

Qualitative Comparative Analysis

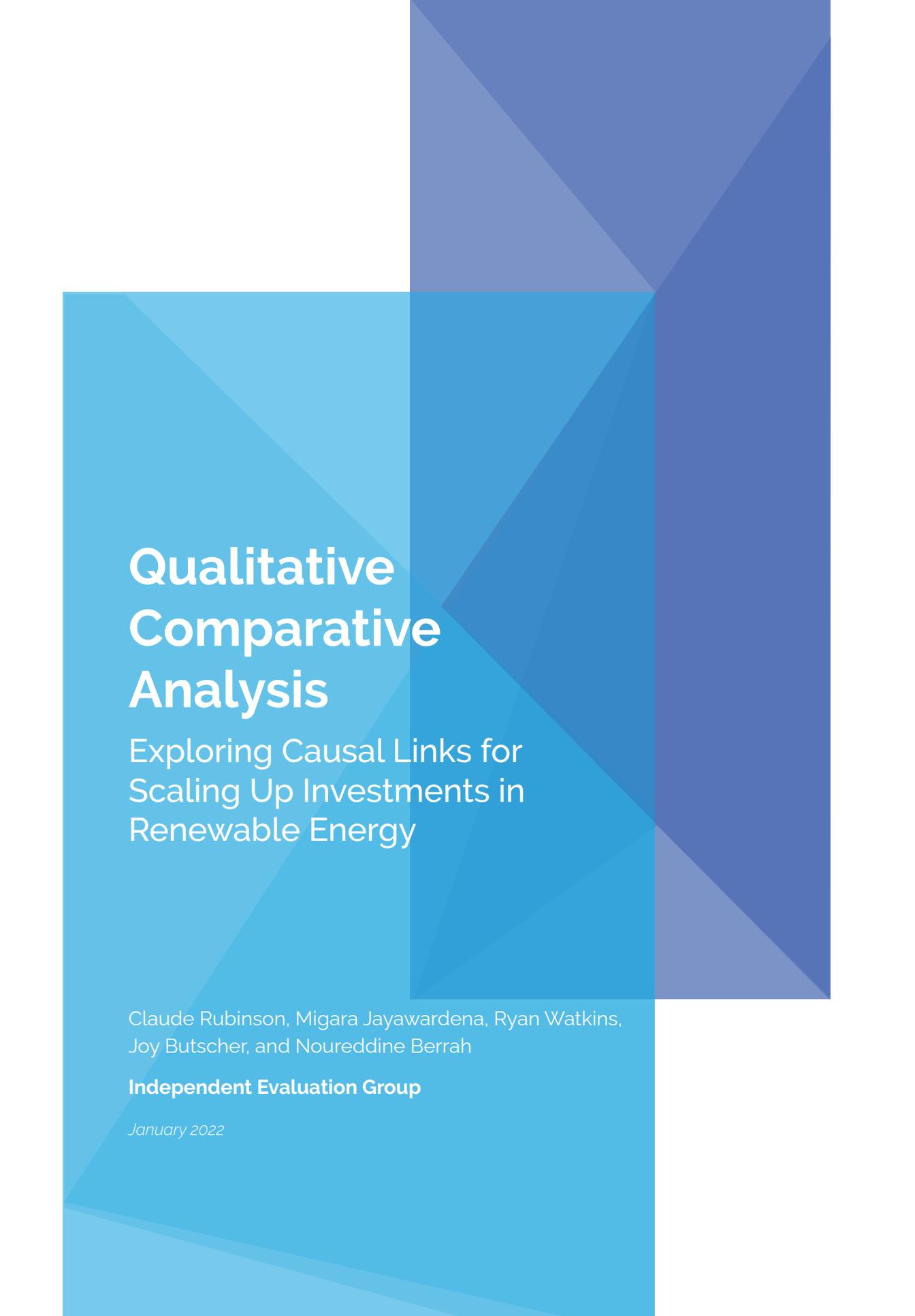
Exploring Causal Links for
Scaling Up Investments in
Renewable Energy

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ABBREVIATIONS

IEA	International Energy Agency
CO ₂	carbon dioxide
IEG	Independent Evaluation Group
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
MIGA	Multilateral Investment Guarantee Agency
PV	solar photovoltaics
QCA	qualitative comparative analysis
RE	renewable energy
SDG	Sustainable Development Goals
ToC	theory of change

All dollar amounts are US dollars unless otherwise indicated.

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Although many people contributed to the exercise and the preparation of this paper, it is noted that the findings, interpretations, and conclusions expressed in this paper are entirely those of the authors and should not be attributed in any manner to the World Bank Group, to members of its Board of Executive Directors, or to the countries they represent.

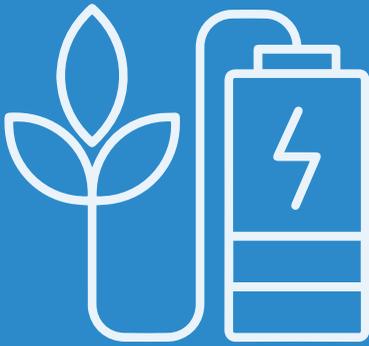
OVERVIEW

This paper illustrates how qualitative comparative analysis (QCA) was used to identify causal pathways for scaling up renewable energy to meet the sustainable development and climate goals. The analysis was a part of a multimethod evaluation that was carried out to assess the World Bank Group's performance in supporting the development of renewable energy (RE) from 2000 to 2017. The evaluation explored the World Bank Group's role in helping clients achieve the United Nations' Sustainable Development Goals and the targets in the Paris Agreement on climate change. QCA was used to validate the theory of change developed for the RE evaluation and identify pathways for scaling up RE as a key solution.

The paper was prepared for international development professionals, with both evaluation specialists and energy sector practitioners in mind. It delves into issues of RE investments and the strategic context for those investments. It remains, however, a methods-focused paper that also examines in detail the approach and process for designing and carrying out the QCA and the analysis of results and key conclusions drawn from the findings. The QCA presented an opportunity to synergistically bring together energy sector and development specialists together with methods experts, which was essential to designing, conducting, and analyzing results from the methodological application. This approach was vital to developing robust conclusions that could be triangulated with other methods in the RE evaluation. Ultimately, the QCA findings, together with results from other methods, helped validate the theory of change developed for the RE evaluation and helped identify three pathways through which six key challenges to scaling up RE (precondition barriers) can be overcome so that the clean energy transition can be successfully achieved.

1

BACKGROUND AND CONTEXT



Expanding clean energy
and other generation
technologies



Scaling up renewable
energy to limit global
warming



Shifting fuel sources
for global electricity
production

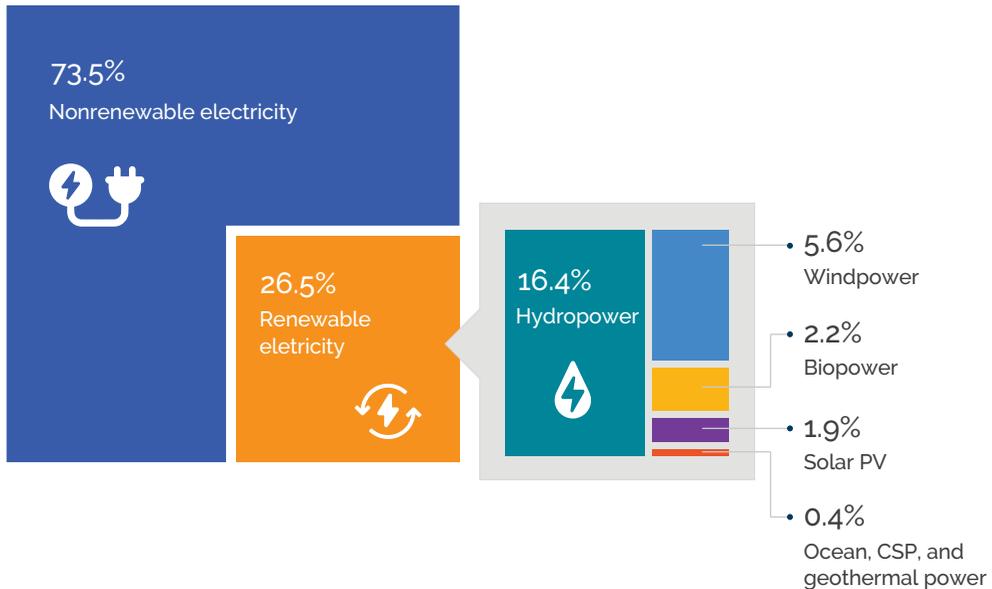
Renewable energy (RE) is central to achieving the Sustainable Development Goals (SDGs) and responding to the urgency of climate change. According to the United Nations, the availability of affordable and clean energy (SDG 7) is an explicit and interdependent goal “crucial for achieving almost all [16 other] SDGs,” such as eradicating poverty, improving health and education, supplying clean water, industrialization, and combating climate change (UN 2018). (These are further emphasized through SDG 13 on climate action). The Paris Agreement on climate change, which became effective in 2016, places even greater prominence on scaling up RE as a key solution to limiting global temperature rise to no more than 2°C by 2100 and to “make best efforts to limit warming to 1.5°C” (World Bank, IFC, and MIGA 2016, 1).

RE has experienced a dynamic expansion over the years through the development of multiple technologies and has the potential to scale up further in the future. The major RE technologies—hydropower, solar power, wind power, geothermal power, and biopower—produce over a quarter of the world’s electricity (figure 1.1). Hydropower, which has been the dominant technology by scale, makes up the highest proportion in the global RE mix, with a 62 percent share in 2017 (or 16.4 percent of total global electricity production). Around 2000, wind power began to expand at a globally significant scale, followed by a major scale-up of solar photovoltaics (PV) starting around 2008. Together, wind and solar PV made up 7.5 percent of global electricity produced in 2017. For the same year, biopower and geothermal—two long-standing technologies—produced less than 3 percent of global electricity. RE markets experienced a major transformation during the period assessed, with multiple technologies now showing a significant global impact (box 1.1). Future expansions of RE will need to navigate this anticipated continued market volatility.

A monumental scale-up in RE is required to achieve global energy and environment goals, which needs to be set in motion immediately and sustained for several decades. Despite the expansion of RE, electricity produced from fossil fuels make up nearly three-quarters of the global generation mix, since these technologies have also continued to grow. Therefore, the expansion of RE will need to accelerate and be sustained so that the growth of fossil-based technologies can be reduced without locking into a less sustainable pathway to meeting energy demand. Several studies propose different pathways to achieving such goals,¹ but all options involve an unprecedented scale-up in RE. One such analysis by the International Energy Agency used in a 2018 report by the Intergovernmental Panel on Climate Change estimates that the RE share in the global energy mix will need to more than double by 2030 (consistent with the SDGs) and further accelerate to almost quadruple by 2040—a program of action commonly referred to as the clean energy transition (table 1.1). The 2018 Intergovernmental Panel on Climate Change report calls for “rapid and far-reaching” transitions in the energy sector (among others)

to limit global warming to 1.5°C. It is estimated that such an expansion will double the present global level of investments in RE from \$300 billion to \$600 billion (IEA 2017, 2019; IRENA 2017).

Figure 1.1. Renewable Energy Share of Global Power Generation, 2017



Source: Renewables 2018 Global Status Report

Note: CSP = concentrated solar power; PV = photovoltaic.

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Table 1.1. A Pathway to Achieving the Clean Energy Transition

Renewable Energy Technology	Installed Capacity (GW)			Average Annual Increase (percent)	Average Capacity Addition (GW/year)	Electricity Produced (TWh)		
	2016	2030	2040			2016	2030	2040
Hydropower	1,241	1,723	2,060	2.1	34.0	4,070	5,688	6,928
Wind	466	1,706	2,629	7.5	90.0	981	4,193	6,950
Solar PV	299	1,846	3,246	10.4	123.0	303	2,732	5,265
Biopower	127	243	347	4.3	9.2	570	1,209	1,807
Geothermal	13	44	82	8.0	2.9	86	292	563
CSP	5	92	328	19.0	13.5	11	287	1,066

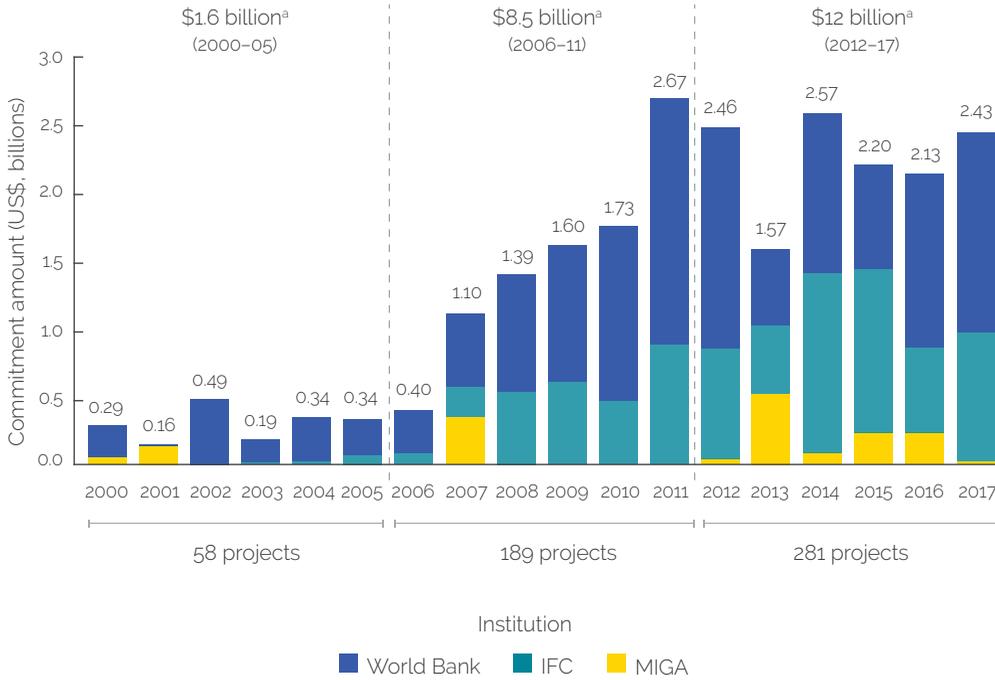
Source: Based on International Energy Agency forecasts for its Sustainable Development Scenario.

Note: 2030 represents a target consistent with meeting the Sustainable Development Goals. CSP = concentrated solar power; GW = gigawatt; PV = photovoltaic; TWh = terawatt-hour.

The World Bank Group has mainstreamed its support to RE and is committed to the SDGs and the climate goals in the Paris Agreement. The institution has a long history of financing hydropower, but its support for other RE technologies was initially modest and mostly for increasing electricity access, particularly in rural areas not served by the power grid. However, in 2004, the president of the Bank Group made a commitment at the Renewable Energy Conference in Bonn, Germany (the Bonn Commitment), to increase its lending for RE by 20 percent over five years (figure 1.2). This commitment coincided with the global expansion in wind and predated the boom in solar power that followed. After the Bonn Commitment, there was a notable uptick in the Bank Group’s financial support to RE covering all major technologies, averaging about \$2 billion per year. The scale-up in funding extended to the greater involvement of the private sector, including through the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency—two institutions within the Bank Group. Although the Bank Group’s financing for RE is dwarfed by the \$300 billion in annual global flows into the sector, the institution’s significant international role in supporting reforms, convening partners and mobilizing financing, and disseminating global experiences is a unique position of

influence. It also explains the Bank Group’s interest in evaluating its performance in support of RE so that it is optimally geared to help client countries successfully navigate the clean energy transition.

Figure 1.2. World Bank Group Commitment to Renewable Energy, 2000–17



Source: World Bank Group.

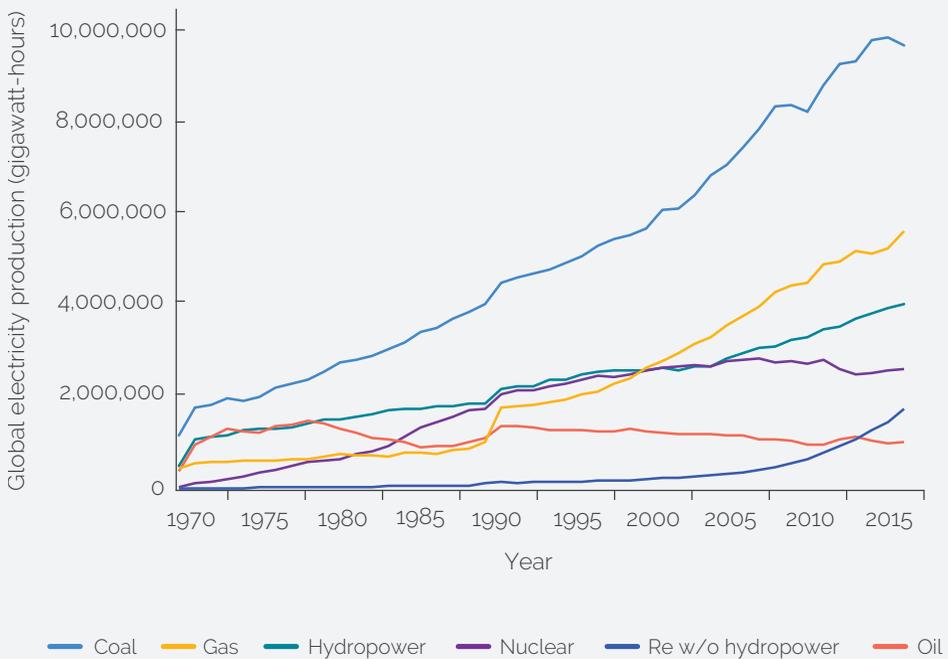
Note: The renewable energy portfolio evaluated includes 18 additional projects that had been approved previously and were evaluated in 2000 or later. IFC = International Finance Corporation; MIGA = Multilateral Investment Guarantee Agency.

a. Total commitment amounts do not include issuances of MIGA guarantees.

Box 1.1. The Evolution of Renewable Energy and other Generation Technologies

The global power supply has evolved over time, with renewable energy (RE) playing an increasing role. The global electricity production grew more than fourfold over the 45 years between 1971 and 2015, with shifts in the mix of generation technologies (figure B1.1.1). **Coal use**, given its reliability and low production cost, grew steadily to reach a 40 percent share as the main nonrenewable source of power generation. **Hydropower** is a long-standing RE technology that has also continued to increase, although its share of global electricity declined from 23 to 17 percent over 1971–2015, as fossil fuel use grew more rapidly over the same period.

Figure B1.1.1. Shifting Fuel Sources for Global Production of Electricity, 1971–2015



Source: Independent Evaluation Group, based on International Energy Agency data.

Note: RE = renewable energy.

(continued)

Box 1.1. The Evolution of Renewable Energy and other Generation Technologies (cont.)

Decreases in prices led to a rise in the use of oil for power generation in the early 1970s, followed by a decline later in the decade due to global oil shocks. **Nuclear power**, viewed as an alternative to fossil fuels, expanded until the 1990s, but several accidents progressively led to a slow-down in its growth, out of safety concerns. **Natural gas** was used sparingly for power generation, with a global share of only 13 percent in 1971, mostly relegated to countries that produced the fuel. However, technological advances in extraction and more efficient means of transportation allowed natural gas to overtake hydropower as the second-largest fuel source for power production by the late 1990s.

RE technologies such as **wind** and **solar photovoltaics** were developed at small scale or for demonstration purposes, before their rapid global expansion starting around 2000. Electricity produced from **wind** and **solar photovoltaics** grew from negligible shares in the early 2000s to reach a combined share of 7.5 percent share of global electricity produced by 2017. Other more niche RE technologies, such as **geothermal power**, **concentrated solar power**, and **biopower**, are not globally significant by scale, but some make important contributions in specific countries.

Notes

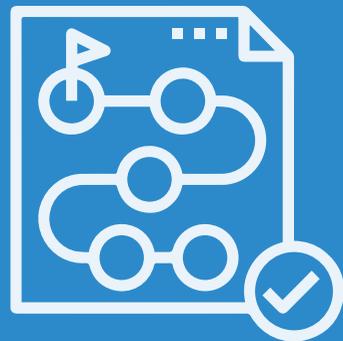
- 1 The Intergovernmental Panel on Climate Change 2018 report considers the following three studies: the Energy Technology Perspectives series (IEA 2014, 2015, 2016, 2017), the International Energy Agency and International Renewable Energy Agency report (OECD/IEA and IRENA 2017), and the Shell Sky report (Shell International B. V. 2018).
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2

RATIONALE FOR QUALITATIVE COMPARATIVE ANALYSIS IN EVALUATING RENEWABLE ENERGY



Methods used in the
renewable energy
evaluation



Reasons to use qualitative
comparative analysis

Qualitative comparative analysis (QCA) is an analytical technique that was developed in the 1980s for use in the qualitative study of macrosocial phenomena. It has proven itself particularly useful in mixed methods research, although its introduction to evaluation is relatively recent. QCA draws on both the variable-oriented and case-oriented methodologies as a “means of bridging quantitative and qualitative analysis” (Cragun et al. 2016). It combines the use of quantitative techniques to identify patterns within one’s data with in-depth qualitative understanding of the cases and subject matter being studied. The QCA methodology uses Boolean algebra to generate a set of inferences based on underlying data across multiple qualitative cases. Thus, the methodology integrates both quantitative and qualitative analysis, generating findings that are generalizable across a wider population. QCA can help identify causal patterns when triangulated with results from other methods.

“QCA is based on two primary assumptions:

change is often the result of different combinations of factors, rather than on any one individual factor; and different combinations of factors can produce similar changes.”

—Charles Ragin, who is credited with developing QCA

QCA can be a useful methodology for analyzing multiple cases in complex situations to identify causal links and explain conditions under which changes happen. QCA is especially useful for identifying and understanding cross-case patterns in small- and medium-N data sets (for example, 5–50 cases) with qualitative or mixed methods findings, or both. The application of the methodology requires an in-depth understanding of circumstances within each case and must be accompanied by a robust theory of change (ToC). When these conditions are present, the results of a QCA can be interpreted and generalized across the case studies and across the population.

The Bank Group’s Independent Evaluation Group (IEG) was carrying out a multi-method evaluation of the institution’s performance in supporting RE development in its client (emerging market) countries (box 2.1). QCA was one of the methods selected, to be applied in combination with country case studies, to (i) validate the ToC developed for the evaluation (or make adjustments as necessary), and (ii) identify different pathways through which RE can be scaled up so countries can achieve the clean energy transition. Together with other methods, QCA helped formulate key evaluative conclusions and provided the basis for recommendations that would allow the Bank Group to improve its performance in supporting its clients as they navigate an evolving global RE landscape.

Box 2.1. Multimethod Evaluation of World Bank Group Support to Renewable Energy Development

The renewable energy (RE) evaluation was designed to assess the World Bank Group's performance during 2000–17 supporting clients in developing and scaling up their RE resources (World Bank 2020). Specifically, the RE evaluation attempted to answer the following questions: (i) In what ways—and how well—has the Bank Group contributed to addressing the evolving RE needs of its clients? and (ii) What lessons from experience can be identified to strengthen the role of the Bank Group in helping clients achieve their emerging RE goals (that is, the Sustainable Development Goals and the clean energy transition)?

Figure B2.1.1. Methods Used in the Renewable Energy Evaluation



Source: Independent Evaluation Group.

Note: AS = advisory services; ASA = advisory services and analytics; CAS = Country Assistance Strategy; CBA = cost-benefit analysis; CPF = Country Partnership Framework; RE = renewable energy; QCA = qualitative comparative analysis; PPAR = Project Performance Assessment Report; SLR = structured literature review.

Various methods were applied to triangulate findings into robust conclusions. These methods included the following:

- » Structured literature review. An assessment of the evolution of RE markets; a literature review of barriers to developing RE, the energy and environment outcomes of electricity produced from RE, and development impacts. *(continued)*

Box 2.1. Multimethod Evaluation of World Bank Group Support to Renewable Energy Development (cont.)

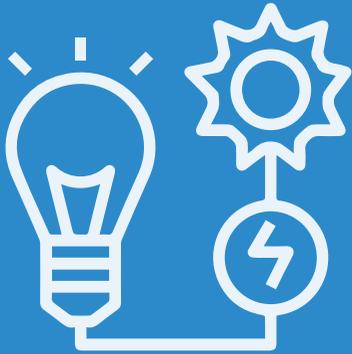
- » **Portfolio review and analysis.** A review of 546 investment projects in the Bank Group's RE portfolio, select World Bank advisory services and analytics and International Finance Corporation advisory services from a portfolio of 245 activities, and 19 Project Performance Assessment Reports, and an in-depth review of hydropower.
- » **Semistructured interviews.** Interviews with public and private stakeholders, development partners and key Bank Group managers, and a survey of a purposive sample of Bank Group staff working on RE.
- » **Independent Evaluation Group 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.
- » **Comparative case studies.** In-depth country case studies for a set of purposefully selected countries and a qualitative comparative analysis of the case study results to validate the theory of change for the RE evaluation and identify pathways for scaling up investments in RE to navigate the clean energy transition.

The remaining chapters focus specifically on the QCA methodology and how it was applied within IEG's RE evaluation:

- Chapter 3 provides a road map for applying QCA,
- Chapter 4 describes how the QCA was designed including the strategic decisions made by the evaluation team, the selection of in-depth case studies, and the criteria established for scoring factors and preconditions,
- Chapter 5 analyzes the results from the QCA modeling, and
- Chapter 6 interprets findings and draws conclusions from the QCA results.

3

A ROAD MAP FOR APPLYING QUALITATIVE COMPARATIVE ANALYSIS



Applying qualitative
comparative analysis



Identifying causal links
among case studies

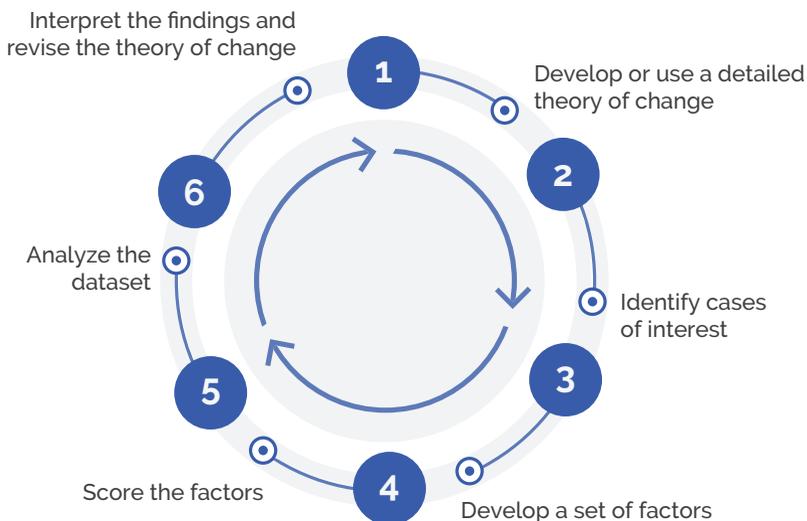


Strengthening the
theory of change

Undertaking QCA requires several distinct and carefully designed steps that can further strengthen the ToC and identify potential causal (near-necessary, sufficient, or both sufficient) links within this framework, as illustrated in figure 3.1.

1. **Developing the detailed ToC.** The successful application of QCA begins with the development of a detailed and robust ToC for the subject being evaluated. The ToC should include the change that is being evaluated and key factors that would drive these changes based on the theoretical and experiential understanding of the subject. A sound ToC is essential since it hypothesizes the causal relationship and underlies the interpretation of results.
2. **Identifying case studies.** The qualitative data that will be used to analyze potential causal links are based on case studies. These studies will need to be sufficiently representative of the key sources of variation under scrutiny (that is, where RE expanded rapidly and where it was less prolific; where the private sector was mobilized heavily and where the public sector had a larger role). The assessments must be detailed and in-depth so that qualitative data can be accurately transposed into quantitative figures to be analyzed through QCA. It is also vital that the criteria applied across the case study assessments are clear and consistent, ensuring that the results are comparable.

Figure 3.1. Process for Applying Qualitative Comparative Analysis



3. **Developing a set of explanatory factors or preconditions.** Factors, or preconditions, are the causal (that is, necessary, sufficient, or both) drivers that influence outputs and outcomes. They should be developed to include the factors that influence behavior change within the ToC framework.
4. **Scoring the factors or preconditions.** Once the ToC is developed and the factors or preconditions are identified and defined, as much as is feasible must be learned about each selected case. This may include the use of a combination of existing data, desk reviews, and site visits, including stakeholder interviews. The information gathered through the case studies is then analyzed to assign scores for the factors or preconditions for each case. This is a vital step in converting qualitative findings into quantitative data, and it should be consistently applied across all cases. The factors or preconditions may be coded as crisp sets (dichotomies scored as 0.0 or 1.0), fuzzy sets (with scores assigned within the 0.0–1.0 interval), or a combination of crisp and fuzzy sets.
5. **Analyzing results.** At this stage, with all of the groundwork completed, the data are analyzed using specialized software.¹ The QCA software is used to analyze patterns among the factors or preconditions and outputs or outcomes.² By using Boolean algebra, the software provides a rigorous logic-based approach to identifying patterns across multiple case studies and factors or preconditions.³ In addition to confirming causal links, the QCA software also looks for combinations of factors or *pathways* that can lead to various solutions. A unique aspect of QCA is that it is sensitive to *equifinality* and will recognize the presence of multiple distinct pathways that lead to the same solution.
6. **Interpreting findings.** The next step is to interpret the QCA findings. This requires referring back to the case studies and ToC to ensure that the results make sense. This stage may require seeking additional case material or revisiting the ToC, and carrying out steps 1–5 again. In this sense, the QCA can be an iterative process for seeking multiple causal pathways to address a particular problem.

Box 3.1. A Cautionary Note on Applying Qualitative Comparative Analysis

Although qualitative comparative analysis (QCA) presents a rigorous methodology for analyzing drivers of change through a sample of cases that may otherwise be too small for conventional statistical analysis, the approach has its limitations. They include the following:

- » QCA relies on the strength of the underlying theory and understanding of the subject matter that is being evaluated.
- » QCA depends on the quality, depth, and consistency of the evidence gathered through case studies.
- » The scoring of factors or preconditions can require considerable judgment and subject matter expertise, making it subjective if it is not calibrated for consistency through clear application of criteria across case studies.
- » QCA cannot cope with missing data; therefore, all factors or preconditions must be scored.
- » QCA is susceptible to varying sample size, which may reduce the diversity of data sets, especially if there are fewer than five cases and potential pathways are not found in the available data.
- » It can be tempting to apply statistical mind-sets to QCA (such as using sample size for power analysis), but with Boolean algebra and set theory as its foundation, QCA must be interpreted through a deterministic lens.

As with most complex methodologies, the weaknesses of QCA often result from the way in which it is applied (Simister and Scholz 2016).

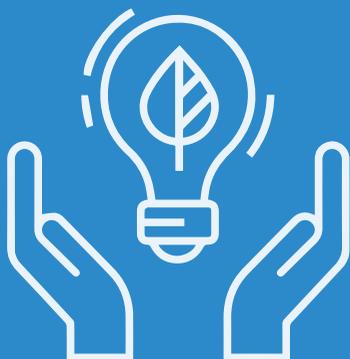
The following three chapters discuss the way in which QCA was systematically applied in IEG's RE evaluation. Chapter 4 discusses the strategic decisions and steps taken to prepare for running the QCA model; chapter 5 describes the QCA results and how they were analyzed; and chapter 6 documents how QCA results were interpreted and triangulated with results from other methodological sources to draw key conclusions in the context of scaling up RE.

Notes

- 1 See <http://grundrisse.org/qca/>.
- 2 In very simple cases, patterns can be discerned visually. However, complex relationships, a large number of cases, or both require specialized computer software to identify causal patterns accurately.
- 3 Unlike conventional statistics, which are based on vector algebra, the qualitative comparative analysis algorithms use Boolean algebra to identify the relationships between the pre-conditions and outputs or outcomes.

4

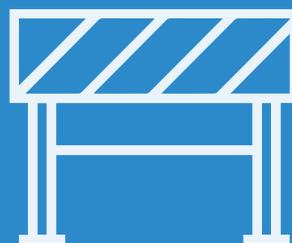
APPLICATION OF QUALITATIVE COMPARATIVE ANALYSIS: STRATEGIC DECISIONS AND CASE STUDY ANALYSIS



Developing a theory of
change for renewable
energy development



Identifying country
case studies



Determining major
barriers to renewable
energy development



Reviewing the
energy evaluation

This chapter details the steps the Bank Group’s IEG took to carry out the QCA for the RE evaluation, in line with figure 3.1 in chapter 3.

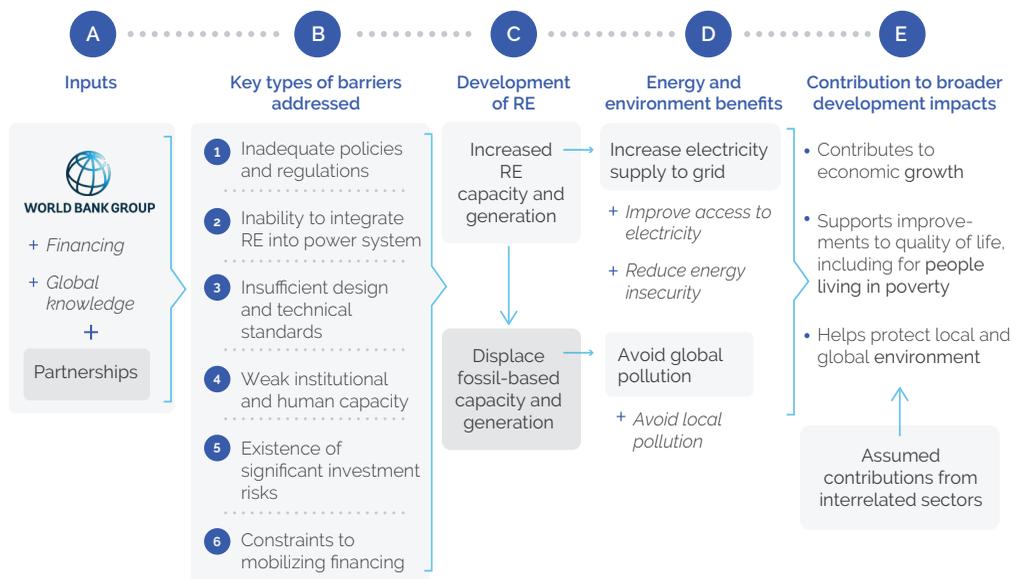
Developing a Theory of Change

The first step in carrying out a QCA requires the development of a ToC or the adoption of an existing one. The ToC should clearly define the potential causal links that will be tested and refined through the QCA process. The development of the initial ToC itself may need to be an iterative process to ensure that the theoretical concept is robust and based on sound experience. It is vital to include subject matter specialists who have the necessary expertise to contribute to the development of the ToC. This may also be augmented with desk research (literature review). If an existing ToC is used, it may also require adjustments depending on the specific subject matter being tested through QCA. This will also require inputs from subject matter specialists and possibly coordination with the original preparer of the ToC.

The ToC for the RE evaluation was developed with a team of energy sector specialists with experience developing RE, those with expertise in investment projects supported by the Bank Group, and evaluators who specialize in multimethod evaluations.

The concept was also developed with input from a sector literature review. The resulting ToC is illustrated in figure 4.1.

Figure 4.1. Theory of Change for Renewable Energy Development



Source: Independent Evaluation Group.

Note: RE = renewable energy.

The ToC is most easily understood beginning in column C in figure 4.1, which depicts the output as increasing investments in RE technologies. This essentially means the construction and operation of RE power plants and associated infrastructure such as transmission lines to transport electricity to consumers (that is, to load centers). The production of RE-based electricity is also theorized to displace an equivalent amount of alternative generation from fossil fuels, also depicted under column C.

Column D identifies the outcomes that result from the increased investments in RE and the displacement of fossil-based power generation illustrated in column C. The increase in investments in and production of RE-based electricity to the power grid supplies consumers who benefit from the use of this electricity. The production of RE-based electricity can also help increase access to those who are currently not connected; and, as indigenous resources, RE-based electricity can reduce energy insecurity that arises from reliance on fossil fuel imports. As RE-based power generation expands, the resulting displacement of fossil fuel-based electricity will help curtail the emission of carbon dioxide (CO₂)—a greenhouse gas that contributes to global climate change. As a result, a key outcome of developing RE is the anticipated avoidance of global pollution. Additionally, the replacement of fossil fuels also helps avoid local pollution that can lead to respiratory illnesses and other health impacts. The emission of sulfur oxide, nitrogen oxide, and particulate matter from fossil fuel combustion is also avoided when electricity is produced from RE.

Although columns C and D identify a causal relationship between outputs and outcomes, the mobilization of investments to develop RE resources faces major barriers in most countries, which are the precondition barriers or factors that will be tested through QCA. These precondition barriers, separated into six major categories based on input from subject matter specialists and from review of literature, are illustrated in column B. Theory and experience suggest that these barriers constrict the investment climate for RE and need to be addressed to scale up electricity produced from RE, which in turn, will offset equivalent production from fossil-based technologies. Sufficiently overcoming barriers should mobilize investments in RE-based power generation facilities and associated infrastructure, leading to the energy and environment outcomes defined in the ToC.

The QCA will assess the causal model proposed by the ToC (the three shaded columns in figure 4.1), testing the relationships between addressing precondition barriers (column B) and mobilizing investments in RE and displacing fossil-based generation (column C) and whether the results are electricity supply and global environmental outcomes being realized (column D). However, the overall ToC extends beyond the application of the QCA and conceptualizes two additional aspects. First, it notes that energy and environmental outcomes and outcomes from other development efforts

are interdependent, contributing together toward an overall set of development impacts, depicted in column E. They include the contribution to economic growth, improvements in the lives of people living in poverty, and the protection of the local and global environments. Second, because the overall RE evaluation is designed to assess the Bank Group's performance in supporting RE, column A represents the support provided by the institution to client countries to address various barriers to RE (column B). This support includes providing funding support (loans, grants, and guarantees), sharing global knowledge and experiences, and convening partners to also mobilize the same. It should be stressed that the QCA is applied to information related to columns B, C, and D, and not to columns A and E, which are evaluated through other methodological means in the overall RE evaluation (see box 2.1).

Identifying Country Case Studies

The next step in the QCA process was to identify case studies that would provide the data required for the analysis. For the RE evaluation, the case studies were prepared at the country level to determine the extent to which different countries addressed key precondition barriers to RE development and mobilized investments that would lead to scaling up and securing energy and environmental benefits.

The case studies were prepared by sector specialists with extensive experience in RE in developing countries, although not necessarily in the specific countries that they were assigned to evaluate. The country case studies were prepared not solely for the QCA but also to serve multiple purposes in the complex RE evaluation. In fact, the case studies were conceptualized before the QCA, although its structure was based on the overall ToC developed for the RE evaluation. However, the QCA approach was formulated and fully embedded into the case study design before the country-specific work was carried out. Moreover, each case study preparer became familiar with the QCA, was instructed how to tabulate the data and score against the established criteria to adhere to a QCA format, and was informed how these efforts would contribute to the QCA.

Nine countries were purposefully selected for in-depth case work, as illustrated in map 4.1. The initial aim was to carry out up to 15 country case studies, but the evaluation faced budget constraints because preparing original case studies can be costly. However, undertaking original case work has the benefit of customizing the inquiry to meet the specific needs of the evaluation. Thus, it was decided that the nine selected countries would suffice if they were sufficiently representative and adequately in-depth, since one advantage of QCA is its ability to identify potentially generalizable inferences from a small number of cases. The selected number of cases surpassed five, which is typically considered a minimum for QCA, and with nine cas-

es the evaluation applied in-depth case knowledge, particularly for understanding outlier cases, to a greater extent than cross-case analysis.¹

Countries were selected for the case studies based on balancing several criteria to have an adequate representation of significant sources of variation that would influence expansion of RE. The key criteria applied in country selection included the following:

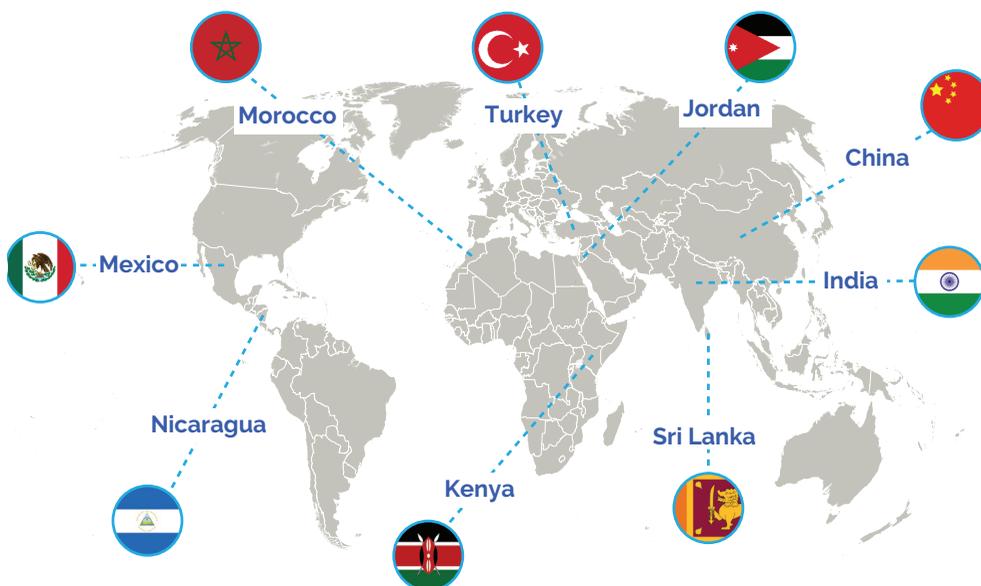
1. Global geographical variation among emerging markets, especially since the Bank Group has client countries across developing regions,
2. Availability of a diverse array of renewable natural resources across the selected countries,
3. A mix of public and private markets for RE investments that signify the nature of various barriers facing investment mobilization,
4. A blend of larger and smaller markets where the nature and magnitude of scaling up RE would vary, and
5. Bank Group support for RE activities in the country, since the overall multimethod RE evaluation was designed to evaluate the institution's performance.

The Energy Evaluation

Map 4.1 shows the nine countries selected for the in-depth case studies in the RE evaluation. Although budget constraints prevented comparative case studies in countries without a Bank Group program, the institution is supporting RE in an expansive 98 developing countries worldwide. Therefore, the selected countries provided the needed diversity of key characteristics noted in the selection criteria. For example, China, India, and Mexico represented larger markets with substantial populations. They are expected to play prominent roles in the clean energy transition. Nicaragua and Sri Lanka represented medium-scale countries, and Jordan and Morocco represented smaller markets. Similarly, the proportion of public and private participation in the energy sector in general and RE in particular also ranged across the selected countries. This included countries such as Jordan and Turkey and that have transitioned from greater public control to more private participation in RE over the evaluated period. The collective nine countries were also endowed with renewable resources that covered all major technologies. Country case studies for China, India, Kenya, Nicaragua, and Sri Lanka were prepared with in-country visits, and desk research was the primary source of information for the remaining four countries. All case studies included interviews with Bank Group and external

stakeholders to ensure the accuracy of the findings and to incorporate the views of different stakeholders. The selected case studies were adequately representative of important distinguishing characteristics of the RE sector.

Map 4.1. Country Case Studies Selected for Qualitative Comparative Analysis in RenewableSource: Independent Evaluation Group.



Source: Independent Evaluation Group.

Developing a Set of Factors or Preconditions

To adequately prepare case studies and carry out QCA, it is essential to clearly define the preconditions, and establish criteria for rating them within each country example.

The six preconditions or factors applied in the evaluation are barriers to RE development, as shown in the figure 4.1, which illustrates the ToC. They include the following barriers that affect the investment climate for RE: (i) inadequate policies and regulations, (ii) inability to integrate RE into power systems, (iii) insufficient design and technical standards, (iv) weak institutional and human capacity, (v) existence of significant investment risks, and (vi) constraints to mobilizing financing. More detailed definitions of the precondition barriers are presented in table 4.1. The case study specialists were tasked with determining the extent to which the country had addressed these precondition barriers to facilitate RE investments. To make this determination consistently across all case studies, a clear set of criteria was established.

Table 4.1. Major Barriers to Renewable Energy Development

Barrier	Description
Inadequate policies and regulations	Shortcomings in the policy and regulatory environment established by governments can hinder public and private investments in RE, especially when they do not provide adequate opportunities or incentives for investors
Inability to integrate RE into power systems	Inadequate planning, transmission bottlenecks and insufficient capacity, limited scope for power trading and pooling, and inability to store electricity can all result in inflexibility of power systems to smoothly and efficiently integrate RE, especially as the share of variable RE such as wind power and solar photovoltaic increases.
Insufficient design and technical standards	Insufficient design and technical standards can make it difficult to consistently develop high-quality RE infrastructure in line with industry practices 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 undertake new investments or operate ongoing projects.
Existence of significant investment risks	Even with improved policies and enhanced institutional capabilities, projects may face residual risks: either transitional risks, while reforms are being implemented, or permanent risks that are outside the control of developers and which may discourage investments (these include commercial or offtaker risks, political risks, and RE resource risks).
Constraints to mobilizing financing	In addition to already identified barriers, the typically high upfront investments make it more challenging to mobilize financing for RE. This can occur when RE technologies 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.

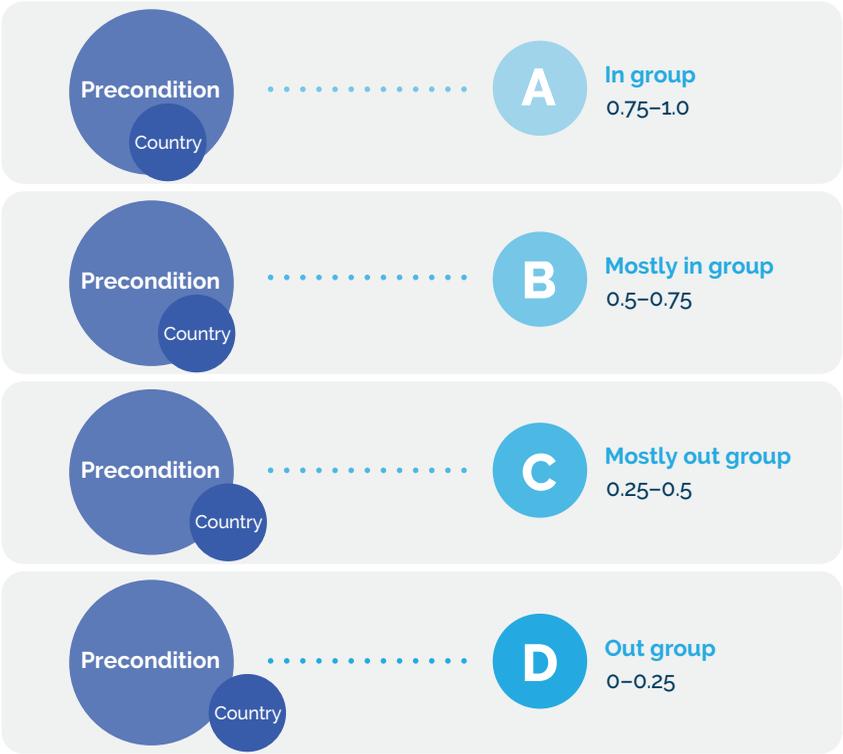
Source: Independent Evaluation Group.

Note: RE = renewable energy.

QCA requires the relationship between a specific case and each precondition to be established based on the extent to which the barrier was addressed. The case study specialists were tasked with determining whether the country they were assessing for a given RE barrier falls “within group” or “outside group.” For the RE evaluation, the extent to which a precondition barrier was addressed was classified into a fuzzy set of four progressively different relationships to a group. Figure 4.2 illustrates these different relationships to the group, which reflected the different degrees to which a country overcame specific barriers to RE development. This required clear definitions for criteria that case study specialists could apply to screen and score the relationship between the circumstances in each assessed country to the respective

precondition barrier group. If the precondition met the criteria for fully addressing a specific precondition barrier, then it would be considered fully within the group (in group) and would be given a score between 0.75 and 1.0 (the score within the range also indicated the extent to which it successfully addressed the precondition). Similarly, a country that did not adequately address a specific precondition barrier as per the defined criteria would be considered as falling outside the group (out group) and assigned a score between 0 and 0.25. Countries that fell mostly within group or mostly outside the group based on the defined criteria were scored within the ranges of 0.5 to 0.75 and 0.25 to 0.50, respectively. An example is illustrated in box 4.1, and detailed criteria for classifying and scoring each barrier precondition is provided in appendix A. The example in box 4.1 highlights the significant levels of sectoral nuance that are required to create criteria for a fuzzy set, which also requires considerable subject matter expertise to apply and evaluate. Despite the complexity, a fuzzy set of criteria will lead to results and insights from the analysis that are likely to be richer and more robust with greater differentiation of group relationships than the simpler binary option in a crisp set criteria (that is, in or out of group).

Figure 4.2. The Relationship between Country Cases with Preconditioned Barrier Groups



Source: Independent Evaluation Group.

Box 4.1. Example of Setting Criteria for Scoring Precondition Barriers to RE Development

To ensure consistent coding across the nine countries included in the analysis, the specialists carrying out the in-depth case studies were provided specific scoring criteria for measuring the degree to which a given precondition barrier has been overcome in the country. Below is an example describing the criteria for scoring the degree to which a country has improved design and technical standards. Similar criteria were defined for each of the six precondition barriers, which are detailed in appendix A.

Table B4.1.1. Example Criteria for Scoring Precondition Barriers

<p>A In group 0.75–1.0</p>	<p>Industry and international standards for project design, development, and operation for renewable energy (RE) are established at the country level covering most of the significantly available RE technologies. Similar international and industry standards are adapted for the country context and adopted for major RE equipment. All of these standards related to RE are vigorously enforced during implementation.</p>
<p>B Mostly in group 0.51–0.74</p>	<p>Industry and international standards for project design, development, and operation for RE are established at the country level, covering some specific available RE technologies. Similar international and industry standards are adopted for RE equipment but at times are not fully adapted for the country context. All of these standards related to RE are mostly enforced during implementation.</p>
<p>C Mostly out group 0.25–0.49</p>	<p>There are few standards affecting RE development that are consistent with industry and international standards; ones that are established are typically loosely enforced; often higher standards and good practices are applied only when required by development partners or project financiers.</p>
<p>D Out group 0–0.24</p>	<p>There are no established standards in the country for RE that are consistent with industry practices and international standards for design and implementation of RE or RE equipment; application is inconsistent and ad hoc.</p>

Source: Independent Evaluation Group.

Scoring the Factors or Preconditions

Equipped with the ToC, the barriers that should be explored, and the scoring criteria, the specialists prepared the case studies for the nine countries. The case studies included a variety of information exploring electricity supply and demand in the country; the power sector structure; the institutional setup, including the roles of the public and private sectors; policies and regulations in place; electricity costs and pricing; RE resources availability; the status of RE development; and plans for scaling up in the future, among other aspects. The case studies also included the performance of the Bank Group's RE portfolio during the evaluation period for the purposes of the broader RE evaluation, although this information was not directly used in the QCA. The case study specialists used the in-depth understanding obtained about the country and sector to translate the qualitative assessment of addressing barriers into quantitative scores based on the established common criteria.

To ensure that the scoring was correct and consistently applied across countries, the team overseeing the overall evaluation, including a QCA methodology specialist, met with each case study specialist. It was an opportunity to discuss their findings and ensure that their assessments were calibrated to the established standards and scored appropriately. This effort was the first of two important initiatives to calibrate the assessment across countries for greater consistency. After the individual discussions, the scores for each country were transferred to an overall matrix representing all nine cases, in preparation for a subsequent group discussion with all country case study specialists, the team overseeing the RE evaluation, and two QCA methodology specialists (who carried out the analytical work during the next stage). Convening this broader evaluation team led to clarifying edits in the qualitative membership statements and revisions to measures of outcome variables related to energy and environmental benefits. It was a crucial step, since a group discussion enabled the sharing of information among the case study specialists, further clarification of scoring criteria, and better calibration of scores across countries for improved consistency.² The final consensus-based recalibrated scores are shown in table 4.2 (and a more detailed data-collection matrix is presented in appendix B).

Table 4.2. Scores from Country Case Studies

Country	B Barriers						C Outputs		D Outcomes
	Policies and Regulations	Integration into Power Systems	Design and Technical Standards	Institutional and Human Capacity	Investment Risks	Mobilizing Financing	Develop Renewable Energy	Energy Benefits	Environment 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	B (0.70)	B (0.60)	B (0.60)	B (0.60)	B (0.70)	B (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)

Source: Independent Evaluation Group.

Note: The letters in the first row of headings correspond to the columns in the theory of change in figure 4.1. Output reflects the rounding conventions used by the software.

The matrix also included scores reflecting country relationships to groups for the outputs and outcomes in the ToC (columns C and D in figure 4.1). These were based on industry-recognized global data sets that include information for each of the case study countries. The installed capacity of RE (column C, “Output,” in figure 4.1) for each country was based on data from the United States Energy Information Agency. The respective scores were determined by comparing the relationship of each case study country situation with that of the global average for developing countries (reflecting Part II developing countries that borrow from the Bank Group). If the total installed capacity of RE (in megawatts) in a given case study was above 75 percent of the global average for developing countries, then the country was categorized as A (fully in group). If the RE capacity in a case study was in the second quartile, more than at least 50 percent of countries but less than the top 25 percent, it was classified as B. In countries classified as C in the third quartile, the installed capacity of RE was less than at least 50 percent of developing countries globally but higher than the bottom 25 percent. Those countries where the RE installed capacity was less than 25 percent of the global developing country average were in the bottom quartile, classified as D. The installed capacities of RE were adjusted for country populations so that the results would not skew toward the larger-scale countries. More detailed information on the classification criteria for the installed capacity of RE is presented in appendix A.

The matrix also included information reflecting the final causal link in the ToC used for the QCA, reflecting the relationship between installed capacity of RE (column C, figure 4.1) and global energy and environmental benefits (column D, figure 4.1). The information for energy and environmental outcomes was sourced from the International Energy Agency. The electricity supplied to the power grid from RE resources (kilowatt hours) were adjusted for their populations, and the results classified into percentile groups between 0.0 and 1.0. A higher percentile score reflected a higher level of electricity produced from RE resources. The global environmental benefits were measured as follows: CO₂ emissions specifically from electricity generated (grams of CO₂ per kilowatt hour) were multiplied by the RE share in total electricity production to calculate the counterfactual avoided emissions, which were then adjusted for the countries’ populations. The avoided emissions figures were also classified into percentile groups between 0.0 and 1.0 based on their ranking across developing countries. A higher percentile score reflected a higher value of avoided emissions.

The final matrix included scores reflecting the status for each country at the end of the evaluation period across the key causal links defined in the ToC as follows: (i) the extent to which barriers to RE development were addressed, (ii) the installed capacity of RE based on the investments that were mobilized, and (iii) the resulting electricity supply and global environmental benefits.³

Notes

1 Most qualitative comparative analysis projects examine between 15 and 50 cases, relying upon both cross-case and within-case analysis to draw their conclusions. Studies with fewer cases, such as this one, typically lean more heavily on in-depth case knowledge, particularly for understanding anomalous or aberrant cases, but studies with more cases place greater emphasis on the cross-case regularities. That is because a greater number of cases naturally limits the degree to which a research team may conduct in-depth case studies. Therefore, those qualitative comparative analysis projects with fewer cases tend to be more qualitative and case oriented, and those with more cases tend to be more quantitative and variable oriented.

2 Further intercoder reliability was not tested, as theory may suggest, because it was not deemed to be necessary nor practical in application to have multiple case study specialists review each country case study for consistency.

3 Based on data availability, the installed capacity of renewable energy was from United States Energy Information Agency data in 2015, and the International Energy Agency was the source for the electricity supply data from renewable energy in 2015 and the carbon dioxide emissions from 2014.

5

APPLICATION OF QUALITATIVE COMPARATIVE ANALYSIS: ANALYZING RESULTS



Analyzing qualitative
comparative results



Identifying precondition
barriers for renewable
energy development



Finding pathways for
renewable energy
development

Analyzing results. QCA was used to analyze the relationships among the precondition barriers, the output (RE installed capacity), and the energy and environmental benefits (electricity supplied and CO₂ emissions avoided). The technique is implemented through specialized software that uses Boolean algebra to identify the superset or subset relationships present within the data matrix (table 4.2).¹ Since QCA is a descriptive technique, its results should be evaluated in the context of the theoretical understanding of the subject matter and the in-depth knowledge of the cases to determine causality.

The superset or subset relationships identified by QCA are interpreted in terms of necessity, sufficiency, or both. A near-necessary condition is one that must be present all or almost all of the time for the outcome to occur; the absence of the near-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 (near-necessary and sufficient conditions may be composed of multiple individual conditions), equifinality (there may be multiple paths to an outcome), and imperfect relationships (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 precondition barrier and output or outcome co-occur within the data set.

- **Coverage** provides a measure of empirical relevance, reporting the degree to which a necessary or sufficient condition explains instances of the occurrence of the outcome.
- **Consistency** is the more crucial measure and reports the strength of the superset or subset relationship. When used to test for the presence of a necessity relationship, consistency 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, 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 necessity consistency threshold is 0.9, which permits a small degree of inconsistency to accommodate measurement error and imperfect relationships. The standard sufficiency consistency 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.

Table 5.1. Abbreviations Used in the Quantitative Comparative Analysis Model

Precondition Barriers	Outputs or Outcomes	QCA Results
Pol: Policy and regulatory	Re: Development of RE capacity	Ncon: Necessity consistency
Int: Integration into power systems	Re.d: Change in RE capacity (2000–16)	Ncov: Necessity coverage
Imp: Improvements to design and technical standards	—	Scon: Sufficiency consistency
Str: Strengthen institutional capacity	Eng: Energy benefits Eng.d: Change in energy benefits (2000–16)	Scov: Sufficiency coverage
Mit: Mitigate investment risks	Env: Environmental benefits	—
Mob: Mobilize financing	Env.d: Change in environmental benefits (2000–16)	—

Source: Independent Evaluation Group.

Note: — = not available; QCA = qualitative comparative analysis; RE = renewable energy.

Multiple QCA analyses were run to test the relationships theorized within the initial ToC based on empirical information translated from the in-depth country case studies. The main variation applied was to model the static output or outcomes (2016) and changes in output or outcomes (2000–16). The remainder of this chapter focuses on the final results of the QCA.

The first step in analyzing the QCA results was to confirm whether the empirical evidence substantiated the causal relationship that high levels of RE capacity (outputs) result in greater energy supply and environmental benefits (outcomes). This would validate, for example, whether development of RE capacity is followed by its adequate integration into power systems and operations that produce the electricity that is consumed. It would also confirm whether the development of RE is displacing fossil-based generation, which is necessary to secure environmental benefits through avoided emissions. The QCA found high RE capacity to be necessary and al-

most always sufficient for the realization of high energy produced and high environmental benefits (table 5.2, first and second rows, Static). A substantial increase (that is, change) in RE capacity was found to be almost always necessary and almost always sufficient for substantial increases in energy and environmental benefits (table 5.2, third row, Change). There are two aberrant cases here (the rationale is further described in box 5.1): (i) Mexico experienced a substantial increase in RE capacity yet did not realize a substantial increase in energy benefits (violating sufficiency) primarily because of substantially lower levels of precipitation during the year of data selection (2016) to fuel its significant hydropower capacity, and (ii) Kenya, in contrast, realized a substantial increase in energy benefits despite not experiencing a substantial increase in RE capacity, primarily because geothermal power was substituted for hydropower that had become less reliable—a swap between two environmentally friendly technologies. Hence, change in RE capacity is almost always necessary and sufficient for change in energy benefits. A substantial increase in RE capacity was found to be near-necessary but not sufficient for a substantial increase in environmental benefits (table 5.2, fourth row, Change).

Table 5.2. Summary of Installed Capacity of Renewable Energy in Relation to Energy and Environment Benefits

Output or Outcomes	Proposition Tested	Interpretation of Results	Ncon	Scon
Static (2016)	Re → Eng	Re is necessary and almost always sufficient for Eng	1.0	0.87
	Re → Env	Re is necessary and almost always sufficient for Env	1.0	0.91
Change (2000–16)	Re.d → Eng.d	Re.d is almost always necessary and almost always sufficient for Eng.d	0.96	0.92
	Re.d → Env.d	Re.d is necessary but not sufficient for Env.d	1.0	0.76

Source: Independent Evaluation Group.

Note: Eng = energy benefits; Eng.d = change in energy benefits (2000–16); Env = environmental benefits; Env.d = change in environmental benefits (2000–16); Ncon = necessity consistency; Re = development of renewable energy capacity; Re.d = change in renewable energy capacity (2000–16); Scon = sufficiency consistency.

These results validate that the theorized output-to-outcomes relationship in the ToC are consistent within these country contexts. High RE capacity is near-neces-

sary and almost always sufficient for the realization of substantial energy and environmental benefits. Increased RE development is, in general, both near-necessary and sufficient for increased energy benefits, with the previously noted exceptions. Finally, increased RE development was found to be near-necessary but not sufficient for substantially improved environmental benefits. This latter results was expected, since the environmental benefits depend greatly on (i) the types of energy production being offset with renewable energies, which can contextually vary according to the generation mix in power systems, and (ii) whether there is concurrent growth of traditional (fossil-based) energy production when RE is also expanding.

Box 5.1. Noteworthy Anomalies in the Qualitative Comparative Analysis Results

There were some noteworthy anomalies in the qualitative comparative analysis results, which required revisiting the country case studies and relying on case study specialists' knowledge to better understand.

Kenya: Renewable energy (RE) growth is replacing hydropower with geothermal; this offers far fewer environment benefits than replacing fossil fuel-based production, since it is a swap between two RE technologies. Nevertheless, Kenya is unique in that RE is the most economically viable source of electricity, though only 32 percent of the population has access to electricity.

Jordan: The country added all of its wind energy capacity in 2016, but the evaluation did not have access to environmental benefits data for 2016; rather, the evaluation used 2015 data, which does not include the additional 2016 capacity.

Mexico: RE production went down in 2016 (especially in terms of hydroelectricity production), likely brought about by precipitation variations that year; this is a data outlier rather than an indication of a systematic trend. This one-year change in RE production, however, substantially influenced calculations of change in RE capacity for the country.

The Kenya and Mexico results were based on data anomalies that can be explained, and therefore, should not alter the conclusions drawn from the results. The Kenya results further validate the robustness of the qualitative comparative analysis results, since it is an outlying circumstance that is fully consistent with the theory of change.

Source: Independent Evaluation Group.

The second step in analyzing the QCA results is to assess the relationships among the six precondition barriers identified in the ToC in relation to RE production. The remainder of this section examines the effect of the preconditions on two measures of RE production: (i) high RE production (static measure) and (ii) substantial increases in RE capacity per capita between 2000 and 2016 (change or delta measure). Between these two analyses, Jordan and Nicaragua were the two countries with substantive differences in static and change or delta measures, and variances in analytical results can be attributed to these differences.

The relationship between the precondition barriers and QCA was used to identify the combinations of preconditions that are near necessary, sufficient, or both for RE output (both static and change or delta measures). As part of the sufficiency analysis, QCA can distinguish among core and contributory causal conditions by applying a counterfactual logic. Core conditions are those that counterfactual analysis identifies as fundamental to understanding the occurrence of the outcome. Contributory conditions are not less important than core conditions but serve a different purpose, providing context and nuance for a full account of the outcome’s occurrence.²

The results of the initial analysis were derived using the static measure for RE development (data from 2016). Consistent with the ToC, the analysis indicates that policy and regulation (POL in table 5.3), and integration of RE in power systems (INT in table 5.3) are each, individually or in combination, near-necessary precondition barriers that need to be addressed to develop RE (table 5.3). Improvements to design and technical standards (IMP in table 5.3) also met the threshold of 0.90 for consistency, though this was not observed in Morocco and Nicaragua. Therefore, it was determined that these two precondition barriers should be considered almost near-necessary rather than near-necessary factors for RE development.

Table 5.3. Necessity of Precondition Barriers for Renewable Energy Development, Static Measure of Renewable Energy, 2016

Precondition	Consistency	Coverage
Policy and regulations (POL)	0.95	0.84
Integration in power systems (INT)	0.93	0.87
Improvements to design and technical standards (IMP)	0.93	0.87

Source: Independent Evaluation Group.

Continuing to use the static measure of RE, the QCA reveals two overlapping pathways in the case study sample for RE development (table 5.4). The most common pathway (S1 in table 5.4) is the one followed by China, Mexico, Sri Lanka, and Turkey, which was to address all six precondition barriers. Counterfactual analysis identified integration of RE into power systems and mobilization of financing as core explanatory conditions. Morocco and Nicaragua reveal a second pathway (S2 in table 5.4) to successful RE development, one that does not require all six barriers to be addressed. Both countries successfully addressed their policies and regulations (POL in table 5.4) and integration into power systems (INT in table 5.4); Morocco additionally mitigated investment risks (MIT in table 5.4) to mobilize the private sector. Nicaragua appears unique in that it successfully achieved RE development with a minimum of advantages. Here, the absence of successfully improving design and technical standards emerges as a core condition, which suggests that understanding how these countries overcame the disadvantage of not having successfully addressed this barrier is important to making sense of their success. It may be due to participation of qualified external private developers, who typically adhere to industry norms and international standards. These results must, of course, be interpreted based on theoretical and substantive knowledge of the RE sector and the country contexts.

Table 5.4. Pathways for Renewable Energy Development Based on Sufficiency Analysis, Static Measure of Renewable Energy, 2016

Pathway	Pathway of Pre-conditions Barriers Addressed	Consistency	Raw Coverage	Unique Coverage	Observed in Cases
S1	POL*INT*IMP*STR*MIT*MOB	1.00	0.77	0.35	China; India; Mexico; Sri Lanka; Turkey
S2	POL*INT*imp*str*mob+	0.99	0.47	0.06	Morocco; Nicaragua

Source: Independent Evaluation Group.

Note: In qualitative comparative analysis, preconditions in all CAPS are those achieved within the observed case studies; * indicates *and*; and + indicates *or*. imp = improvements to design and technical standards; int = integration into power systems; mit = mitigate investment risks; mob = mobilize financing; pol = policy and regulatory; str = strengthen institutional capacity.

The results of the additional subsequent analysis were derived using the change or delta measure for RE development (data from 2000 to 2016). In this analysis, the QCA results indicated a single condition as consistent with near necessity, successfully addressing policy and regulation barriers (POL in table 5.5). However, the integration of RE into power systems (INT in table 5.5) had a near-necessary score of 0.89. In contrast, under the static scenario, four preconditions (POL, INT, STR, and IMP in table 5.4) were identified as necessary for achieving the static level of RE development.

Table 5.5. Necessity of Precondition Barriers for Renewable Energy Development, Change or Delta Measure of Renewable Energy, 2000–16

Precondition	Consistency	Coverage
Policy and regulations (POL)	0.93	0.87
Integration in power systems (INT)	0.89	0.91
Improvements to design and technical standards (IMP)	0.87	0.89
Mitigate investment risks (MIT)	0.85	0.95
Strengthen institutional capacity (STR)	0.83	0.93
Mobilize financing (MOB)	0.83	0.91

Source: Independent Evaluation Group.

The findings of the sufficiency analysis for the change or delta in RE development are similar to those of the static analysis (table 5.6). Three pathways to success emerge, the most prominent of which (D1 in table 5.6) includes addressing all six barriers and accounts for five countries (China, India, Mexico, Sri Lanka, and Turkey). The other two pathways provide routes to RE development that do not address all six barriers. Pathway D2 in table 5.6 represents Morocco and Nicaragua, which substantially increased RE capacity despite addressing just two of the six barriers. Pathway D3 in table 5.6 represents Morocco and Jordan and therefore overlaps with pathway D2. These countries were able to address inadequate policies and regulations, overcome challenges integrating RE into power system, and cover residual shortcomings to a degree by mitigating investment risks (MIT in table 5.6). Nicaragua therefore again stands out as unique because it was able to develop its RE capacity by addressing just the two near-necessary precondition barriers.

Table 5.6. Pathways for Renewable Energy Development Based on Sufficiency Analysis, Change or Delta Measure of Renewable Energy, 2000–16

Pathway of Preconditions Barriers Addressed		Consistency	Raw Coverage	Unique Coverage	Observed in Cases
D1	POL*INT*IMP*STR*MIT*MOB	1.00	0.74	0.33	China; India; Mexico; Sri Lanka; Turkey
D2	POL*INT*imp*str*mob+	1.00	0.43	0.03	Morocco; Nicaragua
D3	POL*INT*str*MIT*mob+	1.00	0.47	0.03	Jordan; Morocco

Source: Independent Evaluation Group.

Note: In qualitative comparative analysis, preconditions in all CAPS are those achieved within the observed case studies; * indicates and; and + indicates or. Kenya is an outlier case and is omitted from the list of observed cases. See box 5.1 for more details. imp = improvements to design and technical standards; int = integration into power systems; mit = mitigate investment risks; mob = mobilize financing; pol = policy and regulatory; str = strengthen institutional capacity.

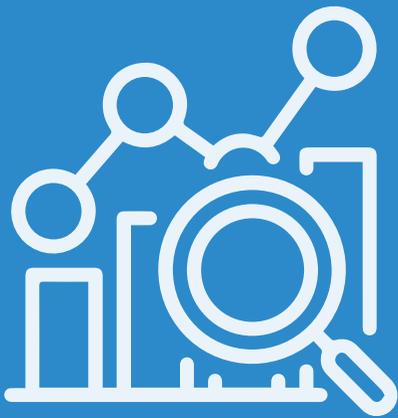
Two preconditions are shared by all three pathways. The presence of successful improvement of the policy and regulatory environment reflects its status as a near-necessary condition, as discussed above. Successful integration of RE into power systems emerges as the single core condition across all three pathways, indicating that successfully addressing this barrier is essential to improving RE capacity. Addressing this barrier, however, is not sufficient by itself, as all pathways also include the successful reduction of at least one other barrier. The successful improvement of the policy and regulatory environment emerges as a common condition across all three pathways, reflecting its status as a necessary condition. The veracity of the findings was checked with additional comparative analysis (for instance, with and without hydropower energy benefits included), and, although not presented here, these findings further solidified confidence in the QCA results.

Notes

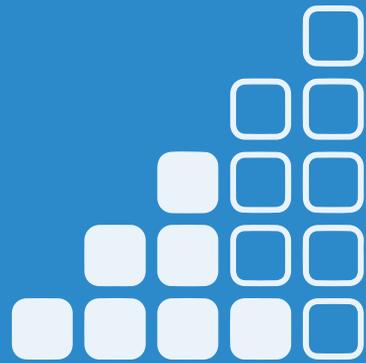
- 1 See <http://grundrisse.org/qca/>.
- 2 The sufficiency results for the outcomes analysis do not distinguish between core and contributory conditions because that analysis included just a single explanatory condition (renewable energy installed capacity).

6

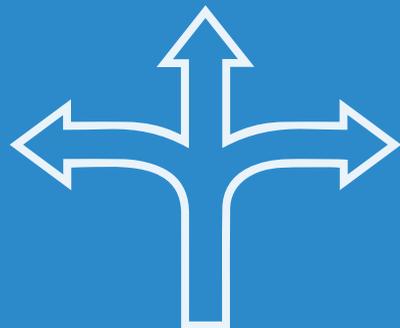
APPLICATION OF QUALITATIVE COMPARATIVE ANALYSIS: INTERPRETATION OF FINDINGS AND CONCLUSIONS



Interpreting findings
and conclusions



Assessing barriers in
the theory of change



Finding alternative
pathways for scaling up
renewable energy

Interpreting Findings

The QCA results provided insights based on the case study analysis into the factors that were critical to scaling up RE. These findings, triangulated with results from other methods, enabled conclusions to be drawn that are generalizable to other countries.

The QCA validated the ToC that was initially developed for the RE evaluation.

It found potential causal links between the six originally identified barriers in the ToC and mobilizing investments in RE (figure 6.1). The same set of barriers were also independently identified as important obstacles to overcome by a global expert panel on RE (the Delphi panel; see figure B2.1.1 in box 2.1), which was convened by IEG for the RE evaluation. Together, the two methods affirmed the Bank Group's attempts to help clients address all six of these barriers to different degrees through its investment portfolio. Successfully investing in RE capacity was also found to be near necessary and almost always sufficient for the realization of energy and environmental benefits. The example of Kenya confirmed that the environmental benefits are indeed contingent on RE displacing alternatives that are more polluting (that is, fossil-based generation), and that the causal relationship is weaker if the supplanted technologies are cleaner (that is, other renewables). This outlier finding further substantiated the causal relationships within the ToC. Since the QCA together with other methods fully validated the ToC illustrated in figure 3.1, further adjustments to the theory were not necessary in the case of the RE evaluation.

Figure 6.1. Barriers in the Theory of Change with Causal Link to Scaling Up Renewable Energy



Source: Independent Evaluation Group.

Note: RE = renewable energy.

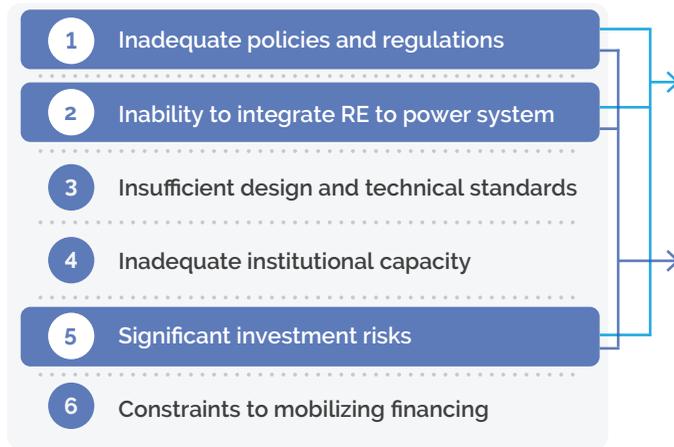
Several countries mobilized investments in RE by adequately addressing all six barriers. The following five countries expanded RE by adequately addressing all of the identified major barriers: China, India, Mexico, Sri Lanka, and Turkey. Although the QCA did not find it strictly necessary to address all six barriers, the approach was identified to be sufficient given the potential causal relationship between each barrier and the expansion of RE capacity. This approach also highlighted the need for coordination among the primary institutions that make up the Bank Group (International Bank for Reconstruction and Development, International Development Association, IFC, and Multilateral Investment Guarantee Agency). A portfolio review of RE interventions and country case studies undertaken as a part of the overall RE evaluation found the three institutions to have different comparative advantages helping clients address the various precondition barriers. The need for coordination would also extend to external development partners supporting similar complementary interventions, calling for closer partnerships.

Improving policies and regulations and better integrating RE into power systems were identified as two near-necessary conditions for scaling up RE, presenting an additional causal pathway. The QCA results indicate that no country successfully scaled up RE without addressing these two critical precondition barriers (illustrated as 1 and 2 marked by the blue arrow in figure 6.2), implying they are priorities within the overall six. The global expert panel on RE convened by IEG for the RE evaluation also independently corroborated the importance of addressing inadequate policies and integrating RE into power systems by ranking them within the top three challenges facing a future scale-up in RE. In fact, Morocco and Nicaragua only adequately addressed these two essentials barriers yet managed to mobilize investments in RE by enhancing its investment climate for private participation, partly to develop concentrated solar power resources and wind, respectively. Sector analyses and assessment of the Bank Group portfolio indicate that the comparative advantage for addressing these two critical precondition barriers primarily rests with the public sector. The portfolio review also confirmed that the public sector arm of the group (International Bank for Reconstruction and Development and International Development Association) was well positioned to provide extensive support to help clients address inadequate policies and regulations (a third of the 217 projects), although it had far less experience assisting with integration of RE into power systems (less than 7 percent of interventions in the portfolio).

The latter shortcoming was identified in the overall RE evaluation as a key emerging challenge for the institution, since the precondition barrier is expected to increase in importance because of greater penetration of variable RE in energy mixes as wind power and solar PV expand in client countries according to projections in the clean energy transition. Thus, it can be concluded that the two precondition barriers are

priority areas to address, and, in some cases, successfully reforming them may be sufficient by themselves, at least for initial and immediate scale-up of RE.

Figure 6.2. Two Additional Alternative Pathways for Scaling Up Renewable Energy



Source: Independent Evaluation Group.

Note: RE = renewable energy.

The QCA identified a third pathway to scaling up RE, especially through private participation, by taking additional action to mitigate any residual risks when policy and regulatory shortcomings and integration of RE into power systems are also adequately addressed simultaneously. Jordan and Morocco (in the change or delta scenario), which mobilized private participation in developing its RE resources, combined efforts to reform its policy framework and facilitate grid integration with additional measures to mitigate residual risks (illustrated as 1, 2, 5 marked by the green arrow in figure 6.2). For example, the World Bank helped Jordan publicly assess its solar and wind resources (to mitigate RE resource risks), which helped mobilize private investors and develop markets for both technologies; IFC assisted with standardizing project documentation to create a common platform for investing in solar PV, which facilitated the development of seven 10–20 megawatt projects. In Morocco, the World Bank funded a standby facility to ensure continued payments by the offtaker for purchases of electricity generated from concentrated solar power, providing assurances to the private developer against commercial and market risks. The RE evaluation found the Bank Group is well placed to mitigate investment risks, since it can mobilize multiple instruments through its three primary institutions—World Bank (International Bank for Reconstruction and Development and International Development Association), IFC, and Multilateral Investment Guarantee Agen-

cy. This specific third pathway identified by the QCA was recently independently highlighted by the International Energy Agency as “the three main challenges” that need to be addressed to “accelerate significantly” RE growth for meeting the long-term goals established under the SDGs and the Paris Agreement.

“Renewable electricity growth still needs to accelerate significantly to meet long-term sustainable energy goals. This growth is possible if governments address the three main challenges to faster deployment: policy and regulatory uncertainty; high investment risks in many developing economies; and system integration of wind and solar PV in some countries.”

Source: IEA 2019.

Conclusion

The application of QCA proved to be useful in triangulating findings with other methods within the broader RE evaluation, helping to draw conclusions related to scaling up RE and meeting global goals established by the international community. In addition to helping validate the ToC underlying the entire evaluation, the QCA also helped identify three specific pathways through which precondition barriers could be addressed to overcome challenges facing the successful achievement of the clean energy transition. Addressing all six precondition barriers was one such pathway, given that they were all found to have a potential causal link to mobilizing investments in RE. A second specific pathway was to address inadequate policies and regulations and grid integration challenges—two precondition barriers that were near necessary in all pathways. A third pathway was to simultaneously address the two near-necessary precondition barriers together with mitigating residual risks—a particularly useful approach for mobilizing private investments in RE.

Two preconditions are shared by all three pathways. Improvements to the policy and regulatory environment appear to be a necessary condition, as discussed above. Successful integration of RE into electrical power systems emerges as a core condition across all three pathways, indicating that overcoming this barrier is essential to improving RE capacity. Addressing this barrier, however, is not sufficient by itself, since all pathways also include the reduction of at least one other barrier. The successful improvement of the policy and regulatory environment emerges as a common condition across all three pathways, reflecting its status as a necessary condition.

Although the inclusion of QCA added value to the overall RE evaluation, as with all methodologies it should be applied with rigor, awareness of its limitations, and recognition of the real-world trade-offs that need to be made in its design and application. Several of these limitations are listed here. First, since QCA relies on the strength of underlying theory and the quality and depth of evidence, and is susceptible to varying sample diversity, size, or both, subject matter specialists were needed for developing the ToC, preparing in-depth country cases, and helping contextualize and interpret the results. Second, it was equally important to have methods experts familiar with QCA to help with experiment design, running the model, and interpreting the results. Third, it was also important to select an adequately representative group of countries within the available budget, ensuring sufficient variation within the sample for key areas of scrutiny.

Fourth, another potential limitation involves the reliability and consistency of scoring across participants. Although the team met with a case study specialist to ensure that case assessments were correctly calibrated, the use of intercoder reliability testing (in particular, the blind testing of country scores) would have provided a more objective analysis of the scores. This in turn would have provided additional insights on the range and convergence of results relative to each country case study. Although panel discussions on the results may have reached the same conclusions, they are not immune from the various intergroup dynamics that might inadvertently introduce confirmation bias or satisficing. Finally, the analysis would also have benefited from a more nuanced discussion of the timing of reforms, since all three of the discussed pathways are likely to shift at different rates over time.

Taken together, findings from the QCA provided vital corroboration of evidence from other methodological approaches used in the evaluation of RE investments. Taken alongside a structured literature review, semistructured interviews, a Delphi-moderated expert panel, and the review of the Bank Group's over 500 investment projects, the approach offered a disciplined and collaborative approach to ensure consistency across case studies. The QCA method provided a means of accurately translating qualitative judgments into quantitative information used in the analysis. It helped overcome other traded-off design features such as multicoder reliability tests, which time and budget did not allow for in this particular case. Ultimately, the robustness of the results and the added value provided in triangulating among various evidence streams made the QCA method a valuable analytical tool for evaluative synthesis.

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APPENDIX A

**COUNTRY-LEVEL
RATINGS CRITERIA
FOR QUALITATIVE
COMPARATIVE
ANALYSIS**

Preconditions (Barriers to Developing Renewable Energy)

The following ratings criteria and ranges are provided for assessing the barriers to renewable energy (RE) at the country level, which will serve as input to the qualitative comparative analysis (QCA). Please apply the criteria to the country you are reviewing and insert the appropriate rating for each barrier (1.0 being the highest and 0.0 being the lowest score).

1. Assessment of investment climate at the end of a specified time period after attempts to improve policy framework for development of RE (mark the appropriate group based on your knowledge of the country and determine a rating from within the range adjusted for deviations in application based on country-specific evidence).

Group	Rating Range	Description
A	0.75–1.0	A substantial and adequate legal and policy framework is adopted and is being enforced, with policy measures and regulations in place, including funding, where required, to incentivize the development of RE in line with goals or targets.
B	0.5–0.75	A significant legal framework is in place but with noticeable shortcomings in the issuance of regulations and enforcement, and despite lack of overall policy clarity, there are some policy-based incentives available to incentivize some degree of RE development in general or specifically in a targeted RE technology.
C	0.25–0.5	Although a legal framework exists, policies and regulations are unclear enforcement is lacking, and there are limited or no incentives to invest in RE.
D	0–0.25	The legal and policy framework is insufficient, with critical shortcomings, and there are inadequate incentives to mobilize investments in RE in line with goals or targets.

2. Assessment of adequate consideration for **integration of RE into power systems** at the end of a specified time period (mark the appropriate group based on your knowledge of the country and determine a fuzzy number rating from within the range adjusted for deviations in application based on country-specific evidence).

Group	Rating Range	Description
A	0.75–1.0	Substantial and adequate integrated systems planning is well implemented to connect RE power plants into the grid through a well-coordinated transmission network and generation nodes, and the electricity from RE sources, especially variable (intermittent) ones, is mostly dispatched with little or no curtailment.
B	0.5–0.75	RE power plants are largely able to physically connect to the system through an adequately planned and implemented transmission network, but there are significant inefficiencies in dispatch of RE-based electricity because of technical issues such as inadequate grid code, standards for grid-friendly equipment, requirement for priority dispatch, and curtailment of energy, in particular that from variable (intermittent) resources.
C	0.25–0.5	There is poor integration into the power system planning and implementation, where transmission and generation planning does not take into consideration linking areas of RE resource availability with load centers. There may be a limited number of RE projects, which may face technical issues in dispatch such as inadequate grid code, standards for grid-friendly equipment, requirement for priority dispatch, and curtailment of energy, in particular that from variable (intermittent) resources.
D	0–0.25	Lack of integrated power planning results in few RE projects, which face challenges for integrating into the power grid, including a lack of transmission access to key areas with known renewable resources, or the inability of what little scattered RE that has been developed unable to dispatch for technical reasons such as lack of an adequate grid code and standards for grid-friendly equipment.

3. Assessment of establishment and adherence to **industry and international standards** for good practice in design, development, and operation of RE at the end of a specified time period (mark the appropriate group based on your knowledge of the country and determine a rating from within the range adjusted for deviations in application based on country-specific evidence).

Group	Rating Range	Description
A	0.75–1.0	Industry and international standards for project design, development, and operation for RE are established at the country level, covering most of the significantly available RE technologies. Similar international and industry standards are adapted for country context and adopted for major RE equipment. All of these standards related to RE are vigorously enforced during implementation (through checks and balances).
B	0.5–0.75	Industry and international standards for project design, development, and operation for RE are established at the country level, covering some specific available RE technologies. Similar international and industry standards are adopted for RE equipment but at times are not fully adapted for country context. All of these standards related to RE are mostly enforced during implementation.
C	0.25–0.5	There are few standards affecting RE development that are consistent with industry and international standards; those that are established are typically loosely enforced; often higher standards and good practices are applied only when required by development partners or project financiers.
D	0–0.25	There are no established standards in the country for RE that are consistent with industry practices and international standards for design and implementation of RE or RE equipment; application is inconsistent and ad hoc.

4. Assessment of **institutional capacity** for developing RE at the end of a specified time period (mark the appropriate group based on your knowledge of the country and determine a rating from within the range adjusted for deviations in application based on country-specific evidence).

Group	Rating Range	Description
A	0.75–1.0	The key institutions in the power sector have adequate capacity to plan and facilitate the uptake of RE; most investors and developers are capable of designing and sustainably implementing RE projects in line with industry and international standards (including meeting fiduciary, environmental, and social requirements). There is sound awareness of private sector requirements and good capacity to negotiate arrangements for RE independent power producers (IPPs) and public-private partnerships (PPPs). There is very limited reliance on consultants to prepare and develop RE projects, since there is adequate in-house capacity within domestic institutions to meet needs.
B	0.5–0.75	There is adequate planning capacity, although there is room for further improvements; there are enough capable developers who can fill capacity gaps by acquiring additional support to undertake a majority of the RE capacity that is targeted in national plans. There is awareness of private sector requirements and sufficient capacity with consultant support to negotiate arrangements for RE IPPs and PPPs. There is limited reliance on consultants to prepare and develop RE projects, and some in-house capacity within domestic institutions falls short of needs.
C	0.25–0.5	The institutional capacity and ability to plan is sufficient for initial development of RE, but planning skills are significantly in short supply for integrating larger volumes of RE (especially variable [intermittent] resources) and limited qualifications across a larger number of key developers and investors needed for scaling up sector development in line with RE development goals. There is limited awareness of private sector requirements, and consultant assistance is required to negotiate arrangements for RE IPPs and PPPs. There is significant reliance on consultants to prepare and develop RE projects; the very limited in-house capacity within domestic institutions falls far short of needs. It would take considerable time and continuous support before these institutions are capable of sustainable implementation of RE without additional support.
D	0–0.25	There are very few qualified developers within the domestic market or interested entrants who have the capacity to sustainably develop RE; there is poor performance in existing RE operations. The key institutions responsible for planning and facilitating RE offtake have limited knowledge and experience planning for the integration of RE into power systems. There is poor understanding of private sector requirements and lack of capacity to negotiate arrangements for RE IPPs and PPPs. There is heavy reliance on consultants to prepare and develop RE projects.

5. Assessment of efforts to **mitigate key risks** to development of RE at the end of a specified time period (mark the appropriate group based on your knowledge of the country and determine a rating from within the range adjusted for deviations in application based on country-specific evidence).

Group	Rating Range	Description
A	0.75–1.0	Major risks faced by RE developers have been systematically and substantially mitigated, with the availability of high-quality resource assessments. Financing and investment risks (offtake, pricing, timely payments) are at acceptable levels for developers or can be easily hedged. The overall country risk for investments is moderate or low.
B	0.5–0.75	These are countries with low or modest country risks. RE resource estimates are well developed and of high quality, but there are some unaddressed financing or investment risks (offtake, pricing, timely payments) that require some financial or other mitigation measures that would provide sufficient assurance to developers for undertaking investments.
C	0.25–0.5	Although RE resource availability is known, there are substantial financing and investment risks and country-level risks that are a significant barrier; these require measures such as guarantees, insurance, credit enhancements, and other similar instruments to mobilize investments and meet RE development goals.
D	0–0.25	There are considerable risks to investing in RE, with little investment-grade knowledge about the availability of RE resources. There are high investment and financing risks because of lack of credibility with electricity offtakers and nascent or undeveloped financial markets for diversifying risks. There is a high overall country risk faced by investors.

6. Assessment of **leverage and mobilization of financing for RE** at the end of a specified time period (mark the appropriate group based on your knowledge of the country and determine a rating from within the range adjusted for deviations in application based on country-specific evidence).

Group	Rating Range	Description
A	0.75–1.0	There are robust capital markets, including international financing, public funds, or both readily available for undertaking RE investments, including financiers (especially domestic ones) knowledgeable in carrying out due diligence related to specific RE technologies.
B	0.5–0.75	There are emerging capital markets where a combination of credit enhancement, and targeted public support is sufficient for bankability of RE projects and meeting financing needs.
C	0.25–0.5	Development of capital markets is expected to take considerable time, but there are substantial public financing efforts to develop RE, including support from development partners, enabling the country to meet some part of its RE development goals.
D	0–0.25	There are weak capital markets and an inability in the domestic market to mobilize financing for RE projects, with limited interest from foreign financiers. There is significant reliance on development aid and concessional financing for the limited RE projects that are undertaken in the country.

Output (Investment Leading to Development of Renewable Energy)

7. Assessment of investments in the development of installed generation **capacity from renewable sources** in a given country at the end of the specified time period (2015) across all developing countries.¹ This measure is calculated by dividing the installed generation capacity from renewable sources by each country's population at the end of the period (2015), and classifying the results in percentile groups between 0.0 (0 percent) and 1.0 (100 percent). A higher mark means a higher value of installed RE capacity.

Group	Rating	Description
A	0.875 (midpoint of first or top quartile)	There is a substantial level of installed RE capacity (per capita) development (top quartile—better than 75 percent of developing countries)
B	0.625 (midpoint of second quartile)	There is well-integrated installed RE capacity (per capita), but below the top performers (second quartile—better than at least 50 percent of countries but worse than top 25 percent)
C	0.375 (midpoint of third quartile)	There is below-average installed RE capacity (per capita), but above the bottom performers (third quartile—worse than at least 50 percent of countries, but better than the bottom 25 percent)
D	0.125 (midpoint of fourth or bottom quartile)	There is a low level of installed RE capacity (per capita) development (bottom quartile—worse than 75 percent of developing countries)

Outcomes (Energy and Environment Benefits from RE)

8. Assessment of the **energy benefits** based on electricity produced from renewable sources in a given country in the final year of the specified time period (2015) across all developing countries.² This measure is calculated by dividing the electricity production from renewable sources by each country's population at the end of the period and classifying the results in percentile groups between 0.0 and 1.0. A higher mark means a higher value of electricity production from RE.

Group	Rating	Description
A	0.875 (midpoint of first or top quartile)	There is a substantial level of installed RE capacity (per capita) development (top quartile—better than 75 percent of developing countries)
B	0.625 (midpoint of second quartile)	There is well-integrated installed RE capacity (per capita), but below the top performers (second quartile—better than at least 50 percent of countries but worse than top 25 percent)
C	0.375 (midpoint of third quartile)	There is below-average installed RE capacity (per capita), but above the bottom performers (third quartile—worse than at least 50 percent of countries, but better than the bottom 25 percent)
D	0.125 (midpoint of fourth or bottom quartile)	There is a low level of installed RE capacity (per capita) development (bottom quartile—worse than 75 percent of developing countries)

9. Assessment of the **environmental benefits** of carbon dioxide (CO₂) that could be reduced because of the amount of electricity produced from renewable sources in the final year of the specified time period (2014) across all developing countries. This measure is based on data for CO₂ emissions from electricity generated (grams of CO₂ per kilowatt hour)³ at the end of the period multiplied by per capita electricity production from renewable sources, and classifying the results in percentile groups between 0.0 and 1.0 based on their ranking across developing countries. A higher mark means a higher value of avoided emissions.

Group	Rating	Description
A	0.875 (midpoint of first or top quartile)	There are substantially reduced CO ₂ emissions per capita based on electricity produced from renewable sources (top quartile—better than 75 percent of developing countries)
B	0.625 (midpoint of second quartile)	There are significant levels of reduced CO ₂ emissions per capita based on electricity produced from renewable sources (second quartile—better than at least 50 percent of countries but worse than top 25 percent)
C	0.375 (midpoint of third quartile)	There are below-average levels of reduced CO ₂ emissions per capita based on electricity produced from renewable sources (third quartile—worse than at least 50 percent of countries, but better than the bottom 25 percent)
D	0.125 (midpoint of fourth or bottom quartile)	There are low levels of reduced CO ₂ emissions per capita based on electricity produced from renewable sources (bottom quartile—worse than 75 percent of developing countries)

Endnotes

1. Data for installed capacity is from the United States Energy Information Agency for 2015. Developing countries are those eligible for World Bank Group borrowing (Part II countries).
2. Data for energy production is from International Energy Agency for 2015.
3. Data for grams of carbon dioxide per kilowatt hour of electricity is from International Energy Agency for 2014.

APPENDIX B

**MATRIX OF
CONSOLIDATED
PRECONDITION
BARRIER SCORES**

Table B.1. Scores from Country Case Studies

Country	Addressing Barriers to Developing Renewable Energy					
	Policy and Regulatory	Integration into Power Systems	Improvements to Design and Technical Standards	Strengthen Institutional Capacity	Mitigate Investment Risks	Mobilize Financing
Key lines of inquiry	<p>Identify which policy and regulatory barrier(s) were addressed and indicate how:</p> <ul style="list-style-type: none"> » Laws: Energy law, electricity law, RE law (1) » Policies and regulations related to the above (2) » Pricing: Pass-through, FIT, sustainable subsidization plans (3) » Mandatory offtake with pass-through, subsidies, or both (4) » Concessioning: Policies that clarify approaches to assigning development rights for RE (5) » Other (please list) (6) 	<p>Identify which integration (connection and dispatch) of RE (especially intermittent resources) were addressed and indicate how:</p> <ul style="list-style-type: none"> » Power systems planning (G&T) (1) » Adequate grid code (2) » Standards for grid-friendly RE equipment (3) » Strengthening of transmission to facilitate RE (4) » Requirements for priority dispatch with regulation to ensure integrity of the system (5) » Power trade and pooling that improves RE offtake (6) » Other (please list) (7) 	<p>Identify which RE project design and technical standards were improved and indicate how:</p> <ul style="list-style-type: none"> » Good industry practice for feasibility and safeguards studies (1) » Enhanced standards for project design (2) » Development or introduction of improved or international RE standards (countrywide, institution) (3) » Other (please list) (4) 	<p>Identify which RE development capabilities, at the country, institutional, or project level, were strengthened to achieve improved RE outcomes; indicate whether they were accomplished through learning-by-doing and on-the-job training, knowledge transfer, specialized workshops, or expert support in following areas:</p> <ul style="list-style-type: none"> » Improve planning capacity for RE expansion (1) » Enhance technical capabilities for design and implementation of RE investments (2) » Expand capacity to secure financing for RE (3) » Strengthen the governance, procurement, and financial management practices and capacity (4) » Improve the ability to meet environmental and social safeguard needs (5) » Other (please list) (6) 	<p>Identify which specific investments risks outside the control of developers were addressed and indicate how:</p> <ul style="list-style-type: none"> » Enhanced RE resource assessment (1) » Financial or investment risks related to pricing, offtake, and timely payments (that is, specific risks that underlie financing constraints) (2) » Credit enhancements for financial intermediaries to extend funding to RE (3) » Political risks such as expropriations (4) » Other (please list) (5) 	<p>Identify whether funds were mobilized, leveraged, or both by the World Bank Group to finance RE projects and indicate how:</p> <ul style="list-style-type: none"> » Grants and concessional financing mobilized to sustain subsidy schemes (GEF, CTF, ESMAP/AS-TAE) (1) » Mobilize other development partner support (Other MDBs, local banks, DFID, KfW, CAF, other bilateral) (2) » Attracted or facilitated private financiers for financing RE (3) » Other (please list) (4)
China	A (0.80)	B (0.70)	A (0.90)	A (0.90)	B (0.70)	A (0.90)
India	A (0.85)	A (0.80)	B (0.55)	A (0.90)	B (0.60)	B (0.70)
Jordan	A (0.80)	B (0.70)	B (0.70)	C (0.40)	B (0.60)	C (0.40)
Kenya	B (0.70)	D (0.20)	A (0.80)	C (0.40)	B (0.60)	A (0.80)
Mexico	B (0.70)	A (0.90)	B (0.70)	B (0.70)	B (0.60)	B (0.60)
Morocco	B (0.55)	B (0.60)	C (0.40)	C (0.40)	B (0.60)	C (0.40)
Nicaragua	B (0.70)	B (0.60)	C (0.40)	C (0.40)	C (0.40)	C (0.40)
Sri Lanka	B (0.70)	B (0.60)	B (0.60)	B (0.60)	B (0.70)	B (0.60)
Turkey	A (0.80)	A (0.90)	A (0.90)	A (0.80)	B (0.70)	A (0.80)

(continued)

Table B.1. Scores from Country Case Studies (cont.)

Addressing Barriers to Developing Renewable Energy				
Country	Development of RE	Displacement of Fossil-Based Alternatives	Energy Benefits	Environmental Benefits
Key lines of inquiry	<p>Identify the development of RE due to the project with the help of the barriers that were addressed:</p> <ul style="list-style-type: none"> » Total investments made in RE generation capacity (1) » RE power generation capacity (2) » Electricity produced as a result of RE capacity from project (3) <p>Score based on RE capacity per capita</p>	<p>Identify the displacement of fossil-based fuels as a result of RE:</p> <ul style="list-style-type: none"> » What fossil-based technology is displaced as result of RE (1) » Is it displacing existing or proposed fossil-based capacity? (2) 	<p>Identify the energy benefits from the project and how successfully they were:</p> <ul style="list-style-type: none"> » Increase in access to electricity (connections and population) (1) » Increase in RE-based electricity (capacity and electricity) (2) » Reduction in energy insecurity (diversification of generation mix) (3) 	<p>Identify the environmental benefits from project, and how successfully they were:</p> <ul style="list-style-type: none"> » Avoided local pollution (SO_x, NO_x, PM) (1) » Avoided global pollution (CO₂) (2) <p>Score based on reduced CO₂ emissions per capita based on electricity produced from renewable sources</p>
China	A (0.84)	—	A (0.79)	A (0.94)
India	B (0.56)	—	C (0.36)	B (0.61)
Jordan	C (0.48)	—	C (0.27)	C (0.41)
Kenya	C (0.40)	—	C (0.38)	C (0.30)
Mexico	B (0.69)	—	B (0.60)	B (0.69)
Morocco	B (0.54)	—	C (0.37)	B (0.58)
Nicaragua	B (0.64)	—	B (0.57)	B (0.60)
Sri Lanka	B (0.64)	—	B (0.55)	B (0.68)
Turkey	A (0.86)	—	A (0.80)	A (0.90)

Source: Independent Evaluation Group.

Note: ASTAE - Asia Sustainable and Alternative Energy Program; CAF - Development Bank of Latin America (Corporacion Andina de Fomento); CO₂ - carbon dioxide; CTF - Clean Technology Fund; DFID - Department for International Development (UK); ESMAP - Energy Sector Management Assistance Program; FIT - feed-in tariff; GEF - Global Environment Facility; G&T - generation and transmission; MDB - multilateral development bank; NO_x - nitrogen oxide; PM - particulate matter; RE - renewable energy; SO_x - sulfur oxide. Numbers after each item indicate number of items in key lines of inquiry.



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