assist in developing an economically and environmentally sustainable market for renewable energy (RE) in Croatia

b. Components: Component I: Market Framework; Component II: Project Preparation

Ratings for the Energy Efficiency Project for Croatia were as follows: outcomes were moderately satisfactory, risk to development outcome was negligible to low, Bank performance was moderately satisfactory, and Borrower performance was satisfactory. Ratings for the Renewable Energy Resources Project were as follows: outcomes were moderately unsatisfactory; risk to development outcome was moderate. Bank performance was moderately unsatisfactory, and Borrower performance was also moderately unsatisfactory. Ratings for the District Heating Project were as follows: outcomes were moderately unsatisfactory; risk to development outcome was significant. Bank performance was satisfactory, and Borrower performance was moderately unsatisfactory. Some lessons learned included: a supportive regulatory environment is crucial for overcoming risk aversion to adopting new financing instruments for energy efficiency projects, creating a level playing field for a competitive Energy Service Company (ESCO) market, and to ensure sustainability of energy services. Ensuring reliable means for verifying energy savings provides a clear basis for sharing the resulting gains between the beneficiary and the financing source, and therefore incentivizes energy efficiency efforts. The Energy Efficiency project was unable to stimulate the ESCO market beyond some sectors in the public domain due to remaining regulatory and legal constraints (as for example in the residential sector). There is a need for the Government to coordinate its various ministries in order to provide common technical and other support services, with a view to mitigating risks for investors and consumers in renewable energy efforts.

China – Renewable Energy II (CRESP II) (P096158)

a. Objectives: To demonstrate early success in large-scale renewable energy investments with participating local developers in one pilot autonomous region and one pilot province.

b. Components: 1) Huitengxile Wind Farm, Inner Mongolia 2) Small Hydro Projects, Zhejiang

Ratings for the China: Renewable Energy Scale-Up Program Phase 1 project are as follows: Outcome was highly satisfactory, Risk to development was low, Bank performance was satisfactory, and Borrower performance was satisfactory. The main lessons that emerge from the experience of this complex project are: (i) Combining institutional development and investments in one package can help overcome difficult challenges. (ii) Adequate time and resources for preparation and consultations should be planned and allowed. (iii) Cost-shared grants can enhance selectivity and efficiently leverage knowledge transfer, technology improvement, and counterpart funding. (iv) A long-term, predictable price signal can provide an effective stimulus for continuing investments in renewable energies.

Peru – Rural Electrification (P090116)

a. Objectives: To increase access to efficient and sustainable electricity services in rural areas of Peru", through (a) investments in sub-projects to supply electricity services to some 160,000 unserved rural households, schools and health clinics, and businesses and public facilities; (b) a framework for electricity provision in rural areas that would attract investment from private and public sector providers (including local governments); (c) a pilot program to increase productive uses of electricity so as to increase opportunities for income generation in rural areas.

b. Components: 1) Investment in Rural Electrification Sub-projects 2) Technical Assistance for Rural Electrification 3) Pilot Program for Promotion of Productive Uses of Electricity 4) Small Hydro Financing Facility 5) Project Management.

Ratings for the Rural Electrification Project were as follows: outcome was satisfactory, risk to development outcome was negligible, Bank performance was moderately satisfactory, and Borrower performance was satisfactory. Lessons from this project included: i) The promotion of productive uses of electricity needs consistent and adequate levels of technical assistance and investment support, without which their sustainability is put at risk. (ii) Achieving the financial sustainability of solar photovoltaic systems remains a challenge that the government and electricity distribution companies need to address. (iii) To reach "the last mile" of rural electrification while ensuring sustainability, the government and the EDCs need to take specific actions.

Turkey – Enerjisa Enerji (26016)

a. Objectives: The project had five objectives (i) development of a merchant power operator; (ii) meeting incremental demand and decreasing overdependence on imported fuels; (iii) supporting power sector reform and economic liberalization; (iv) benefits to customers by improving the industrial competitiveness; and (v) contributing to environmental benefits for the country.

Ratings for the Enerjisa Energi Project were as follows: outcome was mostly successful, investment outcome was satisfactory, IFC's work quality was satisfactory and role and contribution was satisfactory. The lessons from this project included: 1) Corporate investments with large infrastructure or manufacturing subprojects require a team of Environmental and Social (E&S) specialists including an OHS specialist for greenfield, and complex projects. 2) Triangulating supply-demand forecasts in energy projects using market consultants and external sources may be useful at the time of deal structuring

Senegal – Energy Sector Recovery Development Policy Financing (P105279)

a. Objectives: To ensure a sustained and sound long -term development of electricity services and supply of petroleum products for Senegal.

b. Policy Areas: 1. Restoring the financial viability and sustainability of the electricity and hydrocarbon sectors; 2. Improving the governance of the electricity and hydrocarbon sub-sectors and 3. Long-term development of the energy sector

Ratings for the Electricity Sector Efficiency Enhancement Project; and Energy Sector Recovery Development Policy Credit Project for Senegal was as follows: outcomes were satisfactory, the risk to development outcome was low or negligible, the Bank performance was satisfactory, and the Borrower performance was also satisfactory. Some lessons learned included: proper sequencing of sector policy dialogue and investment support is important for success when the two are closely connected. The Bank has an important role in ensuring that investment decisions are made based on technical, financial, and economic merits. Where a country's political timetable is liable to bring significant shifts in policy, a keen appreciation of political economy is necessary. The Bank has much to gain from locating key operational staff in the field, particularly where a continuous and intense dialogue is required, such as Senegal's energy sector. Inattention to the good practice principles for the application of conditionality can result in policy-based operations that are unbalanced and lack focus. In designing policy-based operations, a realistic sense of the pace of reform will take account of political economy considerations.

Brazil – First Programmatic Development Policy Loan for Sustainable Environmental Management (P095205)

a. Objectives: The SEM DPL series supports the GOB's concerted efforts to strengthen environmental management, with particular attention to: improvements in the overall environmental management system, sustainable management of agricultural lands, forests, and water resources; reduction of deforestation in the Amazon; reduction of the environmental degradation of land and water resources that are key determinants of the well being [sic] of the poor; and, promotion of renewable energy .

b. Policy Areas: A. Improving the overall Brazilian environmental management system; B. Integrating principles of sustainable development in key sectors: B.1. Natural Resource Management and Conservation B.2. Water Resource Management B.3. Environmental Sanitation B.4. Renewable Energy

Ratings for the First Programmatic Development Policy Loan (DPL) for Sustainable Environmental Management Project for Brazil were as follows: outcome was unsatisfactory; risk to development outcome was moderate; Bank performance was unsatisfactory; and Borrower performance was moderately unsatisfactory. Some lessons learned included: certain aspects of the World Bank's policies and guidance on development policy lending should be clarified. Particularly for DPLs focused on reforms in a sector - rather than on macro-economic stability - the impacts of the actions supported can often not be adequately perceived within the short timeframe of the loan, making monitoring and evaluation of outcomes difficult. Back-loading of reforms in a DPL programmatic series can increase the risk of later loans in the series being canceled without full realization of the objectives of the series. In future, when attempting to support reforms in state-owned banks like National Bank for Economic and Social Development (of Brazil) (BNDES) that finance both public and private-sector investments, it will be important to take a one World Bank Group approach. The level of government targeted by DPL reforms should be consistent with the outcomes intended and the client country's institutional structure.

Turkey – Programmatic Electricity Sector Development Policy Loan (P110643)

a. Objectives: To support the implementation of the Government's program that aims to address the projected electricity supply-demand imbalance: (a) through energy efficiency measures to reduce the rate of growth of demand for electricity, and (b) by enhancing the efficient supply of electricity.

b. Policy Areas: 1) Energy Sector 2) Climate Change 3) Sustainable Environmental Management

Ratings for the First Programmatic Electricity Sector Development Project and Second and Third Programmatic Environmental Sustainability and Energy Sector Development Policy Loan (DPL) Project were as follows: outcome was satisfactory, risk to development outcome was significant,

Bank performance was moderately satisfactory, and Borrower performance was satisfactory. Some lessons learned included: the Bank can maximize its development impact by concentrating its strategic engagement including its lending and advisory support in sectors with track records of success. A well-designed programmatic DPL can be a key instrument in the Bank's long-term engagement. The DPL instrument can leverage the Bank's strengths on technical advice, convening power, and credibility to help support sector reforms that can have substantial impacts. Prior actions should focus selectively on those reforms that are critical to achieving project objectives but are difficult to undertake because of political or institutional resistance. Prior actions should also ensure that they are additional to what will occur in the absence of the DPL operation. DPLs can achieve good outcomes when they serve as the culmination of a process of engagement, as in the electricity sector in Turkey. A comprehensive yet well integrated set of market reforms can provide credible signals and incentives to private investors. Changing laws and regulations may not have much impact on environmental outcomes when environmental management agencies are weak and lack implementation and enforcement capacity. A Bank DPL may have little additional impact if the design does not fully incorporate the existing political and institutional motivations.

Turkey – Environmental Sustainability and Energy Sector (ESES) (P121651)

a. Objectives: To help: (a) enhance energy security by promoting private sector clean technology investments and operations; (b) integrate principles of environmental sustainability, including climate change considerations, in key sectoral policies and programs; and (c) improve the effectiveness and efficiency of environmental management processes.

b. Policy Areas: 1) Energy Sector (Supply Security, Climate Change & Enhanced Private Investment) 2) Climate Change 3) Sustainable Environmental Management

Ratings for the First Programmatic Electricity Sector Development Project and Second and Third Programmatic Environmental Sustainability and Energy Sector Development Policy Loan (DPL) Project were as follows: outcome was satisfactory, risk to development outcome was significant, Bank performance was moderately satisfactory, and Borrower performance was satisfactory. Some lessons learned included: the Bank can maximize its development impact by concentrating its strategic engagement including its lending and advisory support in sectors with track records of success. A well-designed programmatic DPL can be a key instrument in the Bank's long-term engagement. The DPL instrument can leverage the Bank's strengths on technical advice, convening power, and credibility to help support sector reforms that can have substantial impacts. Prior actions should focus selectively on those reforms that are critical to achieving project objectives but are difficult to undertake because of political or institutional resistance. Prior actions should also ensure that they are additional to what will occur in the absence of the DPL operation. DPLs can achieve good outcomes when they serve as the culmination of a process of engagement, as in the electricity sector in Turkey. A comprehensive yet well integrated set of market reforms can provide credible signals and incentives to private investors. Changing laws

and regulations may not have much impact on environmental outcomes when environmental management agencies are weak and lack implementation and enforcement capacity. A Bank DPL may have little additional impact if the design does not fully incorporate the existing political and institutional motivations.

China – Hubei Hydropower Development in Poor Areas (P068049)

a. Objectives: The project has three objectives: (a) facilitate economic growth in Hubei by expanding electric power generation capacity in an economically and environmentally sustainable manner; (b) enhance the efficiency of the electricity sector in Hubei by commercializing county generation companies; and (c) contribute to poverty alleviation efforts in poor communities in Hubei.

b. Components: 1) Dongping Hydroelectric Power Station 2) Najitan Hydroelectric Power Station 3) Songshuling Hydroelectric Power Station 4) Xiakou Hydroelectric Power Station. Each of the above components consisted of four activities: a. Construction of a hydroelectric power station, including: (i) a single purpose concrete arch dam; (ii) a power house; an associated step-up substation; and (iv) construction of a transmission line to connect the power station to the grid. b. Carrying out a program of institutional strengthening, including: (i) development and implementation of appropriate organizational arrangements, staffing and information systems appropriate to the operational phase; and (ii) provision of training to the Project Company staff in project management and hydropower station operation. c. Development of a plan for enhancement of poverty alleviation efforts in the county to be partially funded from the fiscal revenues accruing to the county as a result of the project. d. Compensation, resettlement and rehabilitation of project affected persons

The ratings for the Hubei hydropower project were as follows: outcome was satisfactory, risk to development outcome was moderate, bank performance was moderately satisfactory and borrower performance was moderately satisfactory. Some lessons included: Integrating hydropower investments with institutional development and poverty alleviation can yield strong synergies and the rigorous quality and depth of appraisal for implementing agencies needs to be maintained throughout the project cycle, including project components added late.

Nicaragua – Off-Grid Rural Electrification (PERZA) (P073246)

a. Objectives: To support the sustainable provision of electricity services and associated social and economic benefits in selected rural sites in Nicaragua, and strengthen the Government's institutional capacity to implement its national rural electrification strategy. This would be accomplished by (i) supporting the Government in the design and implementation of its national rural electrification strategy; (ii) implementing innovative public/private off-grid electricity delivery mechanisms in several pilot sites for later replication on a national scales; and (iii) demonstrating in the pilot areas the potential of targeted rural microfinance and

business development services (BDS) to significantly enhance the development impact of rural electrification.

b. Components: 1. Rural Electrification and Renewable Energy (RE) Policies and Strategies; 2) Rural Electrification Subprojects; 3) Microfinance development program 4) Business Development Services (BDS); 5) Social Strategy Consultations and Communications; 6) Project Management an Institutional Strengthening of the National Energy Commission

Ratings for the PERZA project were as follows: outcome was moderately satisfactory, risk to development outcome was moderate, World Bank performance was moderately satisfactory and borrower performance was moderately satisfactory. Some lessons included: Impact of productive uses of electricity can be further increased if rural electrification projects are complemented by other infrastructure development, specifically through the improvement in transportation infrastructure, Low income level of solar home system users can jeopardize the sustainability of these systems and A stable policy and regulatory framework, and its consistent enforcement is a must for private sector participation in rural electrification projects.

Mongolia - MN-Renewable Energy for Rural Access (REAP) (P099321)

a. Objectives: To expand access to electricity and improve reliability of electricity services in selected off-grid soum centers1 and among the herder population, and to remove barriers to the scale-up of renewable energy use. Given its anticipated global environment benefits from the replacement of heavy oil-based sources by the renewable energy, the project was co-financed by the GEF and had a global environment objective (GEO) to reduce emissions of carbon dioxide by 9,000 metric tons a year.

b. Components: 1. Herders' Electricity Access; 2) Soum Center Electricity Service; and 3) National Capacity Building

Ratings for the Renewable Energy for Rural Access Project (REAP) are as follows: Outcome is moderately satisfactory, Risk to development outcome is significant, Bank performance is moderately satisfactory, and Borrower performance is moderately satisfactory. Lessons from the project include: (i) An appropriate balance between affordability and cost recovery is essential for scaling up the adoption of portable renewable energy systems by those who cannot afford the full investment costs. (ii) Proper market assessments are an essential requirement for projects that rely on the private sector for distribution of equipment, after-sales service, or the operation of local off-grid utilities. (iii) To be sustainable and to realize the potential for expansion in demand, renewable energy technologies (RETs) require established and regulated equipment quality standards to guide purchases, and proper handling and disposal of used SHS batteries. (iv) Regular dialogue and consultation at the appropriate client government level regarding government policy intentions and their consequences are critical to inform project design and implementation.

Appendix G. Hydropower

This Appendix summarizes the methodology and results of the cost-benefit analysis that was carried out to assess the impact of cost and time overruns in a sample of WBG supported hydropower projects, to assess the impact and confirm whether the projects conferred the originally envisaged net economic benefits. In addition, it also estimates the avoiding carbon dioxide emissions resulting from these project, and thereby, the contribution that they have made to mitigating climate change; a significant role hydropower is expected to play in the *Clean Energy Transition.*

I. Methodology

Introduction

The analysis examines the net economic benefits achieved by a sample of World Bank Group (WBG) hydropower investment projects constructed between 1976 and 2015. Project information was collected from Project Appraisal Documents (PADs) and Implementation and Completion Reports (ICRs) for a portfolio of 49 WBG power dam hydropower project operations, of which four project operations consist of a combination of multiple power dam projects; thus, making the total number of power only dams physical projects equal to 57 that are considered in the analysis. Information about the 57 projects are included at the end of the Appendix.

As Table G1 shows, the 57 power only dam projects are concentrated in East Asia and Pacific islands (16), Latin America and the Caribbean islands (16), Sub-Saharan Africa (12), Europe and Central Asia (8), and in South Asia (5). The average size (in MW) of the projects is much smaller in Sub-Saharan than in Latin America, Asia, Europe, and Caribbean and Pacific islands. The average cost per MW of capacity of projects when fully implemented is significantly lower in East Asia and Pacific islands (US$ 1.13 million/MW) than in Sub-Saharan Africa (US$ 2.81 million/MW), Latin America and Caribbean islands (US$ 2.05 million/MW), South Asia (US$ 1.93 million/MW), and in Europe and Central Asia (US$ 1.59 million/MW).

Table G1. Summary of projects by Region

Geographical Location	Number of Dams	Capacity (MW)	Average real cost (US$ million, 2010)			
			Real Capital Cost, Estimated	Real Capital Cost, Actual	Estimated Cost/MW	Actual Cost/MW
	[1]	[2]	[3]	[4]	[5]	[6]
East Asia and Pacific	16	7,139	6,983	8,099	0.978	1.134
Europe and Central Asia	8	3,106	4,813	4,947	1.549	1.593
Latin American and the Caribbean	16	10,283	13,428	21,032	1.306	2.045
South Asia	5	2,303	3,998	4,448	1.736	1.931
Sub-Saharan Africa	12	1,575	4,066	4,430	2.582	2.813
Aggregate	**57**	**24,405**	**33,289**	**42,956**	**1.364**	**1.760**

Note: Columns 3 and 4 present the undiscounted but deflated sum of the actual costs incurred for all projects within each regional category. Figures in column 5 and 6 are weighted averages of cost per MW for various regions.

Measuring the Benefits of the 57 Power Only Dams Hydropower Projects

For a balanced view of the true value of hydropower projects, the proposed analytical framework incorporates the uncertainties underlying both benefits and costs of the 57 hydropower projects. The uncertainty underlying the benefit side is the volatile price of fuel of the alternative power plant that is avoided by undertaking the hydropower investment. The downside uncertainty in the cost of hydropower, is the risk of capital cost and time overruns.

The benefits of a hydropower projects can be quantified as the value of the avoided generation cost of the fossil-fuel power plant that would be required to be built and operated to supply the same volume of electricity as would be supplied by the hydropower project (Zuker and Jenkins 1984). While the avoided cost of thermal generation does not capture all the economic benefits, or externalities, associated with a hydropower project, these cost savings are a good proxy for a major part of the benefits of hydroelectric generation when there is a commitment to supply the quantity demanded by one means or another.

Assuming that the next best alternative energy can be generated from a standard thermal plant, the benefits of hydropower projects are measured in three parts: (i) cost savings on the fixed annual cost of the alternative electricity-generation plant, (ii) marginal running cost (fixed and variable) of the alternative plant; and when considering global externality to society, (iii) the avoided impacts of emissions (CO2e)1. The social benefits from making electricity available to facilitate economic activities are not included, since such benefits would have occurred with the alternative thermal system.

The type of standard thermal alternative power plant technology - heavy fuel oil, natural gas, diesel, and coal - considered for the benefit analysis, are those assumed at the project appraisal stage by the WBG and which are collected from the World Bank PADs for each of the 57 projects. Data on capital costs to calculate cost savings on the fixed annual cost of the alternative electricitygeneration plant that are avoided by constructing the hydropower plant, are sourced from industry literature and as well as from the World Bank database of implemented projects2.

[1] The benefit of the hydropower dam is measured as:

$$KK \sum_{tt=0}^{ZZ+40} \frac{(1^{rr}(+^{1}rr^{+})_{NN}{}^{rr})-^{NN}1}{IIII + VVVVVV + (ff_{tt}pp_{tt})GG_{tt} + SSIIII\,(1+rr)^{-tt}}$$

where *K* represents the capital cost and *N* is the economic life of the alternative plant. *IC* denotes the installed capacity in MW, and *G* the equivalent electricity output expected to be generated from the hydropower facility in period *t*; *f* stands for fuel requirement in liter/kWh, and *p* for price of fuel at period *t*. *SCC* denotes the social cost of carbon emission. Fixed operating and maintenance costs have been estimated to be similar for both the hydropower facility and the thermal plant (EIA, 2013). Hence, we do not include fixed operating and maintenance in the formula for estimating the hydro benefit.

[2] Data on the capital cost of single-cycle and combined-cycle power generation plants are from the World Bank database of

implemented projects (SARs and ICRs).

Technical parameters for fuel requirements per KWh, heating values per Btu/KWh and variable operating and maintenance costs (VOM) per MWh for different alternative thermal plants used in the analysis are sourced from the Energy Information Administration (EIA). The social cost of carbon emissions is taken from the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG, 2016) estimates and is assumed at US$39 per ton of CO2. IWG estimates are used as guide on estimating the social cost of carbon emissions by WB. The technical and thermal plants parameters assumed are shown in Table G2.

Table G2. Parameters/Assumptions on Alternative Thermal Plant

	Type of power plant			
	OCGT	CCGT	Diesel	Coal
Capital cost (US$/kW)	900	1,260	650	3,636
Variable O&M cost (US$/MWh)	3.5	3.5	15.0	4.6
Efficiency rating (%)	34.1%	51.7%	34.5%	38.8%
Fuel requirement, HFO (litre/kWh)	0.252	0.167	0.250	-
Fuel requirement, NG (ft3/kWh)	9.747	6.433	9.649	-
Fuel requirement, diesel (litre/kWh)	0.259	0.171	0.257	-
Fuel requirement, coal (kg/kWh)	-	-	-	0.405
Heating values (Btu/KWh)	10,000	6,600	9,900	8,800
	HFO	NG	Diesel	Coal
CO2 factor (CO2kg/kWh)	0.256	0.181	0.256	0.326

Source: EIA (2016), EPA (2015), Lazard (2015), and World Bank database of implemented projects (SARs and ICRs)

The annuity formula is used to estimate the annual capital cost per kW, which includes both the depreciation and economic opportunity cost of capital investment. The economic life (N) of the alternative plant is assumed to be 25 years. The calculated annual capital cost per kW is then multiplied by the installed capacity size of the hydropower plant to obtain the total fixed annual capital cost.

The marginal running cost (MRC) is taken as the value of the fuel and the VOM expense that would be necessary to operate the alternative plants if the hydro dams had not been implemented. This value of fuel is a function of the price (pt) of fuel and the amount of fuel required per unit of electricity to be generated (ft). Given that the market price of fuel varies substantially by fuel type, four common types of fuel are considered for the estimation of benefits – heavy fuel oil (HFO), natural gas, diesel, and coal.

The actual fuel prices for the period of 1970-2015 from the U.S. Energy Information Administration (EIA) database are used in the calculation of benefits of hydropower projects corresponding to each of the years the hydro power plants have operated to date. The fuel prices after 2015 to the end of the hydro dams' life cycle (40 years) are assumed to be constant at 2015's

prices and assumed at US$356.5 per ton (HFO), US$5.6 per thousand cubic feet (natural gas), US$731.1 per ton (diesel), and US$93.2 per ton (coal). The fuel prices are adjusted upward by 20 percent when calculating the fuel cost for all regions. This margin/markup on price is to cover port charges, transportation cost, insurance, and distribution cost (IEA, 2014). Heating values and fuel requirements parameters for each type of thermal plant, together with VOM parameters are shown in Table 2 above.

Data for net electricity generation of hydro dams are available from the World Bank PAD and ICRs for various projects. When there is only one alternative thermal plant assumed at the appraisal stage, the quantity of electricity projected is attributed solely to that thermal power plant. However, if the thermal alternatives are different for the peak and off-peak periods, and the amounts of electricity are not explicitly distributed among those periods in the PADs, then we assume electricity generation during peak period as 4 hours a day for 260 days and the rest goes to the off-peak period.

A real discount rate (baseline) of 10 percent is used to adjust the benefits to bring them to a common point in time at 2016.

Construction Costs

For the analysis of cost overruns, four concepts are used: estimated nominal cost, estimated real cost (base year price), actual nominal cost, and actual real cost. The estimated nominal cost used is the sum of base cost (using constant prices), plus an amount to reflect the provisions for physical and price contingencies.

According to the World Bank appraisal methodology that has been formally applied since 1976, cost estimates for projects should include a price contingency to account for expected changes in the price level of both imported and locally purchased inputs. In addition, an amount is set aside for physical contingencies. This contingency accounts for expected errors in forecasting of base cost estimates that affect the quantities of inputs required to complete the project (Bacon et al., 1996). Therefore, the estimated real cost at appraisal is derived by simply deducting the price contingency from the estimated nominal project cost but including physical contingencies.

The change in the real cost schedule of a large project can be the result of two factors. First, real cost changes can occur because of changes in input quantities and real price adjustment; second, change orders will alter the real cost as a project is redesigned. The change in real cost in the analysis is the difference in cost between the real estimate of cost (which includes physical contingencies) at the time of appraisal – the point of decision making – and the actual real completion cost. Real cost overruns as measured in this study excludes cost changes owing to change orders. The actual nominal cost (in current prices) is the completion cost of the project as reported in the World Bank's Implementation and Completion Reports (ICRs), while the actual real cost is the deflated values of the actual nominal costs. The impact of general inflation on the cost of a project will usually be transferred eventually to consumers of the project's output through adjustment of electricity tariffs to reflect movements in the general level of prices. Hence, a budget overrun caused by general inflation should not be counted as a real cost overrun.

Cost overrun computation

The World Bank project ICRs give the cost of a project along with the percentages of the total that are foreign and local costs3. The actual project cost, however, is expressed in nominal dollar terms. To compute the actual real cost, it is necessary to spread the actual nominal cost over the entire project construction period. The distribution of capital expenditure over the construction period follows the mathematical formulation by Drummond (2012), which is similar to that used by Bacon et al. (1996)4.

The annual nominal costs are split into foreign and local components, and then deflated to the prices of the starting year. The domestic costs are first converted from nominal US$ to nominal domestic currency units using the market exchange rate for each period. These nominal amounts of domestic costs are deflated by the domestic price index, and then converted back into US$ of the starting year of the project using the market exchange rate for that year. The foreign costs are deflated with the GDP deflator index for the USA. Adding up these two components gives the actual real cost of the project, expressed in dollar terms5.

This procedure is used to estimate the actual real costs of constructing the hydropower projects (See Table 1 and Table 2 above, column 4). The real cost overrun is then computed as the deviation of the actual real cost from the estimated real cost, taken as a percentage of the estimated real cost. We estimate the nominal cost overrun as the percentage deviation of the actual completion cost over the estimated real cost of constructing the dam. This includes both the changes resulting from price escalation and the real cost growth in excess of physical contingencies set aside during appraisal.

[3] Information on decomposition of total costs into foreign and local components was missing only for four projects out of sixty-eight. The average proportion for the foreign and local components calculated from the other hydro projects implemented in the same country was used as a proxy.

[4] The spreading of the construction costs was carried out using the function:

$$YY_{ii} = \frac{1}{2}(ss+1)\ pp + \pi\pi ss\,ii\pi\pi\pi\pi \quad ii_{ss} \quad ii_{ss+1} \quad + pp \quad II \quad II$$

where Y_i is the share of total capital expenditures allocated to period i of the entire construction span that is I years; S represents the skewness of the cost lay-out curve assumed to be 0.2 for a positively skewed curve over the construction cycle; flatness of the curve, and it varies according to the length of construction cycle. p is the

[5] Actual real cost (US$) is:

$$ii \quad ii=0TT\ II \quad nn\$ * FFFFIIFF + EE10mm\ ii=0TT\ IIiinn\$ * (1 - II0DDFFIIFF,ii\ ) * EEiimm$$

$$II_{oo,ii}$$

where Cn$ denotes the actual nominal cost, FCX is the share of imported components of the total cost; IF and ID are the foreign and domestic price indices, respectively.

Cost of time overrun

Delays often occur during the implementation of a hydropower project that extend the construction period beyond its original schedule. More than 77 percent of the projects in our sample experience a time overrun of more than 10 percent of the initial time estimated for completion. In planning for power project investments with alternative forms of energy generation, it is important to consider that there are both economic costs and benefits from delaying the construction of these projects. When there is time overrun, there are benefits in PV terms from cost savings from postponing the real capital expenditure outlays6. The actual project cost will be subjected to a longer period of discounting. These benefits, however, may not be significant enough to offset the cost of supplying power by alternative means during the delay period7.

Although cost overrun and time overrun are not completely separable concepts in project appraisal, the cost implication of the latter is best explained by a marginal evaluation of the societal resource flows that may ultimately be beneficial to the society. The cost of power generation through the best available alternative is the estimate of the economic value of the lost benefits of electricity generation that are the result of the delay in construction of the hydropower facility (or opportunity cost). The most likely scenario is that with the delay in the dispatch of the hydro plant, during the peak and off-peak periods other thermal plants will operate for more hours. These will be the plants with the highest marginal running costs (MRC) in the system, which would have been partially or fully retired as a result of the introduction of the hydro dam. The additional costs will include the fuel and VOM costs incurred in keeping these marginal plants operating.

This opportunity cost varies with oil price fluctuations. For countries with a low cost of generating electricity with hydropower, a delay will be costlier because of the relatively unfavorable cost of generating power from alternative sources. The net social cost of delay is then measured as the difference between the marginal running cost of the alternative power generation and the cost savings from the postponed real investment in the dams.

A real discount rate of 10 percent is used to adjust construction costs to bring them to a common point in time.

6

$$\text{Cost savings} \quad = [II_{ii}^{TT\,rr\$} * (1+rr)^{-ii}] - [II_{jj}^{ZZ\,rr\$} * (1+rr)^{-jj}]$$

$\sum_{ii=1}$ $\sum_{jj=1}$ where i is the construction year within the scheduled period T; j is the construction year up to the actual completion period Z; Cr$ is the real capital expenditure on the hydro project during construction years.

[7] If the energy demanded goes unsupplied, the actual cost to the economy may be higher than the hypothetical marginal thermal supply cost that is used in the estimation of the cost of delays.

Net Benefits

Once the benefits of hydropower projects are estimated, the net benefits of the dams are derived by subtracting the actual [real] cost of hydropower projects from their estimated benefits, and then expressed as the stream of net benefits over time in real PV terms, using 2016 as the base year. The value of electricity that is estimated in this study includes all generation costs but does not include any differentiated transmission and distribution costs if these were not included in the project reports.

Since the hydropower projects produce benefits over long period of times, the results are expected to be sensitive to the choice of discount rates. Therefore, a range of discount rates are considered in a sensitivity analysis to test the robustness of the result of the analysis.

II. Results and Discussion Findings

Findings on Cost Overruns

The reasons for cost overruns are summarized in Table G3.

Table G3. Causes of cost overruns (summary)

#	Most recurring causes of cost overrun	Frequency of reason given
1	Changes in work volume	13
2	Geological problems	10
3	Inflation/Currency fluctuation	8
4	Unrealistic appraisal estimates	8
5	Real price escalation	5
6	Management challenges	4
7	Time overrun	3
8	Adverse weather condition and natural calamities	3
9	Unsatisfactory contractor/implementing agency performance	3
10	Resettlement cost	3
12	Challenges with government procedures & policies	3
11	Transportation challenges	2
13	Construction challenges	2
14	Conflict among stakeholders	1
	Total number of stated reasons	68

Of the 68 reasons given for the cost overruns (for some projects more than one reason was given), a total of 13 times a change in work volume was identified as a cause. Geological problems were identified 10 times, while inflationary/currency fluctuations and unrealistic appraisals estimates were identified 8 times each. Real price escalation was identified 5 times. These five reasons account for 64.7 percent of the total reasons given for the cost overruns.

The weighted average cost overruns (column 5) across regions for the sample of 57 power dam only projects is calculated at 31.4 percent and is shown in Table G4. We look at the value of the real cost overruns measured as the excess of the change in actual real cost over estimated physical contingency, expressed as a percentage of estimated real cost.

Table G4. Estimated average cost overruns across regions.

Region	Number of Dams [1]	Nominal Cost Overrun as Percentage of Estimated Real Cost (%) [2]	Estimated Price Contingency as percentage of Estimated Real Cost (%) [3]	Actual Price Escalation as Percentage of Estimated Real Cost (%) [4]	Real Cost Overrun as Percentage of Estimated Real Cost (%) [5]
East Asia and Pacific	16	35.57%	22.22%	15.36%	20.22%
Europe and Central Asia	8	12.99%	12.07%	10.29%	2.70%
Latin American and the Caribbean	16	87.37%	18.02%	32.17%	55.20%
South Asia	5	18.44%	16.59%	5.26%	13.18%
Sub-Saharan Africa	12	30.96%	17.60%	21.14%	9.82%
Weighted average	***57***	***52.61%***	***18.33%***	***21.22%***	***31.39%***
Weighted average*	51	44.93%	17.24%	21.30%	23.64%
East Asia and Pacific*	15	35.50%	22.22%	15.36%	20.15%
Latin American and the Caribbean*	12	75.07%	16.12%	34.48%	40.60%
South Asia*	4	7.25%	12.50%	2.17%	5.08%

* Excluding 3 outliers in Latin America and the Caribbean, 1 outlier in East Asia and Pacific, and 1 outlier in South Asia (based on the analysis of the distribution of real cost overrun)

As Table 4 shows, the lowest real cost overruns are found in Europe and Central Asia and the highest in Latin America and the Caribbean region, where real costs are on average 55.2 percent greater than initial estimates. **Findings on Time Overruns**

The underlying causes of time overruns as reported in Table G5 are varied.

Table G5. Causes of time overruns

#	Most recurring causes of cost overrun	Frequency of reason given
1	Geological problems	15
2	Conflict among stakeholders	12
3	Adverse weather condition and natural calamities	11
4	Financing	11
5	Delay in equipment delivery	9
6	Challenges with government procedures & policies	7
7	Changes in work volume	7
8	Management challenges	7
9	Delay in bidding/award process	6

10	Construction challenges	6
11	Unsatisfactory contractor/implementing agency performance	5
12	Unrealistic appraisal estimates	4
13	Delay of civil works	3
14	Damages	3
15	Delay in project design	2
16	Quality problems	1
17	Transmission challenges	1
18	Corruption/Lack of financial disclosure	1
	Total number of stated reasons	111

The most frequent reasons given are geological problems (15), conflict among stakeholders (12), adverse weather and national calamities (11), financing (11) and delay in equipment delivery (9). It is interesting to note that among the top 10 factors causing time overruns only two, geological problems and changes in work volume, rank in the top 5 causes of real cost overruns. Moreover, as Table G6 shows, the largest percentage of average time overruns was in South Asia with 33.1 percent over the estimated construction schedule at appraisal stage. **Table G6. Incidence and cost of time overruns across regions.**

Region	Number of Dams [1]	Number of dams with time overrun [2]	Average capacity (MW) [3]	Scheduled (months) [4]	Slippage (months) [5]	Average time overrun (%) [6]	Cost of time overrun as percentage of estimated real costs (%) [7]
East Asia and Pacific	16	13	446	90.7	3.2	5.27%	3.62%
Europe and Central Asia	8	8	388	81.0	17.1	22.04%	18.15%
Latin American and the Caribbean	16	14	643	75.8	18.5	26.94%	10.42%
South Asia	5	5	461	73.9	23.6	33.14%	28.68%
Sub-Saharan Africa	12	9	131	53.0	11.1	21.25%	9.26%
Weighted average	***57***	***49***	***428***	***79.2***	***13.8***	***20.20%***	***11.06%***

Findings on Net Benefits of Hydropower Dams

The present value of the net benefits (NPV) of the portfolio of hydropower projects equals US$529.4 billion as reported in Table G7, column 6.

Table G7: Present Value of Net Benefits (NPV) according to region with and without SCC

Region	Number of dams [1]	Total capacity installed (MW) [2]	Avoided CO2 avoided (thousand tonnes)	PV of actual costs @ 10% (US$ million, 2016) [4]	PV of benefits @ 10% with avoided CO2 (US$ million, 2016)	Net PV of hydro @ 10% (US$ million, 2016)	Net PV of avoided CO2 @ 10% (US$ million, 2016)	Net PV of hydro @ 10% with avoided CO2 (US$ million, 2016)	Ex-ante EIRR with avoided CO2(%)	Ex-post EIRR with avoided CO2(%) [3] [5]	Difference in ex-ante EIRR (%) [9]	Difference in ex-ante EIRR (%)
[10]	[11]	[12]		137,123								

						[6]	[7]	[8]				
EAP	16	7,139		367,372	292,544	100,218	55,203	155,422	20.9%	19.3%	2.5%	2.3%
ECA	8	3,106	136,021	113,472	219,816	57,449	48,895	106,344	15.9%	15.6%	2.2%	2.2%
LAC	16	10,283	386,464	553,300	971,084	232,142	185,642	417,785	19.1%	15.5%	2.1%	1.8%
SAR	5	2,303	104,546	32,168	87,736	49,977	5,591	55,568	22.6%	21.8%	0.8%	0.8%
SSA	12	1,575	74,679	116,055	252,551	89,614	46,882	136,496	18.3%	17.1%	2.1%	2.1%
Total	***57***	***24,405***	***1,069,082***	***952,118***	***1,823,732***	***529,401***	***342,213***	***871,615***	***19.5%***	***17.3%***	***2.1%***	***1.9%***

When the social benefits of carbon avoidance are included, the net benefits of the hydropower portfolio increase to US$871.6 billion. More specifically, the 16 dams in Latin America and the Caribbean avoid the most emissions at 386 million tons of carbon dioxide throughout their project lives and regions and generate the most benefits of the regions equivalent to US$418 billion.

Sensitivity of net benefits of the dams to the choice of discount rates

Given that hydro dams are capital intensive, with most of their costs coming as up-front capital outlays, while the benefits are to be realized in later periods of the project's life cycle, the net benefits are quite sensitive to the choice of discount rate, as shown in Table G8.

Table G8. Sensitivity of net benefits to choice of discount rate (US$ million, 2016)

Discount rate	*PV of estimated costs @ discount rate (US$ million, 2016)* [1]	*PV of actual costs @ discount rate (US$ million, 2016)* [2]	*PV of benefits @ discount rate (US$ million, 2016)* [3]	*Net PV of hydro @ discount rate (US$ million, 2016)* [4]
8%	385,191	515,810	1,023,470	507,660
9%	521,424	700,643	1,223,964	523,321
10%*	706,327	952,118	1,481,519	529,401
11%	957,209	1,294,087	1,812,540	518,454
12%	1,297,465	1,758,825	2,238,333	479,508

*base rate.

Table G9. WBG Supported Projects Evaluated in the Analysis (next page)

#	Project ID	Type	Start	Complete	Capacity (MW)	Energy generation (GWh)	Load factor (%)	Estimated capital cost (US$ million)	Actual capital cost (US$ million)	Estimated physical contingency (US$ million)	Estimated price contingency (US$ million)	Construction months, estimated	Construction months, actual
	Power only dams												
1	Gitaru HPP, Kenya	WS	1974	1978	145	750	59%	123.6	112.1	12.5	12.5	51	51
2	Kapichira Hydroelectric, Malawi	WOS	1992	2000	64	135	24%	231.3	139.9	20.6	55.6	72	96
3	Ruzizi Hydroelectric, Burundi-Rwanda-CDR	WOS	1983	1990	30	140	53%	84.9	79.9	7.8	12.2	82	98
4	Kiambere Hydroelectric, Kenya	WS	1984	1988	150	790	60%	311.8	269.1	33.6	55.1	44	44
5	Andekaleka Power, Madagascar	WS	1979	1982	56	278	57%	116.3	142.1	11.2	22.7	37	39
6	Nkula II Project, Malawi	WOS	1977	1981	56	315	64%	66.4	82.5	6.8	9.8	44	60
7	Mtera Hydroelectric, Tanzania	WS	1984	1991	80	340	49%	197.1	161.0	16.6	45.8	66	92
8	Kidatu Hydropower Plant, Tanzania	WS	1971	1975	200	523	30%	59.0	66.6	6.3	9.1	51	49
9	Volta River Hydroelectric Project, Ghana	WS	1977	1982	324	1,400	49%	190.0	265.0	8.7	25.0	60	76
10	Kpong Hydroelectric, VRA, Ghana	WOS	1977	1982	160	940	67%	236.0	296.0	14.8	45.7	60	72
11	San Carlos, Colombia	WS	1980	1987	1,240	5,144	47%	523.0	601.0	36.6	96.8	79	92
12	Fourth Guadalupe, Colombia	WOS	1981	1986	213	1,077	58%	228.3	211.7	18.9	68.3	51	63
13	Playas Hydropower, Colombia	WS	1983	1988	200	1,450	83%	311.4	235.1	28.1	82.0	48	75
14	Itumbiara Dam, Brazil	WS	1974	1981	2,080	6,430	35%	593.0	1051.0	67.5	56.3	87	84
15	Pehuenche Hydroelectric Dam, Chile	WS	1988	1993	500	2,765	63%	680.5	353.2	48.5	110.3	58	70
16	Nispero Power Project, Honduras	WOS	1979	1984	23	70	36%	53.0	65.0	4.9	2.8	42	63
17	Guavio Hydro Power Project, Colombia	WS	1983	1993	1,000	5,200	59%	1303.0	2545.0	100.5	270.9	72	132
18	Paulo Afonso IV Complex, Brazil	WS	1974	1984	2,462	6,200	29%	692.6	1414.0	60.5	80.5	96	120
19	Aguacapa Power Project, Guatemala	WOS	1978	1981	90	392	50%	100.0	183.0	5.1	14.3	34	44
20	La Fortuna, Panama	WS	1978	1984	300	1,320	50%	222.1	522.0	22.6	71.5	67	84
21	Chixoy Hydro-power, Guatemala	WS	1978	1982	300	1,470	56%	373.0	519.0	42.5	36.5	48	60
22	El Cajon Hydropower Dam, Honduras	WS	1981	1985	300	1,228	47%	493.2	543.4	39.0	142.4	60	58
23	Aguamilpa Hydroelectric project, Mexico	WS	1989	1995	960	2,131	25%	858.0	850.3	120.4	109.7	60	84

24	Zimapan Hydroelectric project, Mexico	WS	1989	1995	292	1,291	50%	418.0	829.2	36.6	33.4	60	84
25	GaziBarotha Hydropower, Pakistan	WOS	1995	2003	1,450	6,600	52%	1864.0	1616.0	169.8	178.5	84	108
26	Cirata Hydroelectric Site, Indonesia	WS	1994	1999	500	1,424	33%	313.0	193.2	30.9	24.7	58	68
27	Saguling Dam, Indonesia	WS	1981	1986	700	2,156	35%	726.7	663.0	55.7	206.8	66	72
28	Bersia Hydroelectric project	WOS	1980	1986	72	238	38%	87.3	69.6	5.3	13.1	72	84
29	Kenering Hydroelectric project	WOS	1980	1986	120	456	43%	145.6	116.1	8.8	21.9	72	84
30	Ban Chao HPP, Thailand	WS	1974	1979	360	1,230	39%	158.7	210.2	12.3	15.5	78	78
31	Yantan Hydroelectric Project, China	WS	1987	1994	1,100	5,040	52%	542.0	661.0	47.4	196.7	87	94
32	Kerala Power Project, India	WOS	1986	1992	180	604	38%	333.3	420.0	16.8	60.6	64	84
33	Marsyangdi Hydroelectric, Nepal	WOS	1986	1989	69	349	58%	323.3	252.0	33.6	44.0	44	49
34	Lubuge Hydroelectric, China	WS	1985	1991	600	2,393	46%	615.0	566.6	35.8	66.5	74	85
35	Ertan I, Sichuan, China	WS	1992	2000	3,300	17,000	59%	1885.0	2282.0	164.0	228.7	111	108
36	Karakaya Hydropower, Turkey	WS	1980	1988	1,800	7,353	47%	1160.4	1135.6	99.8	119.6	85	102
37	Grabovica hydroelectric power plant, Yugoslavia	WS	1980	1989	116	346	34%	104.8	116.3	5.2	11.2	105	116
38	Salakovac Hydroelectric power plant, Yugoslavia	WS	1980	1989	206	580	32%	185.6	206.0	9.1	19.8	105	116
39	Mostar Hydroelectric power plant, Yugoslavia	WS	1980	1989	65	293	52%	154.3	167.1	8.0	24.5	105	116
40	Sir Hydropower Project, Turkey	WS	1986	1991	282	710	29%	241.0	286.9	21.8	38.0	50	61
41	Sigalda HPP, Iceland	WS	1973	1977	100	650	74%	64.3	88.0	3.8	6.4	61	66
42	Berke Hydropower, Turkey	WS	1985	1992	510	1,672	37%	592.1	502.6	50.9	55.7	72	98
43	Yonki Dam, Papua New Guinea	WS	1987	1991	30	165	63%	99.6	124.0	9.2	16.2	52	66
44	Afulilo Hydropower project, Western Samoa	WS	1987	1992	6	24	43%	17.2	33.0	1.7	1.8	42	73
45	Wailoa Hydroelectric, Fiji	WS	1977	1981	80	200	29%	77.1	89.0	6.5	12.5	60	63
46	Rampur Hydropower project, India	WOS	2008	2014	412	1,835	51%	595.0	674.3	43.0	75.0	59	80
47	Dongping hydroelectric power plant, China	WS	2003	2008	110	324	34%	86.6	91.5	7.8	4.9	65	65
48	Najitan hydroelectric power plant, China	WOS	2003	2011	51	151	34%	42.3	43.9	3.6	2.3	65	101
49	Songshuling hydroelectric power plant, China	WOS	2003	2011	50	154	35%	42.1	39.0	3.5	2.2	65	101
50	Xiakou hydroelectric power	WS	2003	2011	32	80	29%	31.6	31.1	2.2	1.4	65	101

	plant, China												
51	Guangrun hydroelectric power plant, China	WS	2003	2011	28	93	38%	35.8	50.9	2.0	1.2	65	101
52	Felou hydroelectric project, Mali, Mauritania, Senegal	WOS	2007	2014	60	330	63%	222.2	183.5	1.3	23.2	38	92
53	Bujagali, Uganda	WOS	2007	2012	250	1,438	66%	735.0	902.0	18.0	23.0	44	54
54	La Higuera, Chile	WOS	2005	2010	155	840	62%	191.6	347.6	20.0	17.8	30	60
55	Cheves Hydro, Peru	WOS	2010	2015	168	840	57%	415.0	633.0	21.5	29.8	38	58
56	Allain Duhangan II, India	WOS	2005	2012	192	810	48%	365.5	546.4	20.1	139.3	50	86
57	Pamir Private Power Project, Tajikistan	WS	2003	2010	28	236	96%	24.4	29.4	1.4	0.7	45	93

Appendix H. Global Partnerships in the RE Sector

1. Climate Funds

WBG commitment for contributing to addressing climate change and access to energy through sustainable energy solutions is visible through partnerships within the portfolio as well as its ASA/AS activities. The RE portfolio utilizes four of these climate funds for investment projects, as well as advisory services for both WB and IFC. Overall, climate fund partnerships cover 52% of WBG RE portfolio.

Global Environment Facility (GEF)

The Global Environment Facility (GEF) was established as a pilot program in order to assist in the protection of the global environment and promote thereby environmentally sound and sustainable economic development. The GEF operates, on the basis of collaboration and partnership among the Implementing Agencies, as a mechanism for international cooperation for the purpose of providing new and additional grant and concessional funding to meet the agreed incremental costs of measures to achieve agreed global environmental benefits in the following focal areas: (a) biological diversity; (b) climate change; (c) international waters; (d) land degradation, primarily desertification and deforestation; (e) chemicals and wastes.

81 projects in RE portfolio: US$794M (63 WB US$631M, 17 IFC US$237M)

Clean Technology Fund (CTF)

Climate Investment Funds comprises two funds, the Clean Technology Fund and the Strategic Climate Fund. The Clean Technology Fund provides new large-scale financial resources to invest in clean technology projects in developing countries, which contribute to the demonstration, deployment, and transfer of low-carbon technologies with a significant potential for long-term greenhouse gas emissions savings.

30 projects in RE portfolio: US$2,200M 17 IFC US$645M

Scaling up Renewable Energy Program (SREP)

The Scaling up Renewable Energy Program (SREP) in Low Income Countries is a targeted program of the Strategic Climate Fund (SCF), which is one of two funds within the framework of the Climate Investment Funds (CIF). The SREP was established to scale up the deployment of renewable energy solutions and expand renewables markets in the world's poorest countries.

14 projects in RE portfolio: 13 of which are WB.

Canada Climate Change Program (CCCP)

The IFC-Canada Climate Change Program, established in 2011, is a partnership between the Government of Canada and IFC to promote private sector financing for clean energy projects, through the use of concessional funds to catalyze investments in renewable, low-carbon technologies. The program's funds, invested at concessional, or below market, terms are blended alongside IFC's own funds to enable climate change investments that would not otherwise happen, due to market barriers preventing sponsors or other financiers from making those investments, and aims at demonstrating the viability of similar projects that can later be financed on fully commercial terms.

12 projects in RE portfolio: US$162M 2 WB US$30M

2. Multilateral Development Banks

WBG partnerships with other regional and international development banks covers 17% of renewable energy portfolio. Although number of projects partnering with MDBs and bilaterals is low, these institutions generally cooperate for high risk and high investment projects such as hydropower and geothermal. Overall, MDBs and bilaterals financing is more than double compared to climate funds.

Asian Development Bank (ADB)

The Asian Development Bank was established as a financial institution to foster economic growth and cooperation in the region. ADB assists its members, and partners, by providing loans, technical assistance, grants, and equity investments to promote social and economic development. Tackling climate change has been included as an operational priority in ADB 2030 strategy with a focus on building climate resilience and enhancing environmental sustainability for the developing needs of the region.

12 projects in RE portfolio. US$583M 5 WB US$250M

African Development Bank (AfDB)

African Development Bank (AfDB) Group is working towards sustainable economic development and social progress for poverty reduction in its member countries. AfDB mobilizes and allocates resources for investment and provides policy advice and technical assistance. Green growth as a development objective for AfDB is highlighted in the organizations 2013-2022 strategy.

17 projects in RE portfolio. US$1,900M 1 IFC US$100M

European Bank of Reconstruction (EBRD)

EBRD operates as the largest investor on energy projects within the region. Organization has launched the Green Economy Transition (GET) approach in 2015 for investments that bring environmental benefits and follow the energy strategy put forward in 2013 to provide clean and sustainable energy for the region with a focus on energy efficiency while tackling transition barriers for emerging technologies.

7 projects in RE portfolio. US$235M 3 WB US$82M

Inter-American Development Bank (IDB)

Inter-American Development Bank provides grants, technical assistance and three types of lending for the member countries within the region focusing on investment, policy and special development for crisis areas. Climate change has been highlighted as one of the cross-cutting issues within institutional strategy for 2016-2019, focusing on alleviating pressure on most vulnerable populations through sustainable green energy solutions.

4 projects in RE portfolio. US$462M all IFC

Islamic Development Bank (IsDB)

Islamic Development Bank (IsDB) is a multilateral development bank focusing on sustainable development through economic and social development, including infrastructure development for its member countries.

6 projects in RE portfolio. US$192M. 3 WB US$95M

United Nations Development Bank (UNDP)

UNDP operates in 170 countries focusing on sustainable development, governance and climate resilience. Clean and sustainable energy solutions are highlighted in the most recent 2018-2021 strategic plan for the organization.

4 projects in RE portfolio. US$4.4M 1 IFC

3. Bilateral Organizations

Agence Française de Développement (AFD)

Agence Française de Développement (AFD) operates as a public development bank in France, providing financing or sustainable development heavily in the French-speaking world. AFD

reported climate and development benefits for 50% of their 2016 grants and loans portfolio, committing 24B Euros since 2005.

15 projects in RE portfolio. US$963M all WB

KfW

Working closely with the German government, KfW has been involved in international development for 50 years including assistance on environment, climate and energy sector in partner countries. KfW involvement in energy sector mainly focuses on financing high budget projects in developing countries such as hydro, geothermal and wind. 13 projects in RE portfolio. US$1,400M 1 IFC

Appendix I. IEG Global Expert Panel on RE

IEG convened a high-level panel of global experts to participate through a Delphi process to benefit from their expertise and experience to ascertain potential future directions and challenges that may face RE going forward. To establish the *IEG Global Expert Panel on RE*, IEG invited various men and women who are globally recognized thought-leaders in energy, international development, environment and climate change with extensive expertise and experiences on the subject. The final *Panel* consisted of eight global experts, representing the private and public sectors, as well as the developed and developing countries. The objective of the *IEG Global Expert Panel on RE* was to utilize the depth of knowledge and experience of the panelists to: a) identify and prioritize the emerging opportunities and challenges to developing and integrating greater levels of RE for producing electricity in developing countries to contribute to meeting the Sustainable Development Goals (SDG)[4] and the Paris Agreement on climate change; and, b) ascertain their views on how the Bank Group is positioned to assist client countries achieve these RE development goals. The *IEG Global Expert Panel on RE* participated through a Delphi methodological approach that allowed for surfacing of ideas, iterative prioritizing of issues, and identification of areas of consensus and divergence in issues and priorities.

Box I1. An Introduction to the Delphi Technique

The Delphi technique – developed by the Rand Corporation in the 1950s – is a widely used systematic forecasting technique for achieving convergence of opinion by soliciting information from experts on a certain subject through an interactive, iterative and anonymous approach. Rooted in the premise that "[more] heads are better than one" (Dalkey 1972, p. 15), the Delphi technique is a group communication exercise that aims to examine a specific issue for goal setting, policy examination and forecasting of future events (Ulschak 1983; Turoff and Hiltz 1996; Ludwig 1997). While regular surveys explore "what is," the Delphi technique attempts to address "what could/should be" (Miller 2006) – as the Delphi technique is named after the Ancient Greek oracle who could predict the future. The technique typically seeks to: (i) shed light on alternatives; (ii) correlate expert insight on a specific subject; (iii) provide background information for decision making; and (iv) reveal consensus in expert opinion (Watkins et al 2012).

Unlike regular surveys, the Delphi technique employs two or more rounds of data collection (usually through a questionnaire) and controlled feedback to encourage reflection of one's own, and others, contributions (Hsu and Sandford 2007). During the first round, the group of experts independently share their views with a facilitator who reviews the data and provides a summary. The experts review this summary, and are requested to provide updated inputs through one or more additional rounds. Throughout the process, the experts have a complete record of what insights and forecasts others have shared during each round, without attribution to any specific individual. This allows each expert to (i) review the aggregated inputs of the group; (ii) reassess their initial judgments; (iii) generate additional insights; and (iv) clarify the information developed by previous iterations (Hsu and Sandford 2007). Anonymity ensures free expression of opinion and helps prevent potential pitfalls of conventional means of pooling group opinion e.g., reluctance to revise opinions, influence of dominant individuals, and group pressure for conformity – either real or perceived (Dalkey, 1972).

The technique seeks to find convergence of opinion by asking experts to prioritize emerging issues, which enables quantitative analysis of the opinions (Thangaratinam and Redman 2005) and makes the process more problem-

[4] SDG #7 on energy, further elucidated through the Sustainable Energy for All (SE4ALL) initiative sets a target of doubling the share of renewable energy in the mix by 2030.

solving in nature. A Delphi Panel continues until a significant level of consensus is reached – typically two to four rounds.

Ultimately, the abovementioned advantages of the Delphi Technique make it a well-suited method to gain expert insight and forecasts on RE and, thereby, help set the future direction of the WBG's support to client countries in developing RE to meet climate change and Sustainable Development Goals.

Sources:

Hsu, C. and Sandford, B. A. (2007). The Delphi Technique: Making Sense of Consensus. *Practical Assessment, Research & Evaluation*. Vol 12, No 10, 1-8.

Watkins, R., West Meiers, M. and Visser, Y. L (2012). *A Guide to Assessing Needs: Essential Tools for Collecting Information, Making Decisions, and Achieving Development Results*. The World Bank. 137-143.

Thangaratinam, S. and Redman, C. W. E. (2007). The Delphi technique. *Royal College of Obstetricians and Gynaecologists*. 7, 120-125.

The Key Themes Explored

To obtain the views of the *IEG Global Expert Panel on RE*, IEG requested the panelists to respond to two rounds of questions around the following three key themes:

- Emerging **opportunities** going forward to further develop RE around the developing world for power generation. An opportunity can be defined as a specific condition that is favourable or conducive to developing and scaling-up RE, including but not limited to technological advances, improving market conditions, changes in demand patterns, shifts in policy, and influences outside the RE space (i.e. shifts in fossil fuel prices, heightened awareness of the impact of climate change).

- Emerging **challenges** going forward to further develop RE around the developing world for power generation. A challenge can be defined as a specific constraint or barrier faced by countries attempting to develop and scale-up RE going forward, which, if not addressed, will hamper their ability to achieve RE development goals. These could be, but not limited to, natural resource constraints, technological limitations, technology or power systems related costs, technological or market risks, affordability and shifts in demand, changing market conditions, financing shortfalls, challenges from civil society, and influences from outside the RE space (i.e. improvements in fossil-fuel technologies, availability and costs of fossil fuels).

- Role of the Bank Group to assist client countries[5] around the developing world to seize the opportunities, and address the challenges, to further develop RE for producing electricity. This includes the position of the Bank Group to influence clients and the capacity of the institution to assist clients formulate and implement commensurate solutions. The Bank Group's position can be further defined as its placement, especially among other development partners, to influence development outcomes related to RE with various stakeholders either at the country, regional or global level. The capacity of the Bank Group can be further defined as the combination of skills and experience as well as financial resources that can be mobilized by the institution to assist client countries achieve a given development goal related to RE.

[5] WBG client countries are defined as those developing nations who are eligible for borrowing from the institution.

The Global Expert Panelists on RE

The members of the High-Level *IEG Global Expert Panel on RE* were (their biographies are included later in Appendix I:

1. **Ajay Mathur:** Director General of The Energy & Resources Institute (TERI), and a member of the Prime Minister's Council on Climate Change in India.
2. **Andrew Reicher:** Independent Adviser and Investor, Berkeley Energy, Energy Access Ventures Fund, Catalyst Principal Partners.
3. **Anil Markandya**: Distinguished Ikerbasque Professor, Basque Center for Climate Change, member of team that prepared the IPCC 4th Assessment, awarded the Nobel Peace Prize.
4. **James Fletcher**: Head of SOLORICON and former Minister for Public Service, Sustainable Development, Energy, Science and Technology in Saint Lucia, who led the Caribbean's delegation to the negotiations on the Paris Agreement within the United Nations Framework Convention on Climate Change (UNFCCC) in 2015.
5. **Jérôme Pécresse**: President and Chief Executive Officer of GE Renewable Energy, and formerly the President of Alstom's Renewable Power business.
6. **Laszlo Varro**: Chief Economist of the International Energy Agency (IEA) and leads the Economics and Investment Office (EIO) at the agency.
7. **Li Junfeng**: First Director of National Center for Climate Change Strategy and International Cooperation (NCSC) in China and President of Chinese Renewable Energy Industries Association (CREIA).
8. **Nathan Hultman**: Director of the Center for Global Sustainability and Associate Professor at the University of Maryland School of Public Policy; Associate Director of the Joint Global Change Research Institute; and Senior Fellow at the Brookings Institution. He was part of the US climate and energy policy team that participated in the climate negotiations in Lima and Paris.

The Delphi Evaluation Approach

The following steps were carried out to apply the Delphi technique with the *IEG Global Expert Panel on RE* for this evaluation:

1. Establishment of the *Global Expert Panel on RE* by IEG
2. Formulation of the key themes and questions by IEG
3. Design of Round 1 templates by IEG (one for opportunities, one for challenges) to structure inputs and facilitate contributions by *Global Expert Panelists*
4. Kick-Off meeting for *IEG Global Expert Panel on RE*, to bring together panelists, clarify process and expectations, and provide guidance on the use of templates
5. Completion by the Panelists of the Round 1 templates

6. Compilation of Round 1 inputs by IEG, synthesis results and design of Round 2 templates accordingly
7. Completion by the Panelists of Round 2 templates based on the IEG synthesis of Round 1 results
8. Compilation of Round 2 inputs by IEG, analysis of results, and extraction of conclusions
9. Final report write-up of the Delphi process and results
10. Utilization of conclusions from the *IEG Global Expert Panel on RE* in the evaluation as appropriate

The *IEG Global Expert Panel on RE* Delphi exercise was carried out over two rounds, with an option to utilize a third round, which was not deemed to be necessary.

Round 1: The Questions

The global experts on RE were asked the following questions in Round 1:

Emerging opportunities

1. What are the main emerging **opportunities** going forward to further develop RE around the developing world for power generation in order to meet climate and Sustainable Development Goals? And why?
2. What is the relative importance of the specific emerging future **opportunities** you mentioned? (By awarding in total 100 points across the opportunities you identified)
3. What specific key action(s) should be taken by developing countries to seize each **opportunity** you mentioned?

Emerging challenges

4. What are the main emerging **challenges** going forward that could hold back developing countries from further development of RE for power generation, and hamper their ability to meet climate and Sustainable Development Goals? And why?
5. What is the relative importance of the specific emerging future **challenges** you mentioned? (By awarding in total 100 points across the challenges you identified)
6. What specific key action(s) should be taken by developing countries to address each **challenge** you mentioned?

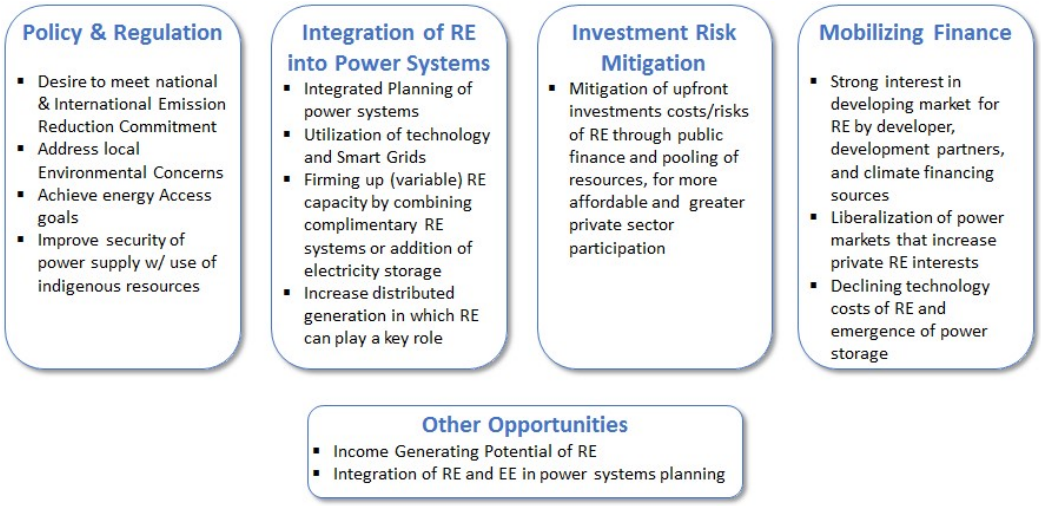
Future Role of World Bank Group

7. For each action mentioned (to seize the respective **opportunity,** or address the respective **challenge**), please indicate how well you think the WBG is positioned to help clients to successfully carry out the action to seize the opportunity or address the challenge. (Using a 4-point scale)

8. What specific intervention(s)/engagements(s)[6] do you think the World Bank Group is in a position to undertake or support to help client countries seize the opportunity or overcome the challenge?
9. How do you assess the current capacity of the World Bank Group to successfully implement each intervention/engagement mentioned above? (Using a 4-point scale)

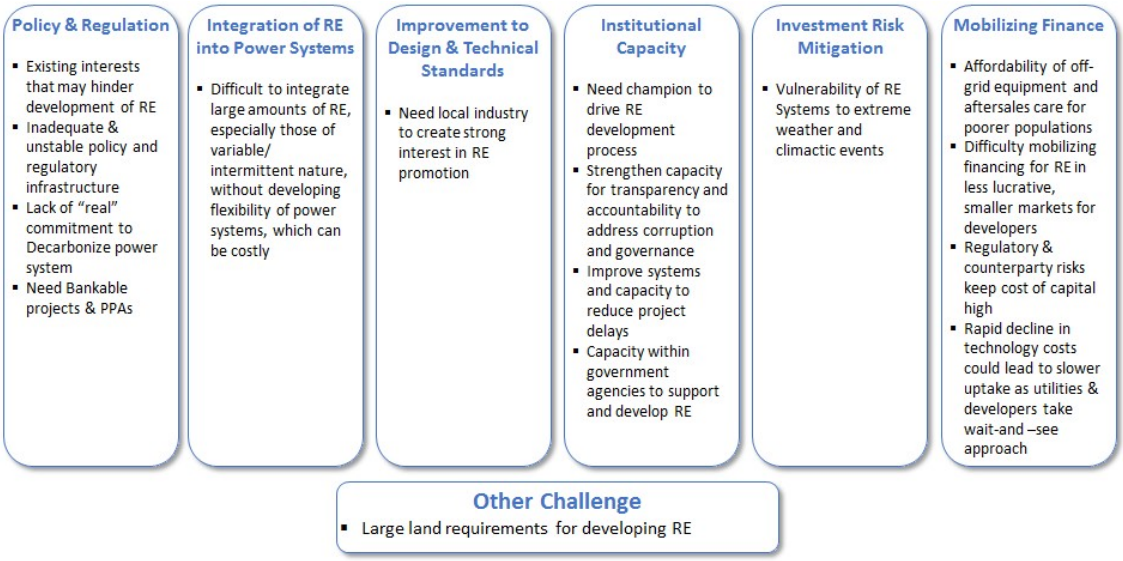
Round 1: Summary of Results

The following **emerging opportunities** for developing RE, grouped by reform areas and organized into categories, were put forward by the Panel in Round 1:



The following **emerging challenges** to developing RE, grouped by reform areas and organized into categories, were put forward by the Panel in Round 1:

[6] An intervention/engagement is defined as any potential support that the institution can provide or an action it can take to help client countries develop RE, including activities that harness and share global knowledge, help mobilize financial resources, and convene stakeholders within countries or around the world.



Round 2: The Questions

The templates for Round 2, one each for opportunities and challenges, provided each panelist with a prepopulated synthesis of the inputs provided by the entire panel in Round 1 without attribution to any specific panelist. Only modest variations were made by IEG to the original panel responses, which were classified based on the categories as indicated in the summary of round 1 results. In Round 2, the panelists had the opportunity to review all input from the panel in round 1, and were then requested to re-evaluate the entire set of inputs by re-prioritizing the identified opportunities and challenges for scaling-up RE. The panelists were free to select their own input or others as priorities. This enabled them to change/revise their own prioritization on the basis of the input from others. Furthermore, based on their prioritization of opportunities and challenges for scaling-up RE, the panelists were also requested to prioritize the various actions/solutions for seizing opportunities and addressing challenges. For each of the selected actions/solutions, the panelists were then requested to rate the Bank Group's position to influence clients and capacity to assist clients take action/implement solution.

TEMPLATE 2

Emerging Opportunities/Challenges

1. What is the relative importance of the specific emerging future **opportunities/challenges** identified by the Panel, including ones identified by yourself? We request that you answer this question in two ways:

   a. By selecting the relative importance of each category of opportunities by applying the following 5-point scale:

   - 5: Opportunity of VERY HIGH importance.
   - 4: Opportunity of HIGH importance.

- 3: Opportunity of MODERATE importance.
- 2: Opportunity of LOW importance.
- 1: Opportunity of VERY LOW importance.

2. How important are the identified key specific actions for seizing each category of **opportunities/challenges**? Please indicate the importance of each proposed specific action by applying the following 5-point scale:
    - 5: Action of VERY HIGH importance.
    - 4: Action of HIGH importance.
    - 3: Action of MODERATE importance.
    - 2: Action of LOW importance.
    - 1: Action of VERY LOW importance.

Future Role of the World Bank Group

3. For each specific action identified in Round 1 by the Panel, please indicate how well the WBG is positioned to help clients to successfully carry out the action to seize each of the categories of opportunities, by applying the following 4-point scale:
    - 4: WBG is EXTREMELY WELL positioned to help clients seize the opportunity
    - 3: WBG is VERY WELL positioned to help clients seize the opportunity
    - 2: WBG is MODERATELY WELL positioned to help clients seize the opportunity
    - 1: WBG is POORLY positioned to help clients seize the opportunity
    - X: Do not know/No opinion
4. For each specific action identified in Round #1 by the Panel, please indicate how you assess the current capacity of the World Bank Group to help clients to successfully carry out the action to seize each of the categories of opportunities, by applying the following 4-point scale (column 8):
    - 4: WBG has VERY HIGH capacity to help clients seize the opportunity.
    - 3: WBG has HIGH capacity to help clients seize the opportunity.
    - 2: WBG has MODERATE capacity to help clients seize the opportunity.
    - 1: WBG has LOW capacity to help clients seize the opportunity.
    - X: Do not know/No opinion.

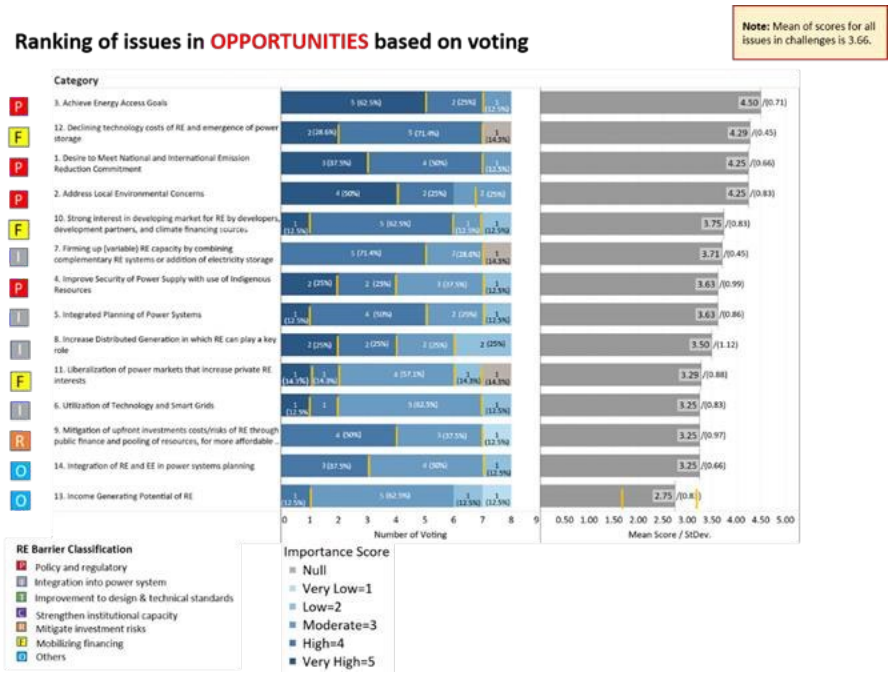
ADDITIONAL QUESTIONS:

In addition to the request to complete the templates, as indicated above, the panelist also were asked two open-ended questions in round 2 to ascertain their in-depth views on a couple of areas of importance that emerged in the Round 1 responses. They are as follows:

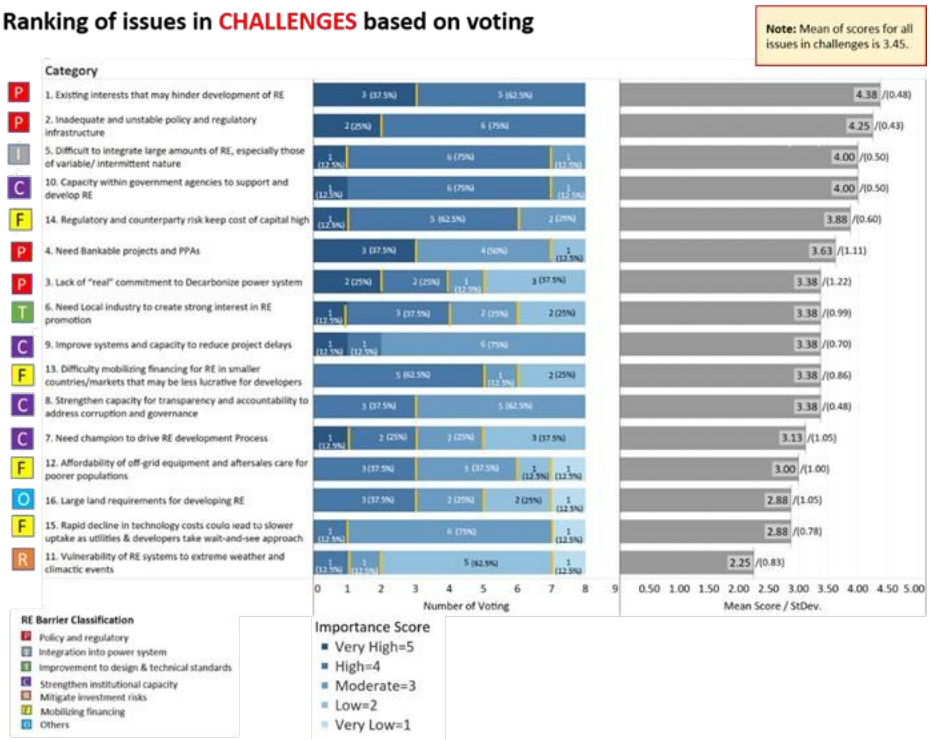
1. Given the tradeoff between: (a) decreasing costs of RE technologies, particularly wind and solar; and (b) increasing costs on power systems to ensure adequate flexibility for a smooth integration of variable/intermittent RE generation sources:
   i. How can developing countries manage this tradeoff going forward?
   ii. What are the prospects for availability of economical electricity storage solutions (e.g., thermal, batteries), and how will this affect the tradeoff indicated above?
2. b. If the Paris Climate Agreement and its emission reduction commitments are a significant opportunity that can support the development of RE, then how important is the mobilization of the funds committed in the Agreement by developed countries (i.e. $100 billion per year goal by 2020) to the deployment of RE generation in developing countries to meet the climate change goals?

SUMMARY OF FINAL RESULTS

The figure below shows the **Opportunities** in order of priority placed by the *IEG Global Panel of Experts on RE*, the score based on importance including the mean and standard deviation.

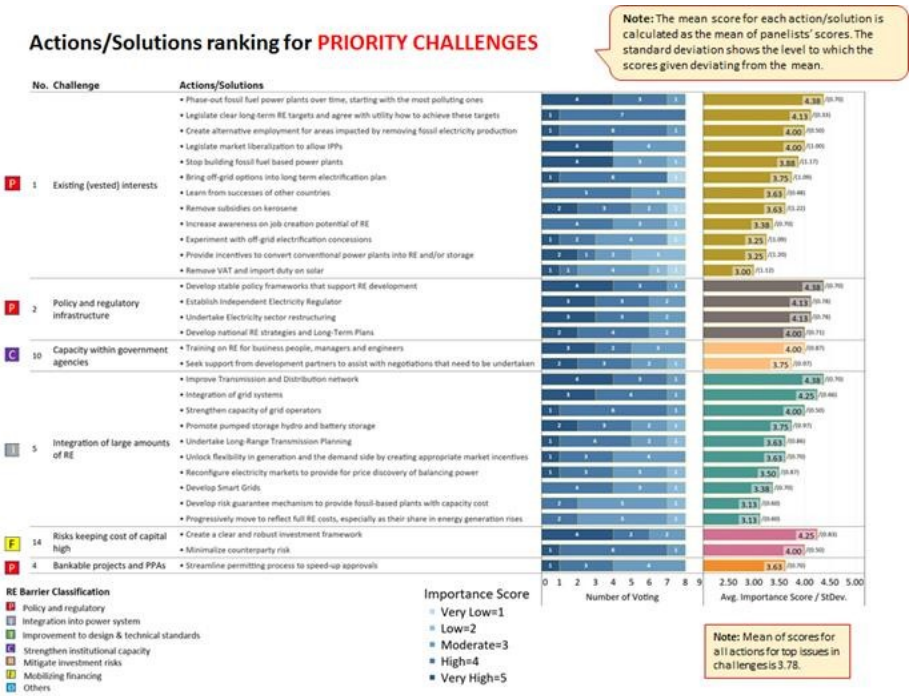


The figure below shows the Challenges in order of priority placed by the *IEG Global Panel of Experts on RE*, the score based on importance including the mean and standard deviation.

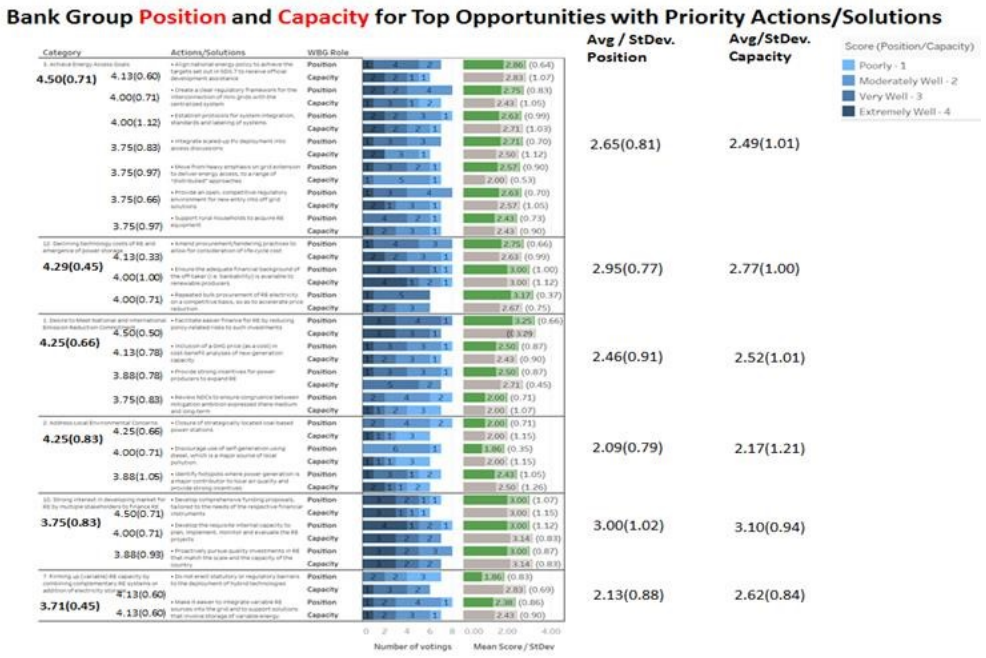


The figure below shows **Actions/Solutions** identified by the *IEG Global Panel of Experts on RE* for seizing the top priority Opportunities, the score based on importance including the mean and standard deviation.

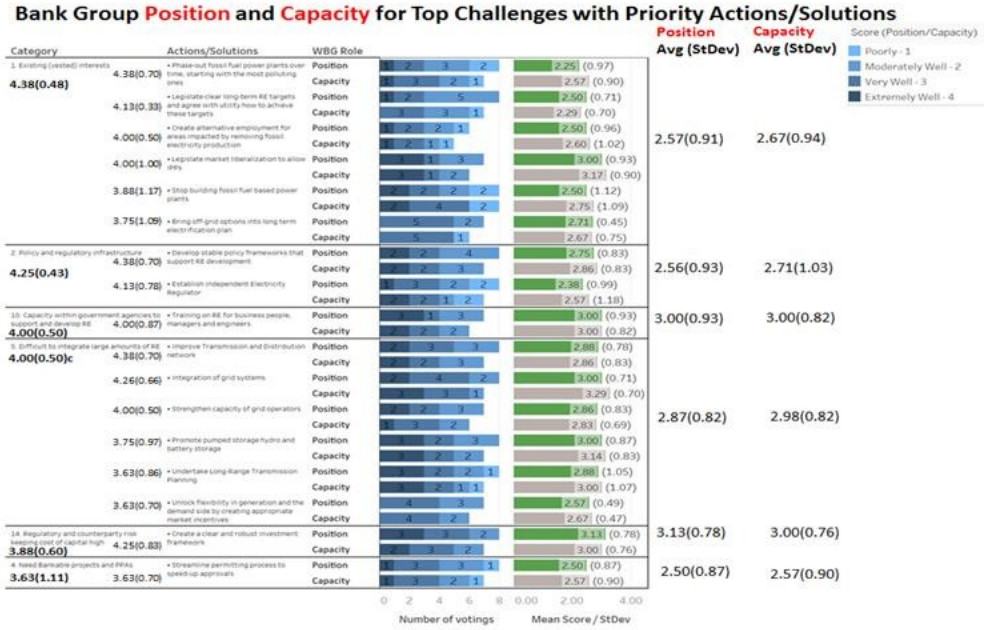
The figure below shows **Actions/Solutions** identified by the *IEG Global Panel of Experts on RE* for seizing the top priority Challenges, the score based on importance including the mean and standard deviation.



The figure below shows the **Bank Group's Position** to influence and **Capacity** to help clients design and implement top priority Actions/Solutions identified by the *IEG Global Panel of Experts on RE* for seizing the top priority Opportunities, the scores based on importance including the means and standard deviations.



The figure below shows the **Bank Group's Position** to influence and **Capacity** to help clients design and implement top priority Actions/Solutions identified by the *IEG Global Panel of Experts on RE* for seizing the top priority Challenges, the scores based on importance including the means and standard deviations.



Biographies of High-Level IEG Global Expert Panelists

Ajay Mathur

Director General
The Energy & Resources Institute (TERI), India

Dr. Ajay Mathur is Director General of TERI – The Energy & Resources Institute, and a member of the Prime Minister's Council on Climate Change in India. He was Director General of the Bureau of Energy Efficiency in the Government of India from 2006 till February 2016, and responsible for bringing energy efficiency into homes, offices, and factories, through initiatives such as the star labelling program for appliances, the Energy Conservation Building Code, and the Perform, Achieve and Trade program for energy-intensive industries. Dr. Mathur was earlier with TERI from 1986 to 2000, and then headed the Climate Change Team of the World Bank in Washington DC. He was President of Suzlon Energy Limited, and also headed the interim Secretariat of the Green Climate Fund. He has been a key Indian climate-change negotiator, and was also the Indian spokesperson at the 2015 climate negotiations in Paris, France. He is a global leader on technological approaches to address climate change; and is co-chair of the Energy Transitions Commission, a global group of industrial, financial and think-tank leaders focusing on strategies for companies and countries to move towards climate-friendly energy futures.

Andrew Reicher

Independent Advisor and Investor at Berkeley Energy and Chairman of Catalyst Principle Partners

Mr. Andrew Reicher is an Independent Adviser and Investor, Berkeley Energy, Energy Access Ventures Fund; and Chairman of Catalyst Principal Partners – a Kenya-based private equity firm. Since 2011, Andrew is a veteran in private equity and investment banking working on renewable energy with over two decades of experience in emerging markets. He also served on the Board of Trustees for Global Village Energy Partnership (now Energy for Impact), a UK charity. He has previously held the position of CEO at Globeleq (2007-2009), Head of the first Africa Infrastructure Fund at emerging markets private equity group, Actis (2004-2007), and Executive Director, Chief Investment Officer and Head of Infrastructure at Commonwealth Development Corporation (2000-2004).

Anil Markandya

Distinguished Ikerbasque Professor
Basque Center for Climate Change

Professor Anil Markandya is a resource economist who has worked in this field for over thirty years and is acknowledged as one of the leading authorities. He divides his time between academic and advisory work. On the academic side he has published widely in the areas of climate change, environmental valuation, environmental policy, energy and environment, green accounting, macroeconomics and trade. Some of his best-known works include, ´Blueprint for a Green Economy', ´Green Accounting in Europe', ´Reconciling Trade and Development' and ´Cleaning the Ganges'. Professor Markandya was a lead author and core team member of the 3rd and 4th IPCC Assessment Reports on Climate Change, for which he shared in the Nobel Peace Prize in 2007. He was also the author of a paper on climate regulation that was awarded 2nd Prize at the World Energy Council in Rome in November 2007. In 2008, Dr. Markandya was appointed the Executive Director for the Basque Centre for Climate Change, where he continues to work as the Distinguished Ikerbasque Professor. The same year, Professor Markandya was recognized by Cambridge University as one of the 50 most influential thinkers on sustainability in the world. In 2012 he was elected as the President of the European Association of Environmental & Resource Economists (EAERE). Throughout his career, Professor Markandya has held a number of additional academic positions including at the universities of Princeton, Berkeley and Harvard in the US and at University College London and Bath University in the UK. He has also been an advisor to many national and international organizations, including all the international development banks, UNDP, the EU and the governments of India and the UK. At the World Bank he was a Lead Advisor and worked closely on energy and environmental issues with many governments in Asia, Central Europe and the Former Soviet Union. Dr. Markandya graduated from the London School of Economics with a Master of Science in Econometrics in 1968 and was awarded his Ph.D. on the Economics of the Environment in 1975.

James Fletcher

Head of SOLORICON, and former Minister for Public Service, Sustainable Development, Energy, Science and Technology, Saint Lucia

Dr. James Fletcher is the Head of SOLORICON, and the former Minister for Public Service, Sustainable Development, Energy, Science and Technology in Saint Lucia (2011-16). During his tenure with the Government of Saint Lucia, he led an aggressive path toward the modernization of the energy sector, with an emphasis on legislative reform and the use of renewable sources of energy. Dr. Fletcher is perhaps best known for his work in international climate change negotiations. He led the Caribbean's delegation to the negotiations on the Paris Agreement in 2015 and was an integral part of the region's '1.5 to stay alive' climate change civil society advocacy campaign. He was a member of a small, select group of ministers who were charged with the responsibility for achieving consensus among the Parties to the UN Framework Convention on Climate Change on the elements of the Paris Agreement. He also played a key role in negotiations on behalf of the Alliance of Small Island States (AOSIS) on the sensitive subject of Loss and Damage. Prior to his stint as a Cabinet Minister, James Fletcher served as the Director of Social and Sustainable Development at the Secretariat of the Organization of Eastern Caribbean States, the Cabinet Secretary in the Government of Saint Lucia, and the Permanent Secretary in the Ministry of Agriculture, Forestry and Fisheries. Dr. Fletcher is the author of the recently published book on *Governing in a Small Caribbean Island State*. Dr. Fletcher holds a Bachelor of Science degree in Biochemistry from the University

of Ottawa, Canada, and a Doctor of Philosophy degree in Crop Physiology from the University of Cambridge, England.

Jérôme Pécresse

President & CEO
GE Renewable Energy

Mr. Jérôme Pécresse leads GE Renewable Energy, which combines the broadest renewable energy portfolio in the industry. The business includes on-shore wind, off-shore wind, hydro and concentrated solar power. Mr. Pécresse was appointed President of Alstom Renewable Power Sector and Executive Vice-President of Alstom, in June 2011. He created Alstom's Renewable Power business which had close to 10,000 employees and sales of around €2 billion. He joined Alstom from Imerys, where he held several positions during his 12 years there, starting with Vice-President Strategy and Development until being appointed Chief Operating Officer of Imerys in 2008. Prior to this, he was with Crédit Suisse First Boston from 1992, firstly as associate, then Vice-President, and finally Director responsible for mergers and acquisitions for France. Born in 1967, Jérôme Pécresse is a former student of the Ecole Polytechnique and an engineer from Ponts & Chaussées.

Laszlo Varro

Chief Economist
International Energy Agency

Dr. Laszlo Varro, who has worked at the IEA since 2011, is the Agency's Chief Economist. He also leads the Economics and Investment Office (EIO), a newly created group within the IEA that aims to offer sound and consistent energy economics and methodological support for the Agency's work. Prior to assuming his current role, Dr. Varro served as IEA Head of Gas, Coal and Power Markets. In this post he was responsible for gas market and supply security analysis, LNG markets, gas market reforms and infrastructure policy. He led the Electricity Security Action Plan, the IEA work program that provides comprehensive coverage of the policy, market design, infrastructure regulation and investment aspects of maintaining electricity security during the transition to a low-carbon power system. Before joining the IEA, Dr. Varro was the Director for Strategy Development at MOL Group. From 2000 to 2005, he worked as the Head of Price Regulation at the Hungarian Energy Office. A Hungarian national, Dr. Varro started his career at the National Bank of Hungary after completing his graduate degree at the University of Cambridge and the Corvinus University of Budapest.

Li Junfeng

First Director and Chairman of Academic Committee, National Center for Climate Change Strategy and International Cooperation (NCSC); and President of Chinese Renewable Energy Industries Association (CREIA)

Dr. Li Junfeng is the First Director of National Center for Climate Change Strategy and International Cooperation (NSCS) and currently serves as the Chairman of the academic committee of NCSC. He is also a member of National Energy Advisory Council, a member of Expert-committee of National High-tech Program, a member of National Environmental Scientific Committee, a member of Expert-committee of National Energy Administration Energy Internet. In addition, Dr. Li serves as a consultant of low carbon development for Beijing, Shanghai and Shanxi Provincial People's Government. Dr. Li is the President of both Chinese Renewable Energy Industries Association (CREIA) and Renewable Energy Professional Committee of China Energy Research Society. He also serves by invitation as a professor and doctoral supervisor in several universities, including Peking University and Renmin University of China. Previously, Dr. Li served as the Director General of NCSC. Dr. Li has dedicated nearly three-decade to the Energy Research Institute of National Development and Reform Commission (NDRC), having served as the Deputy Director General of ERI and the Chairman of the Academic Committee of ERI. Some of Dr. Li's major publications include *China's Low Carbon Energy Strategy Study*, *Strategic Research on Climate Change*, *Ecological Civilization Construction and Energy Revolution*, *Study on the Control of Greenhouse Gas Emissions in China*, *China Renewable Energy Technology Evaluation, Wind power 12*, *Interpretation of the People's Republic of China Renewable Energy Law*, *China PV Power Technology Market Analysis*, and the *Study on the Development Strategy of Renewable Energy in China*. Dr. Li also participated in the preparation of the IPCC second to fourth evaluation reports. In 2017, Dr. Li was awarded the Ninth Annual Zayed Future Energy Prize Lifetime Achievement Award.

Nathan Hultman

Director, Center for Global Sustainability; Associate Professor, University of Maryland School of Public Policy, Non-Resident Fellow, Brookings Institute

Dr. Nathan Hultman is Director of the Center for Global Sustainability and Associate Professor at the University of Maryland School of Public Policy. He is also associate director of the Joint Global Change Research Institute, and a nonresident senior fellow at the Brookings Institution. From 2014-2016, Dr. Hultman worked on the Obama Administration's climate and energy policy team, during which time, he helped develop the U.S. 2025 climate target, worked on various U.S. bilateral engagements, and participated in the international climate negotiations in Lima and Paris. He has participated in the UN climate process since the Kyoto meeting, and is a contributing author to the IPCC Fifth Assessment Report and Special Rep ort on Renewable Energy. Dr. Hultman's research focuses on national climate targetsetting and assessment, U.S. emissions mitigation policy, energy technology transitions in emerging economies and international climate policy. He was formerly a visiting fellow at the University of Oxford, assistant professor at Georgetown University, Fulbright Fellow, and NASA Earth Systems Science Fellow

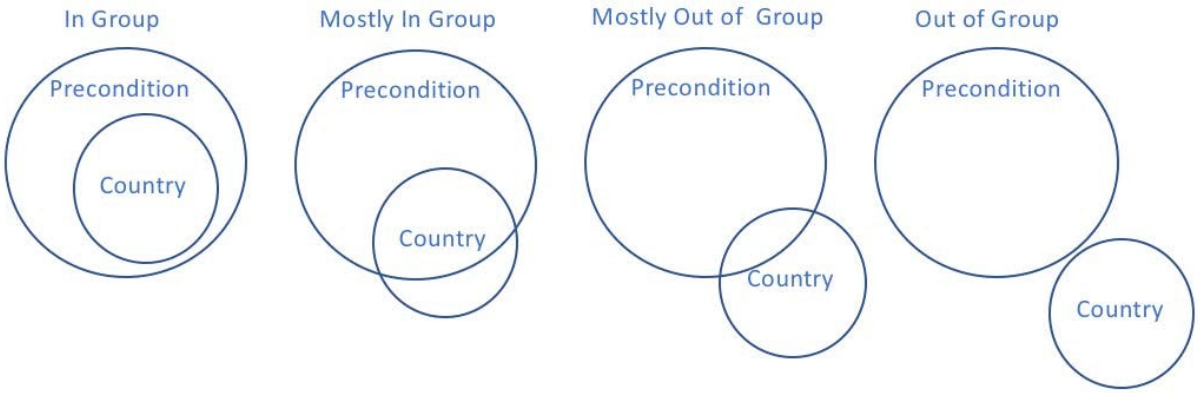
in climate sciences. He holds an M.S. and Ph.D. in Energy & Resources from the University of California, Berkeley, and a B.A. in Physics.

Appendix J[7]. Qualitative Comparative Analysis

QCA in a nutshell

"Qualitative Comparative Analysis (QCA) is a new analytic technique that uses Boolean algebra to implement principles of comparison used by scholars engaged in the qualitative study of macro social phenomena. integrative … examining how the different parts of a case fit together, both contextually and historically."[2] As a *case-oriented* and *set theory-based* method, rather than variable-oriented and statistics-based method, the QCA technique begins by establishing qualitative descriptors for *group membership* in each *precondition* and *outcome variable* (See Figure J1).

Figure J1. Levels of Group Membership for Qualitative Anchors



QCA operates by identifying any superset/subset relationships within the data, which reflect the presence of relationships of *necessity* and/or *sufficiency*. A necessary condition is one that must be present, all or almost all of the time, for the outcome to occur; the absence of necessary condition prevents the outcome. A sufficient condition is one that, when present, causes the outcome to occur, all or most of the time. QCA recognizes causal complexity (i.e., necessary and sufficient conditions may be composed of multiple individual conditions), equifinality (i.e., there may be multiple paths to an outcome), and imperfect relations (i.e., a condition may be "almost always" necessary or sufficient).

QCA provides two goodness-of-fit measures: consistency and coverage. Ranging between 0.0 and 1.0, the metrics report the degree to which a condition and outcome co-occur within the data. Coverage provides a measure of empirical relevance, reporting the degree to which a necessary

[7] This Annex is a very simplified and summarized version of the report prepared by IEG's QCA team. [2] fuzzy set/Qualitative Comparative Analysis. www.socsci.uci.edu/~cragin/fsQCA/

or sufficient condition explains instances of the occurrence of the outcome. Consistency is the more crucial measure and reports the strength of the superset/subset relationship. When used to test for the presence of a necessity relationship, consistency (**ncon**) reports the degree to which cases exhibiting the outcome also exhibit the proposed necessary condition. A score of 1.0 indicates that the necessary condition is present whenever the outcome is present. When used to test for sufficiency (**scon**), a score of 1.0 indicates that whenever the sufficient condition is present, the outcome is present. Scores less than 1.0 indicate imperfect relationships. The standard ncon threshold is 0.9, which permits a small degree of inconsistency in order to accommodate measurement error and imperfect relationships. The standard scon threshold is 0.8, which indicates that a given condition (or combination of conditions) is "generally sufficient" to produce the outcome. Scores closer to 1.0 indicates stronger relationships.

Objective and Undertaking of the QCA analyses

The nuances and complexities of RE growth are distinctive to the country contexts in which RE is being developed. It was determined that a qualitative approach to assess the validity and comprehensiveness of the Theory of Change (TOC) was most appropriate. QCA was therefore undertaken to achieve two primary objectives: (a) the first being to validate the TOC for RE investments, developed during the evaluation; and (b) the second, to identify the pathways used by countries to grow RE capacity, depending on contextual factors within the case countries.

By validating the TOC, the QCA analysis would contribute to determining if the approach to RE development applied over the past almost-two decades has been addressing the appropriate barriers (equivalent to preconditions in QCA terminology) to achieve RE growth, and thereby potential energy and environmental benefits, within the contexts in which the WBG is operating.

In addition to validating the TOC, the QCA technique was used to identify pathways to RE growth (i.e., differing combinations of addressing preconditions that led to RE capacity) that are consistent with the sometimes-unique experiences of countries. For example, the preconditions pathway for a country with pre-existing investments in hydro-electricity were distinct from countries without these investments, both may achieve RE development but through different means. *These pathways can offer beneficial insights as the WBG considers future country-specific investments in RE, illustrating the paths that comparable countries took to increase their RE capacity*.

The QCA undertaking began by establishing qualitative descriptors for group membership in each barrier (equivalent to precondition in QCA terminology) and outcome variable (See Table J1). These were established for the country-level of the nine case studies conducted during the evaluation (Turkey, Mexico, Sri Lanka, India, Morocco, Jordan, Kenya, Nicaragua, and China). The case studies were conducted by evaluation team members knowledgeable in the RE sector and with experience in Bank Group interventions. Team member were provided with background information on assessing the achievements of the countries in relation to the QCA preconditions. These preconditions (based on "expected behavioral change processes" from the

TOC (refer to Figure C1 in Appendix C) are: (a) Policy and Regulatory, (b) Integration into Power System, (c) Improvements to Design & Technical Standards, (d) Strengthen Institutional Capacity, (e) Mitigate Investment Risks, and (f) Mobilize Financing.

Following the completion of the case studies, the QCA Team provided each country case evaluator with a template illustrating the TOC, and a document describing the group membership statements (ranging from full membership **rated 1.0** to no membership **rated 0.0**)[8]. Each evaluator was tasked with determining the extent to which the country he was assigned had attained the qualitative description of group membership for each precondition based on the criteria developed by the QCA Team and available in the evaluation files. In analyzing the case studies, the evaluators also used their knowledge of the country and its context to make judgments about the qualitative position of each country in relation the TOC.

After completion of the first round of scoring, i.e. production of country membership matrices, the QCA Team met with each evaluator to discuss their assessment of the country and the context in which group membership was assessed for each precondition. During these meetings, allowed for the QCA team asked questions and discussed the goals of the QCA component of the evaluation, and gave the evaluators the opportunity to ensure that their case assessments were aligned with the criteria provided to them before the membership scoring (country specific calibration).

After completing the initial calibration of the country to the TOC model was done, the whole evaluation team (including the evaluators of each country) met to calibrate the assessments of preconditions across all nine involved countries to ensure that all calibrations were to the same standard. This calibration activity led to clarifying edits in the qualitative membership statements and revisions to measures of outcome variables related to energy and environmental benefits. Two additional contextual conditions were also added to the analysis: (a) Gross National Income (GNI) per capita, PPP, and (b) Ease of Doing Business rating from the Bank Group. Evaluators were also given the opportunity to raise and discuss issues relating to all the nine countries to ensure the inter-coder reliability.

The consolidated results of these iterations (Cf. Table J1.) were used in running the QCA model utilizing a static measure (RE capacity in 2017) and a change measure (capacity increase between 2000 and 2017-Deltas).

Table J1: QCA: CONSOLIDATED RE BARRIERS AT THE COUNTRY LEVEL

	Level of country Membership to Preconditions/Barriers) Groups	Energy and Environment Benefits

[8] This simply means that countries were assessed as to how completely they met the condition (have addressed the barrier), on a scale of 0.0-1.0.

	Policy and Regulatory	Integration into Power Systems	Improvements to Design & Tech. Standards	Strengthen Institutional Capacity	Mitigate Investment Risks	Mobilize Financing	Development of RE	Energy Benefits	Environmental Benefits
China	A (0.80)	B (0.70)	A (0.90)	A (0.90)	B (0.70)	A (0.90)	A (0.84)	A (0.79)	A (0.94)
India	A (0.85)	A (0.80)	B (0.55)	A (0.90)	B (0.60)	B (0.70)	B (0.56)	C (0.36)	B (0.61)
Jordan	A (0.80)	B (0.70)	B (0.70)	C (0.40)	B (0.60)	C (0.40)	C (0.48)	C (0.27)	C (0.41)
Kenya	B (0.70)	D (0.20)	A (0.80)	C (0.40)	B (0.60)	A (0.80)	C (0.40)	C (0.38)	C (0.30)
Mexico	B (0.70)	A (0.90)	B (0.70)	B (0.70)	B (0.60)	B (0.60)	B (0.69)	B (0.60)	B (0.69)
Morocco	B (0.55)	B (0.60)	C (0.40)	C (0.40)	B (0.60)	C (0.40)	B (0.54)	C (0.37)	B (0.58)
Nicaragua	B (0.70)	B (0.60)	C (0.40)	C (0.40)	C (0.40)	C (0.40)	B (0.64)	B (0.57)	B (0.60)
Sri Lanka	C (0.70)	B (0.60)	B (0.60)	C (0.60)	B (0.70)	C (0.60)	B (0.64)	B (0.55)	B (0.68)
Turkey	A (0.80)	A (0.90)	A (0.90)	A (0.80)	B (0.70)	A (0.80)	A (0.86)	A (0.80)	A (0.90)

Summary of main results: Focus on necessity and pathways that lead to development of RE

While QCA is a valuable technique for identifying necessity relationships and pathways, the relationships that QCA identifies must be evaluated in light of the theoretical understanding of RE and the evaluation team's substantive knowledge of the country cases. Several meetings were held between the QCA Team and experts to ensure the soundness and robustness of the results and their alignment with the knowledge about the sectoral issues and country specific conditions that justify the exceptions.

The QCA validated the TOC for RE investments developed at the early stage of the evaluation with exceptions justified by the context in which RE was developed. The QCA results confirmed that TOC barriers are valuable preconditions for increasing RE capacity and gaining the related energy benefits. The ability of RE capacity to gain environmental benefits is however more dependent on the context in which RE is being developed. For example, in Kenya, where

new RE capacity is largely replacing or supplementing previous RE capacity, there are more limited environmental benefits to be gained; or in China where RE growth remains outpaced by traditional fossil fuel growth, environmental benefits are harder to observe.

Addressing policy and regulatory and integration barriers are necessary conditions for successful RE investment programs. In terms of determining which preconditions must be addressed in order to promote RE capacity, the *necessity* analysis utilizing the static measure of RE capacity analysis identified that (a) Policy and Regulatory, and (b) Integration into Power Systems were each necessary preconditions for RE capacity. Yet, when changes in RE capacity over 16 years (2000 – 2016) was introduced into the analysis, the Policy and Regulatory preconditions was identified as the sole *necessary* barrier to be addressed for growing RE capacity per capita (with Integration into the power system, following closely); indicating that reducing Policy and Regulatory barriers to RE development is a *necessary* component for investment strategies in RE growth.

It is important to recognize, however, that while Policy and Regulatory improvements are is a necessary precondition in the change (i.e., delta) model, this doesn't mean that it's the singular most important precondition to RE investment. The static model also illustrated that integration into the power systems is also essential to developing sufficient conditions for RE development, and further in the pathways (sufficiency) analyses both barriers were of substantial importance. Therefore, necessity and sufficiency analyses should be interpreted in combination.

The QCA combined with the knowledge gained through the case studies identified the pathways used by countries to grow RE capacity, depending on contextual factors within the case countries. The QCA, identified three unique pathways to growing RE capacity, each dependent on contextual factors within the country. The primary pathway (as observed in China; India; Mexico; Sri Lanka; Turkey in the 'change' analysis) indicates that addressing all six precondition barriers is consistent with achieving the desired outcomes – as posited in the TOC. Yet, as illustrated in the cases of Morocco and Nicaragua, successful growth of RE capacity over time can also be achieved within certain contexts with a focus on addressing Policy and Regulatory and Integration into the power system barriers. A third path, demonstrated by Jordan and Morocco, added to Policy and Regulatory and Integration into the power system intervention to Mitigate investment risks especially to attract private sector investments.

In light of that, the team identified a fourth pathway to success that is illustrated by important of geothermal capacity development in Kenya. The development can be very successful because the renewable technology was part of the least cost generation mix. And even in this case, the WBG started assistance to the government to develop a geothermal law to sustain the development of the technology followed by MIGA guarantees to address the country risks to attract private investments. QCA paths were identified based on the growth in RE capacity per capita in other case study countries and identifiable growth was not observed in Kenya largely

because of limited access to electricity and the replacement of one RE technology with another. Focus on Policy and Regulatory reforms and Improvements of Design & Technical Standards contributed to the substantive development of geothermal and provided opportunities the door to intermittent technologies.

These results suggest that countries seeking to substantially increase investments in RE need to necessarily focus improving the Policy and Regulatory environment, a required precondition to achieving results. Likewise, the pathways to results analysis further illustrates that interventions that support RE integration into the power system are required to bring about growth in RE capacity. Whereas other preconditions in the TOC were also identified as valuable, the case studies demonstrated the greater relative importance of these two.

However, there were contextual factors to be considered and some cases were considered anomalies. As was the case with Kenya where mitigating investment risks to attract private sector (MIGA guarantees) and mobilizing finance (Bank finance and leveraged funds) have been important elements of their pathway to RE growth.

QCA models that included Income per capita and Doing Business: Getting Electricity were analyzed, but these conditions demonstrated no consistent relations to the outcomes.

Appendix K: Bank Group Staff Survey on RE

As explained in the Methodology Appendix C, a structured survey was administered electronically (via Survey Monkey) to a purposive sample of Bank Group staff (professional grades GF-GH) working on or has experience in RE (approximately 17 WB 23 IFC = 40 staff members). The survey was kept open for two weeks (from June 15 to 22, 2018) and the responses were anonymous and confidential. 34 responses were collected (85% response rate) (18 WB 16 IFC). Non-respondents were given reminders in the second week. The survey was structured as in Table K1 and the summarized results are illustrated in Figure K2.

Table K1. IEG Questionnaire for Bank Group Staff on Key Issues related to RE Development

Section 1: Integration of RE into Power Systems[9]

1. Challenges with integration of RE into power systems, in particular variable /intermittent technologies such as wind and solar-PV, is a significant barrier to increasing the share of RE in developing countries. Please provide the rationale for your assessment.

2. Challenges related to integration of RE into the power system, including variable/intermittent wind and solar-PV, is a problem facing specific countries that I have worked on.

3. **Which integration related issues did you encounter in the countries you are working on?** 3a) I have not encountered issues related to RE integration in the countries where I work 3b) I have encountered the following integration issues in the countries I work (please select all that apply or enter additional issue(s) that are not listed)

- Lack of Integrated Power System Planning (Generation &Transmission)
- Insufficient investment in transmission infrastructure
- Inadequate grid code
- Lack of standards for grid friendly RE equipment
- Insufficient flexibility to respond to sudden loss of capacity
- Lack of requirements for priority dispatch of RE
- Underutilization of power trade and pooling opportunities to improve RE offtake
- Other 1 (Please specify)

4. **Please identify any projects/investments or Advisory Services (ASA/AS) activities that you have worked on in the past or working on presently, where the WBG is attempting to help client address any of the above identified RE integration challenge(s)?** Please indicate

[9] Could include, but not limited to, Integrated Systems Planning for Transmission and Distribution, the development of physical infrastructure for evacuating power from RE sites, development of balancing power capacity, adequate grid codes and standards for grid friendly RE equipment, requirements for priority dispatch, power trade and pooling that improves RE off-take.

project/investment or ASA/AS name, country, and P Code and describe the nature of support your team is providing.

Section 2a: Grid Connected Distributed RE Generation[10]

5. Achieving the ambitious RE targets will require grid-connected distributed RE generation, for which grid systems need to be prepared.

6. **Please identify the grid connected distributed RE generation related issues you are encountering in the countries you are working on?**
6a) I have not encountered any grid-connected distributed RE generation related issues 6b) I have encountered the following grid-connected distributed RE generation related issues in the countries I am working on (please list)

7. **Please identify any projects/investments or Advisory Services (ASA/AS) activities that you have worked on in the past or working on presently, where the WBG is attempting to help client address any of the above identified grid connected distributed RE generation challenge(s)?** Please indicate project/investment or ASA/AS name, country, and P Code and describe the nature of support your team is providing.

Section 2b: Off-Grid/Mini Grid Distributed RE Generation

8. For off-grid electricity access, distributed RE generation is often a least-cost option, which is vital to meeting the SE4ALL objective of universal access by 2030.

9. **Please identify the grid connected distributed RE generation related issues you are encountering in the countries you are working on?**
9a) I have not encountered any grid-connected distributed RE generation related issues 9b) I have encountered the following grid-connected distributed RE generation related issues in the countries I am working on. (please list)

10. **Please identify any projects/investments or Advisory Services (ASA/AS) activities that you have worked on in the past or working on presently, where the WBG is attempting to help client** deal with off grid distributed RE generation for electricity access**?** Please indicate project/investment or ASA/AS name, country, and P Code and describe the nature of support your team is providing including the RE technology utilized, and the mechanism through which off-grid access is provided (Mini grids, electrification of community services or household solutions).

Section 3: Additional Questions

[10] The purpose of distributed generation is to provide a source of active electric power that is connected directly to the distribution network or connected to the network on the customer site of the meter.

11. To mobilize investments for developing RE in-line with the SDG7 and climate change goals, countries will require a strong policy framework that establishes a supportive

investment climate for RE. The WBG is more effective in influencing clients' policy frameworks when it also maintains a sizable investment portfolio in countries. Please provide rationale of your assessment.

12. The WBG projects/investments and ASA/AS that I work on has utilized substantial development partner support for disseminating knowledge and mobilizing investments in RE

13. **The investments/projects I have worked on have utilized one or more of the following partnerships to support the development RE?**

13a) The investments/projects I have worked on have not benefitted from development partner support.

13b) The **investments/projects** I have worked on have benefitted from the following types of development partnerships for developing RE: (please select all that apply or enter additional sources that are not listed

- Climate-Related Funds (GEF, CIFs, CCCP etc.)
- Bi-lateral financing
- Bi-lateral grants or concessional finance
- Specialized investment funds
- Other (please specify)

13c) The **ASA/AS** I have worked on have benefitted from the following types of development partnerships for developing RE: (please select all that apply or enter additional sources that are not listed)

- ESMAP
- ASTAE
- SIDS DOCK
- Project preparation facilities (PDF, PHRD)
- Bi-lateral grants
- Other (please specify)

14. The WBG projects/investments and ASA/AS that I work on have relied substantially on grants and concessional financing to catalyze investments in RE.

15. The WBG closely coordinates its activities in RE amongst its three key institutions (WB, IFC, MIGA) through efforts in addition to the Country Partnership Frameworks (CPF or CAS)

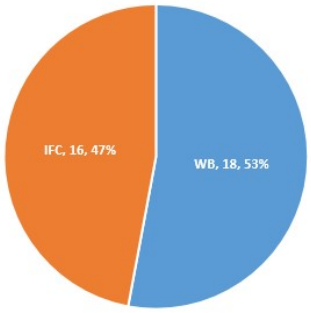
16. **I have been involved in the following key activities that have resulted in the coordination of RE related work between amongst two of more WBG entities (i.e. WB, IFC or MIGA).**

16a) I have not worked on RE related activities that were coordinated with two or more of the WBG institutions

16b) The following **investments/projects** or **ASA/AS** I have worked on were co-financed[11] or joint products between two or more WBG institutions (please indicate name of activity, country, P Code, RE Technology, and description of the nature of co-financing arrangement) (please list and identify the nature of co-financing or co-funding)
16c) The following **investments/projects** or **ASA/AS** I have worked on were strategically coordinated[4] between two or more WBG institutions (please indicate name of activity, country, P Code, RE Technology, and description of the nature of coordination amongst the WBG institutions), (please list and identify the nature of strategic coordination amongst WBG Institutions).

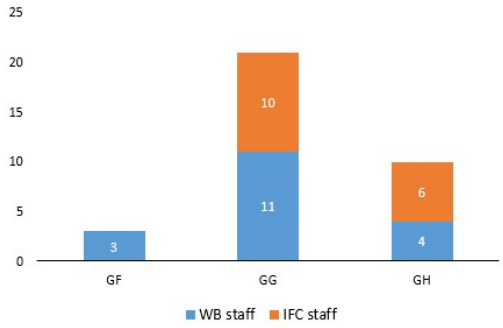
Figure K2. Survey Results on Key Emerging Issues on RE Development, June 2018

Survey Response by Institution (n=34)

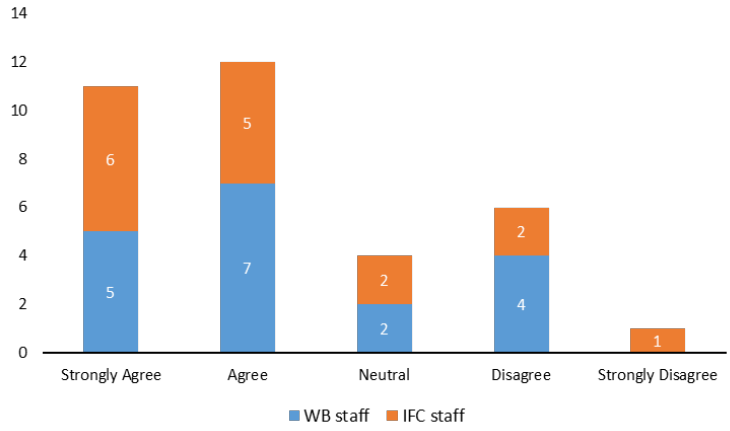


VPU/Dept	WB	IFC
Energy & Extractives GP	10	
Energy GP EAP	3	
Energy GP AFR	2	
Energy GP ECA	1	
Energy GP LAC	1	
VP, SD GP	1	
CAS Energy and Water		8
Power – Global Infra		5
Climate Business - FIG		2
Regional Infrastructure – LAC		1
Grand Total	**18**	**16**

Survey Response by Job Grade (n=34)

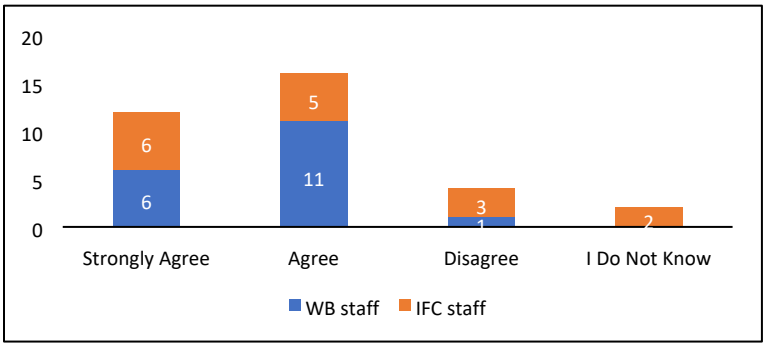


Challenges with integration of RE into power systems, in particular variable /intermittent technologies such as wind and solar-PV, is a significant barrier to increasing the share of RE in developing countries

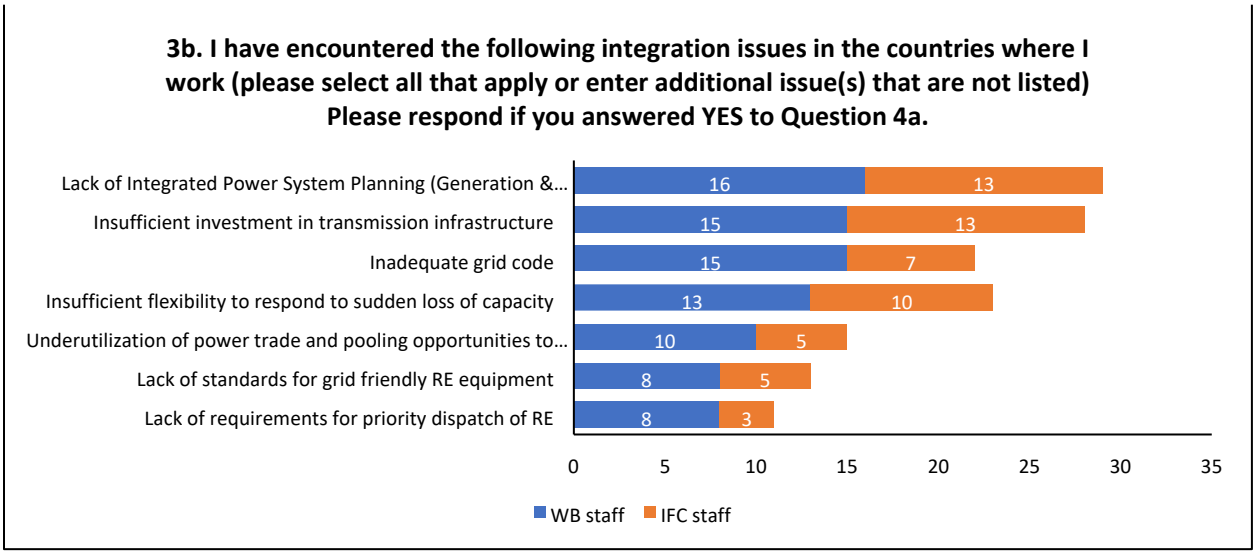


Challenges related to integration of RE into the power system, including variable/intermittent wind and solar-PV, is a problem facing specific countries that I have worked on

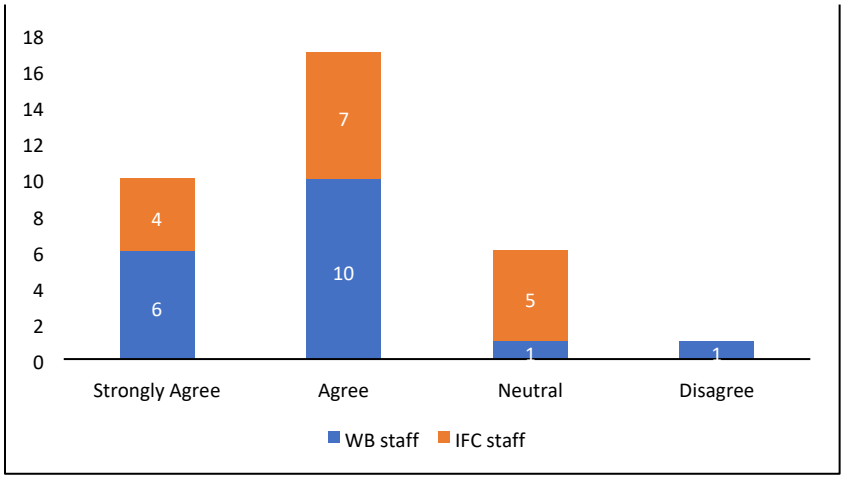
[11] It is either a co-funded project/investment or a formal joint product of two or more of the WBG institutions.
[4] These include efforts to coordinate activities at the strategic level including joint-strategies, undertaking of complementary activities, or strategically relevant follow-on activities.



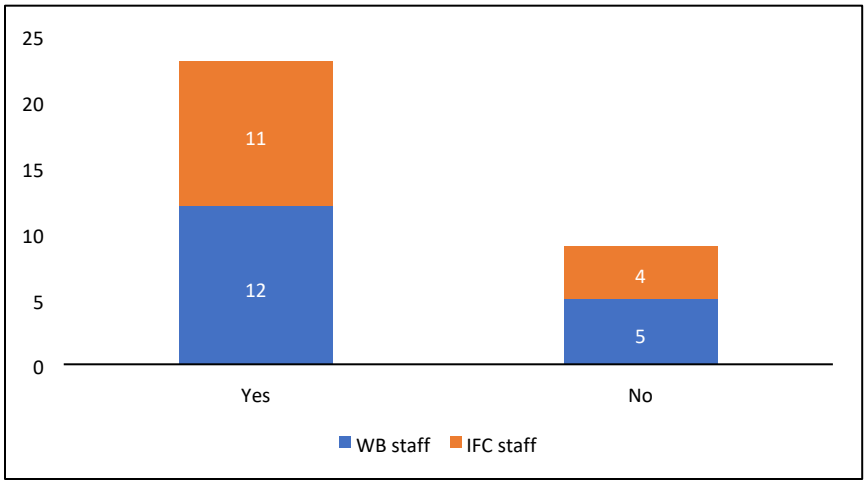
Which integration related issues did you encounter in the countries you are working on?



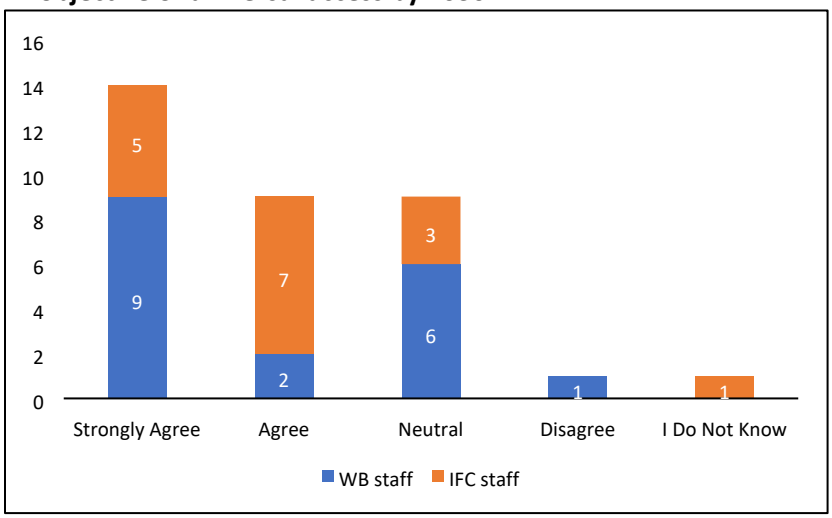
Achieving the ambitious RE targets will require grid-connected distributed RE generation, for which grid systems need to be prepared



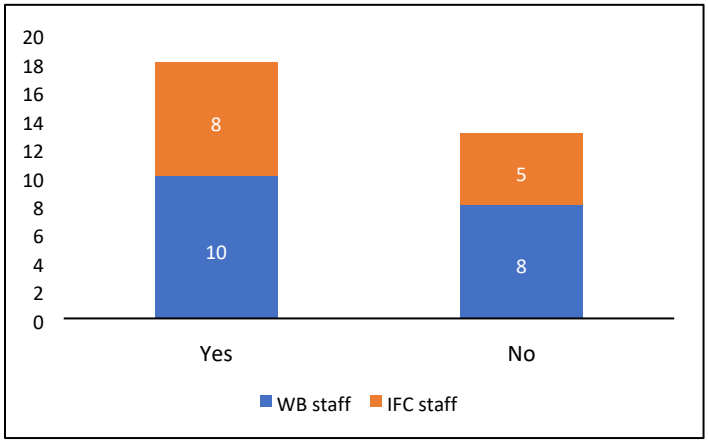
I have encountered the following grid-connected distributed RE generation related issues in the countries I am working on:



For off-grid electricity access, distributed RE generation is often a least-cost option, which is vital to meeting the SE4ALL objective of universal access by 2030.

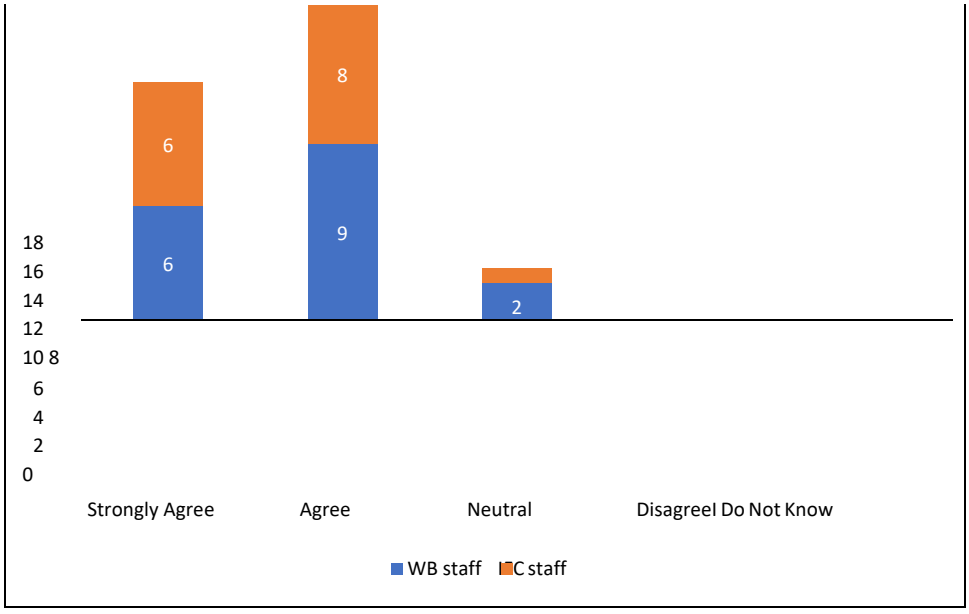


Have you encountered any off-grid distributed RE generation related issues?

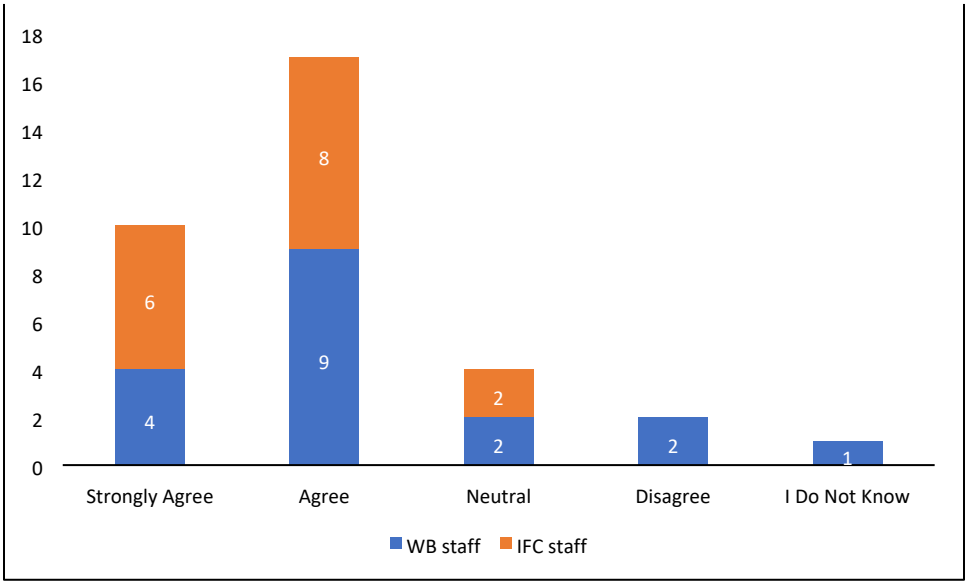


To mobilize investments for developing RE aligned with the SDG7 and climate change goals, countries will require a strong policy framework that establishes a supportive investment climate for RE. The

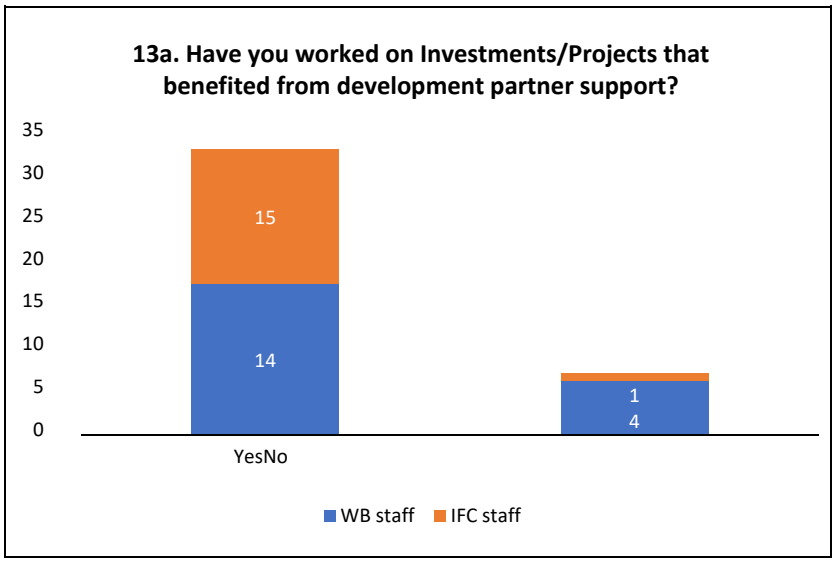
WBG is more effective in influencing clients' policy frameworks when it also maintains a sizable investment portfolio in countries

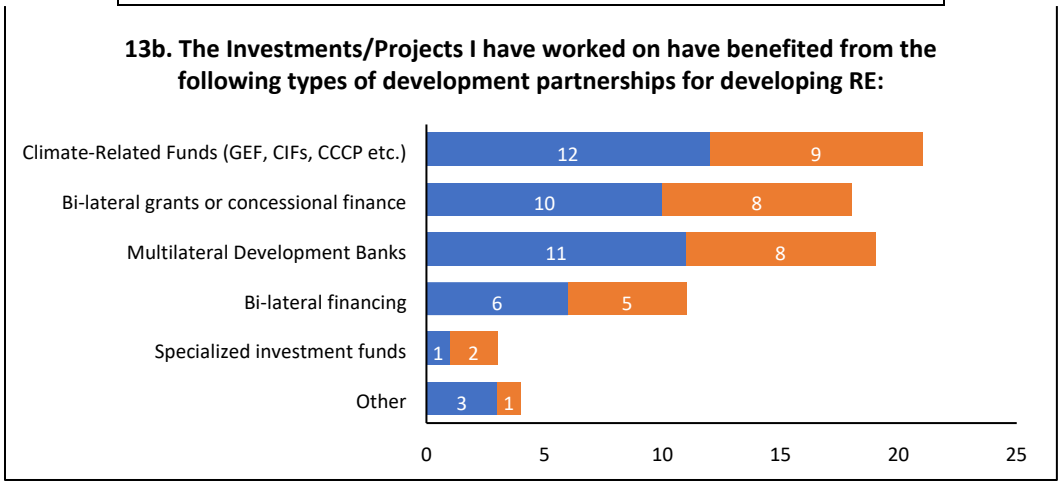


The WBG Projects/Investments and ASA/AS that I work on has utilized substantial development partner support for disseminating knowledge and mobilizing investments in RE

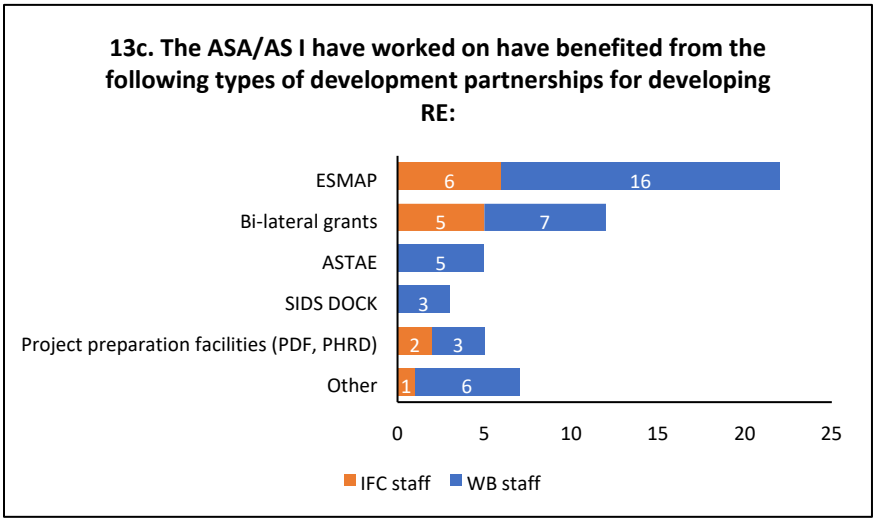


Investments/Projects benefit from Partnerships to support the development of RE



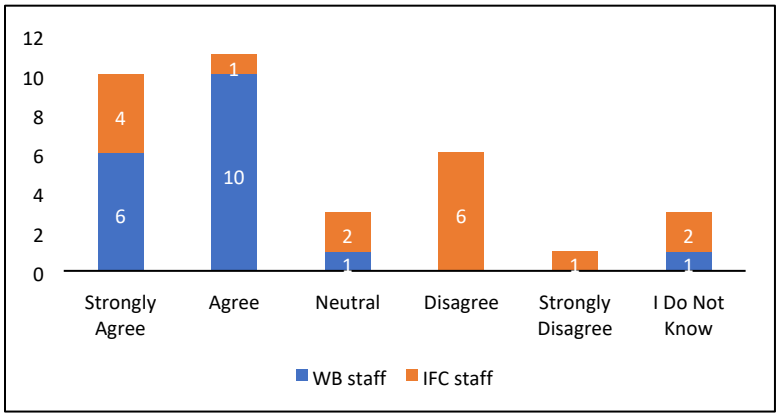


”Other” includes: ESMAP, GPOBA, GIF, GCF, PPIAF, USAID



“Other” includes: EU Funds/EU-IPA, KGGTF, PPIAF, NDC SF, SECO

The WBG Projects/Investments and ASA/AS that I work on have relied substantially on grants and concessional financing to catalyze investments in RE



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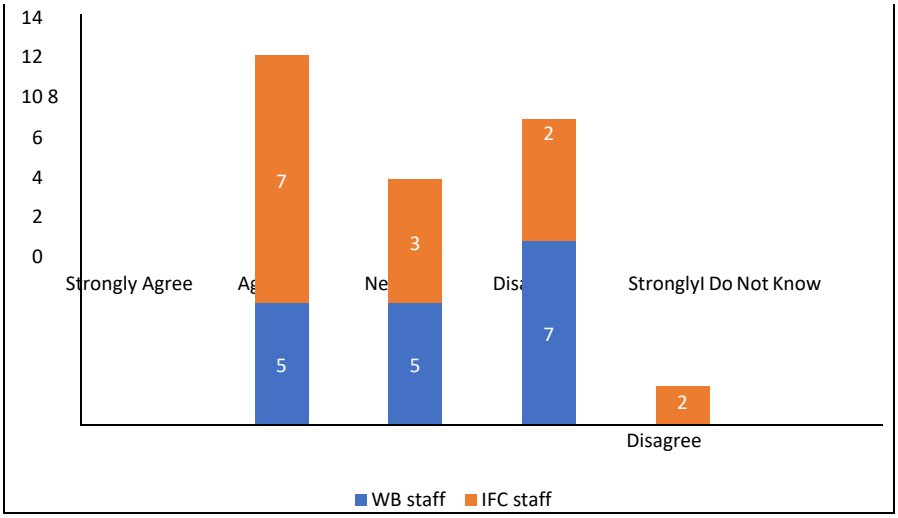

Coordination of RE-related work amongst WBG entities (i.e. WB, IFC or MIGA)