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Ramirez, Jacobo; Velázquez, Diego Abraham Angelino; Vélez-Zapata, Claudia

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Collaboration and investment opportunities for Danish organizations in Colombia's Green Transition: 2021

PROJECT COMMISSIONED BY THE EMBASSY OF DENMARK IN COLOMBIA

Authors

Jacobo Ramirez

Diego Abraham Angelino Velázquez

Claudia Vélez-Zapata

Photo 1. *Jepirachi Wind Park in La Guajira [2019].*

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EMBASSY OF DENMARK
Bogotá

CBS CENTRE FOR BUSINESS AND DEVELOPMENT STUDIES
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The **Centre for Business and Development Studies (CBDS)**, part of the Department of Management, Society and Communication (MSC) at Copenhagen Business School (CBS), is a multidisciplinary research center for business and sustainable development. In addition to a core research group, CBDS welcomes a wider group of researchers (CBDS+) based in other departments and outside of CBS. CBDS researchers conduct research on business and international development from a variety of theoretical perspectives and methods. CBDS's international Advisory Board assists with the Centre's strategic directions, quality controls of the research output, and promotes future collaboration.

CBDS: Centre for Business and Development Studies
Dalgas Have 15, 2200 Frederiksberg, Denmark
E-mail: cbds@cbs.dk
www.cbds.center
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Preface

This report presents an in-depth analysis of the Colombian energy system as of March 2021. The aim is to provide relevant information for Danish private companies and investors to enter into dialogue and collaboration with Colombian public and private organizations for a resilient energy transition, within the framework of the Colombian National Energy Plan toward 2050 (E2050).

The E2050 plan, which was presented in June 2015, is an integral part of Colombia's Green Growth Policy. This Colombian initiative aims to transform the Colombian energy matrix by encouraging investment in *nonconventional renewable energy*. Nonconventional renewable energy is a term used by the Colombian Government [1], and is equivalent to the European and North American understanding of renewable or green energy (large- and small-scale) from the following sources: wind (onshore and offshore), solar, biomass and waste, and geothermal. The E2050 plan integrates climate change mitigation into Colombian public policy, in accordance with Colombia's commitment to the Paris Agreement [1–3], and aims to diversify the Colombian energy matrix with nonconventional renewables to ensure a more competitive, sustainable, resilient, and diversified energy system [a].

There is a growing agreement from the private and public sectors and civil society in Colombia for the need to mitigate climate change. There is a tendency to favor nonconventional renewable energy over traditional fossil fuel-based energy, but at the same time, there is resistance from end-users for this transition. However, in the midst of the COVID-19 pandemic, the Colombian government continues to revise and upgrade its legal framework to transform its energy system and promote foreign direct investment (FDI) in nonconventional renewable energy.

Colombian public policy is clear in the need to increase the share of nonconventional renewables in the energy matrix from less than 1 percent to more than 12 percent by 2022 [a]. Colombia's greenhouse gas (GHG) emission mitigation target has increased from 20 percent to 51 percent by 2030, with the aim of using "sustainable reactivation" as a driving force for economic growth following the downturn caused by COVID-19 [2].

The objectives of this report are to help private companies and investors map investment opportunities and challenges in nonconventional renewable energy in Colombia, aimed at building a resilient energy system.

Scope of the Report

This report provides a compass for Danish companies interested in the Colombian energy market. In addition to illustrating the state of Colombia's energy system to help foster dialogue and cooperation between Colombia and Denmark in sustainable energy systems, it presents an overview of the legal framework for Colombia's energy transition with the aim of elucidating current and future investment opportunities in nonconventional renewable energy in Colombia, particularly in wind, solar, biomass, and geothermal energy.

This report was prepared based on interviews with public officials, governmental representatives, representatives of multinational enterprises (MNEs) and small and medium enterprises (SMEs) in the energy sector in Colombia and Denmark, representatives of financial institutions, representatives of nongovernmental organizations, consultants, academics, and members of civil society. The interviews were conducted between September 2020 and April 2021 and took place online due to COVID-19 restrictions. Face-to-face interviews with members of the Wayúu people in La Guajira were carried out during fieldwork in Colombia in February 2020. The statements and responses by interviewees are anonymized in this report and indicated by [a]. The report also draws from publicly available documents on the energy system in Colombia, private sector reports, and government documents such as the Colombian normative and legal energy frameworks. An important source of information is the internet platform maintained by the Mining and Energy Planning Unit (UPME—Unidad de Planeación Minero Energética) at the Ministry of Mines and Energy (MME) (available at https://www1.upme.gov.co/Paginas/default.aspx). This portal forms the national reference for state-of-the-art technology and best practices within the energy system in Colombia.

Structure of the Report

This report begins with an executive summary for policy makers and investors in the private and public sectors to motivate dialogue, collaboration, and investment in the Colombian energy sector. This is followed by a profile of Colombia, the Colombian energy mix as of 2021, and relevant actors (private and public organizations, including utilities). The legal framework of the Colombian energy system and key nonconventional renewables for collaboration and investment are then discussed in detail. Finally, annexes and supplementary material are provided.

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In addition, the following public and private organizations, consultants, and nongovernmental organizations provided valuable input and comments. *From Colombia*: INDEPAZ (The Institute for Development and Peace Studies), IPD Latin America, Renewable Energy Association (SER Colombia), Universidad de La Guajira, Universidad Pontificia Bolivariana, Medellín, ECOPETROL, and COTECMAR; and *from Denmark*: DanChurchAid, Danish Institute for Human Rights, ROSS DK, Haldor Topsoe, Gehl, EKF (Denmark's Export Credit Agency), IFU (The Investment Fund for Developing Countries), NIRAS, Ringkøbing-Skjern Municipality, Vestas, and Ørsted.

Access to Wayúu people was granted through the help and assistance of INDEPAZ (The Institute for Development and Peace Studies), Colombia. Jacobo Ramirez undertook fieldwork in the La Guajira region in Colombia—the territory of the Wayúu people—with the assistance of the Heinrich Böll Foundation, Germany, and IWGIA (The International Work Group for Indigenous Affairs), Denmark.

This report benefited greatly from the analysis and comments of a range of external experts, including: Alvaro Cuervo-Cazurra, Professor of International Business and Strategy at D'Amore-McKim School of Business, Northeastern University, USA; and Michael Wendelboe Hansen, Associate Professor at Copenhagen Business School (CBS).

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Role of the Funding Source

The funding was used to collect and analyze open-source data and to conduct and analyze interviews.

Declaration of Competing Interests

The authors have no conflicts of interest to declare.

Data Availability Statement

The data consulted in relation to Colombian laws and regulations can be found on the Ministry of Mines and Energy webpage at https://www1.upme.gov.co/Paginas/default.aspx. The data of the interviews collected are confidential.

ABOUT THE AUTHORS

Jacobo Ramirez

is an assistant professor of Latin American business development at the Department of Management, Society and Communication (MSC) of Copenhagen Business School (CBS) in Denmark, and a member of the Centre for Business and Development Studies (CBDS) at CBS. Ramirez's main research interest is organizational strategy in fragile states and other complex institutional environments facing security risks, displacement, and social unrest. Ramirez's current work focuses on how renewable energy investments affect indigenous peoples' communities and livelihoods. Ramirez is a Mexican-Danish double national, born in Mexico to indigenous Mexican parents from the Isthmus of Tehuantepec. He has lived and worked in Copenhagen since 2006. Jacobo Ramirez can be contacted at jara.msc@cbs.dk.

Diego Abraham Angelino Velázquez

is a research assistant at the Department of Management, Society and Communication (MSC) of Copenhagen Business School (CBS) in Denmark, and an international advisor for sustainable development. He holds a master's degree in international development from the Mora Research Institute in Mexico and is a member of the Managing Global Governance program of the German Development Institute (DIE) in Germany. Angelino Velázquez's work focuses on topics such as energy transition, resource scarcity, entrepreneurship, business and development, and partnerships for sustainable development. Diego Abraham Angelino Velázquez can be contacted at daav.msc@cbs.dk.

Claudia Vélez-Zapata

is a titular professor of the School of Economy, Management and International Business at Universidad Pontificia Bolivariana in Medellín, Colombia. Vélez-Zapata acquired her Ph.D. at CEU San Pablo in Madrid, Spain. Her research focuses on Colombia's illegitimate environments and their organizational impacts. Vélez-Zapata is currently an advisor for undergraduate and masters level management students and holds research seminars on Colombia, encounters, disagreements, and organizations. Claudia Vélez-Zapata can be contacted at claudiap.velez@upb.edu.co.

Executive Summary[1]

Country Context

a. Colombia is an equatorial country located in northwestern South America. Colombia has over 48 million inhabitants and is organized into departments (32), municipalities (1123), districts (5), and other special divisions including provinces (141) and indigenous territorial entities (83) [2].
b. Colombia is the 25th largest country in the world, with a total terrestrial area of 1,139,951 km^2, maritime area of approximately 928,660 km^2, and coastline extension of 2,900 kilometers [2].
c. Colombia is still in a transition process after the signing of a peace agreement between the national government and the Revolutionary Armed Forces of Colombia (FARC) in 2016. The peace agreement legally represents the end of more than 60 years of civil conflict in major regions of Colombia. The conflict distorted public policies and the economic development of the affected regions. The FARC controlled 242 municipalities, equivalent to 22 percent of Colombian territory. The peace agreement has enabled the affected regions to be reintegrated into the national economy and energy system [4].
d. Colombia is an important oil producer and a leader in extractive minerals. Exports vary year on year. According to the Office of Economic Studies of the Ministry of Commerce, in 2020, Colombia's main exports were oil and derivatives (23%), coal (16%), other mining (9%), coffee (8%), industrial goods (24%), agricultural goods (13%), iron-nickel (1%), and basic chemicals (6%) [5].
e. Colombia has 14 million homes, of which 96.7 percent have access to electricity, 66.8 percent have connections to pipeline gas, and 43.4 percent have internet access (broadband or mobile) [6].
f. The COVID-19 pandemic has damaged economies around the world. Colombia registered an 8.25 percent fall in GDP in 2020. The World Bank projects a 3.5 percent rise in the Colombian economy in 2021 and a 3.75 percent rise in 2022, which are similar to the figures released prior to the pandemic [7].
g. COVID-19 caused Colombian energy demand to decrease by 21 percent in the large industry sector and by 7.5 percent in the residential and small industry sectors.

[1] This summary is also provided in a separate document available on https://www.cbds.center/publications-1.

Energy Sector

a. The Colombian energy matrix is based on coal, oil, gas, hydropower, biofuel, and *nonconventional renewable energy*. Almost 70 percent of the electricity capacity in Colombia is produced from hydroelectric plants. Thermal energy (gas, coal, and steam) represents 30.7 percent of supply [8].

b. The largest consumers of energy are the residential (42%), industrial (33%), and tertiary (25%) sectors [average figures from 1998 to 2018 [6]]. The energy matrix differs by sector: the residential sector is largely powered by hydropower and gas; industry is powered by coal, natural gas, bagasse (a type of biofuel) and hydroelectricity; and the tertiary sector uses coal, oil, hydropower, and (to a lesser extent) nonconventional renewable energy such as solar power [6, 8].

c. The energy sector in Colombia is relatively decentralized but is controlled by large Colombian utility firms [a].
    - Three utilities have a 63 percent share in the energy production market: Grupo EPM (22.0%), ISAGEN (19.0%), and EMGESA (22.0%).
    - Three utilities dominate the energy transmission market: ISA InterColombia (80%); Gupo Energía Bogotá (GEB) (10%), and Grupo EPM (7%).
    - Three utilities control 64.7 percent of the energy commercialization market: Grupo EPM (25.3%), Electrificadora del Caribe (20.2%), and Grupo ENEL (19.2%).
    - Medium-size firms control 8 percent of the energy production market and 17.2 percent of the energy commercialization market.

d. Grupo ECOPETROL (Colombian Petroleum Company), a private-public company (88 percent government and 12 percent private investors), is the main oil company in Colombia and one of the four largest oil firms in Latin America. Recently (January 27, 2021), Grupo ECOPETROL announced to the national government the acquisition of 51.4 percent shares of Interconexión Eléctrica S.A. E.S.P. (ISA), a mixed utility company (Ministerio de Hacienda y Crédito Público: 51.4%; Grupo EPM: 8.82%; Fondo de Pensiones Obligatorias Porvenir: 8.32%; Fondo de Pensiones Obligatorias Protección: 5.75%; Fondo Bursatil Ishares Colcap: 2.97%; and others: 22.73%). This transaction will position Grupo ECOPETROL as one of the main energy conglomerates in Latin America and the Caribbean.

a. In 2015, Colombia presented the National Energy Plan toward 2050 (E2050). This is a key Colombian initiative for investment in small- and large-scale nonconventional renewable energy projects such as wind, solar, biomass and waste, and geothermal energy [9].
b. The Green Growth Policy, launched in 2018, aims to improve Colombian productivity and economic competitiveness by 2030, while simultaneously ensuring social inclusion and the efficient use of natural capital in a climate-friendly manner [10].
c. The E2050 plan and Green Growth Policy show political understanding of the advantages of energy matrix diversification through nonconventional renewable energy. The Colombian government seems to accept that the energy transition can no longer be reversed [a].
d. The Colombian government is limited to establishing the legal framework and regulations for the management and coordination of different stakeholder priorities in the operation of utilities.
e. A major milestone is Law 1955 of 2019, published in March 2021, which establishes that energy utilities that operate in Colombia will be required from 2023 to source at least 10 percent of their annual energy from nonconventional sources [11].
f. Another major milestone in advancing the legal framework was the approval of Law 1715 in 2014, which is the main legal instrument for the energy sector in Colombia [12].
g. Law 1715 stipulates the key aspects of the functioning and development of the renewable energy sector, such as providing fiscal incentives for investment, defining responsibilities among ministries, and establishing financial and operative instruments for different types of nonconventional renewable energy.
h. The four main incentives in Law 1715 are as follows [12]:
    - Deduction of 50 percent of investment profits for tax purposes on energy generation projects for 15 years;
    - Waiver of value-added tax (VAT) on the purchase of equipment, elements, and machinery or the acquisition of necessary services for the project;
    - Tax exemption on imports of machinery and other necessary supplies for the project; and
    - Accelerated depreciation of applicable assets, equipment, machinery, and civil projects needed for the project.
i. Law 1715 also emphasizes a cultural change in Colombia in terms of the use of nonconventional renewable energy. Different stakeholders (including private- and public-sector representatives and indigenous people) emphasized the importance of improving the consultation process with indigenous people.

Key Findings

a. The Colombian government is committed to the E2050 plan through further development of the Colombian legal framework and new public tenders (e.g., financial support such as tax incentives for importing equipment and material).
b. The infrastructure required to build large-scale nonconventional renewable energy projects and transmit power to end-users needs to be expanded. This provides a further business opportunity for Danish investment.
c. The Colombian energy sector is an oligopolistic industry, controlled by utilities with a mix of ownership (government and private investors).
d. Large-scale nonconventional renewable energy investment in Colombia focuses on climate change mitigation (e.g., reducing CO_2). However, there is little incentive or investment for climate change adaptation. The El Niño-Southern Oscillation (ENSO) warm and cold phases affect Colombian industries such agriculture. There is potential for collaboration and investment in projects that will enable Colombia to adapt to the impacts of climate change.
e. Colombia's rich biodiversity and multiracial population must be considered in the energy transition. Biodiversity should be considered in the planning and development of nonconventional renewable energy projects and adapted according to Colombia's biodiversity and sociodemographics.

Areas for collaboration

This study has identified the following five areas that can be the basis for a broad collaboration between Denmark and Colombia: 1) biodiversity and natural ecosystems; 2) governance in energy democracy; 3) energy culture; 4) energy efficiency; and 5) supporting infrastructure.

1. Biodiversity and Natural Ecosystems

a. **Balance of land use: energy versus food:** The use of adapted modern technology to produce biofuels (e.g., ethanol) raises a controversial discussion about sustainability, both in Colombia and worldwide. There is a business opportunity to develop biofuels from waste and not crops, with new prospects for the production of green hydrogen, green ammonia, and green fertilizers.

b. **Protection and National Parks:** A commitment between government and firms creates an opening to respect and protect biodiversity refuge areas (e.g., Amazonas Department) and ecosystems (e.g., water treatment in sanitation, rivers, and seas).

2. Governance in Energy Democracy

a. **Ensuring compliance with laws and regulations**: The multicultural sociodemographics of Colombia provide an opportunity for firms to promote energy democracy. The Colombian government has invested in human capital through the Directorate of the National Prior Consultation Authority (DANCP) to improve the efficiency of public consultations with indigenous people. Colombia is the first country in Latin America and the Caribbean that has conducted an online public consultation with indigenous people for solar investment. These advances could help to revise the disputed consultations in La Guajira, according to the particularities and needs of the Wayúu people [a].

b. **Fostering accountable and transparent governments**: Public policies at the federal, state, and municipal levels should facilitate the sustained dissemination of information on national renewable energy developments to help local communities build trust in the government and make informed choices [a].

c. **Access to finance**: There are financial incentives and organizations that provide a platform for firms to access credit when investing in nonconventional renewable energy projects (e.g., *Danish*: EKF, IFU, P4F; *UN's Climate Finance*: GCF, SCCF, AF). These incentives provide an opportunity for Colombian firms to access finance and for Danish firms to protect their investments [a].

d. **Renewable ownership:** Exploring local communities and small and medium enterprises' (SMEs') access to existing finance funds could lead to stakeholder partnerships in nonconventional renewable energy investments among financial institutions, multinational enterprises (MNEs), local governments, and local communities [a].

3. ENERGY CULTURE

a. **Expansion of education, training, and development programs in nonconventional renewable energy:** Communities in the La Guajira region and other regions in Colombia are not familiar with the benefits of nonconventional renewable energy. It is necessary to help educate them and to discuss the benefits of energy efficiency practices to foster their participation in nonconventional renewable energy projects. Technical and engineering higher education programs and nonconventional renewable energy training are required to create local skilled workforces. There is an opportunity for the private sector to work with local education institutions and policy makers to develop suitable education programs.

b. **Promote employment through nonconventional renewable energy**: Developers can promote local employment in nonconventional renewable energy by implementing training and internship programs that target local communities and connect students with the local labor market.

4. ENERGY EFFICIENCY

a. Energy efficiency implies flexibility and diversification of the energy matrix and network. Nonconventional renewable energy sources such as solar and wind, particularly on the Caribbean Coast and in the central Andes regions, can complement the hydropower sector during dry seasons of the annual climatological cycle. There is a potential for developing hybrid or complementary pilot projects based on current nonconventional renewable energy technologies.

b. Digital solutions are possible for energy efficiency such as residential and industrial metering.

5. SUPPORTING INFRASTRUCTURE

a. There is a need to upgrade roads and ports in Colombia to facilitate transport of equipment and components for large-scale wind and solar investments.

b. When a limitation with the current infrastructure (e.g., roads) is identified—for example, if the load is heavy or large—the associated costs must be met by private agents (e.g., the investor). Investors in nonconventional renewable energy projects should have a clear understanding of the necessity and costs for adapting existing infrastructure and of the adjustments that need to be made so that these costs are expected during project execution [a].

c. This is an opportunity for foreign firms concerning the collaborative development of transportation infrastructure in Colombia. Danish companies can participate through FDI in the design and construction of infrastructure in Colombia. This may include public-private partnerships for infrastructure development.

Abbreviations

AF	Adaptation Fund
CAF	Corporación Andina de Fomento
CARs	Regional and autonomous corporations (corporaciones autónomas regionales)
CREG	Energy and Gas Regulatory Commission (Comisión de Regulación de Energía y Gas)
DANCP	Directorate of the National Prior Consultation Authority (Dirección de la Autoridad Nacional de Consulta Previa)
E2050	Colombian National Energy Plan 2050
EKF	Denmark's Export Credit Agency
EPM	Empresas Públicas de Medellín
FENOGE	Nonconventional Energy and Efficient Energy Management Fund (Fondo de Energías No Convencionales y Gestión Eficiente de la Energía)
FDI	Foreign direct investment
FPIC	Free, prior and informed consent
GDP	Gross domestic product
GHG	Greenhouse gases
GCF	Green Climate Fund
IAF	Inter-American Foundation
IEA	International Energy Agency
km	Kilometers
kW	Kilowatt
kWp	Kilowatt peak (rate at which a photovoltaic system generates energy at peak performance)
MADS	Ministry of Environment and Sustainable Development (Ministerio de Ambiente y Desarrollo Sostenible)
MADR	Ministry of Agriculture and Rural Development (Ministerio de Agricultura y Desarrollo Rural)
MME	Ministry of Mines and Energy (Ministerio de Minas y Energía)
MNEs	Multinational enterprises
MVCT	Ministry of Livelihood, Cities and Territories (Ministerio de Vivienda, Ciudad y Territorio)
MW	Megawatt
NGOs	Nongovernmental organizations
OECD	Organisation for Economic Co-operation and Development
SCCF	Special Climate Fund
SDGs	Sustainable Development Goals
SMEs	Small and medium enterprises
P4G	Partnering for Green Growth and the Global Goals 2030
UPME	Mining and Energy Planning Unit (Unidad de Planeación Minero Energética)
VAT	Value-added tax (IVA—impuesto al valor agregado)
ZNIs	Non-interconnected zones (zonas no interconectadas)

1 Introduction

In 2015, Colombia launched a National Energy Plan toward 2050, termed the E2050 plan, which responds to the impacts of climate change and recognizes the need to transform the Colombian energy system through an efficient, diversified, and resilient energy matrix [1]. The current worldwide impacts of climate change, particularly on phenomena such as the El Niño-Southern Oscillation (ENSO) warm and cold phases, have already had a damaging consequence on Colombian ecosystems such as rainfall. The reduction in reservoir levels has harmed hydropower capacity, which currently represents 70 percent of the total energy produced in Colombia [7, 10].

The E2050 plan aims to diminish the social and environmental impacts of climate change on the Colombian energy system by diversifying and complementing the current energy matrix with "nonconventional" renewable energy. Nonconventional renewable energy sources are defined as environmentally sustainable renewable energy resources that are available, but not generally used or widely commercialized in Colombia, such as biomass, small hydroelectric, wind, geothermal, solar, and tidal [1]. The Colombian government envisions the transition from fossil fuel-based energy sources toward nonconventional renewables as an opportunity to decarbonize their energy system, and has implemented laws such as Law 1715 to regulate the integration of nonconventional renewable energy into the national energy system.

The E2050 plan is indicative of the Colombian government's long-term vision for the energy sector; rather than total decarbonization, it proposes *diversification* of the energy matrix. Nonconventional renewable energy is a key element of the plan, but diversification is important owing to inherent intermittency of most renewable energies [a].

> *The E2050 plan echoes a consensus heard among all the actors interviewed here: There is no way back to gas or coal [a].*

The E2050 plan necessitates the development of alternative funding channels. Colombia depends on oil for its exports and holds sufficient reserves to cover its own oil needs for the next five years. However, the energy transition is an expensive process and securing access to finance can be challenging. Fracking, a controversial source of energy and income in Colombia [a], is increasingly being discussed in order to supplement Colombian reserves and finance the E2050 plan [1].

More than 40 percent of electricity services in Colombia provide poor quality or inconsistent electricity, typically delivering only four hours

of energy per day. Almost all the electricity provided by these poor-quality energy services relies on diesel plants (98 percent), although a small percentage is based on nonconventional renewable energy (1.2 percent) [8].

Colombia has continued to promote the E2050 plan during the COVID-19 pandemic by changing the regulatory system and launching public auctions for *nonconventional energy investments*. There is a political will to further develop the Colombian legal framework to provide a positive context for investment, collaboration, and transfer practices related to nonconventional renewable energy. Indeed, Colombia's economic prospects and commitment to nonconventional renewable energy make the country a highly attractive partner for collaboration. This presents a unique opportunity for Danish companies and investors to collaborate and invest in energy efficient technologies, energy storage, smart metering, cybersecurity, and governance that empowers communities, while directly mitigating the impacts of climate change. Indeed, the Danish Government's focus on climate diplomacy and green development is embedded in the new long-term strategy for global action to mitigate climate change and provide the world's poorest nations with access to energy and sustainable economic growth [a].

How can public and private Danish organizations collaborate with their Colombian counterparts to meet the E2050 plan?

The following chapters present the general context of the energy transition in Colombia, a country overview, and the main actors in Colombia's energy sector. We describe potential business cases for Danish companies to investment in nonconventional renewable energy in Colombia. The subsequent chapters offer guidance for investing in the energy generation, transmission, and storage markets, and solutions for energy efficiency in Colombia.

2 Background on Colombia

2.1 Geography and Biodiversity

Colombia (capital: Bogotá D.C.) is an equatorial country located in northwestern South America. According to the recent census in 2018, Colombia has over 48 million inhabitants distributed in 32 decentralized departments (regions). Colombia is the 25th largest country in the world with a continental area of 1,141,748 km^2, of which 55.4 percent is non-agricultural (natural forests, forest reserves, indigenous reserves and collective territories, urban, and mining areas) and 44.6 percent is dedicated to agriculture. Colombia's maritime area is approximately 928,660 km^2 [2].

Colombia is rich in biodiversity, with 10 percent of the world's flora and fauna species [13]. It is home to vast rain forests, sprawling savannas, great mountains, and 2,900 kilometers of coastline that spans two oceans. Its position in the northwestern part of the continent where South America connects with Central and North America has earned it the nickname "the gateway to South America" [14]. Colombia is a land of extremes: snow-covered volcanoes and the mountains of the Andes in the center; tropical beaches along the north and west coasts; deserts in the north; and vast grasslands, called Los Llanos, in the east. The dense forests that surround Colombia's Amazon Basin occupy virtually the entire southern half of the country. In northwest Colombia, the warm, wet, jungle-filled department of Chocó reaches across the border with Panama. Colombia's varied geography and dramatic landscapes demand innovative investments in transportation and infrastructure to meet the E2050 plan [1, 12] (see Chapter 5).

Photo 2.1. *Sunset in East Antioqueño, Colombia, where Grupo EPM's major hydroelectric plants operate [2019].*

Source: ©Claudia Vélez-Zapata, 2021. Further permission required for reuse.

2.2 Politics and International Agreements

Colombia is still undergoing a transition process after the signing of a peace agreement between the national government and the Revolutionary Armed Forces of Colombia (FARC) in 2016. This agreement represents the legal end of more than 60 years of civil conflict across the country, which distorted public policies and economic development in the affected regions. The FARC controlled 242 municipalities, equivalent to 22 percent of the territory. The first point of the peace agreement is the "*Integral rural reform*," which aims to regularize 3 million hectares for small farmers [4].

The legacy and economic importance of oil and coal in Colombia present a major political challenge to Colombia's decarbonization goals. Political commitment to a plan to phase out coal is sorely needed. Nevertheless, it seems a social consensus is slowly forming around coal in Colombia [a] as to whether it should be phased out.

The Colombian government has signed international conventions and agreements that indicate its commitment to the energy transition. For example, the Kyoto Protocol was ratified by Colombia on November 30, 2001, and the Paris Agreement was signed on April 22, 2016 and ratified on July 12, 2018 [15]. ILO Convention 169 for "free, prior, and informed consent" (FPIC)—which provides guidelines for consultations with indigenous people—was ratified in 1991 [16].

Colombia also has several regional and international trade and cooperation agreements. For example, in 2011, Chile, Colombia, Mexico, and Peru launched the Pacific Alliance (PA). Among other objectives, the PA aims to drive further growth, development, and competitiveness of the economies of its members, focused on achieving greater well-being, overcoming socioeconomic inequality, and promoting the social inclusion of its members [17]. Colombia signed an Economic Partnership, Political Cooperation and Cooperation Agreement & Free Trade Agreement (FTA) with the European Union in 2012 [18]. In 2020, Colombia became the 37th Member of the Organisation for Economic Co-operation and Development (OECD). The OECD Secretary-General Angel Gurría stated:

> *"We are delighted to welcome Colombia as the 37th member of the OECD. Colombia's accession is tangible proof of our commitment to bring together countries who strive for the highest standards in global public policy in order to improve the well-being and quality of life of their citizens. Given its recent history, Colombia can be rightly proud of what is truly an exceptional achievement." [19]*

However, if the Paris Agreement target to limit global warming to below 2 °C is to be met [20], in addition to the conventions and trade agreements signed by Colombia, it will require amendments to the national legal framework, strong governance practices, and the adaptation of Colombia's main industries. These concerns are presented in the following chapters.

2.3 Macroeconomics and Industry

Colombia has obtained macroeconomic stability with a liberalized economy and a strong emphasis on trade. The COVID-19 pandemic has had a considerable effect on the Colombian economy, similarly to many countries around the world. After a fall in Colombia's GDP of 8.25 percent in 2020, the World Bank projects a rise of 3.5 percent in 2021 and 3.75 percent in 2022. These figures are similar to those released prior to the pandemic [2]. To mitigate the impact of the pandemic, various government interventions have been implemented, such as freezing payments for public services (e.g., electricity) for vulnerable populations [2].

Table 2.1 presents the sectors contributing to Colombia's GDP in 2019 according to the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) [3].

According to the Office of Economic Studies of the Ministry of Commerce, in 2020, Colombia's main exports were oil and derivatives (23%), coal (16%), other mining (9%), coffee (8%), industrial goods (24%), agricultural goods (13%), iron-nickel (1%), and basic chemicals (6%) [5].

Table 2.1. Sectors Contributing to Colombia's GDP in 2019

Sector	Contribution to GDP
Agriculture, livestock, forestry, and fishing	6.39 %
Mining	5.48 %
Manufacturing	10.92 %
Electricity, gas, and water	3.40 %
Construction	6.25 %
Trade and transport	17.74 %
Information and communication	2.78 %
Financial activities	4.43 %
Real estate	8.72 %
Technical, scientific, and professional activities	6.83 %
Public administration	15.06 %
Artistic activities, entertainment, and leisure activities	2.5 %
Taxes	9.5 %

Source: [21].

Note: Colombia's GDP was approximately US$331 billion in 2019.

Colombia is one of the biggest coal-producers worldwide, but very little of the coal produced in Colombia is used there. It is estimated that slightly more than 95 percent is exported, mainly for the generation of thermal energy. In 2018, Colombia exported 82 million tons of coal, the majority of which (72%) was bought by European economies, especially Turkey and the Netherlands, with the remainder going to Central and South America (17%), North America (8%), and Asia (3%) [22]. This dynamic of buying and selling coal for economic is

under threat, because most buyers of Colombia's coal have proposed to decarbonize their energy matrixes in the coming years. This means moving from the use of coal-based thermoelectric plants to gas or renewable energies [23].

***Photo* 2.2.** *Jepirachi Wind Park in La Guajira, 2019.*

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The Colombian economic structure requires a sustainable and reliable energy system to encourage foreign direct investment (FDI) and industrial growth. Nonconventional renewable energy investments have the potential to support economic recovery through job creation while also transforming the Colombian energy system and supporting innovative energy efficiency solutions in sectors that demand high-quality personnel [7].

2.4 Sociodemographics

According to the 2018 census, Colombia has a population of 48,258,494, of whom 68.2 percent are ages 15–65. The majority of the population (77.1%) live in municipal capitals (i.e., urban areas), while the rest live in rural areas (7.1% in "populated centers" and 15.8% in "dispersed rural" areas) [2, 24].

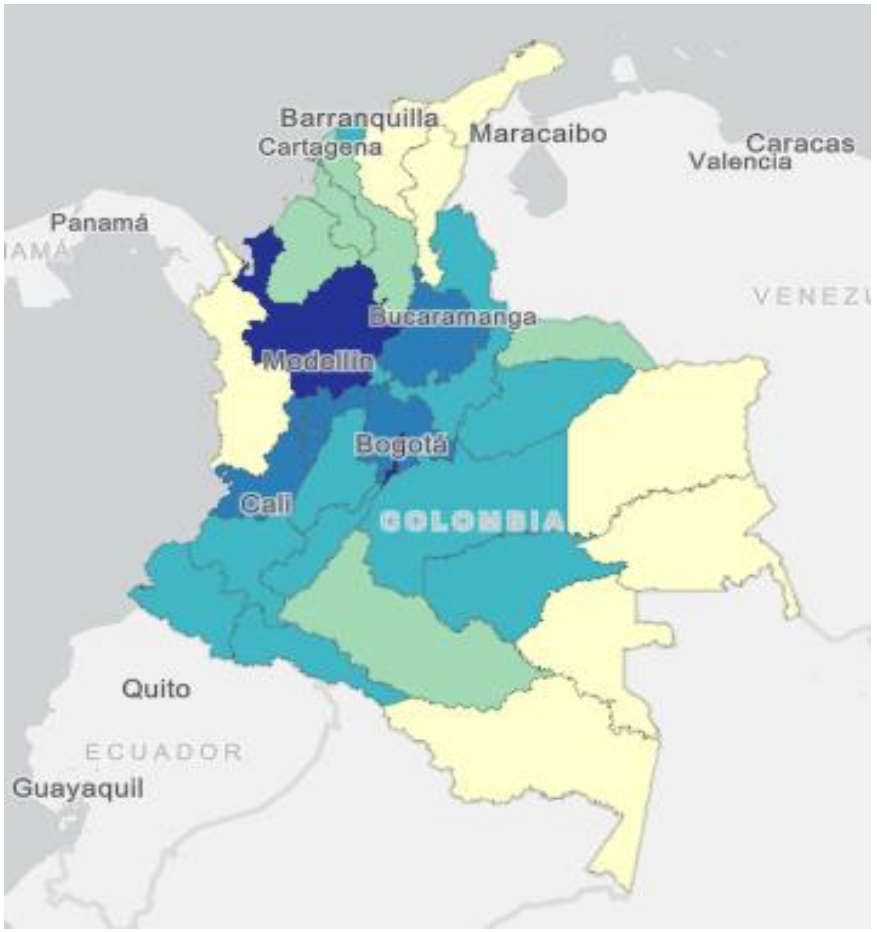
The Afro-Colombian Raizal and Palenquera populations comprise 9.34 percent of the total national population (4,671,160 people), while 2,649 people recognize themselves as gypsy or Roma, and 1,905,617 people identify as indigenous [25].

The departments (regions) with the highest population ages 15–65 are Bolívar, Bogotá, Atlántico, and Antioquia [26] (see Map 2.1). Colombia has 14 million homes, of which 96.7 percent have access to electricity, 66.8 percent are connected to pipeline gas, and 43.4 percent have internet access (broadband or mobile) [26].

Photo 2.3. *Wayúu Artisans with Traditional Wayúu Bags, 2019.*

Source: ©INDEPAZ, 2019. Reproduced with permission. Further permission required for reuse.

Map 2.1. *Colombian Departments.*



Source: [27].

Note: The departments are colored based on their population of 15–65-year-olds, with yellow being the lowest and dark blue the highest.

3 The Colombian Energy System

Colombia's energy system is mainly based on hydroelectric power and thermal energy (gas, coal, and steam), with approximately 70 percent of the electricity produced by hydropower installations. As of 2021, there are 143 hydroelectric plants in Colombia with a total net capacity of 11,846.2 megawatts (28 plants with a net effective capacity of greater than or equal to 20 megawatts and 115 with an effective capacity of less than 20 megawatts), which represents 68.3 percent of the country's energy supply [27].

Thermal energy represents 30.7 percent of the energy supply, and is concentrated in the cities of Barranquilla (Department of Atlántico), Barrancabermeja (Department of Valle), and Mayapo (Department of La Guajira) [27, 28]. Nonconventional renewable energy represents one percent of Colombia's energy supply [a]. COVID-19 caused the energy demand of Colombia's large industry sector to decrease by 21 percent and that of the residential and small industry sectors to decrease by 7.5 percent [8].

Two key challenges for the Colombian energy system are the impact of climate change and the emission of carbon dioxide (CO_2) and other greenhouse gases (GHGs). Hydroelectric power faces uncertainties due to the change in rainfall patterns caused by climate change. Moreover, the construction of hydroelectric power plants has affected Colombian ecosystems (e.g., the deviation of rivers and over-floods) and local communities (e.g., relocation and impacts on their livelihood) [a]. In the case of thermal energy, the consumption of oil, gas, and coal leads to CO_2 and other GHGs emissions, which negatively impacts the environment.

Our informants emphasized that the transition to nonconventional renewable energy in Colombia must be accompanied by a shift in "energy culture." Energy culture is a multidisciplinary framework for understanding consumer energy behavior that integrates legal, sociological, and philosophical disciplines, among others [a]. The consumer mindset about energy consumption must change before Colombian utilities can commit to adopting nonconventional renewable energies. This requires a long-term approach; however, the organizational objectives of Colombian utilities tend to have a short-term focus. According to research by the global renewable energy operator Renovatio Group, of 104 tender processes (for wholesale energy in Colombia) that were initiated between mid-2018 and August 2018, 66 percent of the agreements had terms of two years or less and only 12 percent were for more than five years. This reflects the short-term approach to power purchase agreements (PPAs) and spot market contracts in Colombia (see Section 4.1) [a, 29].

Despite the discourse on nonconventional renewable energy in Colombia, it is not well understood or adopted by businesses or civil society. Businesses need a more robust understanding of the energy technology choices and costs involved, in addition to a legal framework and incentives to adopt nonconventional renewable energy.

3.1 Utilities in Colombia

The energy sector in Colombia is relatively decentralized, but controlled by large utility firms. The regulatory framework is constantly evolving (see Chapter 4).

Energy generation and commercialization follow an open market model, while energy transmission and distribution remain under the control of regulated utility monopolies.

Colombian utilities have a public-private ownership scheme, whereby the Colombian government holds a 20 to 60 percent share. In this ownership model, the role of the Colombian government is limited to establishing the legal framework and regulation strategies for the management and coordination of different stakeholder priorities [a].

Colombian utilities produce and distribute electricity, gas, diesel, and petrol. Appendix A presents the three main utilities that control the Colombian energy market: Grupo Empresas Públicas de Medellín (hereafter Grupo EPM), ISAGEN, and Grupo ENEL (integrated with Condensa and EMGESA).

Utilities in Colombia are organized based on a regional operation model. Figures 3.1–3.3 show the composition of Colombia's energy generation, transmission, and commercialization markets.

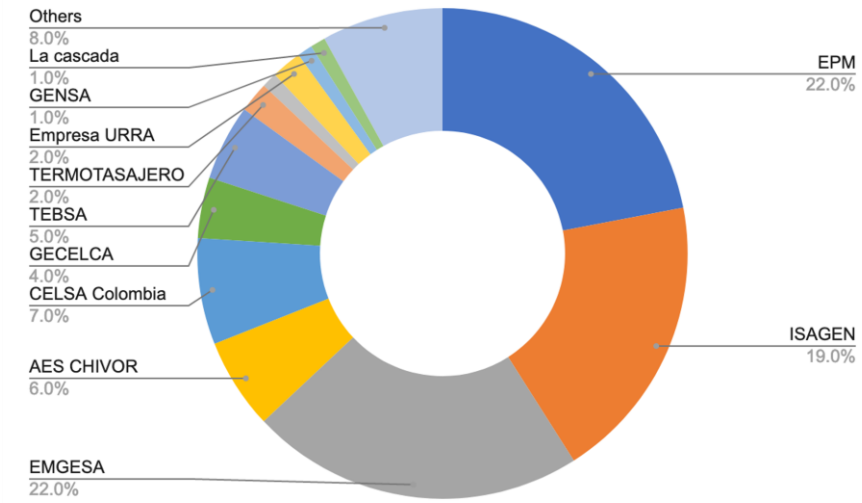
- **Energy generation:** 63 percent of the market is held by three utilities: Grupo EPM (22.0%), ISAGEN (19.0%), and Grupo EMGESA (22.0%). Medium-size firms ("Others" in Fig. 3.1) hold a total of eight percent of the market.
- **Energy transmission:** The energy transmission market is dominated by three main utilities: ISA InterColombia (80%), Gupo Energía Bogotá (GEB) (10%), and Grupo EPM (7%). Other agents account for three percent of the energy transmission market. This data includes transmission lines of all voltage levels.
- **Energy commercialization market:** 64.7 percent of the market is held by three utilities: Grupo EPM (34%), Air-e & Afina (11%), and Grupo ENEL (19.2%). A total of 17.2 percent of the market is controlled by medium-size firms ("Others" in Fig. 3.3).

On January 27, 2021, Grupo ECOPETROL announced the acquisition of 51.4 percent of shares of Interconexión Eléctrica S.A. E.S.P. (ISA), an energy transmission company owned by the Colombian Government. This transaction will position Grupo ECOPETROL as one of the main energy conglomerates in Latin America and the Caribbean, and in the world.

The energy commercialization sector has great scope for major market diversification. Overall, there is an opportunity for Danish companies to explore partnerships for the implementation of energy efficiency solutions for electricity distribution and commercialization.

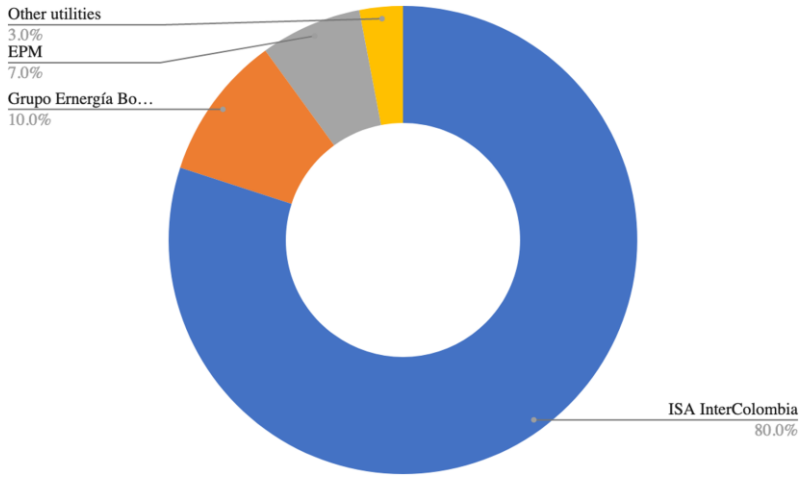
The invitation to Danish companies is to compete. A foreign company could come to Colombia to compete in the nonconventional renewable energy generation and commercialization markets [a].

Fig. 3.1. *Colombian Energy Production Market.*



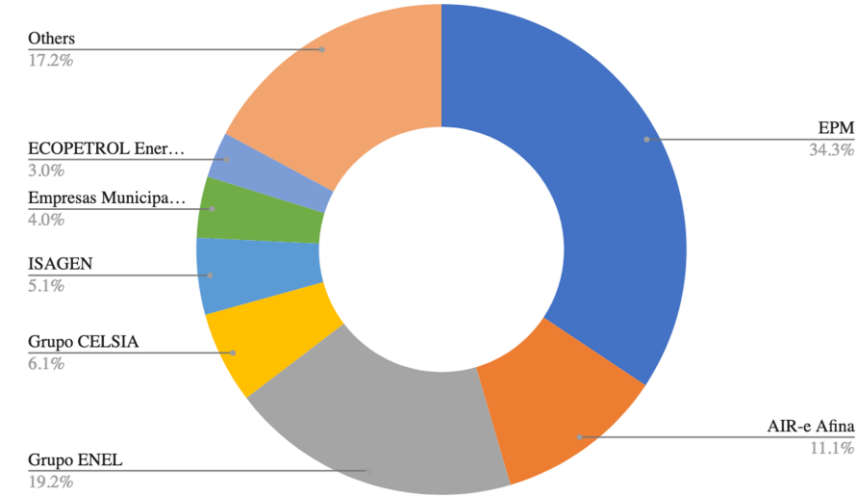
Source: [a].

Fig. 3.2. *Colombian Energy Transmission Market.*



Source: [a].

Fig. 3.3. *Colombian Energy Commercialization Market.*



Source: [a].

Transition to Nonconventional Renewable Energy

Utilities are a powerful political lobbying force in Colombia and have displayed a cautious approach to FDI. Nevertheless, Colombian utilities' negative perception of foreign investors, which is rooted in resentment over foreign firms' "superior" knowledge and dominant market position [a], seems to be shifting toward a more cooperative attitude and a willingness to sign partnership agreements [1]. In the last 15 years, Colombian utilities have started to explore ways to diversify their energy production matrix by introducing nonconventional renewable energy. Unfortunately, there is no homogeneity in the way that Colombian utilities are moving toward modern technologies and business models; a case-by-case analysis is required.

Several foreign companies, together with Colombian utilities, have developed pilot projects in nonconventional renewable energy. For example, Grupo EPM, in collaboration with Nordex, built the country's only wind park to date in La Guajira in 2004. The Jepirachi wind park has 15 Nordex N60/1300 turbines for a total nominal power of 19.5 megawatts, which equals 0.1 percent of the total net generation capacity of Colombia.

The Jepirachi wind park has stimulated interest in nonconventional renewable energy among the public and private sectors in Colombia. In 2021, 16 wind energy projects will be implemented in La Guajira (see Chapter 6).

At the time of the writing of this report, Grupo ECOPETROL announced that it would diversify its energy sources by integrating nonconventional renewable energy. This strategy shift seems to be in response to Law 1955 of 2019, which was debated in Colombia's congress in 2020 and published in March 2021 (see Chapter 4). The law requires energy wholesalers in Colombia to purchase between 8 and 10 percent of their energy from nonconventional renewable sources by 2023 [11]. However, Grupo ECOPETROL shows a global tendency toward making their operations in the oil and gas industries greener.

Overall, Colombian utilities seem impelled to transform their business models because of the impacts of climate change, the consensus surrounding decarbonization revealed in measures such as the Paris Agreement, and public pressure to mitigate the impacts of climate change [a].

3.2 Access to Energy

The average energy consumption per sector between 1998 and 2018 was reported by the Mining and Energy Planning Unit (UPME) in 2019 (see Table 3.1). Energy for residential use, the largest sector, comes mainly from hydropower and gas [6]. The industrial sector has a greater diversity of energy sources, led by coal, followed by natural gas, and finally bagasse (a type of biofuel) and hydropower. Energy for the tertiary sector comes mainly from coal, oil, and hydropower, and to a lesser extent from nonconventional renewable sources such as solar power [6].

Table 3.1. Average Energy Consumption in Colombia, 1998–2018

Sector	Energy Consumption
Residential	42 %
Industrial	33 %
Tertiary	25 %
Total	100 %

Source: [6].

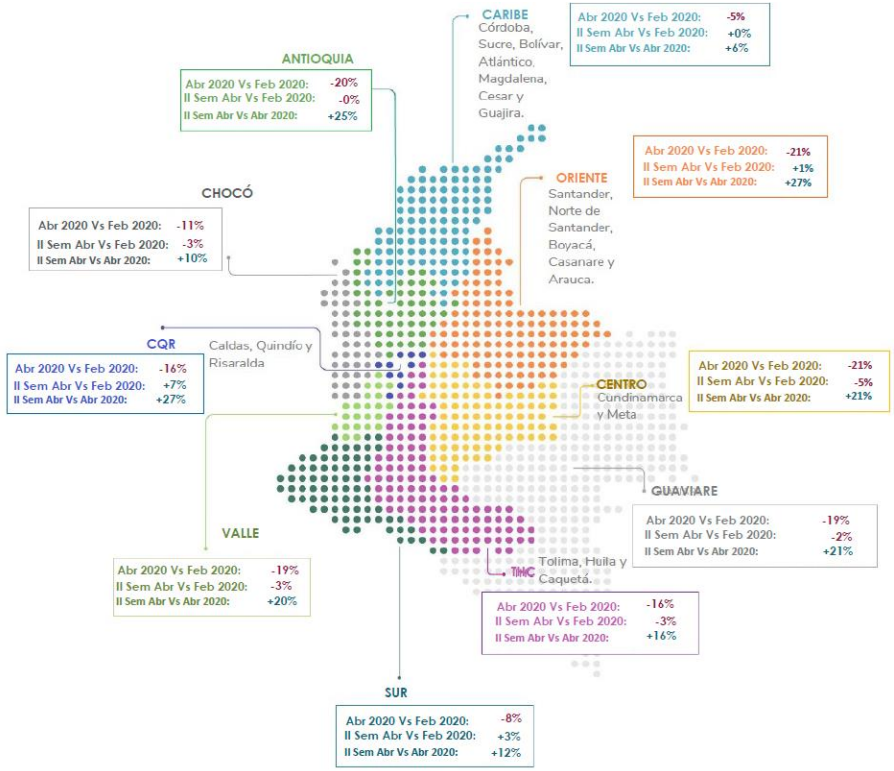
Although parts of Colombia are joined by a connected energy grid, several non-interconnected zones (ZNIs) comprise approximately 66 percent of the national territory of Colombia. Many of these zones cannot be reached by electricity distribution grids. These ZNIs span 17 departments, 5 capital cities, 54 municipal capitals, and 1,262 localities [30]. Most of the energy demand in these areas is supplied by diesel generators because of their high availability and extended network of suppliers, components, and services. In addition, they have low operating costs and are relatively cheap and easy to maintain. However, difficulties arise when operating diesel generators in remote areas, which increases the transportation, fuel, operation, and maintenance costs. Diesel generators are also high polluters that produce large amounts of GHGs and other emissions that directly impact the atmosphere.

Nonconventional renewable energy is considered to be a solution for energizing ZNIs, reducing GHG emissions, and promoting the efficient use of natural resources (see, for example, the work of the Administrative and Special Planning Region of Central Colombia). In off-grid communities in La Guajira, many micro-businesses and households have acquired second-hand solar panels.[2] However, given the poor condition of these solar panels and the lack of tools and equipment to repair them, most are not in use [a]. Most communities have some form of "back-up" power generation capacity. Back-up generators are typically fueled with diesel or gasoline, and capacity can be as little as a few kilowatts. There is unfinished infrastructure to connect off-grid systems such as street lights, which might be developed as part of the investment in new wind parks in the region in

[2] This information is based on fieldwork in Colombia.

2021. Another disadvantage of working in ZNIs is the poor implementation of the distribution network in these areas due to high construction and operation costs [27, 28]. Nevertheless, there is ample opportunity for small-scale projects [a].

Fig. 3.4. *Colombian Energy Demand by Region.*



Source: [31].

According to the variation in consumption in April 2020 compared to February 2020 (see Fig. 3.4), there is growing energy demand in all regions in Colombia. The regions with the greatest recovery as of April 2020 are: Oriente (increase of 27%; indicated in orange in Fig. 3.4), Caldas-Quindío- Risaralda (increase of 27%; indicated in blue in Fig. 3.4), and Antioquia and Centro (increase of 25%; indicated in green in Fig. 3.4). These variations indicate the increasing demand of electricity [31].

In April 2021, the sectors with the highest growth were industry, agriculture, and construction, presenting growth of 10%, 3.8%, and 3%, respectively [31].

The following section presents the general challenges faced by Colombian utilities in the transition to nonconventional renewable energy.

3.3 Challenges and Opportunities for Colombian Utilities

The transition to a sustainable energy system will require a business model that embraces long-term investments toward diversification. This also entails adequate education to prepare a workforce for jobs in the nonconventional renewable energy sector. At the same time, education is needed to teach end users about energy use and investment in small- and large-scale nonconventional renewable energy projects [a]. There is a general perception in Colombia that nonconventional renewable energy is expensive and that large-scale projects have negative impacts on nearby communities [a]. Nonconventional renewable energy technologies compete with "low-

cost" energy sources such as coal and hydroelectricity, which are the traditional energy sources in Colombia.

The Colombian government has traditionally subsidized public services such as electricity, regardless of the energy source, for vulnerable people in both urban and rural areas. Subsidies were also implemented during the Covid-19 pandemic. This subsidy policy discourages investment in nonconventional renewable energy [a], because the price formation of the electricity tariff is market-based and technology neutral; subsidies are given based on income, rather than favoring low-carbon sources [a]. Therefore, in practice, this subsidy policy acts as a barrier to investment in nonconventional renewable energy [a].

Several small-scale renewable energy initiatives are emerging in Colombia, with small and medium enterprises (SMEs) playing a bottom-up role toward E2050. SMEs are an important part of the supply chain of Colombian utilities, and key partners for implementing innovative renewable energy projects. There is a long tradition for agencies and international organizations to cooperate to facilitate nonconventional renewable energy partnership agreements between utilities and SMEs. For example, the Inter-American Foundation (IAF), International Finance Corporation (IFC), Inter-American Development Bank (IABD), Fondo Multilateral de Inversiones (FOMIN), World Bank (WB), and Corporación Andina de Fomento (CAF), among others, are natural alliances for financing nonconventional renewable energy projects. These agencies and organizations can act as financial partners in projects related to nonconventional renewable energy, which can help to strengthen the dialogue, leadership, and negotiation between Danish and Colombian firms.

4 Legal Framework of the Colombian Energy System

Colombia has a positive legal framework and market conditions for investment in nonconventional renewable energy [a]. Its national strategies and long-term public policy plans are aligned with global frameworks of energy decarbonization, which emphasizes the potential of FDI in the energy transition.

Colombia's Green Growth Policy, which was approved on July 10, 2018 (CONPES 3934), seeks to improve productivity and economic competitiveness by 2030 while ensuring social inclusion and the efficient use of natural capital in a climate-friendly manner. The Green Growth strategy integrates policies, activities, and goals that are consistent with the tenets of the 2018–22 National Development Plan ("Pact for Colombia, Pact for Equity"), which seeks to achieve a balance between conservation and productivity to ensure Colombia's natural resources are a strategic asset—and remain so for the foreseeable future.

An important legal enforcement was approved in March 2021, namely Law 1955 of 2019, through which the 2018–22 National Development Plan establishes a pathway for the diversification of Colombia's energy matrix (Article 296). To achieve a complementary and resilient energy matrix and meet commitments to reducing carbon emissions, wholesale energy suppliers are obligated to purchase between 8 and 10 percent of their energy from nonconventional renewable sources through long-term contracts by 2023. This is enforced by market mechanisms and regulation. The foregoing is without prejudice to the fact that the marketing agents may have a higher percentage than that specified in Article 296. This resolution (40060) was published by the Ministry of Mines and Energy (MME) on March 3, 2021.

The E2050 shows a political understanding of the advantages of diversifying the energy matrix by adopting nonconventional renewable energy [a]. It appears to be clear to the Colombian government that the energy transition can no longer be reversed. While the government takes a neutral position regarding technology choice, government ministries are responsible for setting the legal framework and the norms and regulations for the energy transition.

The following entities have direct responsibility for establishing the legal framework and regulations:[3]

- Ministry of Mines and Energy (MME)
- Mining and Energy Planning Unit (UPME)
- Energy and Gas Regulatory Commission (CREG)
- Institute for Planning and Promoting Energy Solutions for Non-interconnected Zones (IPSE)
- Intersectoral Commission for the Rational and Efficient Use of Energy and Nonconventional Energy Sources (CIURE)
- Financial Support Fund for Energizing Non-interconnected Zones (FAZNI)
- National Royalties Fund (FNR)

To facilitate inter-institutional collaboration, Colombia has introduced several intersectoral agendas, such as the Interministerial Strategic and Environmental Agendas of the Ministry of Mines and Energy (MME) and Ministry of Environment and Sustainable Development (MADS). These agendas provide a forum for correspondence and feedback between ministries to review environmental aspects of energy sector projects, which is of particular importance for ensuring compliance with current legislation on environmental licenses for generation and transmission projects in the electricity sector [a].

The amendments to the legal framework on nonconventional renewable energy are derived from the National Strategy for a Circular Economy (ENEC 2018–22) and the E2050 plan. These strategies emphasize the importance of coordination between the national government and the private sector to fulfill key objectives such as the diversification of the energy matrix.

A major milestone in advancing the legal framework was the approval of Law 1715 [a] in 2014, which is the main legal instrument for the energy sector in Colombia. Law 1715 recognizes that the energy sector is based on an open and competitive market. The Colombian legal framework is thus designed to respond to the principles of efficiency, quality, adaptability, neutrality, and solidarity [32]. These principles are a major attraction for FDI in the Colombian energy system. Law 1715 aims to promote the development and use of sustainable energy sources (particularly nonconventional renewable energy) in the national energy system by integrating them into the electricity market, increasing their prevalence in non-interconnected zones (ZNIs), reducing GHG emissions, and achieving energy supply security [8]. Law 1715 also recognizes the need for the ongoing revision and improvement of energy-related regulations, such as those on co-generation and the commercialization of surplus electricity.

[3] The acronyms relate to the Spanish names of the entities.

Law 1715 establishes a series of stipulations for key aspects of the functioning and development of the renewable energy sector, such as providing fiscal incentives for investment, defining responsibilities among ministries, and establishing financial and operative instruments for different types of nonconventional renewable energy. The four main incentives identified in Law 1715 [31] are shown in Table 4.1. Any company that wishes to participate in energy projects in Colombia must first fulfill the legal requirements to establish a company for Colombian public services. They would then be able to access fiscal incentives and public tenders in the energy system.

Danish subsidiaries in Colombia can access fiscal incentives and public tenders in nonconventional renewable energy.

Table 4.1. Colombian Fiscal Incentives

Incentives	
Tax	• Deduction of 50% of the investment profits for tax purposes on the project for 15 years. This applies to energy generation projects only. • Tax exemption on imports of machinery and other necessary supplies for the project.
VAT	• Waiver of that VAT on the purchase of equipment, elements, and machinery or the acquisition of necessary services for the project.
Depreciation	• Accelerated depreciation of applicable assets, equipment, machinery, and civil projects needed for the project (which provides tax relief over time).

Source: [33].

These incentives are related not only to energy production but also to energy efficiency, with a focus on SMEs, to encourage the implementation of nonconventional renewable energy solutions. This is particularly important for foreign companies, such as Danish firms, which may engage in technology transfer and exports to Colombia of machinery, equipment, and other goods related to energy production and energy efficiency solutions.

Law 1715 also establishes an innovative and complementary special fund, the Nonconventional Energy and Efficient Energy Management Fund (FENOGE—Fondo de Energías No convencionales y Gestión Eficiente de la Energía), which aims to support nonconventional renewable energy projects and provides an incentive for potential investors to implement pilot projects [34]. In addition to Law 1715, the CREG-030 resolution provides more clarity and a positive sense of the progressive advancement of the regulatory framework on the topics of distributed and small-scale generation for the national interconnected system, while CREG-038 addresses self-generation in non-interconnected zones (ZNIs). Appendix B presents a selection of the regulations focused on the implementation of nonconventional renewable energy projects.

In April 2021, the Colombian Government announced the "Sustainable Solidarity" tax reform bill, which will be implemented in January 2022.

This bill provides monthly VAT compensation (5% rate[4] up to a fixed maximum of Col$50,000) for power inverters, solar panels, and load controllers for solar energy systems with panels, as well as machinery and equipment for projects that generate energy with certified reductions in GHGs [35]. The five percent VAT rate will also apply to bicycles and electric bicycles whose value exceeds 50 UVT[5] (approximately Col$1.8 million or US$500), motorcycles that do not exceed 50 UVT in value, and all skateboards and electric scooters.

In recent years, Colombia has seen an increase in the use of electric vehicles, particularly electric bicycles. Colombia has made great progress in electromobility. The public transport fleets in the cities of Bogotá, Cali, and Medellín all include electric taxis and buses. In Bogotá, tenders for fleets of electric buses worth Col$9 and 12 million (more than 300 units in total) were awarded in 2019, which should begin operation in the SITP (Integrated Public Transport System) at the beginning of 2021 [36].

With the goal of turning Medellín into the capital of electromobility in Colombia and Latin America [36], in August 2019, the mayor of Medellín announced the arrival of a fleet of 65 electric buses to enter the city's public transport system. The city of Cali has taken the same path, where a fleet of 26 electric buses are already in circulation that will be integrated into its Western Mass Integrated (MIO—Masivo Integrado de Occidente) bus rapid transit system.

The first electric taxis—three BYD e5's (a compact all-electric car manufactured by BYD, China)—are already in operation in Medellín, as part of a project to introduce 200 of these taxis by the end of 2019 (unconfirmed figure) and a total of 1,500 electric taxis for the Antioquia capital in 2023.

The expansion of electromobility schemes demonstrates that the increasing electricity demand in Colombia, as indicated in Fig. 3.4, is likely to continue to rise.

4.1 Energy Market: *PPAs and Spot Market*

The Colombian energy market is divided into two segments: the long-term bilateral contract market and the short-term spot market. The actors that can participate in these markets are energy producers, energy suppliers, and large-scale consumers or non-regulated users. (The Energy and Gas Regulatory Commission (CREG) establishes the minimum consumption limits necessary to become a "non-regulated user"; see Table 4.2.)

[4] The standard VAT rate in Colombia is 19%.

[5] Certain Colombia tax regulations are based on the "Tax Value Unit" (UVT—Unidad de Valor Tributario) value. The UVT value is adjusted yearly; as of 2021, 1 UVT is equivalent to Col$36,308 (US$10).

Table 4.2. Non-Regulated Users According to CREG Resolution 131 of 1998

Characteristics of non-regulated users
• An average monthly power demand of 100 kilowatts for six months. • An average energy consumption of 55 megawatt-hours per month over the previous six months. • Users with high peak consumption can be non-regulated users if they exceed the power limit or if their energy consumption is constantly high, regardless of their power demand.

Source: [37].

In the long-term market, energy producers register purchase contracts known as power purchase agreements (PPAs) with energy suppliers for the supply of energy to users of the regulated market. PPAs are a private initiative [a]; neither the MME nor UPME intervene in this process.

PPAs are signed between energy commercialization utilities (wholesalers), who represent the end-user in the market, and energy producers (generators).

While hydroelectric energy producers might sign short-term (2–5 year) PPAs, this is not common in Colombia [a]. Thermal energy utilities tend not to sign PPAs owing to the expense of thermal energy and their need to meet the reliability charge. The reliability charge scheme is a remuneration scheme that promotes the expansion of energy generation plants in Colombia while also guaranteeing that, in situations where there is an undersupply of energy, existing and new plants are available to meet demand at an efficient price. For example, the reliability charge is applicable to hydroelectric energy suppliers to ensure supply even in times of drought [a]. This makes it possible to invest in electricity generation resources that can guarantee energy supply during times of critical supply through long-term motions with stable income [38].

A problem for nonconventional renewable energy producers (generators) is that, until 2019, PPAs had short terms (2–5 years). These short-term PPAs have been used throughout Colombian history. However, the two- to five-year duration of PPAs is often too short to finance nonconventional renewable energy projects. For example, to make the construction of a wind park financially feasible, the developer requires a fixed income for the duration of the project.

In 2019, Colombia introduced a scheme for long-term (15–25 year) PPAs. Long-term PPAs minimize market price uncertainty, which is beneficial for large electricity consumers to reduce investment costs associated with planning or operating nonconventional renewable energy projects [a]. Further, producers of renewable power have an advantage when entering into long-term (e.g., 15 year) PPAs, because the costs of renewable power, once up and running, are fairly constant.

Colombia introduced a public auction system for nonconventional renewable energy projects to avoid discretion in the assignment of projects [a]. The public auction process is streamlined with simplified procedures and requirements for participation. It seems that PPAs are used as an opportunity to increase nonconventional renewable energy in regions (such as La Guajira) in which the government is unable to provide extended investment and subsidization [a].

Utilities in Colombia with investments in both conventional and nonconventional energy are able to sign PPAs that combine different sources of energy. This strategy could be used to mitigate the inherent intermittency of solar and wind energy, which clashes with the desires of Colombian energy wholesalers to guarantee a constant energy supply. Energy wholesalers aim to buy energy that will fulfill their sales commitments. However, this scheme has not been implemented in Colombia. Further, this might prove problematic for companies entering the Colombian energy market dealing only with wind or solar energy, for example, as they may be seen as less stable than Colombian utilities that have established investments in hydro or thermal energies and are now branching out into the nonconventional renewable energy sector.

Public PPA auctions

The scarcity of long-term PPAs complicates and risks the funding of certain electricity projects [29]. However, in October 2019, Colombia held its first successful public auction for long-term agreements in the commercialization and production of nonconventional renewable energy, with the aim of attracting and facilitating large-scale nonconventional renewable energy in Colombia. Table 4.3 presents the main characteristics of the auction [3].

Table 4.3. Colombian Public Tender on Nonconventional Renewable Energy (October 2019)

Characteristics of the first public tender on nonconventional renewable energy
• Exclusive auction for nonconventional renewable energy • Projects with a capacity of ≥5 MW • Energy by hourly blocks • Financial commitment to the contract • Sellers can cover their obligation with other mechanisms • Price in Colombian pesos updated with Producer Price Index (PPI) • Obligation due from January 1, 2022 • Contract term: 15 years

Source: [a, 3].

Public and private auctions make the Colombian energy system attractive to both local and foreign investors, as they appear to have stimulated the energy market toward long-term PPAs in nonconventional renewable energy.

The auction mechanism was designed to provide flexibility, with simpler requirements for participation, less rigid competition criteria, and, in general, balanced rules to guarantee the financial viability of

the projects and adequate contracting conditions for the demand. The 2019 tender attracted utilities and investors from China, Canada, the United States, Portugal, and other countries with established subsidiaries in Colombia [39].

The nonconventional renewable energy auction in 2019 garnered more national and international attention than expected, demonstrating the market demand for tenders [a].

Approximately 80 percent of the nonconventional renewable energy projects that were assigned in the 2019 auction (see Table 4.4) were wind projects in La Guajira with a projected energy output of at least 150 megawatts. The commercial operation dates of the awarded contracts of the 2019 tender have a window between 2022 and 2025. The resulting contracts specified time slots for the delivery of energy, adjusted to the times when there is more solar radiation or wind, enabling energy to be acquired at different prices depending on the generation mechanism [3].

Public auctions in Colombia are conducted in Colombian pesos. While the ministry is open to considering potential auctions in US dollars, there are no definite proposals in this regard [a]. Therefore, foreign investors and energy producers should consider the cash exchange between Colombia and foreign countries when investing in Colombia [a].

Table 4.4. Colombian Public Auction on Nonconventional Renewable Energy

Mechanism	Auction (176 contracts)	Complementary (84 contracts)
Agents	22 suppliers/7 producers	28 suppliers/3 producers
Total effective capacity	1,298.9 MW	75 MW additional
Assigned energy[a]	10,186 MWh-d	1,864.5 MWh-d
Technology	17.39% solar/82.61% wind	1.26% solar/98.74% wind
Average price[b]	95.65 Col$/kWh	106.66 Col$/kWh

Source: Mining and Energy Planning Unit (UPME) [39].

Note: a. One megawatt-day (1 MWd) is equal to one megawatt of power produced over a period of one day. b. Col$ = Colombian peso. Col$95.65 ≈ €0.02; Col$106.66 ≈ €0.03.

Following the 2019 tender, the Colombian government indicated that there would be upcoming tenders for nonconventional renewable energy production [a]. This may be because electricity generation utilities are struggling to find distributors willing to sign long-term contracts for their energy [a].

In Colombia, it is extremely difficult for an energy producer to sign long-term power purchase agreements (PPAs) *[a]. There are over 100 generation projects with approved connections that have struggled to purchase long-term energy agreements [a].*

There are currently sufficient approved projects with approved connections to ensure significant new energy capability. The issue is that utilities are unable to sell electricity [a]. Projects are not attractive to investors or banks if a PPA cannot be secured. The main obstacle to nonconventional renewable energy projects in Colombia is securing a grid connection, followed by making the project financially viable. Securing long-term PPAs is a key factor in making nonconventional renewable energy projects financially possible [a]. In Colombia, many of the available connections are occupied by projects that will never be completed. As a result, the regulator is looking at removing impediments [a]. Despite these challenges, the Colombian energy market is attractive to international investors.

Colombia has moved from PPAs between individual utilities to a more standardized process via a web platform (SICEP MEM; https://sicep.xm.com.co/). The operating administrator of the energy market is the organization XM (https://www.xm.com.co/).

Private PPA auctions

In November 2020, Bogotá-based RenoVatio, an energy wholesale company, launched Colombia's first private auction of PPAs for the commercialization of renewable energy. The PPAs were for the purchase of up to 20 gigawatt-hours of renewable energy every month for terms of up to 25 years. RenoVatio's energy portfolio includes non-regulated users [29]. Non-regulated users negotiated to obtain RenoVatio's PPAs. The Ministry of Mines and Energy (MME) views private initiatives for auctions in renewable energy in a very positive light, because it helps to promote nonconventional renewable energy projects in Colombia and advance the agenda of the E2050 plan [a]. The 2019 public auction arose due to a lack of contracting mechanism; thus, the introduction of private auctions is good for the market, as it will facilitate a mechanism for long-term contracting [a].

Investors, especially in European countries such as Belgium, the United Kingdom, Spain, and Germany, expressed strong interest in RenoVatio's private auction [a, 29]. The auction was intended for medium-sized projects with the aim of providing a creative solution to legal barriers to renewable energy project financing in Colombia. This removes a barrier that formerly prevented energy wholesale companies from signing long-term electricity contracts [40]. In Colombia, industrial users cannot currently sign contracts directly [a].

Participation in RenoVatio's auction was open to every nonconventional renewable energy project, as specified by the MME under Law 1715. This includes wind, solar, biomass, and minor hydroelectric facilities (less than 20 megawatts).

Spot Market

Spot market contracts present a different path for energy investors without obtaining PPAs. A spot contract is an offer to purchase or sell

a particular volume of a specific product for instant distribution at a certain price [a].

The prices for the spot market are calculated by the firm XM based on an Economic Dispatch Model. This functions as follows [41]:

- Energy buyers offer a price to purchase energy, while energy suppliers present a price to sell the energy they produce.
- These prices are then ranked from low to high, and the price is fixed when the offer price matches the energy demand. This price is from "the day before."
- The energy suppliers present an offer each hour for the following day ("next day"). Thus, there is a spot price for each hour for "the next day."
- XM tells the suppliers which utilities will generate energy for that hour [a].

The system operator computes the optimal schedule for each unit of thermal and hydro energy for each hour of the next day and for the international interconnection with neighboring countries such as Ecuador [42] (see Table 4.5).

The Economic Dispatch Model has proven to be valid in the past decades and has not impeded the development of electrical systems in Latin America. However, it could generate inefficiencies in the future if intermittent renewable energy resources reach substantial market penetration [41, 42]. Additionally, other challenges with the model include the slow speed of modernization in the short term. In addition to state auctions of renewables, DERIVEX and Mercantile Exchange mechanisms have been implemented, which indicates that the Colombian market for nonconventional renewable energies has entered a stage of risk management (Portfolio Theory).

Table 4.5. Economic Dispatch Model (Day Ahead Hourly Dispatch)

Characteristics	• Price bid • Declaration of availability • Transmission constraints (represented by the area's import/export limits and network constraints) • Up and down reserve for Automatic Generation Control (AGC) • Unit characteristics • Forecast of demand • Reliability information
Coordinated Dispatch	• Interconnections price curves (exportation) • Import price curve
Optimization	• 24-hour optimization process aimed at the minimization of operating costs subject to generation and network constraints.

Source: [42].

The spot market is open 24 hours a day, and all energy suppliers registered in the market are obligated to participate. There are explicit trading rules. The contracted energy is independent of the short-term price. The spot marketers are those who serve users and provide them with the billing service. They can sell to non-regulated users (Table 4.2)

at unrestricted prices, and to regulated users at regulated prices. Non-regulated traders and users enter into energy contracts with energy suppliers, thereby setting the price of electricity without state intervention. Note that non-regulated users are represented by a Colombian energy commercialization company (an intermediary) in this process; they cannot negotiate directly with energy suppliers.

The spot market is highly volatile. Price variance of up to 90 percent is possible in any given week, with price increases of three or four times in a matter of months [a, 29]. Price certainty is scarce, especially when looking at longer timeframes (>60 days), as seemingly innocuous factors such as weather conductions can have a significant influence on energy production.

According to financial experts [a], banks are reluctant to fund projects that lack long-term contracts [a]. The last year (2020) has been particularly unpredictable. The year began with strong spot market values because it had not rained in Colombia since November [45]. This was swiftly followed by the arrival of COVID-19. The ensuing lockdowns resulted in a 15–20 percent drop in energy demand in Colombia for many months. Energy consultants suggest that Colombia would have experienced a power supply deficit in 2020 if not for the lockdowns [29].

Danish companies are expected to be at an advantage in the auction process because of their position as world leaders in green transition according to the Environmental Performance Index's average ranking of 82.50 [43].

Denmark's ranking in the Environmental Performance Index [43] reflects public and private investments in research and development (R&D) to produce technology, equipment, and machinery associated with nonconventional renewable energy. For example, Denmark is a world leader in onshore and offshore wind energy. There are different financial institutions that can finance long-term approaches in nonconventional renewable energy projects, which are presented in the following section.

Box 4.1. Power Purchase Agreements (PPAs) vs. Spot Market—Lessons from Emerging Markets

	Characteristics	Risk
PPAs	• PPAs set out the terms of bilateral agreements in which one organization buys energy from another. The main elements of a PPA include the price for capacity, the price for energy (the marginal cost of electricity), and the number of years it will last. • PPAs offer long-term contracts (15–25 years) between parties to purchase a certain amount of energy for future delivery. • PPAs allow for lower capital costs (for both consumers and developers) and higher asset values on the open market. • PPAs demonstrate a commitment to renewable energy and compliance with government regulations. • PPAs act as a subsidy for participants. Consumers can purchase power for a lower price than from the grid, and developers receive funding at lower cost. • Developers reduce risk in projects through stable cash flow. • Consumers, usually from the large industry sector, benefit from locking in power prices at a discounted rate and protection from price fluctuations and volatile operating costs.	• Pricing meters generally cost at least US$8,000, and new transformers are typically needed for new suppliers. A full installation of meters and transformers across several plants can involve investments of more than US$1 million. The transformers are also highly customized, so purchase orders can take six months to complete. • All legally binding agreements are in Spanish. While English translations are available, it is the Spanish language version that will be legally binding. Firms should use local attorneys and consultants as part of the negotiation process.
Spot Market	• Prices are calculated in real time and what is known as "day ahead" prices. • Government operators take bids from producers, and then dispatch the least expensive plants first. This proceeds on to the higher-cost dispatch until the domestic power demand is met. • The kWh price paid is fixed at the value of the last kWh dispatched.	• Prices fluctuate depending on several factors such as supply, demand, oil prices, maintenance, and plant state, among others. • The pricing mechanism is advantageous for consumers—particularly large consumers of energy including manufacturers and companies with a large real estate footprint—because it forces power producers to focus on lowering operating costs to bid lower prices and thus have more of their bids accepted.

Source: [44, 45].

4.2 International Institutional Framework and Market Incentives for Nonconventional Renewables

Various financial instruments and institutions provide Colombian and foreign firms with access to finance for nonconventional renewable energy projects in Colombia. Colombia and Denmark's commitment to the Paris Agreement provides an opportunity to access to such finance. Article 9 of the Paris Agreement states the following:

> *Developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation in continuation of their existing obligations under the Convention [20].*

The Paris Agreement strongly urges developed country parties to scale up their financial support, with a concrete roadmap to achieve the goal of jointly providing US$100 billion annually by 2020 for climate change mitigation and adaptation [46]. Article 2.1-c states that the global response to the threat of climate change should be strengthened by "*Making finance flows consistent with a pathway toward low greenhouse gas emissions and climate-resilient development*" [46].

Colombia's E2050 plan provides a business case for access to finance to invest in nonconventional renewable energy projects through different financial institutions that provide access to finance, aligned to the commitments of the Paris Agreement (see Table 4.6).

The financial institutions presented in Table 4.6, in addition to development and commercial banks worldwide, have created financial instruments such as special climate funds to motivate private-public investors to divest from fossil fuels and invest in low-carbon projects. For example, green bonds are a financial innovation to encourage investment in climate businesses.

The proliferation of energy transition-related financial instruments acts as a positive incentive for developing the nonconventional renewable energy market in Colombia. In 2017, the Colombian banks Bancolombia and Davivienda became the first private banks in Latin America to issue green bonds [a, 53]. The Nonconventional Energy and Efficient Energy Management Fund (FENOGE) is a public fund in Colombia that complements the development of nonconventional renewable energy projects [34]. These financial instruments provide large incentives for companies to propose and plan new nonconventional renewable energy projects. This provides an opportunity for Colombian firms and/or Danish subsidiaries established in Colombia to access finance and for Danish firms (exporters) to protect their investments.

Table 4.6. Access to Finance

Institution	Description
EKF	Eksport Kredit Fonden (EKF) is a Danish credit agency that assists both large and small Danish enterprises with financing and/or insurance against the financial and political risks of trading with other countries [47].
IFU	The Investment Fund for Developing Countries (IFU) was established by law in 1967. IFU is a self-governing institution with the objective of promoting investments that support sustainable development in developing countries and contribute to the realization of the Sustainable Development Goals (SDGs) [48].
P4G	Partnering for Green Growth and the Global Goals 2030 (P4G) is a group of civil society and private- and public-sector organizations who are working together to advance innovative and commercially viable projects in at least one of these five SDG sectors: food and agriculture (SDG 2), clean water (SDG 6), clean energy (SDG 7), sustainable cities (SDG 11), and circular economy (SDG 12) [49].
GCF	The Green Climate Fund (GCF) was established by 194 governments to limit or reduce greenhouse gas (GHG) emissions in developing countries and to help vulnerable societies adapt to the unavoidable impacts of climate change. GCF operates through a network of over 200 accredited entities and delivery partners who work directly with developing countries for project design and implementation [50].
SCCF	The Special Climate Change Fund (SCCF) was established under the United Nations Framework Convention on Climate Change in 2001 to finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry, and waste management; and economic diversification [51].
BR	BlackRock (BR) is the world's largest investment manager. BR provides investment management, risk management, and advisory services for institutional and retail clients worldwide. Its products include single- and multi-asset class portfolios investing in equities, fixed income, alternatives, and money market instruments [52].

Source: [47–52].

It is clear that the E2050 plan presents business opportunities. However, the consideration of financial institutions is always to what degree a proposal (the E2050 plan energy transition) is really "bankable" [a]. There is still a question as to whether financial institutions are willing to finance energy transition projects. In the case of Colombia, some financial institutions have commented that, although there is a need to mitigate climate change and political will to increase the share of nonconventional renewable energy in the electricity matrix, there is no certainty that the system is ready for the energy transition; therefore, the projects involve a high level of risk [a].

> *In practice, project risk generates a gap between the financing instruments available and the appetite of financial institutions to finance [a].*

Risk is not only limited to the financial aspect of energy projects; social issues are another key element to consider. This concern is presented in the following section.

4.3 Social Issues: *Right to Consultation*

To achieve the proposed energy transition in Colombia, it is insufficient to implement a purely technological transformation. The social context is of equal or greater importance because changes to the energy matrix reflect and are defined by the social, political, and even cultural contexts in which they occur.

Private- and public-sector representatives and indigenous people emphasize the importance of improved consultation processes [a, 54]. Law 1715 is complemented by specific technical standards that regulate the long-term stability of FDI and serve as the principal resource for communities and civil society to protect their territory and ensure that FDI has a positive impact. However, there are still major challenges for the operation and implementation of energy projects regarding effective and constructive dialogue with civil society and indigenous communities. There is a need to provide information about the aims of energy FDI and the technicalities of nonconventional renewable energy to facilitate awareness of energy efficiency at the organizational and societal levels. Information sharing related to the design, building, and management of nonconventional renewable energy projects might facilitate an understanding of nonconventional renewable energy technologies and investments.

There appears to be a consensus among private and public organizations and civil society [a] for the need to improve practices for the *right to consultation*. The right to consultation in La Guajira has proved to be inadequate in reflecting the positive transformative potential of energy in terms of coordination among stakeholders [a]. In 2019, the Directorate of the National Prior Consultation Authority (DANCP—Dirección de la Autoridad Nacional de Consulta Previa) drew up a short-, medium-, and long-term regulatory plan. Colombia signed ILO Convention 169 in 1991. In 2007, 144 members including Colombia ratified the United Nations (UN) Declaration on the Rights of Indigenous Peoples, which states that (Article 31.1):

> *"Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions…" [55].*

However, there has been no clear and specific regulation on the rights of indigenous people, such as the right to consultation according to the principles of "free, prior, and informed consent" (FPIC) [a]. Regulations have been issued for inter-institutional coordination between public entities in Colombia, but the regulations have been framed by what the constitutional jurisprudence has stipulated to the DANCP [a]. Colombia has challenges in providing clear and specific regulations on prior consultation. According to the Colombian constitution, fundamental rights must be regulated through statutory law. Therefore, prior consultation—which is a fundamental right of indigenous peoples—must be regulated through statutory law [a].

The Colombian legal framework does not regulate a certain timeframe for prior consultation processes. However, the government has established transformational indicators for the consultation timeframe. There are different time indicators for different stages of the consultation process. The first stage of the process asks whether further consultation is needed based on the social-cultural context where the project will be built. For projects that do not need verification visits, given their nature and location, this needs to be documented. There has historically been a delay if a project does require field (verification) visits. In many cases, this stage has taken years to complete. Nevertheless, the timeframe has improved (see Table 4.7).

The second stage, which is the consultation process, can also take a long time. There is no longer a minimum time goal, but there are cases where the consultation process has lasted up to five years. There are great difficulties and issues that depend on community response and company and government negotiation. A total of 5,269 consultation processes that were started before 2018 were ongoing in 2019. Since these projects had already taken a long time, the DANCP's objective was to simply close these queries by the end of 2022 [a]. As presented in Table 4.7, the majority (4,234) of these consultation processes were closed in 2020.

The DANCP's achievements in accelerating the consultation process and meeting their targets for 2021 and 2022, as presented in Table 4.7, demonstrate the Colombian government's commitment to improving the efficiency of consultation processes. This is key for the implementation of further nonconventional renewable energy projects in accordance with the E2050 plan.

Table 4.7. Consultation Achievements and Goals

Stage of Consultation	2019	2020	2021	2022
Stage 1: Projects requiring a verification visit	**Average time:** 147 business days	**Goal:** 123 business days **Achieved:** 109 business days	**Goal:** 87 business days	**Goal:** 60 business days
Stage 1: Projects not requiring a verification visit	**Average time:** 47 business days	**Average time:** 47 business days	**Goal:** 30 business days	**Goal:** To be defined
Stage 2: Consultation process	**Average time:** 1–5 years	**Goal:** To close 4,266 (77%) of 5,269 ongoing consultations **Achieved:** 4,234 consultations closed (i.e., 99% compliance)	**Goal:** To close 73% of ongoing consultations	**Goal:** To close 80% of ongoing consultations

Source: [a].

The DANCP's achievements are based on strategic changes in different areas [a]. First, the DANCP has developed intensive training programs for companies, communities, and judges to cultivate the notion that consultation is a fundamental human right, not just a procedure [a]. Second, the DANCP has proposed a geographic focus for consultation processes, rather than by sector (mining, oil, gas, infrastructure, and others). The same regulatory consultation framework is applied to all sectors. The geographic focus was proposed based on the inefficiencies observed by the DANCP in organizing multiple working groups to work with communities on similar issues for consultation processes in different sectors [a]. For example, consultation on infrastructure projects would be handled by the infrastructure group, whereas consultation about energy projects would be handled by the energy group, and so on. Multiple working groups resulted in inefficiency and led to community complaints about having to work with many people on the same issue. This had a negative effect on the groups' relationships with communities. Therefore, the consultation processes now have a geographical focus, with work groups determined by geographical area; regardless of the sector of a project, the same work group serves this area of the country. This will facilitate positive relationships with local communities [a].

Finally, there has been a "shift in the chip" [a] (a shift in mindset) from the notion that prior consultation processes are transactional negotiations in which groups are provided resources and/or aid in exchange for allowing an organization to continue with a project. Instead, there is a focus on creating permanent dialogue with communities [a]. The agreements must meet basic needs and all parties must understand that it is a long-term relationship. The DANCP argues that this has helped it to *gain legitimate trust as a government* [a]. The DANCP has been assigned more resources and more staff in the last two years, which has helped it to accomplish these recent achievements [a], as presented in Table 4.7.

In the midst of the COVID-19 pandemic, the DANCP conducted its first-ever online consultation process with the indigenous Mokaná community for a solar energy project [56]. Although this appears to be a positive development given the current COVID-19 pandemic and the need to move forward with nonconventional renewable energy projects, it has provoked uncertainty for indigenous people such as the Wayúu people in La Guajira, because many of them do not have access to the internet, mobile phones, tablets, or even reliable electricity.

As previously stated, public consultations can be challenging. Disputes can escalate between local communities and government representatives before an agreement is reached. In the event of a lack of agreement, the Colombian government has established a *proportionality test*, which is explained in the following section.

Photo 4.1. *Goat Herders in La Guajira, 2019.*

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Proportionality Test

When no agreement is reached between the executing agency of the project and the local communities through the prior consultation process, a proportionality test is used to determine the outcome [57]:

> *Once the consultation process is finished, the proportionality test and determination of management measures will be applied in the event of the following: (i) a lack of agreement in the pre-consultation or consultation process; (ii) non-attendance of the representative authorities, once the established summons procedures have been exhausted; or (iii) a lack of resolution of the conflict of representativeness in the ethnic community. The purpose of the proportionality test is to determine the appropriate management measures to prevent, correct, or mitigate direct effects. The measures must be devoid of arbitrariness, based on criteria of reasonableness, proportionality, and objectivity, and will take into consideration the positions expressed by the ethnic community and by the promoting entity or the executor of the POA [project, work, or activity]. The maximum term of the proportionality test is three (3) months [57].*

Implementing proportionality tests is challenging. Because of the COVID-19 pandemic, most consultation processes have been suspended. Decree 9/90 (Directive 08 of 2020 Presidency of the Republic) includes an exception that allows the DANCP to go to a site to conduct consultation processes with local communities [40]. The DANCP began many consultation processes on August 31, 2020. However, when a community does not agree to carry out a consultation process, the proportionality test arises. In such cases, Directive 8 broadens the spectrum, which enables the government to apply a proportionality test in the case of reluctance or a conflict concerning representativeness [a]. If a community does not want to meet for the consultation process because of the COVID-19 pandemic,

then it is very complex to apply the proportionality test process. The DANCP has not had a case where a proportionality test can be applied, and if it occurs, then it would be quite complex due to the COVID-19 pandemic [a]. The DANCP would have to analyze the particular case. No proportionality tests have been proposed in La Guajira [a] in relation to consultation processes for the proposed transmission line and wind energy projects.

Other Social Issues

Although Colombia has made advances in prior consultation processes, such as in online consultation and consultation for small-scale solar energy projects, Colombia is relatively new to large-scale nonconventional renewable energy projects, particularly for wind energy. The Jepirachi wind park has been an important step in raising awareness among local communities, utility firms, and politicians on the use of nonconventional renewables to secure sustainable and reliable energy [58]. However, local communities' awareness of nonconventional renewable energy investments is important, because these projects require large extensions of land, which, for onshore wind and solar projects, are largely inhabited by ethnic communities.

It might prove challenging to meet public consultation guidelines in non-interconnected zones (ZNIs) inhabited by ethnic communities. Large-scale mining, oil, gas, and hydroelectric investments have had negative impacts on the ethnic communities and marginalized communities that live close to such investments. For example, in La Guajira, where the largest open-air coalmine in Latin America (Cerrejón) is located, the Wayúu people have experienced negative impacts to their health and several of their goats have been killed by the train that divides their land to transport coal to Puerto Bolívar (see Map 5.1).

Photo 4.2. *Cerrejón's mine train tracks in La Guajira, 2019.*

Source: ©INDEPAZ, 2019. Reproduced with permission. Further permission required for reuse.

Compensation agreements between the mining firm and local communities are a matter of constant disputes [a]. The Wayúu people fear that they might encounter similar problems with investments in nonconventional renewable energy such as solar and wind [a].

Nevertheless, there is a unique opportunity to develop innovative civic partnership agreements, also known as civic community engineering or community renewable energy (CRE), to ensure the smooth development of large-scale nonconventional renewable energy projects in regions inhabited by indigenous communities.

Additionally, local and international investors in Colombia's E2050 plan can take the advantage of Colombia's legal instruments, international conventions and treaties when designing and implementing their investments. Table 4.8 presents the instruments available for the Colombian government and national and international firms to mitigate the effects on nonconventional renewable energy investments. These instruments can help to meet the Guiding Principles on Business and Human Rights [59], toward which Colombia has made important advances, such as the National Action Plan on Business and Human Rights that was launched in 2012 [60].

The United Nations Guiding Principles (UNGPs) on Business and Human Rights were endorsed by the UN Human Rights Council in June 2011 [59]. The "*protect, respect, and remedy*" framework of the UNGPs provides an internationally accepted business and human rights framework for states and corporations, and is considered the "most comprehensive discussion to date" of the relationship between corporations and human rights.

Table 4.8. Instruments: Legal instruments, Conventions, and Treaties

Guiding Principles on Business and Human Rights [59]	Instruments: Legal instruments, Conventions and Treaties
• **Protect** • **Respect** • **Remedy**	• The Colombian Constitution presents accountability procedures to protect the human rights enshrined in international treaties and recognizes social and economic rights. • ILO Convention 169 for "free, prior and informed consent" (FPIC) was ratified in Colombia in 1991 [18]. • OECD Declaration and Decisions on International Investment and Multinational Enterprises—Colombia is an adherent country of the Declaration since its incorporation as a member of the Organization in 2020 [61]. • European Union-Colombia Economic Partnership, Political Cooperation and Cooperation Agreement & Free Trade Agreement (FTA). Article 1 states: *To safeguard respect for fundamental human rights, it includes a standard democracy clause. Respect for democratic principles and fundamental human rights, as laid down in the Universal Declaration of Human Rights, and for the principle of the rule of law, underpins the internal and international policies of the Parties. Respect for these principles constitutes an essential element of this Agreement* [62]. • National Action Plan on Business and Human Rights, 2012 [60]. • Human rights impact assessments. • Cultural heritage impact assessments.

Source: [18, 59–62].

The framework includes three components:

- **Protect:** The state has a duty to protect against human rights abuses by third parties, including businesses, through appropriate policies, regulation, and adjudication. Governments should extend civil rights protections to include trade and investment agreements, export credit guarantees, and bilateral treaties, amongst other considerations.
- **Respect:** Corporations have a responsibility to respect human rights, which in essence means to act with due diligence to avoid infringing on the rights of others. Companies and the private sector should "do no harm" and comply with all applicable laws and social expectations.
- **Remedy:** Victims should have greater access to effective remedies. Formal dispute resolution processes should be created so that victims of abuses can seek and access redress.

These principles provide an opportunity for governments and firms to develop a dialogue with local communities that might be affected by nonconventional renewable energy projects. There is room for expansion and improvement, particularly regarding the third principle ("*remedy*"), such as through nonjudicial grievance mechanisms that enable affected communities to address wrongdoing [59].

Local and foreign firms are already holding virtual conferences to raise awareness among firms and civil society of the potential employment and regional development that nonconventional renewable energy can bring to Colombia. The DANCP have developed awareness programs for ethnic communities through videos in local languages. The DANCP created a cross-cultural cutting group that is dedicated to monitoring and controlling pilot projects. For example, a specific working group was created for La Guajira. This helps the DANCP to pay special attention to these projects and move them forward [a]. However, further effort in this area is needed, because there is still much skepticism and mistrust among certain ethnic communities in Colombia toward nonconventional renewable energy [a]. The Colombian Renewable Energy Association's *SER* Colombia collective [63] could be a key partner for Danish firms that seek to engage in dialogue with Colombian businesses to spread awareness about nonconventional renewable energy and to develop programs to publicize the benefits, requirements, and potential of nonconventional renewable energy projects.

To ensure that Danish firms are not limited by a lack of experience or knowledge of the particularities of the Colombian legal framework and energy system, in addition to the sociocultural structures in business relationships, training on these topics could be offered through the Danish Embassy in Colombia or local associations within the framework of governance in energy democracy.

Energy Democracy

Denmark's commitments to the Paris Agreement extend beyond Article 9. This suggests a collaborative effort between governments, companies, and communities to achieve climate objectives and the Colombian ambition to achieve the goals of E2050 plan. This context provides an excellent opportunity for Danish firms to invest in nonconventional renewable energy projects in Colombia and transfer good practices of the Danish energy model regarding integrating local communities, beyond simply meeting the FPIC principles of ILO Convention 169. For example, energy democracy schemes could be developed, with a particular consideration for local communities as key stakeholders in the development of electricity production systems.

Energy democracy is a bottom-up social movement that challenges the centralized monopoly of the energy sector in the transition to. It calls for decarbonization, access to renewable energy, and democratic decision-making [54].

Energy democracy schemes provide a framework for partnership structures between firms and local communities that can benefit from nonconventional renewable energy projects under equal conditions [66, 67]. Such partnership schemes are known in Europe (e.g., Denmark, Germany, the Netherlands, and the United Kingdom) as civic energy [a]. Box 4.2 presents an example of the civic energy cycle in the Municipality of Ringkøbing-Skjern in Denmark.

Box 4.2. Civic Energy Cycle: Ringkøbing-Skjern, Denmark

BACKGROUND

- After the 1970s oil crisis, Denmark prioritized research and development (R&D) and expenditure in green energies. This was widely advocated by anti-nuclear technology social movements.

CIVIC ENERGY CYCLE IN DENMARK

- In 2009, the Ministry of Energy was created to promote and coordinate the region's strategic energy strategy, provide knowledge, and monitor energy plans.
- It introduced a community-focused wind project ownership concept.

CHARACTERISTICS

- Residents living within 4.5 kilometers of the project received first preference to purchase shares.
- The Danish Ministry of Energy, Utilities, and Climate guaranteed loans for cooperative wind and solar investment initiatives.

MUNICIPALITY OF RINGKØBING-SKJERN

- Ringkøbing-Skjern is the largest municipality in Denmark by area (1,494 km^2), with a population of 57,148.

Map B4.2.1. Denmark.

Source: [64].

Civic energy is defined as "decentralized renewable energy generation owned (at least 50 percent) and operated by citizens, local initiatives, communities, local authorities, charities, non-governmental organizations (NGOs), farmers, cooperatives, or small and medium-sized enterprises (SMEs), creating a stream of local value that can stay within the region" [68].

Civic energy projects require a new perspective regarding dialogue; an improvement in the dissemination of reliable information about the energy system; and a capacity to understand and analyze such information to make collective decisions on energy investments [66, 68]. This is an opportunity to engage with the multicultural and indigenous population of Colombia.

A cultural change in Colombia is needed in terms not only of incorporating nonconventional renewable energy sources for energy production at large and small scales but also of other uses of nonconventional renewable energy [Law 1715].

Colombia has progressed their vision and regulations on the future configuration of the energy matrix in Colombia since the launch of the E2050 plan. However, there is a lack of cooperation among the various ministries to coordinate the E2050 vision internally on topics such as education, the environment, and nonconventional renewable

Table B4.2.1. Civic Energy Cycle at Ringkøbing-Skjern Municipality

Development of energy vision and priorities in 2008	• Conducted in collaboration with representatives of society. • Goal: Electricity self-sufficiency dependent on clean fuels by 2020, and by 2040, it would be free of fossil fuels. • An Energy Council was set up as part of the region's transition.

Source: [a, 65].

Table B4.2.2. Energy Council at Ringkøbing-Skjern Municipality

Energy Council	• Eighteen members, including city council members, officials from public sector agencies, businesses, and individuals. • The council held working committees on a regular basis to address tasks related to the achievement of the energy vision. • Members serve as ambassadors for the energy change. One of their responsibilities is to engage with community stakeholders to identify shared options for the region's energy change.

Source: [a, 65].

Fig. B4.2.1. View from Hvide Sande toward the Ringkøbing-Skjern Wind Park, 2020.

Source: ©Jacobo Ramirez, 2020. Further permission required for reuse.

energy [a]. In addition, there is a scarcity of public-private cooperation and strategic planning for renewable energy resources. Wind and geothermal sources are the electricity sources most hampered by these constraints [69].

The following section presents opportunities and areas to be aware of when developing cooperation and investment between Colombia and Denmark.

WIND ENERGY GENERATION AT RINGKØBING-SKJERN

- Wind energy generation was planned as part of Ringkøbing-Skjern's energy vision and priorities.
- The discussions for building the wind farm in the municipality of Ringkøbing-Skjern began in 2008 and lasted three years. It was a concerted effort on the part of city planners, residents, and landowners.
- According to Karsten Sandal, one of the wind farm's founders, dialogue was the key to progress:

> *"For three years, consultations with representatives of the group were conducted every weekend in order to reach a consensus for the construction of the wind farm."*

- At the end of the 1980s, farmers started to invest in wind turbines as part of the self-consumption scheme.
- The operators of wind turbines in Ringkøbing-Skjern decided to work together to build a single wind farm.
- The wind farm's legal structure is made up of those who own the property (60%) and the initial owners of the wind turbines (40%).
- A plan was devised to measure economic compensation to homeowners based on the scale and position of wind turbines. This, according to one of the park's founders, provided peace of mind in the negotiating period.
- The agreements were not individual; rather, they were jointly attained by all landowners, who earned a bonus on the selling price.
- According to recent reports of the municipality's strategic energy program, the wind farm saves the municipality about DKr 220 million (€29 million) a year.
- Ringkøbing-Skjern municipality has since entered arrangements with other municipalities in Denmark to supply them with excess electricity produced at Ringkøbing-Skjern.
- The energy transfer in Ringkøbing-Skern is dependent on several factors, including:
  1. **Electrification:** The vision of green energy self-sufficiency implies that emergency output in the Ringkøbing-Skern municipality is for local use. Currently (2021), Ringkøbing-Skjern municipality is self-sufficient in green energies.
  2. **Implementation of intelligent energy storage systems:** Often entails a shift in the way energy is used in businesses and civil society, with the assistance of experts to develop industrial and domestic facilities.
  3. **Exchanging best practices:** The municipality has established itself as the greenest in Denmark and Europe.

Table B4.2.3. Ringkøbing-Skjern Wind Park

Investment	• Denmark's largest onshore wind farm. • Investment and 20-year service agreement amounts to DKr ~750 million. • 12 country houses were bought to situate the project.
Technology	• Turbines: 22 Vestas V112 turbines; 3.3 MW each. • Total nominal power: 6,000 kW. • Expected production: 9,870 kWh (enough to power 57,000 households). • Turbine height: ~150 m. • Turbines manufactured at local factories in the Municipality of Ringkøbing-Skjern.
Ownership	• The turbines are owned by 22 local investors and landowners. • Residents living ≤4.5 km from the turbines were able to buy shares in the project. • 20% of the overall project (equivalent to 4.4 wind turbines) was sold to neighbors and locals in the form of 44,000 shares. • Buying shares was simple and well accepted by society. • 17 landowners own turbines for no less than DKr 590 million (€77 million). • Residents of the lstrup and No communities purchased wind farm shares for a total of DKr 130 million (€17 million).

Source: [a, 65].

5 Infrastructure: Opportunities and Challenges

As of June 2020, the UPME reported 147 energy production projects (mainly nonconventional renewable energy) with a total capacity of 8,365 megawatts. However, the deadline to begin 29 of them (348 megawatts capacity) had already expired, and there was no guarantee that these projects would be able to use the assigned transmission line capacity. One major challenge of large-scale nonconventional renewable energy projects is the need for developed infrastructure.

The director of infrastructure of the Ministry of Transport is responsible for planning, coordinating, controlling, and evaluating the development of policies, plans, programs, and technical assistance for the construction of physical infrastructure in the transportation sector. In addition, the director of infrastructure coordinates with different public and private entities for pertinent actions toward the development of special or strategic infrastructure projects of importance to the country [a]. The Ministry of Transport and its affiliated entities have generated efforts on various fronts to have a diagnosis of the necessary and available road and port infrastructure; the existing regulatory and procedural framework; and institutional and private sector competencies to assess the permits required for transport to take place or for the adaptation of infrastructure for the construction of nonconventional renewable energy projects [a]. This infrastructure-inventory process demonstrates that Colombia needs a legal framework to enable current infrastructure (such as ports) to be used for the importation of the equipment and material.

Photo 5.1. *Transmission line at Corregimiento del Cabo de la Vela, La Guajira, 2019.*

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The Colombian government introduced a new regulation in March 2021 that renders existing infrastructure available. In particular, this new regulation allows private ports to be used for the logistics of nonconventional renewable energy projects. The idea is not to change the contractual regimes, but to enable all port infrastructure to be used for large-scale nonconventional renewable energy projects [a]. However, challenges remain in the tariff agreement because energy developers will need to pay to use private ports [a].

While Colombia would benefit from more ports, the current infrastructure can serve the required cargo with some adjustments. Therefore, the Ministry of Transportation has no plans to build ports to move certain loads. Given the dimensions of the equipment and material required for renewable energy projects such as wind farms, other infrastructure such as roads and bridge systems also require some modifications. Although the Ministry of Transportation should provide public infrastructure for general uses, there is no legal requirement for ministry to provide infrastructure for specific projects [a]. Therefore, the Ministry of Transportation is very unlikely to build or adapt routes to transport specific cargo.

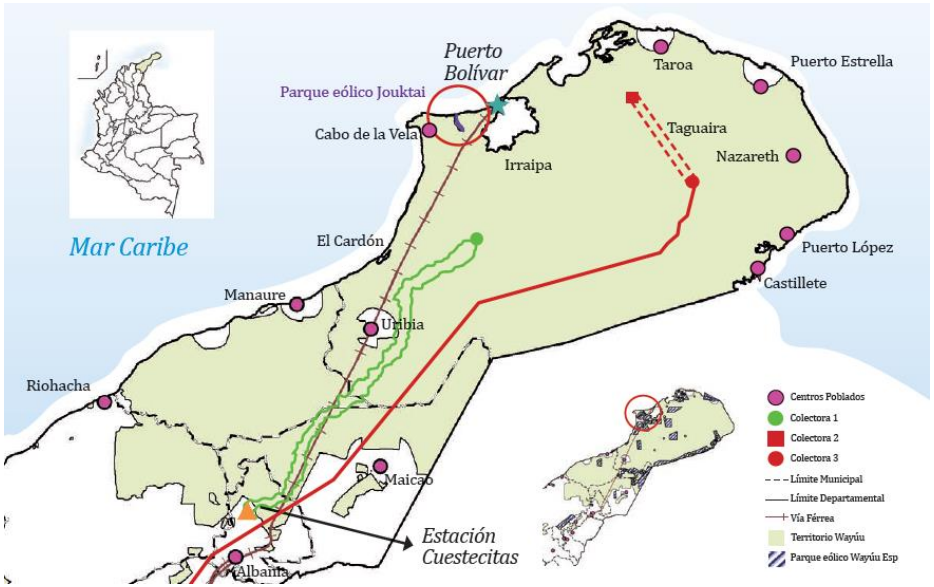
The manufacturer of the equipment (e.g., wind turbines) is responsible for bringing the equipment to the site and putting it into operation. This must be coordinated between the logistics operator and the manufacturer of the equipment (e.g., Vestas). Manufacturers sell equipment to developers (project owners) and must deliver the equipment working at the project's site. For this, manufacturers can outsource some activities (e.g., the transportation and assembly of equipment) to entities such as logistics providers [a]. The owner of the project will oversee the operational aspects. When a limitation of the current infrastructure (e.g., roads) is identified—for example, if the load is heavy or large—the associated costs must be met by private agents (e.g., the investor) [a].

The Ministry of Transportation provides the capacity for nonconventional renewable energy developers to learn about the nature and management of permits. Investors in nonconventional renewable energy projects should enter into such agreements with a clear understanding of the necessity for and costs of adapting the existing infrastructure and of the adjustments that need to be made, so that these costs are expected during project execution and integrated into the total project cost [a]. In addition, the investor must obtain a permit before making the necessary adjustments to roads and must ensure that infrastructure is not damaged either during the adaptation process or the transport of cargo [a]. Finally, the investor is responsible for all changes required to enable freight transport.

Map 5.1 presents the La Guajira region, where several wind parks are currently under construction. The construction of transmission line 1 from the substation in Alta Guajira to the existing substation "Estación

Cuestecitas" near the town and municipality of Albania was contracted by Grupo de Energía de Bogotá (GEB) through a public tender. According to the GEB report, transmission line 1 will allow the distribution of 1,500 megawatts of electricity in 2022, which implies that there is great pressure to immediately contract additional networks to meet the demand from the wind parks that are outside the supply of the current project of transmission line 1 and not directly connected to transmission line at Estación Cuestecitas [54].

Map 5.1. *La Guajira.*



Source: [54].

Note: The purple dots present population centers. The crossed purple line is the railway line of the mining company Cerrejón, which extends to Puerto Bolívar. The green line is "Transmission line 1." The solid and dotted red line is the proposed route of "Transmission line 2."

Photo 5.2. *Transmission Line in Medellin, 2021.*

Source: ©Claudia Vélez-Zapata, 2021. Further permission required for reuse.

A second transmission line is projected to be constructed in La Guajira (see "Transmission line 2" in Map 5.1), with a public auction expected in 2021. Any Danish company can participate through FDI in the design and construction of infrastructure in Colombia, such as transmission lines. This may include public-private partnerships for infrastructure development.

The following section presents Colombia's potential in nonconventional renewable energy, starting with onshore wind energy, which may be the best nonconventional renewable energy source for Colombians to become more familiar with the objectives for geothermal and offshore wind energy in the E2050 agenda.

Nonconventional renewable energy such as solar and wind power, particularly on the Caribbean Coast and in the central Andes region, can complement the hydropower sector during the dry seasons of the annual climatological cycle and the El Niño-Southern Oscillation (ENSO) warm and cold phases, which depend on the year and season [70].

6 Mapping the Potential of Nonconventional Renewables

6.1 Wind Energy

Nonconventional renewable energy technologies compete with traditional energy sources in Colombia such as coal and hydropower. In the last five years, onshore wind power without subsidies has become cost-competitive with coal in many parts of the world. Wind energy is a priority for Colombia's future energy matrix to minimize vulnerability to climate events such as droughts, which have a serious effect on the capacity of hydropower systems.

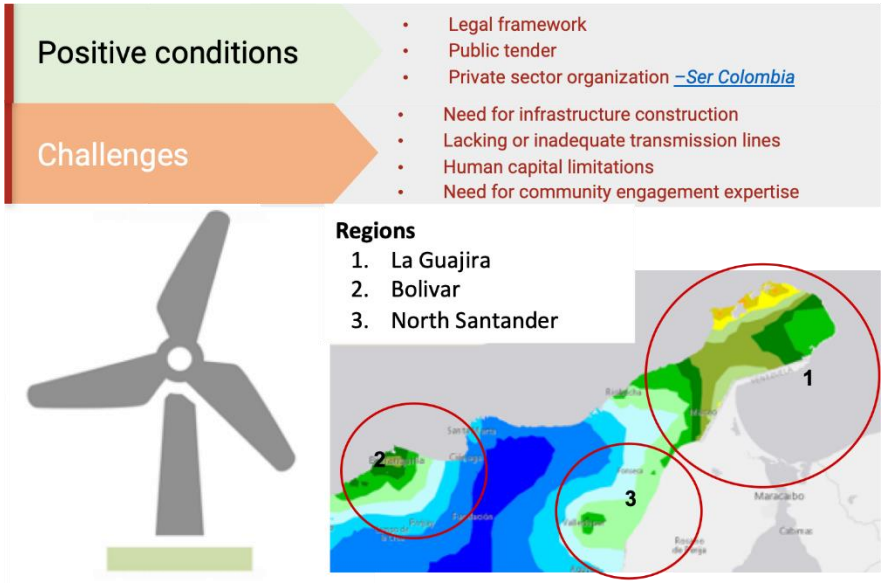
Investing in wind energy projects in Colombia is aligned with the 2030 Agenda and the Danish government's focus on climate diplomacy, green development, and providing the world's poorest nations with access to energy and sustainable economic growth. This is also embedded in Denmark's new long-term strategy for global climate action.

Denmark can be a strong strategic partner in Colombia's energy sector and has an ongoing relationship with Colombia to expand its green energy capacity, particularly in wind energy. In addition, Denmark is working with Colombia on ways to integrate nonconventional renewable energy into the overall electricity system.

The Colombian wind sector is growing in terms of the number of projects; the energy production capacities of these projects; and the complexity of the alliances behind the projects. Given the geographic characteristics of Colombia, there is a particular focus on the La Guajira and Caribbean coast regions, and to a lesser extent on the central Andean region. Figure 6.1 illustrates the onshore wind potential in La Guajira, considered one of the most ideal regions in South America for wind energy; the maximum wind intensity is 15 meters per second, with mean wind speed intensities between 09:00 and 17:00 of at least five meters per second throughout the year, with mean intensities reaching close to seven meters per second between January and August. A key resource to consult is the Climatological, Wind and Solar Radiation Atlas of Colombia at http://atlas.ideam.gov.co/presentacion/. The wind predominantly blows from the east [71].

The wind quality and availability in La Guajira are considered to be superior to that in most other regions in Colombia. However, to be harnessed, there is a need for substantial investment in infrastructure such as ports and transportation. Another challenge is the relation with local stakeholders, specifically with indigenous communities.

Fig. 6.1. *Onshore Wind Potential.*



Source: [72].

Note: In the wind resource map, dark blue represents the lowest average wind speeds, while yellow represents the highest.

The La Guajira region is inhabited by the Wayúu people, a seminomadic community who are the main owners and governors of the land required to install wind turbines. Therefore, there is a necessity to improve the practical dialogue with communities that goes beyond the consultation process according to the Colombian legal framework, and potentially for the implementation of new association schemes, such as civic energy cycles. These problems have led to the onshore wind energy model in Colombia being identified as complex. This has created new impetus in developing the offshore wind sector to leverage the potential of the intense wind currents in the coastal areas of Colombia.

Photo 6.1. *Jepirachi Wind Park in La Guajira, 2019.*

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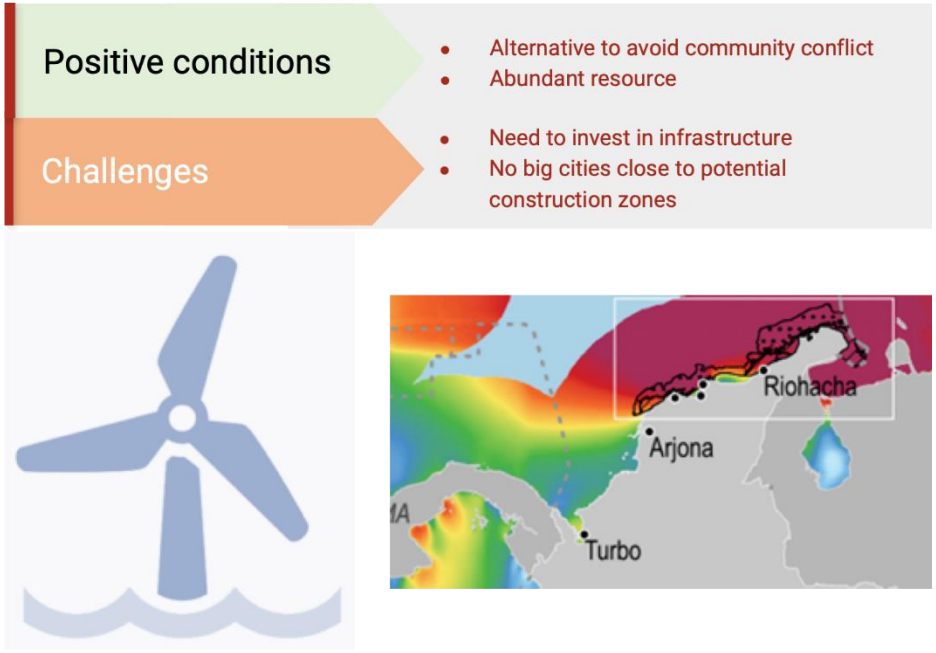
Figure 6.2 shows the offshore wind energy potential. There is great potential for offshore wind energy on the Caribbean Coast, where wind speeds reach 10 meters per second at a height of 10 meters. Cities close to the Pacific Coast such as Cali or the Caribbean Sea such as Barranquilla present increased populations and industries that require

reliable energy sources. This represents an opportunity to develop offshore wind parks in these areas [3].

Fig. 6.2. Offshore Wind Potential.



Source: [72].

Note: In the wind potential map, the red regions have the highest wind intensity, while the yellow and green regions have the lowest wind intensity.

However, despite the potential for offshore wind energy systems in Colombia, the costs related to building and maintaining offshore infrastructure could be a major obstacle. There is a need to define which environmental permits can be assigned on Colombian waters, either by a concession granted by the Environmental Authority, which will establish the limits and areas where the projects will be developed, or by an environmental license equivalent to the ones used by projects in the territory, in which the project promoters carry out the necessary environmental impact studies [4]. Therefore, a medium-term approach (five years) is required to introduce offshore wind as an element of the Colombian energy matrix because of the high cost of these projects compared to onshore investments.

The importance of public auctions, among other incentives, has increased the number of onshore wind projects in Colombia, and helped to stimulate the market and aspects surrounding the development and implementation of these types of projects.

Potential vs Actual Growth from a Government Perspective

Wind energy has market potential for Danish companies for several reasons. As technology providers, developers import sustainable practices and technologies to increase energy efficiency. There are different investment areas to consider advancing wind energy projects, such as in infrastructure (ports, transportation links, and transmission lines), partnership projects, human capital, curtailment problems, and community engagement. These areas are explained further below.

1. **Infrastructure construction:** There is potential to invest in infrastructure in Colombia. In 2019, a Colombian public tender assigned 1,298.9 megawatts of total effective capacity of wind energy

infrastructure construction to a contractor [39]. The construction of the new wind parks started soon after in 2020, with a target commission date of the Guajira I wind park at the end of 2021. Nevertheless, in February 2021, the La Guajira region still faced various challenges regarding roads and ports for the transport of equipment, materials, and wind energy components.[6] Other areas in Colombia that have proven potential for wind energy include the department of North Santander (labeled "3" in Fig. 6.1). This region is located in central Colombia, which suffers from a lack of road links suitable for the transport of wind farm equipment due to its geographical features.

2. **Transmission lines:** Colombia is aiming to match the rapid speed at which MNEs are building wind parks in La Guajira with the rapid construction of transmission lines to central Colombia. These projects are being assigned through public tenders. The construction of transmission lines is expected to start in 2021. However, some consultation procedures with the Wayúu people need to be finalized. The construction of transmission lines in La Guajira is crucial to avoid congestion of the electricity transmission network.

3. **Partnerships:** Colombian hydro, gas, and oil utilities are actively engaged in wind energy projects. The only wind park in Colombia (as of 2020 [1]) was built by Grupo EPM in 2004. In 2021, ISAGEN is building the Guajira I project in collaboration with Vestas.

4. **Human capital:** An onshore wind energy system requires approximately 144,420 person-days to produce 50 megawatts of energy, from procurement, manufacturing, transport, installation, grid connection, operation, maintenance, and decommissioning [73]. Thirty percent of these person-days are needed for installation and grid connection, whereas 43 percent are needed for operation and maintenance [73]. Colombia faces a challenge in providing the specialized human capital needed for the wind energy investments projected under the E2050 energy transition strategy. As of 2020, no Colombian educational institutions offer academic programs in wind energy, although La Universidad de La Guajira offers a master's course in comprehensive management against climate change [74]. Colombia has human capital and educational programs related to the fossil fuel and hydropower industries; thus, there is an opportunity to reskill such professionals and expand existing programs to cover nonconventional renewables. There is potential for foreign universities such as the Technical University of Denmark [75] to expand their education programs on nonconventional renewables such as wind energy in Colombia.

[6] This is information based on fieldwork in Colombia.

5. **Curtailment problems:** Curtailment takes place when there is too much production of a certain energy and too little local demand, grid expansion, or capability to absorb and supply (for commercialization) variable energy to where demand is located. There is a need for a strategic plan for the implementation of wind energy investments to prevent overinvestment and congestion or electricity reductions (e.g., during periods of maintenance of wind turbines) on the grid. One solution could be cross-sector integration between nonconventional renewable energies and traditional low-carbon energies such as hydropower.

6. **Community engagement:** Offshore wind projects present an opportunity for circumventing the challenges represented by community engagement issues and for leveraging the major technical advantages provided by higher wind speeds.

The need for improved transmission and distribution within the electricity grid presents both challenges and opportunities [76]. This includes the required development of reliable onshore and offshore infrastructure to import, transport, and connect projects with the installed transmission grid. With reference to the learning process experienced in other Latin American countries, particularly in Mexico, the importance of building capacities, analyzing small-scale projects, and use of dialogue instruments should be noted. For example, FPIC is a specific right of indigenous peoples and is recognized in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) [77]. This right allows them to give or withhold consent to any project that may affect them or their territories. Consultation with indigenous communities—and more importantly, the possibility of considering communities and social actors as partners in energy projects—are key to successful nonconventional renewables energy projects.

6.2 Solar Energy

Colombia's equatorial location means that certain areas of the country receive steady solar radiation, with some of the highest registered indexes worldwide, alongside those of Africa [14, 78]. The number of solar energy projects is growing quickly, with many new developments and applications for the four incentives presented in Section 4. According to official data, 1,006 projects applied for UPME incentives between February 2016 and October 2020. Among these, 630 projects worth a total of Col$576,854 million (approximately €135.6 million)—more than half of the total invested amount—were in nonconventional renewable energy.

Departments across Colombia have participated in photovoltaic power projects. Atlántico, Cundinamarca, Valle del Cauca, and Antioquia have the largest photovoltaic projects for electric power generation.

Cundinamarca, the home of Bogotá, has 865 kWp[7] of installed photovoltaic capacity, with a total of 9,050 solar panels in different types of infrastructure, from recreational to educational [79, 80]. The highest shares of total solar power are in Antioquia (22 percent) and Bolívar (17 percent).

Photo 6.2. *Solar Panels on a Hypermarket in Medellin, 2020.*

Source: ©Claudia Vélez-Zapata, 2020. Further permission required for reuse.

Antioquia has two projects in private universities for electricity self-consumption. The Laureles Campus of the Universidad Pontificia Bolivariana has installed 4.9 kWp of solar panels, and Universidad EAFIT has installed a solar station in the shape of a parasol that provides power to charge computers, mobile phones, and other devices [81]. Bolívar presents installations in the private sector, with a total of 8.5 kWp installed. There are also various "macro" solar installations, such as in a recreational center (e.g., Centro Comercial El Tesoro), companies in different industrial sectors (e.g., Bancolombia, 1,960 solar panels; Compañía Nacional de Chocolates, 8,000 solar panels) and a supermarket (e.g., Grupo Exito) [14, 81]. These trends can be explained by the positive conditions for the growth of the solar energy market.

Law 1715 establishes that for solar energy, the main responsible institutions are the MME, the Ministry of Livelihood, and regional and autonomous corporations (CARs). This law also establishes the potential of selling surplus energy back to the grid, which multiplies the business attractiveness of technological developments at the residential level.

The solar energy sector is complex because current trends have led to considerable research, which results in newer, cheaper technologies on a regular basis. Although this decreases the costs of energy production, it also makes the business case for large investments less attractive, because the return on investment is typically the only variable of analysis for investment allocation. Additionally,

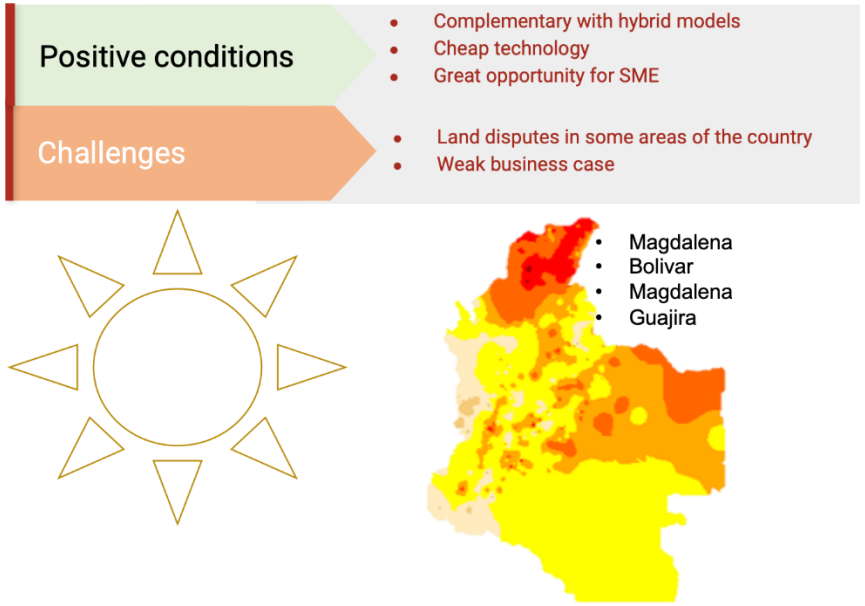
[7] A kilowatt peak (kWp) is the rate at which a photovoltaic system generates energy at peak performance.

photovoltaic solar technology is still not profitable in Colombia, given that it is still expensive to implement and transfer due to the immaturity of the market and the current lack of regulation (in Colombia, solar energy costs US$3.2 per watt compared to US$1.9 per watt in Germany, which has a large solar market) [14].

Small-scale co-generation projects provide a learning platform for solar power in Colombia, with the potential to scale up to large-scale projects. Some ZNIs in the departments of Cundinamarca, Amazonas, La Guajira, and Arauca now have installed photovoltaic systems with capacities of greater than 100 kWp (see Fig. 6.3). For example, Nazareth and Puerto Estrella (towns in the department of La Guajira) have solar gardens that were installed by the Institute for Planning and Promoting Energy Solutions for Non-interconnected Zones (IPSE). These solar-diesel hybrid systems are made from a layout of 1,200 photovoltaic modules with a capacity of 320 kWp and eight solar trackers with a total installed capacity of 100 kWp [81].

Local experiences point to the power of technology to reduce energy waste in residencies and small industrial buildings. The potential of solar energy lies not only in photovoltaic electricity generation but also in complementary heating.

Fig. 6.3. Solar Potential in Colombia.

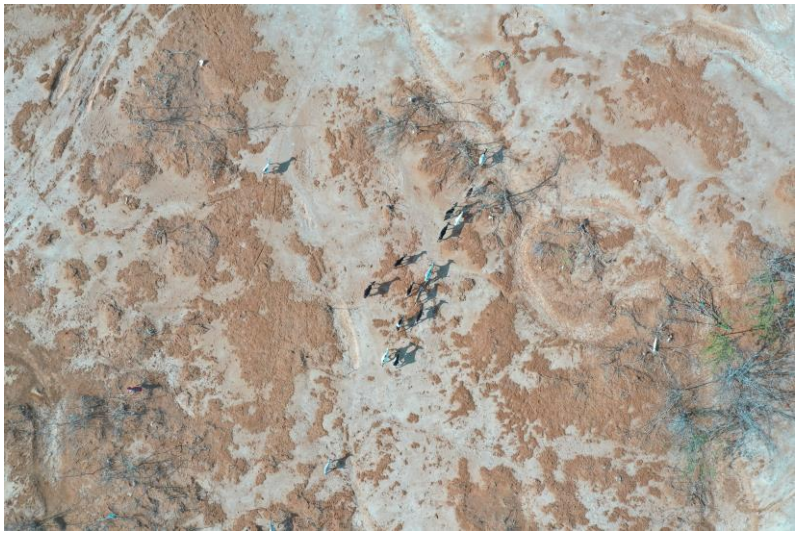


Source: [72].

Note: In the solar potential map, the red regions have the highest solar intensity, while the yellow regions have the lowest solar intensity.

In Colombia, there are several solar energy projects with a total projected installed capacity of 19.9 megawatts. This is because energy production firms are exempt from paying the CERE [charged to market participants for the reliability charge] for plants with capacities below 20 megawatts. This makes projects of this magnitude more affordable, which explains why solar energy has not scaled up in Colombia as it has in Mexico, Brazil, and Chile in recent years [a].

Photo 6.3. *Goat Herders in La Guajira, 2019.*



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In March 2017, the MME issued Decree 348 to govern small-scale self-generation surpluses, which are defined as small-scale "self-generation whose maximum power does not exceed the limit established by UPME 0281 of 2015" [82]. The conditions are as follows:

- The electrical energy produced by the natural or legal person is delivered for their own consumption, without the need to use the assets of the regional transmission system and/or local distribution systems.
- The amount of excess or surplus energy may be any percentage of the value for one's own consumption.
- The generation assets can be owned by the natural or legal person or third parties, and the operation of said assets can be conducted by the owners or by third parties.

In 2018, a new resolution (CREG-030) was issued that defined a mechanism by which residential, commercial, and small industrial users who produce energy to meet their own needs could sell surpluses to the interconnected system. This production is small scale (up to one megawatt) [14].

Considering that Colombia has an extended area of desert (albeit belonging to local communities), it can be argued that there is a deficit of photovoltaic development in the ZNIs, which underutilize solar resources and have great territorial extensions. For example, La Guajira, the department with the highest radiation at the national level (5.5–6 kilowatt-hours per square meter), has relatively few photovoltaic solar systems, despite its large surface area of 20,848 km^2 [14]. One of the concerns in La Guajira is that the territory belongs to the Wayúu people. Therefore, issues might arise regarding to conflicts over the use of land when implementing large-scale solar projects, which require large stretches of land.

6.3 Biomass Energy

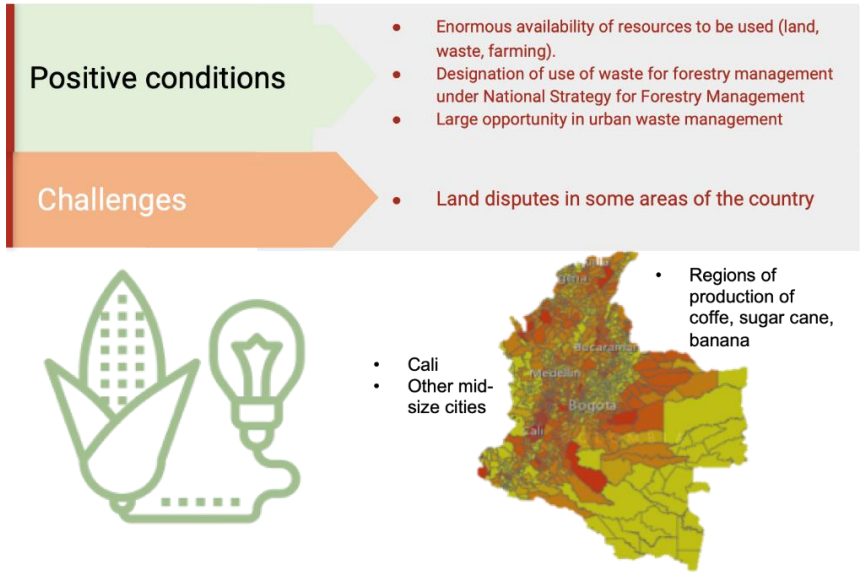
The biomass sector has seen important developments in Colombia, particularly in sugar-producing areas. For this report, the focus is on the use of biomass as an energy source through the generation of heat,

rather than the production of biofuels.[8] Biomass complements alternative fuel mixes [83].

Law 1715 emphasizes the need to align the biomass sector with the National Strategy for Forestry Management, and even establishes an obligation to use forestry management waste as biomass. Furthermore, autonomous authorities must coordinate multiannual plans for the use of biomass. A biomass policy requires major coordination among waste management, forestry, and agricultural management to develop comprehensive plans for the effective use of resources. In this regard, we identify the participation of the Ministry of Environment and Sustainable Development (MADS), the Ministry of Agriculture and Rural Development (MADR), and the Ministry of Livelihood, Cities and Territories (MVCT).

The region surrounding the city of Cali in the Andean region of Valle del Cauca has major potential for biomass capacity [83]. This potential is calculated by following a formula that includes the residual biomass of eight crops and three species of livestock, the organic solid waste from markets in 12 cities, and the maintenance of green areas in 10 cities. Figure 6.4 [72] depicts the potential for biomass energy in Colombia.

Fig. 6.4. *Biomass Potential in Colombia.*



Source: [72].

Note: The biomass potential map is colored red (>10,000 TJ/year), orange (2,001–10,000 TJ/year), and yellow (601–2000 TJ/year) based on the capacity to generate energy from biomass. (1 TJ = 0.278 gigawatt-hour.)

Of particular importance for the biomass sector is the energy potential of certain product wastes, residues, and unmarketable goods, particularly those related to sugar cane, coffee, and bananas, and the farming of cattle, chicken, and pigs. These areas, combined with other potentially useful waste from city markets and residential areas, produce a considerable amount of waste that is useful for biomass

[8] Biofuel production has been identified as being contrary to the spirit of efficiency and inconducive for sustainable development [69].

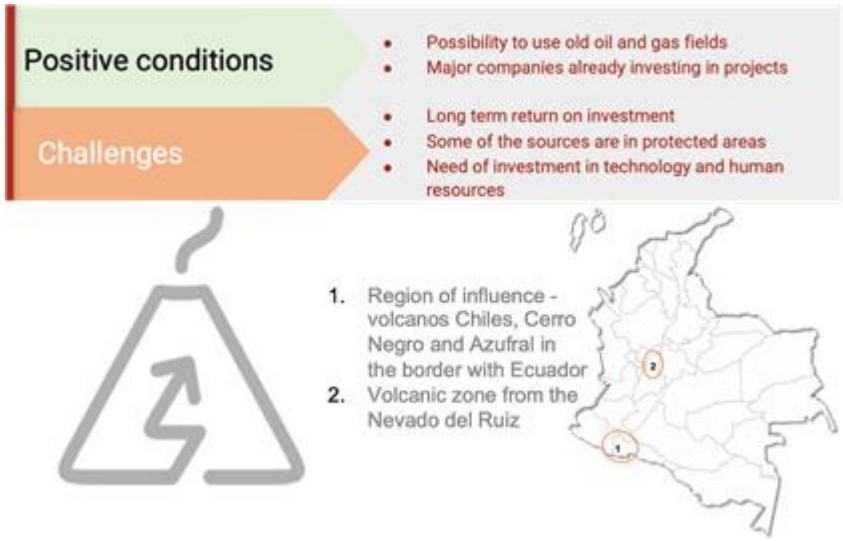
energy production. Currently, this subject is complicated by the need to raise awareness among civil society of waste classification and separate disposal. The biomass sector is especially attractive for future development.

6.4 Geothermal Energy

The geothermal energy sector requires a long-term perspective because the time-to-profit for a geothermal project is approximately eight years [1]. The potential for electricity generation from geothermal resources in Colombia is estimated to be approximately one to two gigawatts. This potential is concentrated in only a few areas, including the Chiles volcanoes, Los Nevados National Park, and the Paipa geothermal area in Boyacá [69]. The necessary conditions for geothermal projects are very specific and usually located in remote regions, which raises issues with infrastructure and transportation. Figure 6.5 [72] identifies the opportunities and challenges for geothermal energy production in Colombia.

Geothermal energy is among a group of technologies with significant potential, but it also has significant challenges. For example, most geothermal sources are located in reserves or national parks. Furthermore, there is a cultural barrier around the subject of underground exploration because it is typically associated with hydrocarbon-based energy sources (e.g., coal mining and fracking).

Fig. 6.5. *Geothermal Opportunities and Challenges.*



Source: [84].

Geothermal technology is a promising option for oil and gas companies seeking to contribute toward the energy transition, because abandoned oil and gas fields can be used to generate energy via geothermal sources. Notably, there are potential synergies in this sector with Danish firms in the geothermal sector.

7 Potential for Denmark-Colombia Cooperation

Colombia has implemented public policies that have laid the foundation for its energy transition to meet the E2050 and the Paris Agreement. Transitioning from conventional large-scale energy sources (e.g., hydropower, oil, and carbon) to a more sustainable energy system requires the energy industry (utilities and infrastructure) and end-users to accept, integrate, manage, and balance conventional and nonconventional renewable energy sources.

Investing in Colombia's energy transition presents a unique opportunity for Denmark at the political, business, research and development (R&D), and social development levels.

Denmark's green energy expertise places it among the top five nations in the World Economic Forum's Energy Transition Index 2020 [43]. This index assesses countries' readiness for the transition to a secure, sustainable, affordable, and reliable energy system. Denmark's high ranking in this index reflects the long tradition of Danish firms at the forefront of green energy technology, energy production, and energy efficiency solutions. The energy transition goes beyond the production, storage, and transmission of nonconventional renewable energy: it requires energy efficiency; the ability to produce sustainable energy; and the capacity to implement mechanisms to safeguard energy for industrial and commercial use.

Danish-Colombian collaboration offers a win-win relationship. Danish companies can enter a growing market with great potential for scalability in South and Central America. Moreover, there is scope to develop the market to provide a comparative advantage, because large technology providers from China, Germany, and the United States are currently focused on large-scale nonconventional renewable energy projects in Colombia. In turn, Colombia will benefit from Denmark's state-of-the-art technology and best practices for energy production and efficiency, while gaining from the introduction of proven and successful green energy models for both small- and large-scale electricity generation.

Denmark has a unique platform that combines firms with the technology and solutions for a green transition and the support of financial institutions, such as the IFU and EKF (see Table 4.6), which have a key focus and expertise in the Latin American and Caribbean market. IFU is open to participating in projects by injecting equity, while the EKF is part of the lending group. IFU and EKF can participate in the same projects, and thereby increase the support of

projects in the Danish interest [a]. These institutions, together with the private sector, are collaborating with the Embassy of Denmark in Colombia to promote and support the green energy transition in Colombia.

According to the EKF, Colombia has a Country Risk rating of 4, where 7 is high risk and 0 is low risk. This classification is consistent with the OECD's country risk classification [a].[9] The risk designation relates to the risk that a customer would be unable to pay because of political risks in the country; the higher the figure, the greater the risk [a]. Denmark, by various private-public organizations, offers a one-of-a-kind forum for identifying the right option for nonconventional renewable energy projects. Denmark's financial firms have local networks in Colombia, which facilitates deals with local banks as well as comprehensive business and project evaluations. To find the best financing option for the scheme, Denmark's private-public agencies collaborate closely with local and foreign networks. Furthermore, internal divisions inside Danish organizations, such as corporate social responsibility (CSR) teams, can evaluate the particularities to consider the nature of the risk under which the investment project will be developed, using international impact evaluation standards [a]. This, along with Denmark's technology and energy solutions, places Denmark as a perfect partner for cooperation and investment in Colombia.

This section presents some areas for dialogue, cooperation, and investment between Colombia and Denmark to meet the E2050 plan and the Paris Agreement, in addition to areas of potential risk that should be considered by any company considering investing in the energy transition in Colombia.

7.1 Implications for Public and Private Organizations

Colombia and Denmark have signed instruments for cooperation, dialogue, and investment, such as the European Union–Colombia Free Trade Agreement (FTA) and the Memorandum of Understanding (MoU), providing a framework for *renewable energy and energy efficiency*. Colombia's commitment to the Paris Agreement is a clear signal to businesses and investors that Colombia is open for investment in nonconventional renewable energy. Additionally, the sustainable development goals (SDGs) are a common language between Colombia and Denmark, particularly in relation to Goal 7, which aims to ensure *access to affordable, reliable, sustainable and modern energy for all* by 2030 [85].

[9] See the OECD's risk assessment criteria at https://www.oecd.org/trade/topics/export-credits/arrangement-and-sector-understandings/financing-terms-and-conditions/country-risk-classification/.

Source: [85].

The public policies implemented in Colombia to meet the E2050 plan have set the groundwork for its transition to nonconventional renewable energy. Nevertheless, this transition will require a transformation of Colombia's energy system (both for businesses and end users/civil society). New regulations on consultation with local communities, infrastructure, and auctions for grid-scale energy storage systems demonstrate Colombia's political will to meet the E2050 and their commitments to the Paris Agreement.

The message conveyed by various ministers interviewed here was unequivocal [a]: ***Danish companies are invited to participate in all aspects of Colombia's energy system.***

Investment from Denmark is expected to have a significant benefit for energy efficiency and electrification (industry, public and private transportation, domestic use, and so on) in Colombia. This offers a unique opportunity for Denmark at the political and business levels but also for R&D, industry, and civil sensitization and education. However, Danish firms and investors should conduct in-depth risk assessments of different areas before investing in nonconventional renewable energy in Colombia. Table 7.1 offers an initial account of the Colombian advances in public policies, legal framework, energy market, sociodemographics, legacy of armed conflict, climate change, and the COVID-19 pandemic, as well as some potential risks associated with each of these areas.

While there is a clear political will in Colombia to foster investments in nonconventional renewable energy, the alignment with other policies still needs to be addressed, which might constitute a future risk. Firms and investors should exercise caution when developing their entry strategy into the Colombia energy market. For example, there is uncertainty about grid access for large-scale investments and the market size. Although it is expected that electricity demand will increase in Colombia, particularly in cities located along the Pacific and Caribbean coasts, in addition to electrification of the transport system (electric cars, buses, and bikes), these are a mid- to long-term perspective that Danish firms and investors should consider when entering the Colombian energy market.

Table 7.1. Potential Risk Areas

Macro Level	Advances	Potential risks
Public Policies	• Signing of the International Energy Charter, 2015. • Colombian Green Growth Policy. • E2050 National Energy Plan. • EU-Colombia Economic Partnership, 2012. • Member of OECD since 2020.	• Long-term commitment to the E2050 plan beyond electoral cycles. Colombia will hold a presidential election in 2022. • Timeframe in adjusting current legal framework in accordance with national and international market demand. • Alignment to a common understanding of the E2050 plan among different ministries. • Political instability with Venezuela, RB. • Instability in migration process from Venezuela, RB.
Legal Framework for Nonconventional Renewable Energy	• Law 1715 & ongoing new regulations. • Public and private auctions.	• Legal framework to de-regulate the energy sector for IPPs and large-scale utilities. • Reinforce legal protection Risk: Public auctions: Guarantees in Payment system: PPAs vs. single payment option trading (Spot market). • Highly volatile spot market with price variance of up to 90% in any given week.
Energy Market	• Private and public auctions stimulate Colombian utilities' investments and international investors. • Commercial operation date window of approximately three years to commercialize nonconventional renewable energy.	• Risk for energy production utilities to sign PPAs. • Uncertainty to sell the energy. If there is no guarantee to secure PPAs the project is not attractive for investors and financial institutions. • In 2019, 42% of energy consumption was for residential use. • Uncertainty to dispatch energy due to delays in the construction of transmission lines. • Unclear signal for future auction for production of nonconventional renewable energy. • Idiosyncrasy of Colombian utilities is short-term.
Sociodemographics & Legacy of Armed Conflict	• Ratification of ILO Convention 169 (FPIC). • Implementation of national action plan on business and human rights. • Signing of Peace Agreement with left-wing FARC rebels, 2016. • Establishment of the Chair of Peace.	• Little training of human talent in technologies oriented to the development of projects in unconventional energies at private and public universities. • Permanence of armed conflict beyond the Peace Process. • Skilled labor is expensive. Expatriate talent may be required. • Delays in consultation processes with indigenous people. • Social mobilizations against energy projects. • Protection of Human Rights Defenders. • Cybersecurity: cyber-attacks on the electric grid leading to disruption of the power system.
Climate Change & Pandemic	• Ratification of Paris Agreement, 2018. • Commitment to SDGs, 2016.	• Possible social and economic instabilities caused by natural disasters and climate fluctuations (e.g., El Niño-Southern Oscillation [ENSO]). • Consequences of COVID-19 Pandemic: Decreased spending and consumer confidence, Private and public investments slowed down and contracting in spending.

Source: [a] and bibliography.

Note: FPIC = free, prior, and informed consent; IPPs = independent power producers; PPAs = power purchase agreements; SDGs = sustainable development goals.

Colombia's unique geographical location offers a business case for developing public policies and investment to invest in grid interconnections in Colombia and internationally to allow electricity to be traded with Central and South America.

Access to land-consultation processes is another risk factor to assess. La Guajira presents some of the best wind and solar resources; however, this region is far from the grid and energy demand. Although there are plans to build transmission lines in La Guajira, there are uncertainties about when construction of these transmission lines will be finished. Additionally, the geopolitical location of La Guajira—bordering with República Bolivariana de Venezuela—presents a security risk given the political instability in República Bolivariana de Venezuela, which has driven the migration of Venezuelan refugees to Colombia [a]. Table 7.1 is not an exhaustive list of aspects to consider in the Colombian context; it is merely an initial overview of the current dynamics of Colombian efforts toward the E2050 plan. Any business considering to invest in Colombia should conduct in-depth risk assessments.

The risk areas of concern can be transformed into a business case, whereby the transition program should take the E2050 into consideration in a holistic approach. Based on the research conducted, we propose that there are five fundamental areas that can form the basis of a broad collaboration between Denmark and Colombia for climate change adaptation and mitigation, specifically:

- Biodiversity and natural ecosystems
- Governance in energy democracy
- Energy culture
- Energy efficiency
- Supporting infrastructure

The following sections offers guidance for collaboration and investment in each of these areas.

Biodiversity and Natural Ecosystems

Climate change impacts such as the El Niño-Southern Oscillation (ENSO) warm and cold phases [70] and other natural disasters are currently affecting Colombia. The La Guajira region typically does not see much rain, but in recent months (2020) flooding has been registered there. In municipalities in Central Colombia close to the Amazon region (e.g., Villavicencio, Acacías, Guamal, El Castillo, El Dorado, Fuentedeoro, Granada, San Carlos de Guaroa, and Lejanías), river overflow in 2020 resulted in the evacuation of people from the region, and many crops such as coffee and other agricultural products were lost because of flooding. Similarly, in recent years, Denmark has experienced flooding and land loss on its coast.

Denmark and Colombia could share knowledge of their experiences and solutions to adapt to climate change impacts in accordance with Goal 13: Climate Action of the SDGs [86].

- **Target 13.1:** "Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters."
- **Target 13.3:** "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning."

There is an opportunity to meet these targets through cooperation and sharing of "best-practices" for climate change adaptation between firms, higher-education institutions, and confederations of industries in Colombia and Denmark.

Source: [86].

Mitigating the impacts of climate change also involves the protection of biodiversity and natural ecosystems. Colombia is one of the most biodiverse countries in the world. One recurring concern among our informants involved the balance of land use between energy and food. Bioenergy is currently the largest source of conventional renewable energy and is expected to be for many years to come [76]. The adaptation of traditional technologies to run on biofuels (e.g., ethanol) raises a controversial discussion about sustainability, both in Colombia and worldwide.

There are concerns and questions worldwide related to whether biofuels are carbon-neutral and whether their production has other unintended consequences (in particular, in the food versus fuel debate). This leads to a business opportunity to develop biofuels from waste and not from crops, with new prospects to produce green hydrogen, green ammonia, and green fertilizers. Based on Colombia's well-established oil and gas industries, projects that combine renewable chemistry and fossil-fuel technologies would form interesting pilot projects in Colombia. This could be one of the future developments in the energy transition to come.

Photo 7.1. *Goats in La Guajira, 2019.*

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In relation to the natural ecosystem, Colombia's E2050 plan and current wind and solar investments focus on climate change mitigation through large-scale investments. The Danish firm Vestas has already signed contracts in this field. However, local value chains in the energy and infrastructure building sectors will gather momentum as prices come down and with a vision that incorporates the conservation of biodiversity and natural ecosystem. Thus, there is a need to consider biodiversity conservation and engage in dialogue among business, government, and civil society such as indigenous communities. The energy transition cannot just occur in the power sector, because it will require input from (and have a significant impact on) end-users in relation to their environment.

Colombian public and private auctions for nonconventional renewable energy focus on large-scale investment projects. However, SMEs could provide novel, innovative energy solutions to tap into emerging nonconventional renewable energy sources. The feasibility of these energy solutions could be assessed through pilot projects and partnership schemes between Denmark and Colombia under the framework of energy democracy.

Governance in Energy Democracy

In recent years, Colombia has made advances in relation to democracy and ending armed conflict, such as signing the Peace Agreement in 2016 and implementing a National Action Plan for business and human rights in 2012 (see Table 7.1). These advances suggest the path of governance in Colombia's energy transition.

The principle of good governance is a cornerstone in the energy democracy debate.

> *Good governance means minimal corruption, rule of law, trust in politicians, improved accountability, transparent decision-making processes, the sharing of high-quality information about energy and the environment, the participation of all people, and ultimately, an overall goal of public good [67].*

Governance in energy democracy has the potential to be a source of innovative solutions to mitigate the risk of investment in large-scale wind or solar energy projects. Programs to engage with civil society, particularly indigenous people, to promote and implement energy democracy can give to Danish firms a competitive advantage to meet the sustainable development goals (SDGs):

- **Goal 7:** "Ensure access to affordable, reliable, sustainable and modern energy for all."
- **Goal 16:** "Peace, justice and strong institutions."
- **Goal 17:** "Partnerships for the goals."

Source: [85, 87, 88].

Engagement with civil society is important for instigating transparent communication concerning nonconventional renewable energy investments and their impacts. This will help to meet the following targets of Goal 16 [88]:

- **Target 16.10:** "Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements."
- **Target 16.3:** "Promote the rule of law at the national and international levels and ensure equal access to justice for all."

There is scope to extend engagement with Colombian civil society beyond public consultations to obtain consent for the development of nonconventional renewable energy projects; for example, partnerships and participation in an energy democracy framework might be an avenue to explore in Colombia, such as Civic Energy Cycle schemes (see Box 4.2).

The Civic Energy Cycle schemes for wind energy investment in Denmark, which are decentralized nonconventional renewable energy models, could inspire the development of a platform for dialogue with civil society in Colombia, particularly with people and communities that might be affected by nonconventional renewable energy investments. Civic Energy Cycle schemes offer an opportunity for Colombia and Denmark to meet the following targets of Goal 17 [87]:

- **Target 17.6:** "Enhance North-South, South-South, and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism."
- **Target 17.7:** "Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favorable terms, including on concessional and preferential terms, as mutually agreed."

Governance in energy democracy also entitles different stakeholders of the energy system (users and producers) to comprehend the benefits and impacts of nonconventional renewable energy. For example, there is a trend toward cost-reduction in both wind and solar energy fields that will soon place nonconventional renewable energy in a cost-competitive position compared to fossil-fuel energy sources. This notion has generated a public perception that electricity bills might decrease [a]. However, this may be true only on long-term timescales, particularly due to the need for investment in infrastructure. In the short term, civil society is unlikely to save money on electricity bills. These technicalities are difficult to explain and communicate. Thus, better communication is needed in Colombia to discuss energy democracy in relation to the energy choice, impacts, and production/distribution processes.

Several aspects have to be synchronized to secure nonconventional renewable energy investments. This is a current (April 2021) constraint in the La Guajira region, where multiple wind parks are under construction. However, the integration of new wind power into the overall energy system will depend on adequate investment. It is unclear whether the transmission line under construction at La Guajira will be ready in the proposed timeframe. There are concerns and delays (e.g., on account of COVID-19) in relation to the consultation process with the Wayúu people about wind parks and transmission lines (see Table 7.1). These social concerns can jeopardize nonconventional renewable energy investments and might lead to curtailment issues.

Curtailment occurs when there is too much production of a certain energy form and too little local demand, grid expansion, or capability to absorb and supply variable energy to where the demand is located. Denmark has one of the most flexible energy networks in the world. The network is interconnected with the Scandinavian and German energy networks, which enables Denmark to export electricity to northern Germany or other European countries when there is too much generation, such as by wind. An understanding of flexibility—and how to implement it—will be a key part of Danish companies' collaboration and investments in Colombia.

Energy Culture

To ensure that the energy transition strategy is successful, human capacities are required to facilitate technical operation, technological development, and sociological analyses of the implications of the energy system. The energy culture is a multidisciplinary framework that integrates legal, sociological, philosophical, and other disciplines [a]. Energy culture requires a change in the way of thinking about energy consumption and the adoption of nonconventional renewable energy. In Colombia, there is a discourse on nonconventional renewable energy, but there is a lack of knowledge and use of it. For example, businesses need a more robust understanding of the energy technology choices and cost involved, in addition to the legal framework and incentives to adopt nonconventional renewable energy in their operations (see Table 4.6).

According to the 2020 Environmental Performance Index [43], which provides quantitative scores for various environmental indicators, Denmark is ranked the world's greenest nation, with an average score of 82.50. Colombia is in 50th place, with an average score of 52.9. Denmark also ranks first place in the category of ecosystem vitality, which is a measure of how well a country preserves, protects, and enhances ecosystems and the services they provide; and has 100 points in the category of water resources and wastewater management, indicating that 100% of its population is connected to a sewer system and 100% of household wastewater is treated [43, 86]. Denmark is well known for its effective greenhouse gas reduction strategies and climate change mitigation initiatives, and the country excels in the categories of species habitat and air quality. Denmark's democratic government and social system facilitate unprecedented social mobility. Denmark traditionally has a holistic vision with respect to energy systems.

Photo 7.2. *Jepirachi Wind Park in La Guajira, 2019.*

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Denmark's experiences in green transition and social welfare can be shared with Colombia through business agreements and with multi-sectorial dialogue that can include universities and events with communities. It is aimed at developing human capital to build, operate, and maintain nonconventional renewable energy technology, which is currently difficult to find in Colombia (see Table 7.1). This requires a medium- or long-term perspective to develop an energy culture in Colombia for nonconventional renewable energy.

Energy Efficiency

Energy efficiency implies flexibility and diversification of the energy matrix and network. Flexibility, regional interconnections, and dispatchable power all require the implementation of new technologies for energy storage. In addition, a number of economic and regulatory incentives require a framework for complementarity in the energy system. Nonconventional renewable energy sources such as solar and wind, particularly on the Caribbean Coast and in the central Andes regions, can complement the hydropower sector during the dry seasons of the annual climatological cycle and the El Niño-Southern Oscillation (ENSO) warm and cold phases, which depend on the year and season [70]. There is potential for developing hybrid or complementary pilot projects based on current nonconventional renewable energy technologies.

Are financial institutions willing to provide the debt to finance energy transition projects?

Our informants in Colombia and Denmark expressed interest in developing initiatives with a long-term perspective [a]. The positive attention on public auctions in Colombia suggests that the energy section is getting attraction to financial institutions to invest in Colombia's energy transition. According to a public sector representative, this long-term perspective is a major factor for the viability of nonconventional renewable energy [a]. However, firms and investors should exercise caution (see Table 7.1).

Colombian public auctions in nonconventional renewable energy focus on large-scale investments. Of the 176 auctioned contracts assigned in 2020, 17.39 percent were for solar photovoltaics and 82.61 percent were for wind energy (see Table 4.4). These projects are important for meeting the E2050 agenda. However, to develop a long-term relationship for cooperation and investment, pilot projects can be the first step to understanding Colombia-Denmark business needs and possible solutions. Funding mechanisms from national governments, alliances such as the Paris Agreement, and Danish financial institutions can help to set up pilot projects to assess the feasibility of nonconventional renewable energy systems according to Colombia's needs. SMEs are important players in leading or integrating pilot projects. Accordingly, pilot projects can help Danish MNEs and SMEs

to understand the legal framework of the Colombian energy system and sociocultural business relationships and dynamics.

The outcomes from pilot projects can lead to sustainable business partnerships for a better world. Partnership agreements between Colombian utilities and/or SMEs and Danish firms can further cement Denmark's market position as a world leader in nonconventional renewable energy in Colombia and beyond. This is important as firms from Canada, China, Portugal, and Spain have participated in Colombian public tenders for nonconventional renewable energy [a]. Although Danish firms such as Vestas have won equipment contracts for wind projects in La Guajira, there is strong competition for technology providers in Colombia. For example, China and Germany are currently actively investing in large-scale nonconventional renewable energy projects in Colombia.

Supporting Infrastructure

Current roads and ports in Colombia need to be upgraded to be able to transport equipment and components for large-scale wind and solar investments. The Ministry of Transportation is responsible for planning, coordinating, controlling, and evaluating the development of policies, plans, programs, and technical assistance for the construction of physical infrastructure in the transportation sector. Foreign firms will need to collaborate with the Ministry of Transportation to adjust current transportation infrastructure or build new infrastructure to meet the needs of large-scale nonconventional renewable energy investments. This is an area of opportunity for foreign firms for the collaborative development of transportation infrastructure in Colombia.

Table 7.2 presents some of the most salient areas for collaboration and investment in Colombia. This is not an exhaustive list. The "Areas with Existing Opportunities" column presents current "urgent" themes that need better integration into the E2050 plan. The "Potential Opportunities for Danish Firms" column presents the competencies of Danish firms that have potential to be transferred to Colombia. This column also presents some concrete actions and examples for contact points in Denmark.

Table 7.2. Potential Areas for Collaboration

Energy System	Areas with Existing Opportunities	Potential Opportunities for Danish Firms
Biodiversity and Natural Ecosystems	• Balance of land use: energy versus food • Sea and land	• Development of national parks and protection areas (e.g., Amazonas Department) • Best practices to protect ecosystems (e.g., water treatment in sanitation, rivers and seas)/State of Green (Denmark)
Governance in Energy Democracy	• Partnerships (public-private) • Engagement with local communities	• Support for regulations and schemes for partnerships • Best practices for *Civic Energy Cycle*, (e.g., Ringkøbing-Skjern Kommune)
Energy Culture	• Development of human capital at technical and higher education levels • Technical expertise • End users • Awareness of nonconventional renewable energy and its use.	• Wind-energy program (e.g., DTU) • Joint academic programs • Industrial training (e.g., internships) • Training of trainers (e.g., Chamber of Commerce, Industrial associations and NGOs)
Energy Efficiency	• Flexibility of the energy network (electricity grids—transmission and distribution) • Energy storage (technology, equipment, and machinery) • Design of public places and mobility	• Digital solutions (operation of nonconventional renewable energy investments) • Energy efficiency (technological solutions) • Batteries • Cybersecurity • Intelligent cities
Supporting Infrastructure	• Building/upgrading transportation infrastructure, e.g., roads and bridges	• Public-private partnerships for the planning, design, and construction of infrastructure

Source: Original table for this publication

8 Conclusions

The objective of this report is to guide for Danish businesses in entering the Colombian energy sector. Colombia is in a unique position to develop a sustainable and flexible energy system with a combination of different energy sources. The E2050 plan aims to provide a *roadmap for the future: efficient, reliable and sustainable energy for the service of all Colombians* [6]. Colombia has a capable and committed public sector that has made major efforts to develop a legal framework to meet the E2050 plan. This is very aligned with Danish objectives. In December 2020, Denmark's Climate and Energy Minister Dan Jorgensen announced that Danish oil and gas production in the North Sea would end by 2050. Minister Jorgensen said, "*We hope this can inspire others*" [54]. Colombia has a commitment to the SDGs. However, the transformation of Colombia's energy system requires political decisions to be made, particularly regarding the future of coal, oil, and gas. Lessons can be learned from Denmark regarding the extent to which Colombia will transform its energy matrix with nonconventional renewable energy sources.

Appendix A

Utility	Ownership	Business Units	Subsidiaries	Markets	Products/services	Business Units
Grupo EPM **Established in 1955** Grupo·epm	Public		Waste water management	47	Colombia	
			Nonconventional renewable energy production			
			Power transmission			
			Energy generation			
			Water supply		Guatemala	
			Commercialization of Energy		Salvador	
			Gas		Panama	
			Investments		Chile	
					Mexico	
ISAGEN **Established in 1967** ISAGEN	Private: • 57.6% BRE Colombia • Hydro Investment S.A.R.L. • 13.14% EPM • 6.06% Pension Fund Porvenir • 23.19% Other shareholders		Nonconventional renewable energy production	–	Colombia	
			Commercialization of Energy			
GRUPO ENEL-CODENSA-EMGESA **Established in 1997** enel codensa - emgesa	Multinational		Nonconventional renewable energy production	6	Colombia	
			Commercialization of Energy			
			Investments			
			Gas		Latin America North America Europa Africa	

Appendix B

Colombia's legal framework for nonconventional renewables	
Law/Norm/Resolution	Purpose
Law 1543. (Ministry of Mines, September 16, 2017)	Regulation of the FENOGE https://www.minenergia.gov.co/documents/10180//23517//47861-dec_1543_160917.pdf
Resolution CREG-010 (January 29, 2018)	Methodology for reimbursement of energy distribution to the interconnected national system http://apolo.creg.gov.co/Publicac.nsf/1c09d18d2d5ffb5b05256eee00709c02/65f1aaf1d57726a90525822900064dac/$FILE/D-010-18%20DISTRIBUCI%C3%93N%20DE%20ENERG%C3%8DA%20EL%C3%89CTRICA.pdf
Resolution CREG-030 (February 26, 2018)	Regulation of the activities of small-scale self-generation and distributed generation in the interconnected national system http://apolo.creg.gov.co/Publicac.nsf/1c09d18d2d5ffb5b05256eee00709c02/83b41035c2c4474f05258243005a1191?OpenDocument
Resolution CREG-038 (April 9, 2018)	Regulation on self-generation in ZNIs http://apolo.creg.gov.co/Publicac.nsf/1c09d18d2d5ffb5b05256eee00709c02/71e64d5b21da40e8052582830078b66e?OpenDocument
Resolution UPME-703 (December 14, 2018)	Procedures and requirements to obtain certification for nonconventional projects to access to the benefits (VAT waiver and import exceptions) of Law 1715 https://www1.upme.gov.co/Normatividad/703-2018.zip
Law 570 (March 3, 2018)	Public policy guidelines to define and implement a mechanism that promotes long-term contracting for electric power generation projects, having as objectives: 1. Strengthen the resilience of the electric power generation matrix to events of variability and climate change through risk diversification. 2. Promote competition and increase efficiency in price formation through long-term contracting of new and/or existing electricity generation projects. 3. Mitigate the effects of climate variability and change by taking advantage of the potential and complementarity of available renewable energy resources, which allow managing the risk of meeting future demand for electricity. 4. Promote sustainable economic development and strengthen regional energy security. 5. Reduce greenhouse gas (GHG) emissions from the electricity generation sector in accordance with the commitments made by Colombia at the World Summit on Climate Change in Paris (COP21) https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=85659
Resolutions 4 0590, 4 0591, and 4 0725 (MME, 2019)	Regulation of the auction carried out in 2019
External circular UPME-042 (2019)	Validation and application of article 174 of Law 1955, the 2019 National Development Plan, modifying article 11 of Law 1715 Incentives https://www1.upme.gov.co/Normatividad/Circular_042_2019.pdf

External circular UPME-037 (September 4, 2020)	Forms 1, 2, 3, and 4 to apply for tax incentives included in Law 1715 for nonconventional renewable energy projects https://www1.upme.gov.co/Normatividad/Circular_037_2020.zip
Resolution UPME-203 (September 3, 2020)	Procedure to access to the tax benefits for investment in research, development, or production of energy through nonconventional renewables https://www1.upme.gov.co/Normatividad/203-2020.pdf
External circular UPME-043 (October 22, 2020)	Online application for certification from UPME to access tax incentives for energy efficiency and nonconventional renewable energy projects https://www1.upme.gov.co/Normatividad/Circular_043_2020.pdf
Circular MME 40007	Preliminary rules for 2021 auction for non-conventional renewables https://www.minenergia.gov.co/documents/10180//23517//48885-400070001+%281%29.pdf

Glossary

Environmental Performance Index indicators:

Biodiversity & Habitat Indicator: This category of the Environmental Performance Index assesses countries' actions toward retaining natural ecosystems and protecting the full range of biodiversity within their borders. It consists of seven indicators, namely, terrestrial biome protection (weighted for the national and global rarity of biomes), marine protected areas, the Protected Areas Representativeness Index, the Species Habitat Index, the Species Protection Index, and the Biodiversity Habitat Index [90].

Climate Change: This category of the Environmental Performance Index measures progress in combatting global climate change, which exacerbates all other environmental threats and imperils human health and safety. It is composed of the following eight indicators: adjusted emission growth rates for four greenhouse gases (CO_2, CH_4, F-gases, and N_2O) and one climate pollutant (black carbon); the growth rate in CO_2 emissions from land cover; the greenhouse gas intensity growth rate; and the greenhouse gas emissions per capita [91].

Ecosystem Services: This category of the Environmental Performance Index is a new category that recognizes the important services that ecosystems provide for human and environmental well-being, including carbon sequestration and storage, biodiversity habitat, nutrient cycling, and coastal protection. It consists of three indicators to evaluate the state of these ecosystems, specifically, tree cover loss and two new pilot indicators for 2020—grassland loss and wetland loss [92].

Key terms and laws referenced in the report:

Civic energy: Decentralized renewable energy generation owned (at least 50 percent) and operated by citizens, local initiatives, communities, local authorities, charities, non-governmental organizations (NGOs), farmers, cooperatives, or small and medium-size enterprises (SMEs), creating a stream of local value that can stay within the region [68].

COVID-19 pandemic: The COVID-19 pandemic has had a considerable effect on the Colombian economy (GDP decreased by 8.25% in 2020) and energy use (energy demand decreased by 15–20% for many months in 2020). Nevertheless, Colombia has continued to promote the E2050 plan during the COVID-19 pandemic by changing the regulatory system and launching public tenders for nonconventional energy investments.

Departments: Colombia has 32 decentralized regions known as departments.

E2050 plan: Colombian National Energy Plan toward 2050, introduced in 2015. The E2050

plan aims to diminish the social and environmental impacts of climate change on the Colombian energy system by diversifying and complementing the current energy matrix with nonconventional renewable energy.

Energy culture: A multidisciplinary framework for understanding consumer energy behavior that integrates legal, sociological, and philosophical disciplines, among others.

Energy democracy: Energy democracy is a bottom-up social movement that challenges the centralized monopoly of the energy sector in the transition to. It calls for decarbonization, access to renewable energy, and democratic decision-making [54].

Energy transition: The energy transition is a pathway toward transformation of the global energy sector from fossil-based to zero-carbon by the second half of this century. At its heart is the need to reduce energy-related CO_2 emissions to limit climate change [93].

FPIC: See ILO Convention 169.

Green Growth Policy: Colombia's green growth strategy integrates policies, activities, and goals that are consistent with the tenets of the 2018–22 National Development Plan ("Pact for Colombia, Pact for Equity") to improve productivity and economic competitiveness by 2030 while ensuring social inclusion and the efficient use of natural capital in a climate-friendly manner.

ILO Convention 169: The International Labour Organisation (ILO) Convention 169 for "free, prior, and informed consent" (FPIC) specifies rules and regulations for consultation processes with indigenous people. This convention was ratified by Colombia in 1991 [18].

Jepirachi wind park: Colombia's only wind park as of April 2021. It was built by Grupo EPM in collaboration with Nordex in the La Guajira region in 2004. The Jepirachi wind park has 15 Nordex N60/1300 turbines, for a total nominal power of 19.5 megawatts, which equals 0.1 percent of the total net generation capacity of Colombia.

La Guajira: Department in Colombia inhabited by the Wayúu people. Site of the largest open-air coalmine in Latin America (Cerrejón). Site of the first wind park in Colombia (Jepirachi). The wind quality and availability in La Guajira are considered to be superior to that in most other regions in Colombia. In 2021, 16 wind energy projects will be implemented in La Guajira.

Law 1715: The main legal instrument for the energy sector in Colombia. Law 1715 stipulates the key aspects of the functioning and development of the renewable energy sector, such as providing fiscal incentives for investment, defining responsibilities among ministries, and establishing financial and operative instruments for different types of nonconventional renewable energy.

Law 1955: This law, which was published in March 2021, requires energy wholesalers in Colombia to purchase between 8 and 10 percent of their energy from nonconventional renewable sources through long-term contracts by 2023 [11].

Legacy of armed conflict: Colombia is still undergoing a transition process after the signing of a peace agreement between the national government and the FARC in 2016. More than 60 years of civil conflict distorted public policies and economic development in the affected regions.

Nonconventional renewable energy: Environmentally sustainable renewable energy resources that are available, but not generally used or widely commercialized in Colombia, such as biomass, small hydroelectric, wind, geothermal, solar, and tidal [1].

Non-interconnected zones (ZNIs): Areas of Colombia that are not joined to the energy grid. ZNIs span 17 departments, 5 capital cities, 54 municipal capitals, and 1,262 localities [29], and cover approximately 66 percent of the national territory of Colombia. Many of these zones cannot be reached by electricity distribution grids.

Paris Agreement: Colombia is committed to the Paris Agreement's target of limiting global warming to below 2 °C.

Power purchase agreements (PPAs): Medium- to long-term agreements to secure energy supply in Colombia. Short-term PPAs are signed for a maximum of five years, and typically between one and three years, whereas long-term PPAs (introduced in 2019) can be for up to 15 years.

Regulated/Non-regulated users: Electricity consumers in Colombia are either regulated or non-regulated depending on their energy usage. Regulated users (those who use below 50 megawatt-hours of electricity per month) cannot enter long-term energy supply contracts; whereas non-regulated users (those with demand of 100 kilowatts or 55 megawatt-hours per month) are able to enter long-term contracts but cannot negotiate directly with energy suppliers.

Reliability charge: A remuneration scheme that makes it possible to invest in the electricity generation resources necessary to efficiently guarantee the attention of the energy demand in critical supply conditions, through long-term signals and the stabilization of the income of the generator [94].

Spot market: Short-term contracts for purchasing or selling a particular volume of energy at a certain price. In Colombia, the prices for the spot market are calculated by XM. Prices are highly volatile based on fluctuations in supply and demand.

Wayúu people: Seminomadic indigenous people of the La Guajira region. Many do not have access to the internet, mobile phones, tablets, or even reliable electricity.

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Photo 1.2. *Solar Panel in a Lounge [Typical House Construction] in La Guajira.*

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