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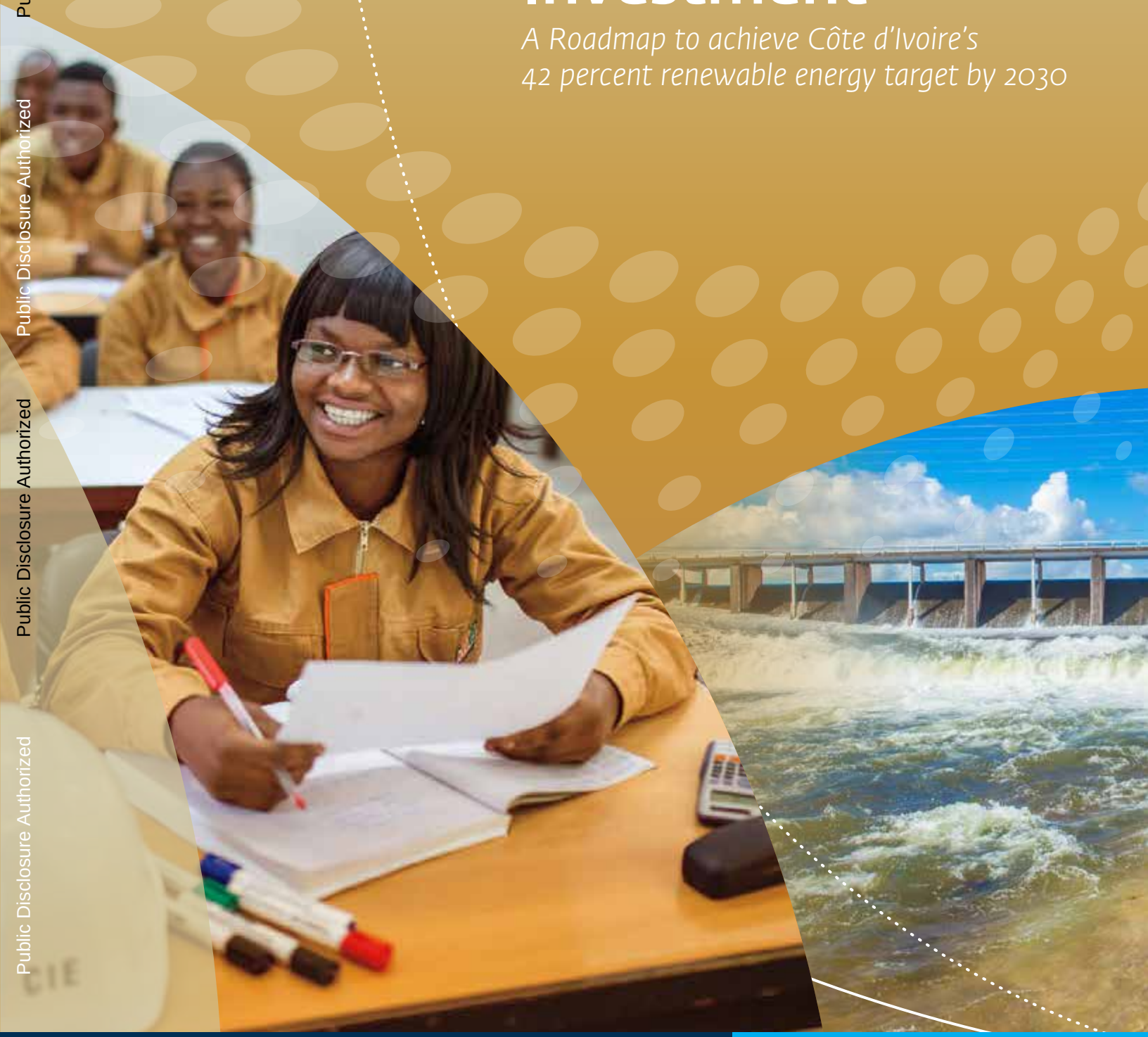
Unlocking Private Investment

A Roadmap to achieve Côte d'Ivoire's 42 percent renewable energy target by 2030



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Contents

Foreword viii

Acknowledgements x

Executive Summary 1

Country Context and Background 7

- Power 8
- Renewable Energy Potential 10

Côte d'Ivoire's Innovative Vision to Attract Investment 11

Hydropower 17

- Status 18
- Challenges 20
  - Management of existing hydropower assets 20
  - Attracting the private sector 20
- Potential Solutions 20
  - Improve the quality and transparency of information about hydropower resources and their development 20
  - Develop a clear government framework for hydro projects 21
  - Revise existing high-level resource study and include site prioritization 21
  - Adjust current approach to site prioritization to increase opportunities for new players in the market 21
  - Carry out feasibility studies to prepare a tender program for small hydropower 22

Biomass 23

- Status 24
- Challenges 25
  - Low demand for on-site thermal energy 25
  - Coordinating a range of stakeholders 25
  - High capital expenditures 26
  - Facilitating management and sourcing supply 26
- Potential Solutions 26
  - Strengthen agricultural sector capacity 26
  - Define a government strategy for biomass and conduct a comprehensive mapping study 26

Develop pilot projects 29
Expand use of municipal solid waste and alternative feedstock 29

Variable Generation: Solar and Wind 31

Utility-Scale Generation and Grid Integration **34**
Current status 34
Challenges for utility-scale generation and grid integration 36
Potential solutions 38

Off-Grid **43**
Challenges 43
Potential solutions 44

Mini-Grids and Distributed Generation **50**
Challenges 50
Potential solutions 51

Cross-cutting Issues: Finance, Policy, and Regulation 55

Status **56**

Challenges **57**
Developing experience in the renewable energy sector 57
Maintaining a neutral, competitive process 57
Identifying appropriate investment promotion incentives 57

Potential Solutions **58**
Map existing sources of funding available for renewable energy in Côte d'Ivoire, including concessional and grant funds 58
Explore feasibility of targeted guarantees 58
Maintain an updated investment prospectus for Côte d'Ivoire's renewable energy sector in consultation with the private sector 59
Develop and implement an ongoing renewable energy policy monitoring framework based on ECOWAS experience 60
Create a renewable energy and energy-efficiency agency and one-stop shop for investment promotion 60

Next Steps 63

Contents

Annexes **65**

Resources **66**

Hydropower 66

Biomass 66

Variable Generation: Solar and Wind **67**

Grid-tied 67

Off-grid 68

Grid, mini-grid, and distributed generation 68

Finance and policy 69

Project Portfolio **70**

Laws and Regulation for Clean Energy **70**

Figure 1: Roadmap process 5

Figure 2: Market share and generation mix (2017) 9

Figure 3: Indicative pathways for scaling grid-tied renewable energy based on government plans (MW) 13

Figure 4: Annual costs of implementing renewable energy project pipeline ($M) 14

Figure 5: Total capacity and costs of identified renewable energy pipeline to 2030 ($M and MW) 15

Figure 6: Breakdown of power generation supply (% total GWh produced) 19

Figure 7: Power generation supply (GWh) 19

Figure 8: Direct normal solar irradiation in Côte d'Ivoire 35

Figure 9: Operating and proposed utility-scale solar PV project installed costs in Africa (2011-2018) 36

Figure 10: Average number of weeks to get connected to electricity 37

Figure 11: Electricity access and mobile phone ownership, Sub-Saharan Africa, 2016 (% of rural households) 48

Table 1: Installed capacity (2017, 2030) 13

Table 2: Costs for installation goals identified in pipeline 15

Table 3: Installed capacity (2017) 18

Foreword

Thierry Tanoh

Minister for Petroleum, Energy and Renewable Energy Development, Côte d'Ivoire

Alzbeta Klein

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Along with the challenges it presents, addressing climate change also reveals immense opportunities. The International Finance Corporation (IFC)—a sister organization of the World Bank and member of the World Bank Group—analyzed the Paris Agreement goals set by 21 of the largest emerging market countries, and found more than $23 trillion in climate-smart investment opportunities leading up to 2030. As a result of government policy leadership and private sector innovation, clean, renewable energy is becoming the technology of choice to meet growing demand and achieve ambitious goals for energy access and reduced emissions. Côte d'Ivoire is no exception. IFC and Côte d'Ivoire have been working together for over a decade to deliver private sector solutions that expand the country's power supply.

When the country set its target to achieve 42 percent renewable energy generation by 2030, IFC approached the Ministry of Petroleum, Energy and Renewable Energy Development to forge a partnership supporting private sector solutions that can help achieve this ambitious goal. This partnership builds on Côte d'Ivoire's significant hydropower assets (nearly 880 megawatts—23 percent of the current generation mix) to integrate new and innovative technologies and business models.

The Ministry and IFC are pleased to report that, over the past year, more than 100 stakeholders across the public, private, and development finance sectors have provided their input and ideas to help Côte d'Ivoire achieve the 42 percent target. It is one of the first countries to analyze its Paris Agreement commitments to identify investment opportunities for the private sector. A series of dialogues contributed to the creation of this Roadmap, which provides a set of practical solutions, including competitive international tenders for new generation; resource availability studies to unlock new hydropower and wind potential; and policies to catalyze innovative off-grid solutions such as solar home systems. If these solutions can be realized, IFC estimates there is a renewable energy investment potential worth about $9 billion. A range of financial sources including blended concessional climate finance and commercial capital will need to be leveraged to achieve this ambitious goal. IFC will work with other development partners to support companies working in Côte d'Ivoire in accessing such funds for projects as needed.

Our partnership does not end with this Roadmap. We want to thank the experts working in the financial, technology, transport, and agriculture industries for their active participation, ideas, and input. We look forward to working with these stakeholders—and others—to implement these solutions. We hope that this Roadmap and the unique private sector engagement process that we have undertaken will serve as an inspiration for other countries that seek to attract private investment and ideas to deliver on their Paris climate commitments while also achieving their economic development goals. ■

Thierry Tanoh

Alzbeta Klein

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Executive Summary

Countries around the world are working towards a low-carbon future. Since the adoption of the Paris Agreement in December 2015, 189 countries have submitted national plans that set clear goals to increase investment in renewable energy, energy efficiency, sustainable infrastructure, climate-smart agriculture, and more. Beyond setting the stage for bottom-up action, these Nationally Determined Contributions (NDCs) also opened up massive potential for investment—nearly $23 trillion according to the 2016 International Finance Corporation (IFC) Climate Investment Opportunities in Emerging Markets report.[1] Much of this investment will need to come from the private sector. Governments—including Côte d'Ivoire—are increasingly interested in working with the private sector to unlock vital finance and develop innovative solutions.

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Costs for renewable energy are rapidly decreasing and in certain cases can be less expensive than generating electricity from fossil fuels. This has helped to radically change the model of energy development and access around the globe, and a larger share of the energy mix is expected to be renewable in future. In regions like Sub-Saharan Africa where there is high interest in expanding infrastructure to improve access to energy, there is an opportunity to leapfrog traditional electrification approaches and develop new models that are cleaner, more efficient, and focused on customer and business needs.

There is significant opportunity for private sector investment to meet Côte d'Ivoire's renewable energy goals

Côte d'Ivoire's commitments are ambitious. The country's NDC, released in 2016, set a target to reduce its greenhouse-gas emissions by 28 percent by 2030, including a target to generate 42 percent of electricity from renewable energy by 2030.[2] As highlighted in the IFC Climate Investment Opportunities report, the country is focused on spurring economic growth and solidifying its role as an economic engine for West Africa.

The government recognizes the important role of private sector investment in expanding renewable energy penetration. Overall, Côte d'Ivoire's 2016-2020 National Development Program aims to attract $32 million in private investment.[3] The main drivers of sustained growth are expected to be both public and private investments in infrastructure, opening up significant opportunities for the energy and electricity sectors.

The Ministry of Petroleum, Energy and Renewable Energy Development is developing the overall strategy and policy framework for including renewables into the energy mix. The Société des Energies de Côte d'Ivoire (CI-Energies), a state-owned asset holding company, is moving this framework forward and has mapped technology-specific needs and is offering tenders to develop the projects that will contribute to NDC goals. Although Côte d'Ivoire has yet to increase its power generation capacity, it has made substantial progress in improving the existing transmission and distribution network and restoring the energy sector's financial viability.

The Generation and Transmission Master Plan, Distribution Master Plan, and Grid Automation Master Plan support the government in defining investment selection criteria that can help meet both domestic and regional demand, and ensure secure supply. For example, although Côte d'Ivoire's grid is extensive, it needs to increase its connections through densification. This is being addressed in part by the largest International Development Association (IDA) loan to the country ($325 million) in 2017.[4] The loan aims to improve the transmission and distribution network to provide electricity access in 200 villages, and is complemented by additional concessional financing to support the government in consolidating the financial viability of the sector. These operations are critical to attract new private investors and achieve the government's ambitious target of near-universal access to electricity by 2020.[5]

The Electricity Code passed in 2014 is another piece of legislation that will harness the existing private sector interest and continue to push innovative projects such as small-scale grid-connected solar photovoltaic (PV) and biomass projects beyond proposals into implementation. However, it is important that the code continue to include renewable-specific objectives and policies to support the continued sale and delivery of electricity to the grid. Autorité Nationale de Régulation du Secteur de l'Electricité de Côte d'Ivoire (ANARÉ), the electricity regulator, is responsible for ensuring that the need for affordable tariffs for all is balanced with the need for the project promoter to profit from its investment.[6]

Partnerships such as that between IFC and the Ministry of Petroleum, Energy and Renewable Energy Development are vital to contributing to the knowledge base that will pave the way for the private sector. Private companies will demonstrate interest once they understand the appropriate demands, incentives, and supporting mechanisms that allow an investment to provide appropriate risk-adjusted returns. Through the structured engagement process and this Roadmap, the private sector can gain this knowledge and use its strengths efficiently and effectively.

One area in which the Roadmap offers value is by identifying opportunities within the renewable energy sector. There are further opportunities for increased use of solar PV in both grid-connected and decentralized (distributed) applications, including off-grid and energy self-supply options. Developing grid-connected solar power via auctions and programs like the IFC's Scaling Solar initiative may help to clarify the true price of solar development in the country. Significant hydroelectricity (hydro) assets have already been developed and will continue to grow. To date, agricultural companies have not seen a strong business case for biomass power projects, but new projects under development may change that perspective. The Biokala project will provide an important test case for utility-scale electricity production. Wind power is also a possibility with good potential that the government of Côte d'Ivoire is interested in exploring further.

The government has prioritized extension of the electricity grid as the primary means of increasing electricity access, and is working with development partners to implement this. However, further improvements to the grid to reduce losses and incorporate proper grid code are needed. Côte d'Ivoire's energy mix is dominated by dispatchable[7] generation sources (hydro and gas), so the grid is already capable of managing the addition of intermittent renewable energy sources. This capability will be improved through smart grid technologies, automation, and control systems.

Renewable energy also has a key role to play in energy access through decentralized solutions, including mini-grids and solar home systems. While these often have a lower initial cost than building the interconnected grid for distant sites, they can incur a higher cost per kilowatt hour (kWh) to generate electricity. In the case of mini-grids this is offset against advantages such as speed of deployment and end-user economic benefits,

savings on grid interconnection, and potentially some reduction in losses, but a subsidy may be required to ensure the government's priority of matching grid-connected retail tariffs is achieved. In addition, separate industries can be connected using innovative business models: pay-as-you-go solar home systems increase financial inclusion, often include the sale of efficient appliances on credit, and build customers' credit history, helping to attract investment.

As a major producer of agricultural products, Côte d'Ivoire has ample feedstock for biomass production. The challenge lies in securing a reliable supply of these feedstocks. The Roadmap offers several options for how this supply chain can become strong and dependable. For example, there are already plans to develop grid-tied biomass generation projects that can support the eventual development of a mechanism that aggregates supply, relieves the burden on individual agricultural entities, reduces upstream risk, and stabilizes prices.

IFC supports Côte d'Ivoire's bright future with an innovative partnership

To chart a course towards achieving these targets, IFC partnered with the Ministry of Petroleum, Energy and Renewable Energy Development to develop a Roadmap for meeting the country's renewable energy goals. This innovative approach is among the first of its kind, and Côte d'Ivoire is leading the way. The partnership strongly promotes the World Bank Group's Maximizing Finance for Development (MFD) approach, which seeks to sustainably leverage the private sector to bolster scarce public resources. This approach helps achieve the dual goals of reducing poverty and boosting shared prosperity.[8]

Through a series of structured public-private dialogues over the past 12 months, IFC and the Ministry of Petroleum, Energy and Renewable Energy Development have worked with stakeholders to identify key constraints and solutions that will help achieve Côte d'Ivoire's NDC target of 42 percent renewable energy by 2030. The dialogues included international and local stakeholders, including government departments, banks, trade groups, civil society, and private businesses. Development partners included IFC, the World Bank, the AfDB, the Centre for Renewable Energy and Energy Efficiency, the European Investment Bank, the European Union (EU), the French Development Agency, GIZ, the Japan International Cooperation Agency, KfW (German development bank), the United States Agency for International Development (USAID), the United States Trade and Development Agency, and the West African Development Bank.

To date, IFC and the Ministry of Petroleum, Energy and Renewable Energy Development have engaged in three main activities as part of the Roadmap process (see Figure 1).[9]

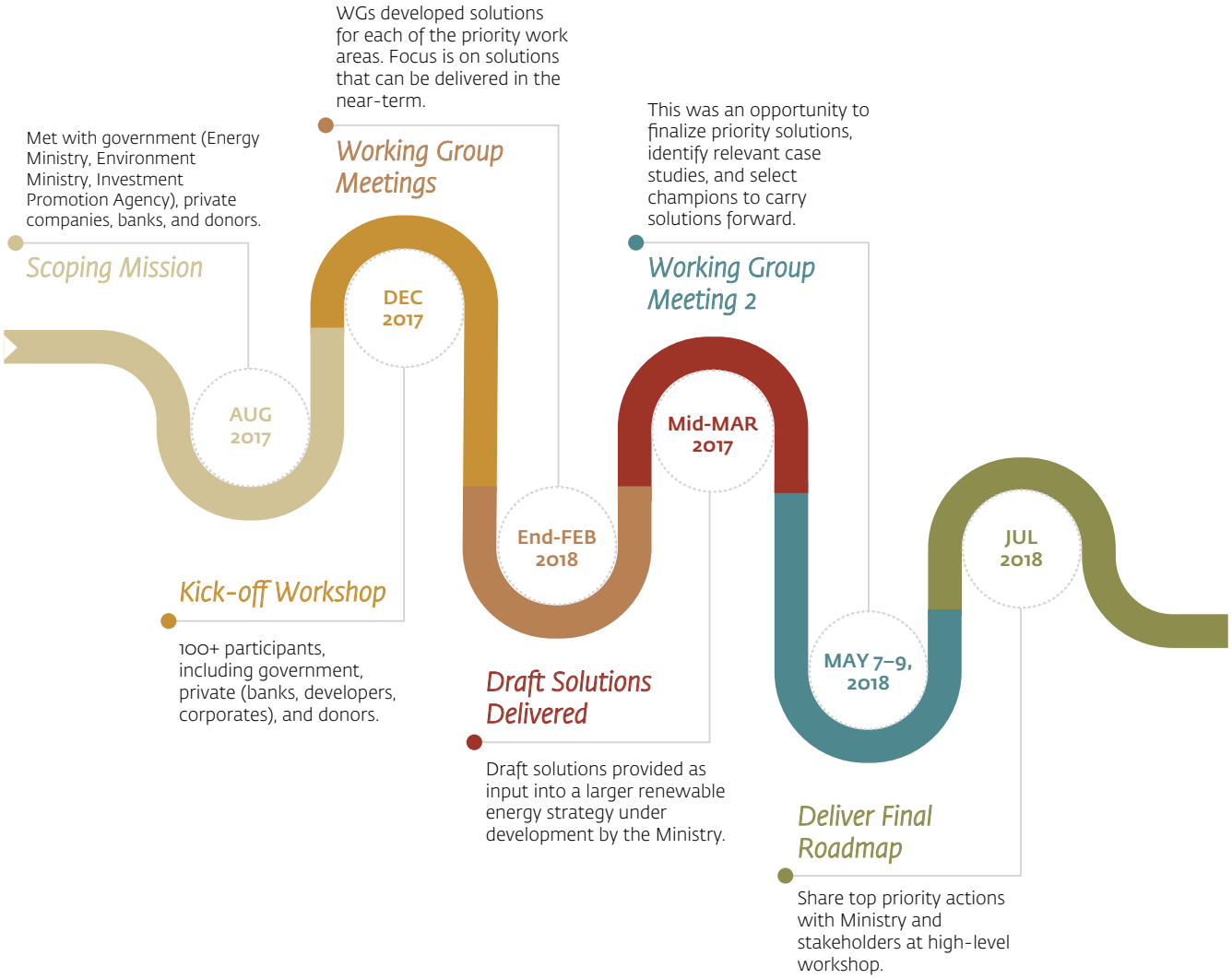
- A launch event from December 14–15, 2017 in Abidjan, attended by over 100 participants from electricity companies, regulators, government agencies, development partners, project developers, distributors, banks, investors, and other private companies.

BOX 1

What is a roadmap?

A roadmap is a specialized type of strategic plan that outlines activities an institution can undertake to achieve stated goals and outcomes. This is best understood as an evolving process of creating and implementing a strategy, and monitoring and updating it as necessary. "Roadmapping" engages and aligns diverse stakeholders in a common course of action while building relationships and generating solutions. The process includes two types of activities (expert judgement and consensus, and data and analysis) and four phases (planning and preparation, visioning, roadmap development, and implementation and revision).

FIGURE 1: Roadmap process



- A Working Group Workshop from February 27 to March 2, 2018, hosted by IFC, to get input from renewable energy stakeholders. Involved direct consultations on potential actions to be included in the Roadmap. Preliminary key solutions were identified in roundtables at that workshop. These solutions were verified in bilateral discussions with stakeholders before and after the workshop.
- From May 7–9, 2018, IFC hosted a second Working Group Workshop to validate the identified solutions, structure them effectively, and seek champions to drive them forward.

The structured dialogues have included extensive bilateral discussions with the government and other actors.

Implementing the Roadmap will help Côte d'Ivoire unlock private investment

Côte d'Ivoire's energy sector is growing, but there is a need to restore and improve its financial sustainability and solidify the private sector's willingness to invest. This will require more sustainable levels of short-term debt to be contracted within the sector, and a plan to clear existing arrears must be agreed upon so the government can re-establish credibility in terms of timely payments. Finally, the effective management and application of the cashflow waterfall—the tiered structure of payments according to seniority, on which investors have historically relied, can be improved. Fortunately, strong government buy-in to the roadmapping process has contributed to the development

of a plan to move forward and reinvigorate the flow of private finance.

This Roadmap process has been strongly supported by the government of Côte d'Ivoire—a vital step in ensuring the longevity and success of the proposed solutions. There is a strong network of dedicated institutions and champions willing to set these solutions in motion, and this Roadmap provides a step-by-step process that includes activities to achieve stated goals and outcomes. IFC aims to continue its support by helping to implement the solutions in line with its understanding of global best practice to help create viable markets for renewable energy.

The road ahead

The roadmapping process generated several key recommendations, most importantly the need to expand existing tender processes across various energy technologies. Progress has been made in the biomass sector with recent tenders issued for cocoa and cotton and lessons can be learned for other technologies as well. Specifically, clarifying and simplifying the necessary procedures and requirements can improve competitiveness for potential investors. Feasibility studies and expanded resource availability reports can improve competitiveness as well, supporting the private sector's understanding of investment potential.

Other recommendations to highlight include:

- When needed, develop or clarify government policies and frameworks for project design and implementation to ensure transparency and effectiveness.
- Institutionalize existing efforts to improve electricity grid access and resiliency.
- Leverage global lessons learned across all sectors to develop appropriate financing structures and incentives for multiple technologies while incorporating quality assurance processes for new products, such as solar home systems.

The main product of the Roadmap has been to engage a variety of stakeholders in consistent and constructive dialogue. The work done by project partners thus far has launched Côte d'Ivoire on a promising pathway towards meeting their 42 percent goal. To build on this success, the Roadmap recommends partnering with a local industry body and potential donors to jointly contribute to a broader private sector engagement platform. The platform could then serve as a bridge to the public sector and donor community to support ongoing development and implementation of clean energy solutions.

Country Context and Background

Côte d'Ivoire is a dynamic country with one of the fastest growing economies in the world. Supportive fiscal policies, renewed political stability, and structural reforms to improve the business investment climate have led to a strong surge in economic activity and unprecedented GDP growth. The country had an average real growth rate of 8.5 percent per year (among the highest in Sub-Saharan Africa) from 2012 to 2015, driven by agriculture, services, industry, increased domestic demand, and growing investment.[10] The agricultural sector is the backbone of the Ivorian economy, accounting for 25 percent of GDP and more than three-quarters of non-oil exports.[11] Two-thirds of households depend on agriculture for their employment and income.[12]

The economic outlook for the next three years is positive, based on an expected average growth rate of about 7 percent, moderate inflation, prudent fiscal and monetary policies to control public finances, and continued reforms to improve the business climate and facilitate the efficient use of public-private partnerships.[13] From a longer-term perspective, this economic environment is expected to increase energy consumption by an estimated 6.55 percent between 2014 and 2030.[14]

Côte d'Ivoire's economic growth has been driven by commodity-based exports, which will remain key to growth in the medium term. The most important export crops—cocoa, rubber, oil palm, cotton, and cashew—are the main sources of smallholders' income and the centerpieces of the country's major farming systems. The impact of producing export commodities extends to other sectors through input provision, processing, transport, financial services, taxes, energy, and final consumption, giving export crops a key role in creating jobs and reducing poverty.

Power

With an installed generation capacity of 2,199 megawatts (MW),[15] Côte d'Ivoire's electrical system is the third largest in West Africa, after Nigeria and Ghana. Power capacity is

dominated by natural gas-fired generation (1,320 MW) and hydropower (879 MW).[16] Despite this significant hydropower capacity, the generation mix—energy generated in megawatt hours (MWh)—is dominated by gas-fired power. Natural gas independent power producers (IPPs) represent 60 percent of total Ivorian production (with a 68 percent capacity factor), while hydro production is 40 percent (with a 27 percent capacity factor).[17] Traditionally, contract structures have favored gas producers. As gas capacity increases under the same contractual framework, it is difficult to displace gas production with renewables. Therefore, while in the near-term gas is cheap because of offshore supplies, in the longer term more diversification will be required.

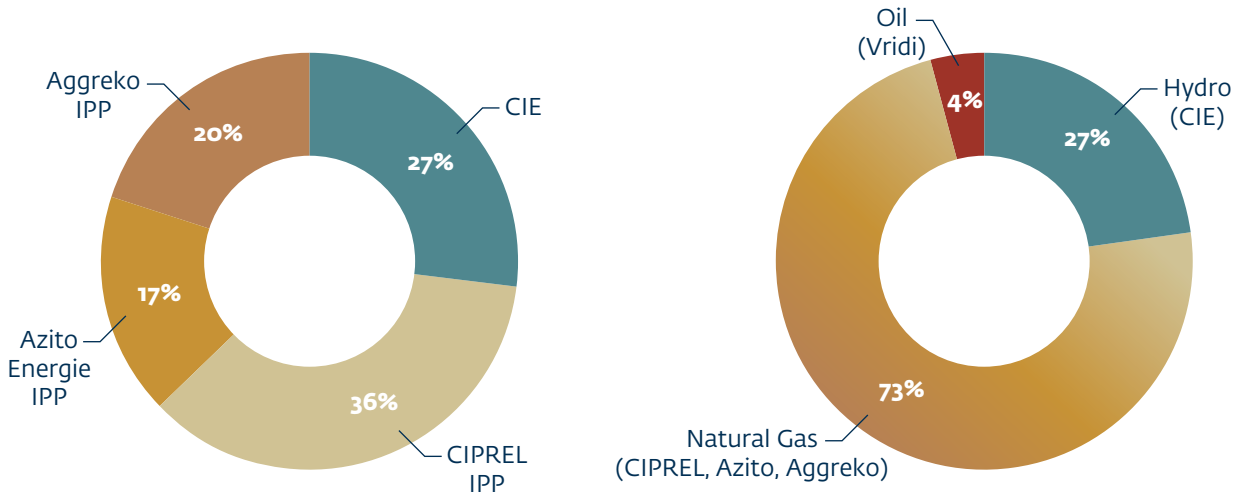
The 2011 National Strategic Action Plan for the Development of the Electricity Sector aims to increase total installed capacity to 3,000 MW by 2020.[18] This will be achieved through public-private partnership arrangements, with hydropower and solar as priority technologies. The increased capacity will allow Côte d'Ivoire to meet growing domestic demand and maintain the country's status as a regional energy hub.

Gross electricity generation in 2016 was more than 10,000 gigawatt hours (GWh), up from 8,607 GWh in 2015. Power consumption (net of energy losses and exports to neighboring countries) is about 6,400 GWh (8 percent higher than in 2015). Since 2011, net power demand has grown at an average rate of more than 11 percent per year, outpacing the average yearly GDP growth rate, which was almost 9 percent for the same period. Due to increasing electrification, industrial activity, and higher energy exports, peak demand has grown at an average rate of 6.9 percent since 2011, reaching almost 1,300 MW in December 2016.

Power demand is expected to continue to grow at more than 7 percent per year until 2025, driving demand for limited natural gas, which is needed for industry and gold mining.[19] In addition, Côte d'Ivoire is a net exporter of electricity, with grid connections to Benin, Burkina Faso, Ghana, and Togo.[20] Its export commitments to other West African Power Pool[21] countries will expand with the expected 2019 completion of the Côte d'Ivoire-Liberia-Sierra Leone-Guinea transmission line.[22] Another contributing factor is the "Electricity for All" program (Programme Électricité Pour Tous), which was adopted in 2014. Electricity for All aims to annually connect 200,000 households to the electricity system, achieving a 60 percent access rate (1 million households) by 2020.[23]

Despite the government's aim to develop a better balance in its energy mix to reduce reliance on fossil fuels, thermal generation is expected to grow. About 1,340 MW of new combined cycle gas turbine capacity is being developed and a 700 MW coal

FIGURE 2: Market share and generation mix (2017)



plant is planned in San Pedro, although it has questionable viability and low support.[24] There are also questions as to whether there are cost-effective renewable alternatives to these projects.

Renewable Energy Potential

There is strong potential for renewable energy investment in Côte d'Ivoire. IFC's 2016 Climate Investment Opportunities in Emerging Markets report found that meeting the country's NDC will create an estimated $10 billion[25] in investment potential in climate-smart sectors, $9 billion[26] of which is tied to the 42 percent renewable energy target. The private sector is expected to make up the bulk of these investments, with government support. This Roadmap provides guidance on how Côte d'Ivoire can work towards achieving this objective, identifying relevant stakeholders, their roles, and the steps that will make generating the required investment possible. Potential projects and solutions include:

- **Hydro:** With an estimated capacity of more than 879 MW —which can theoretically generate about 700 GWh per year—Côte d'Ivoire has good potential for hydropower development.[27] To date, the Soubré development (275 MW) on the Sassandra River is the most recently commissioned project. Hydropower projects in the pipeline for the next 10 years include Singrobo (44 MW), Gribo Popoli (112 MW), Boutoubré (156 MW), and Louaga (283 MW). The Ivorian government has identified 33 other hydro projects which have been financed, for a total capacity of 3,883 MW (including Tahibli, Daboitié, Tiboto, Tayaboui, and Gao).[28] The Ministry of Petroleum, Energy and Renewable Energy Development is planning the development of at least 81 MW of small hydropower projects before 2030. The EU also has plans to develop several new sites. Twenty potential sites with individual capacities between 1 MW and 12.5 MW were identified in a high-level study.[29] When combined with improved access to quality information about existing resources and revised high-level resource studies, these projects are just the beginning. A new policy and regulatory framework can help support priority sites to achieve maximum energy potential and open the market to new players.
- **Biomass:** The government has announced plans to include biomass-fueled generation capacity in the energy mix by 2030 and has identified some pilot projects to develop and build grid-connected facilities that can contribute to this target.[30] They have also issued recent tenders for cotton and cocoa biomass. Proposals are mainly for small-to-medium scale power from agri-processors and private project developers. The biofuels sector is still in its early stages, but biogas pilot projects and bioethanol are being investigated using sugarcane, maize, and sweet sorghum. A comprehensive mapping study could inform a national biomass strategy that includes strengthening the agricultural sector's capacity.
- **Variable generation (solar and wind):** Solar and wind resources are extensive, but their full potential requires further study.[31] An important part of this process is to include grid connectivity plans because the country's highest irradiation is in the northern region, where there is less demand. However, with the grid updates specified in the Generation and Transmission Master Plan, these resources can be delivered nationally. As with other energy projects, an improved and simplified tender process can bring in new investors eager to enter the growing market in grid-tied, off-grid, and mini-grid/distributed generation.

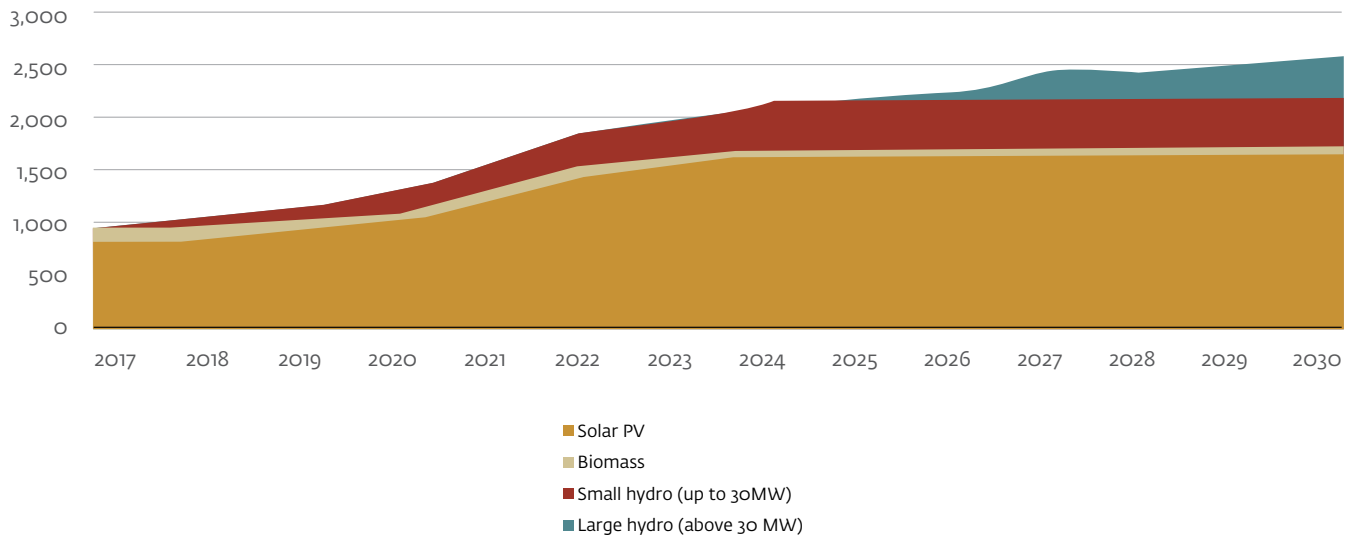
Côte d'Ivoire's Innovative Vision to Attract Investment

In its NDC, Côte d'Ivoire set a target to have 42 percent of its energy produced by renewable energy by 2030 (with a breakdown of 26 percent large hydro and the other 16 percent into "other"—solar biomass, small hydro, and wind).[32] The National Action Plan for Renewable Energy outlines plans for installed capacity (MW) and generation (GWh).[33] The projections are ambitious, partly because they give high capacity factors[34] to hydro (60 percent for small, 46 percent for large) and biomass (84 percent), but they show the 42 percent target being achieved in generation (MWh).

Photo © Dominic Chavez / IFC

CI-Energies has published a pipeline of energy projects, some of which are for renewable energy.[35] It is estimated that even if all these projects are built, there will still be a 13 percent shortfall in installed renewable energy capacity by 2030.[36]

FIGURE 3: Indicative pathways for scaling grid-tied renewable energy based on government plans (MW)



Source: Plan d'Actions National des Energies Renouvelables (PANER) (2016)

TABLE 1: Installed capacity (2017, 2030)

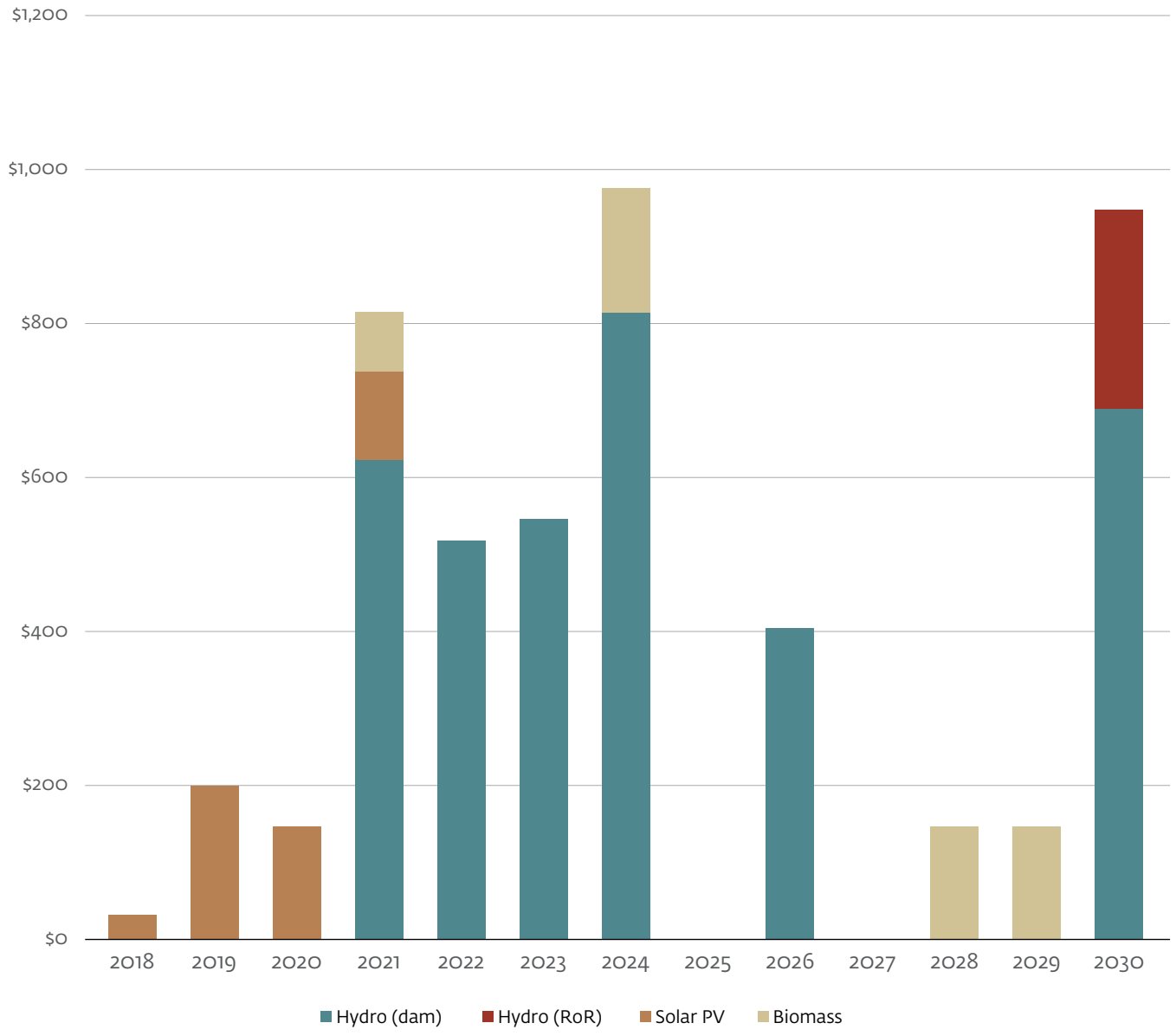
	2017	2030	
Installed capacity (MW)	**2017 actual**	**2030—plan**	**2030—pipeline**
Thermal—gas	1,320	2,548	2,728
Thermal—coal		1,400	1,400
Hydro	879	1,891	1,891
Solar		420	320
Biomass		500	236
Total installed capacity (MW)	**2,199**	**6,759**	**6,575**
Total thermal	1,320	3,948	4,128
Total renewable energy	879	2,811	2,447
Shortfall vs. plan			-13%

Source: CI-Energies Reference Document (February 2018), Developpement du Secteur de L'electricite de la Côte d'Ivoire.

To achieve its targets, Côte d'Ivoire will need to consider increasing the number of high-likelihood renewable energy projects in the pipeline. The pipeline plan should be aligned with the targets to ensure consistency and communicate the government's objectives to investors.

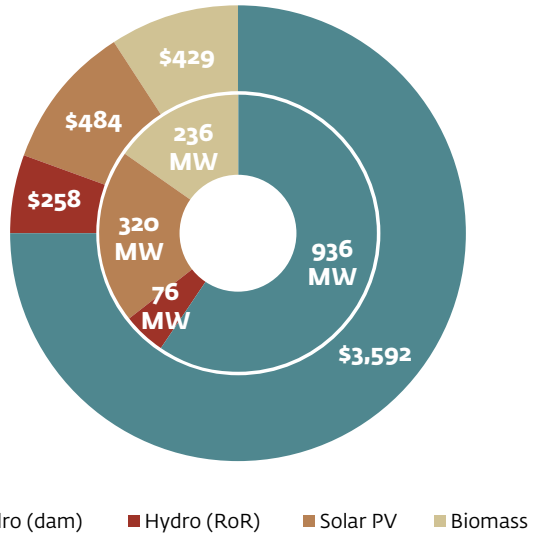
Using the CI-Energies pipeline for each source of energy, IFC estimates that delivering on these plans could create an investment opportunity of over $4.7 billion.[37]

FIGURE 4: Annual costs of implementing renewable energy project pipeline ($M)



Source: CI-Energies Reference Document (February 2018), Developpement du Secteur de l'electricite de la Côte D'ivoire

FIGURE 5: Total capacity and costs of identified renewable energy pipeline to 2030 ($M and MW)



Source: CI-Energies Reference Document (February 2018) utilizing cost/MW information from pipeline using XOF/USD exchange rate of 556.56 as of May 16, 2018

TABLE 2: Costs for installation goals identified in pipeline

Source	cost ($/w installed)	2030 new build pipeline (MW)	Total Cost ($M)
Hydro (dam)	$3.84	936	$3,592
Hydro (RoR)	$3.40	76	$258
Solar PV	$1.54	320	$494
Biomass	$1.82	236	$429
Total		**1,568**	**$4,773**

Source: CI-Energies Reference Document (February 2018). Using XOF/USD exchange rate of 556.56 as of May 16, 2018

Hydropower

Status

Today, electricity in Côte d'Ivoire comes from a mix of thermal (mostly natural gas) and hydropower generation sources. As shown in Table 3: Installed capacity (2017), total installed electrical generation capacity was 2,195 MW[38] at the end of 2017, including 879 MW in hydro capacity (seven hydroelectric stations).

Photo © Arne Hoel/The World Bank

TABLE 3: Installed capacity (2017)

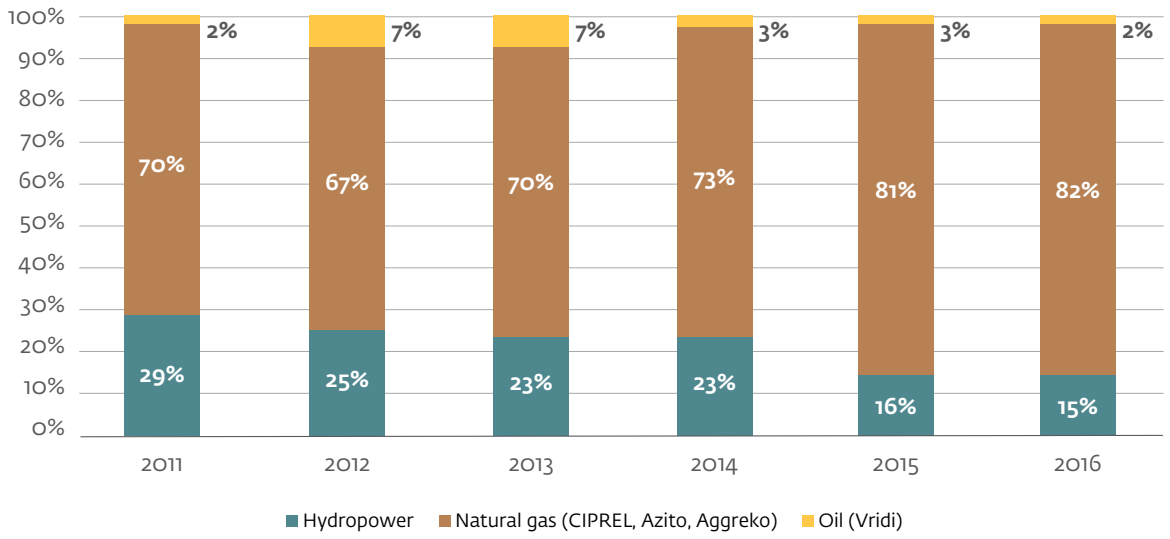
Plant	Type	Installed capacity (MW)	% of total
Soubré	Hydro	275	13%
Taabo	Hydro	210	10%
Kossou	Hydro	174	8%
Buyo	Hydro	165	8%
Ayame 1	Hydro	20	2%
Ayame 2	Hydro	30	2%
Faye/Grah	Hydro	5	0%
Total hydro		879	42%
CIPREL	CCGT	543	25%
Azito Energie IPP	CCGT	430	20%
Aggreko IPP	Gas	200	9%
Total gas		1,173	53%
Vridi Tag 5000	OCD, IGCC	100	5%
Total HVO-Oil		100	5%
Total installed capacity		**2,152**	**100%**

Source: IFC elaborations on CIE, ANARÉ, operators' websites, excluding solar PV and biomass.

Côte d'Ivoire has substantial untapped hydroelectric potential, but still relies on limited natural gas to fuel its generation capacity. Natural gas-fired plants represent 55 percent of total installed capacity, all run by independent power producers. Hydropower stations represent 40 percent of the total and are all managed by the private utility Companie Ivorienne d'Électricité (CIE). The oil plant Vridi Tag 5000, controlled and managed by CIE, represents the remaining 5 percent of capacity.[39]

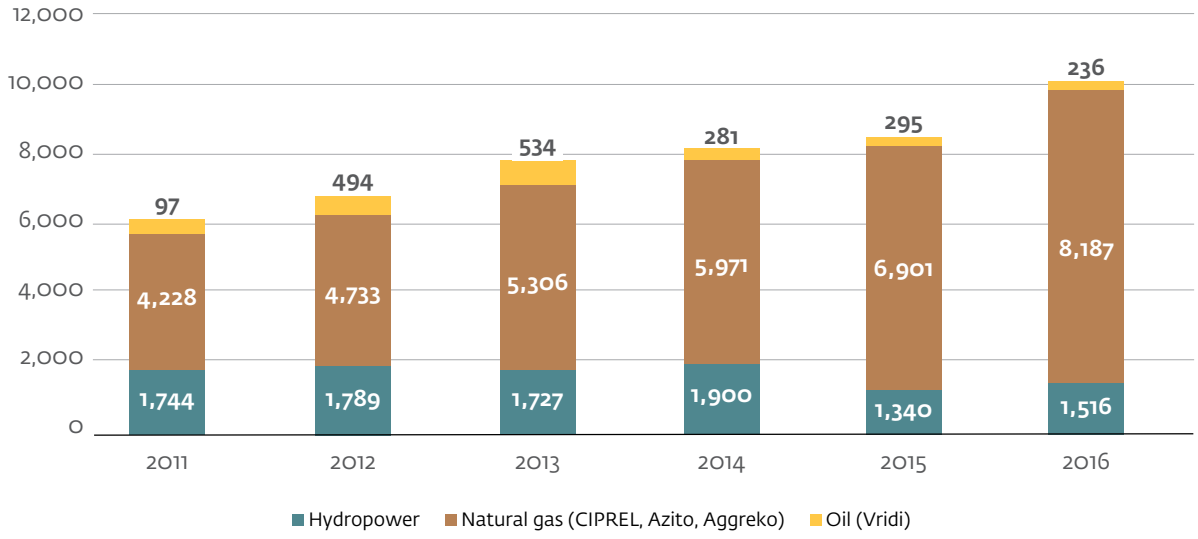
Almost all thermal power generation is owned and operated by the private sector, representing 60 percent (55 percent gas, 5 percent oil) of Ivorian electricity generation in terms of MW installed, and 82 percent of energy generation in terms of GWh (see Figure 6). The hydropower plants are all state-owned. Since 2011, power generation has increased by 10 percent per year, reaching 9,939 GWh at the end of 2016 (see Figure 7).[40]

FIGURE 6: Breakdown of power generation supply (% total GWh produced)



Source: IFC elaborations on ANARE (Rapport d'Activités, 2015), CIE (Rapport Annuel, 2016).[41]

FIGURE 7: Power generation supply (GWh)



Source: IFC elaborations on CIE, ANARÉ (2016)[42]

Large hydropower is one of the most cost-effective generation options in the country. Through CI-Energies, the government intends to ensure that no more than 60 percent of generation capacity is made up of a single technology and is targeting a 30 percent contribution from hydropower.[43] The country has considerable potential for hydropower, with an estimated capacity of more than 1,900 MW, which could generate about 10,000 GWh per year. However, these assumptions are based on studies conducted in 1979, and probably do not reflect the capacity that can be economically developed within the current environmental and social performance standards. There remains significant untapped hydroelectric potential, but only one hydro plant has been built in the past 30 years: The Soubré project (275 MW) was commissioned on the Sassandra River in 2017, with financing from EximBank China. It will be transferred to CI-Energies.[44] Other potentially attractive hydro sites are not yet at sufficiently advanced stages of technical preparation to be commissioned before 2020. Hydropower projects in the pipeline over the next 10 years include Singrobo (44 MW, concession agreement signed), Gribo Popoli (112 MW, concession agreement signed), Boutoubré (156 MW), and Louaga (280 MW).[45] There are substantial opportunities for public-private partnerships in the sector.

The Côte d'Ivoire government has also signed several memoranda of understanding with private developers on other sites (Gao, Tayaboui, Aboisso, Daboitié, Kouroukoro, and Tiboto). The studies are at various stages.[46] Challenges include increased social and environmental change since the sites' potential was originally assessed. In addition to these medium/large hydropower projects, the Ministry of Petroleum, Energy and Renewable Energy Development is planning to develop 81 MW of small hydropower projects before 2030. In addition, 20 potential sites with individual capacities between 1 MW and 12.5 MW have also been identified.

A Master Plan for hydropower development in Côte d'Ivoire was prepared by the government in 2014. The list below shows the distribution of existing (in bold) and planned hydropower projects from upstream to downstream for each main Côte d'Ivoire river basin.[47]

- Sassandra River basin: Gao, Kouroukoro, Tayaboui, **Buyo, Soubré,** Gribo Popoli, Boutoubré, Louga.
- Bandama River basin: **Kossou, Taabo,** Daboitié, Singrobo, Tiassale.
- Comoé River basin: **Ayamé 1, Ayamé 2,** Aboisso.
- Cavally River: Tiboto.

Challenges

MANAGEMENT OF EXISTING HYDROPOWER ASSETS

The average existing hydropower capacity factor was 26.7 percent in 2016,[48] below an average global factor of 50 percent for new projects.[49] This low capacity is partly due to take-or-pay commitments. Although favorable to IPPs, these commitments can lead to inflexibility in the management of generation facilities and even force water spillage. As a result, energy produced by the IPPs must be produced and purchased as a priority. This arrangement can increase the complexity of developing a cost-effective, efficient development plan.

ATTRACTING THE PRIVATE SECTOR

Most hydropower project memoranda of understanding for the next 10 to 15 years have been allocated to private developers. It is important to consider potential delays to projects and the effect this could have on private developers. Private companies may hesitate to invest heavily in much-needed viability studies, which may not guarantee that the project will move forward once the studies are completed. More broadly, a lack of existing demand and performance data from the power sector makes it difficult for private developers to know if these are solid development opportunities. In addition, lack of competition makes it difficult to achieve the best price for each project. While IPPs have historically been the favored structure, future projects will likely involve private sector participation at the engineering, procurement, and construction stages, and be transferred to CI-Energies on completion.

Potential Solutions

IMPROVE THE QUALITY AND TRANSPARENCY OF INFORMATION ABOUT HYDROPOWER RESOURCES AND THEIR DEVELOPMENT

- Review existing data and identify gaps in data availability and quality.
- Develop consensus among stakeholders on how to capture high-quality, relevant data that is useful for projections. As a start, publish data on who owns existing hydrological data, so that developers can provide information from active sites continuously. This will allow potential stakeholders to compare projections and actual production, and help

the government identify the impacts of climate change and other threats.

DEVELOP A CLEAR GOVERNMENT FRAMEWORK FOR HYDRO PROJECTS

The framework should incorporate systems for responding to environmental and social impacts, as well as guidelines for acquiring land that are in line with best practices and lender requirements. While the framework exists, it requires further institutional support from Ministries in charge of Energy, Water and Forests, Environment, Construction, the Interior, Fisheries, and Agriculture to be fully implemented. This approach should bear in mind the cost of feasibility studies.[50]

REVISE EXISTING HIGH-LEVEL RESOURCE STUDY AND INCLUDE SITE PRIORITIZATION

Using existing resource studies as a base, updated hydrology data on river basins should be incorporated by Ministries in charge of Energy and Finance as well as CI-Energies to assess flows, storage, installed capacity, output of downstream sites, and institutional options for optimizing water resource management. High-priority sites could include a pre- or full feasibility study, a geological study, hydrology data, and more. Because developers have found detailed safeguard studies necessary but expensive, the government could explore new ways of funding them.[51] For example, the government could conduct a high-level study and share these results with interested bidders in a transparent manner.

Improving the ability to identify whether the hydrology risk allocations between developers and the government are fair and examining whether they should be reallocated would support further developer interest. Studies for site prioritization that place a project in the context of a national strategy for resource use could draw private interest by signaling its role in a broader public sector strategy.

ADJUST CURRENT APPROACH TO SITE PRIORITIZATION TO INCREASE OPPORTUNITIES FOR NEW PLAYERS IN THE MARKET

CI-Energies has already overseen the attribution of potential hydro sites for development. As such, a tender process for these sites is not necessary. However, other sites could be approached differently. For example, the government could carry out feasibility studies, followed by a re-tendering process. Alternatively, it could conduct competitive bidding

BOX 2

Developing Togo's hydro sector

IFC and the AfDB are supporting the development of Togo's hydropower potential to maximize private sector investments. The project includes a review of the sector's structure and projected developments, with a focus on energy balance and generation cost-related changes. The project also outlines the energy sector's overall strategy and least-cost expansion plan while considering the challenges relating to national and regional interconnection.

The project will determine private developers and financiers' interest in investing in and developing the best site. Research will include risks perceived, main operational constraints, preferred structure, and cost assumptions. After an analysis of risk allocations, and financial and operational implications from a public and private sector perspective, the project will select two or three priority sites out of eight and develop a roadmap for these sites, possibly using a competitive tender. Finally, the project will review the legal and regulatory framework, including enterprise-level regulations and fiscal issues on project finance and operational development (both for IPPs and public-private partnerships)—and make recommendations on the future development of private sector-led hydropower generation in Togo.

for developers who can carry out their own feasibility studies where appropriate. While the government will continue to own large hydro and CI-Energies will continue to manage it, tests could determine whether the private sector could efficiently manage the operation, maintenance, or rehabilitation of older sites.

CARRY OUT FEASIBILITY STUDIES TO PREPARE A TENDER PROGRAM FOR SMALL HYDROPOWER

Tenders need to define the project in detail, including a feasibility study, in the request for proposal package. Such studies are time-consuming, expensive, and the government is more likely to conduct them with support from development partners. For example, the EU is preparing a project as part of Energos 2 that includes the development of eight small hydro sites totaling over 40 MW, including feasibility studies.[52] To reduce costs, sites could be bundled and documentation and processes standardized.

Working Group Contributors

The following organizations participated in the Hydropower Working Group:

- Bureau National D'Etudes Techniques et de Developpement (BNETD)
- Électricité de France (EDF)
- AfDB
- Eranove
- Platinum Power
- CI-Energies
- Direction Générale de l'Energie
- Developers including Bandama and Sinohydro
- EU
- Oikocredit

Biomass

Status

Biomass energy—the use of organic products like plants and animal waste as fuel—can reduce households' dependence on a power grid challenged by consistent connectivity. Agriculture is one of Côte d'Ivoire's key sectors, providing a significant source of biomass for achieving the country's 42 percent target.[53] Using agricultural waste can support continued growth in the sector while harnessing a new energy source.

Until recently, no large-scale biomass projects had been implemented in Côte d'Ivoire.[54] In December 2017, a tariff agreement was signed for the 46 MW Biovea biomass plant—the first of its kind in the country—developed by Biokala at Aboisso. The plant is expected to use 400,000 tons of waste from palm oil production, to generate up to 288 GWh of electricity per year.[55]

Various agricultural operators and agri-processors, especially in the sugar industry, have been using biomass on a smaller scale to generate energy for their own use. Sources of fuel for generating power include sugar bagasse, palm husks, cotton husks, and cocoa, and there is 80 MW of potential installed capacity.[56]

Agri-processors and project developers have built a pipeline of proposals to develop and build grid-connected facilities that could contribute to the renewable energy mix. Additional small-to-medium power plants, including a 20 MW facility in Gagnoa and a 25 MW in Boundiali, are also under development.[57] Small-scale municipal waste-to-energy projects (more than 15 MW capacity) are being developed, which will use biomass waste and landfill gas in the Abidjan area.[58]

The country's agricultural sector produces more than 13 million tons of residues (byproducts) per year from growing and processing crops on farms, such as stalks, leaves, and pulp, as well as from forestry and wood processing.[59] IFC estimates that, on average, about 9 million tons (70 percent of the total generated amount) would be available as fuel. The total technical potential for generating energy would exceed 1,200

MW, based on the assumed energy content of different types of residue.[60]

Biomass technology is proven in Côte d'Ivoire, with strong participation from the EU and the French Development Agency. As part of the EU's support for the selection of renewable energy IPPs across a range of technologies, it is preparing a study evaluating biomass resources and energy potential, and identifying potential sites, transport, and logistics requirements, and the heat and electricity needs of potential customers. It also supports the preparation of tenders and power purchase agreements for biomass and other technologies. The EU supports the Ministry of Petroleum, Energy and Renewable Energy Development in preparing regulatory texts for the energy sector and a non-electric energy code for the government.

Challenges

LOW DEMAND FOR ON-SITE THERMAL ENERGY

While technologies may be proven, many business models that work in other countries are not directly applicable in Côte d'Ivoire, largely because excess heat cannot be used through a district heating system and the only use would be to generate steam and/or hot water for agricultural processing needs. Despite the continuing trend toward more local processing, the demand for thermal energy is likely to remain limited.

COORDINATING A RANGE OF STAKEHOLDERS

Managing negotiations among stakeholders remains a challenge, even for well-prepared projects. Biomass projects would need to involve the Ministry of Agriculture and the procedures for such engagement are not yet institutionalized. To date, projects such as Biokala have been implemented on a case-by-case basis. Scaling up biomass will require a defined set of rules, such as acceptable protocols to confirm calorific value, availability of biomass, and security of supply to justify expected electric output and its fluctuations.

To date, most developers in Côte d'Ivoire have gained experience in large-scale thermal power plants and hydropower facilities. The technical risks of managing biomass as a volatile and unreliable supply into the grid will need to be identified, as will the tariff structure for this renewable-based generation. In addition, legislation on including smaller-scale renewables into the grid mix should be clarified, and a transparent project shortlisting procedure put in place.

BOX 3

Biokala: Demonstrating the potential of biomass in West Africa

The only biomass project in Côte d'Ivoire with a signed power purchase agreement, Biokala, thoroughly covered required legal and regulatory challenges related to coordinating stakeholders at the development stage and during consultation with relevant government agencies. However, even Biokala had to undergo a long consultation process to obtain a license to operate, because biomass is a multi-disciplinary space. The ministries of Energy, Environment, and Agriculture needed to participate in the project development and approval process, which took about two years.

Additional legal and regulatory challenges related to coordinating stakeholders include:

- Lack of clarity regarding ownership rights and status of agricultural residue, preventing the incorporation of agricultural waste into project revenues to enhance profitability.
- Lack of regulation related to greenhouse-gas emissions.

HIGH CAPITAL EXPENDITURES

An issue flagged by most private sector players, domestically and globally, is the relatively high capital expenditure requirements of biomass projects. Depending on the project's scale, capital expenditure would typically be between $2,500 and $4,500 per kilowatt-electric (kWe) of installed capacity.[61] Most pipeline projects and opportunities for self-supply at agri-processing facilities in the country are below 10 MW, which would push the costs up and make projects less economically attractive. Expanding projects would help achieve better economies of scale, but peak demand of a typical processing facility would not exceed 10 MW, so the economic feasibility of a project is largely predicated on its ability to feed energy into the grid.

FACILITATING MANAGEMENT AND SOURCING SUPPLY

Biomass-to-energy facilities are technically complex. Combustion-based solutions require a steam boiler and turbine, while a biogas solution involves an anaerobic digester. Such equipment requires regular maintenance and its reliability depends on locally available technical skills, contributing to operating costs. When considered as part of a cost-benefit analysis, these challenges often make the total cost of generating electricity uncompetitive, resulting in projects being put on hold and rejected, especially if there is no grid feed-in option.

Another obstacle for uptake is the fact that much of the raw material is sourced from small-scale farmers (2–5 hectares) that are often scattered within 150 kilometers of a processing facility.[62] This makes sourcing feedstock logistically complicated and difficult to secure for both large and small-scale biomass projects, and adds to the cost. However, this will change as processing becomes more local, resulting in growing demand for energy and more feedstock generated on-site. Additional guarantees on volume and price are crucial to ensuring bankability of these projects. Improving farmer understanding of these concepts and providing the technical assistance that allows them to make needed investments, based on biomass offtake agreements, can help improve efficiency.

Potential Solutions

STRENGTHEN AGRICULTURAL SECTOR CAPACITY

The government may benefit from a coordination body to ensure information exchange between agribusiness (and other sectors) and the power sector. This could also include biomass capacity building for government officials, cooperatives, and farmers.

DEFINE A GOVERNMENT STRATEGY FOR BIOMASS AND CONDUCT A COMPREHENSIVE MAPPING STUDY

The government could address some of the challenges discussed above by developing a vision and defining the regulatory and institutional framework for the biomass sector, including how pricing for biomass is regulated and which institutions are involved, and coordinating energy, agricultural, and environmental regulations. This would include a feedback mechanism to capture best practices from successful projects conducted in other countries.

Mapping the country's projects will provide an inventory of existing biomass projects, including status, completed project studies, assessment of bankability, and readiness. Simultaneously, a stakeholder mapping exercise should identify players along the value chain. The various roles should be detailed, including those of financial and research institutions and public authorities.[63] This mapping process should also account for potential environmental impacts and positive externalities of biomass, potential health impacts resulting from transformation of certain species, and the impact on agri-industrial players.

A supply chain mapping is also needed, including an inventory of the available types of biomass and different crop clusters, waste streams, and actors that could source the supply chain. This will help stakeholders understand the logistics, costs, and benefits of different collection and supply options, various geographical boundaries, and the potential impact of competition for feedstock on price stability. Ideally, the data and results from this study would be provided in a one-stop-shop such as a web resource or unit within an agency.

Biomass to energy: Lessons from Kenya and Ukraine

IFC has learned the following lessons during its long involvement in biomass-to-energy projects:

The Gorge Farm Energy Park in Naivasha, Kenya, is Africa's first electricity producer powered by biogas to sell surplus electricity to the national grid. It produces 2 MW of power at a quarter of the cost of diesel power, **demonstrating that low-carbon sources of energy can be low cost as well.** The farm also makes heat for its greenhouses and natural fertilizer as a byproduct to replace expensive synthetic fertilizer. This represents a huge opportunity, as anaerobic plants using biomass from 1 percent of Kenya's landmass could match the country's entire current installed electrical capacity of about 1,800 MW. While there are concerns that the tariff may be too low to attract sufficient investment, the multiple benefits from such projects offer various revenue streams and reduce costs.[64]

To minimize waste and reduce emissions, the supply chain must be analyzed along with "end-of-pipe" solutions. A $30 million IFC loan has led Mironovsky Hliboproduct to introduce chilled poultry distribution to the Ukrainian market, reducing losses and allowing the company to expand internationally.[65] In 2012, the company built a biogas plant to the highest international standards to produce power (5 MW for 15,000 apartments) and heat (for 1,500 apartments) using chicken waste. A second 20 MW biogas plant ($27 million) will be completed in 2020, at the Vinnytsia poultry farm, which could be the biggest biogas complex in the world, **demonstrating the commercial viability of such technologies and their ability to reduce landfill waste.**[66]

Also in Ukraine, Astarta has launched a biogas facility at Hlobyne sugar plant, fermenting sugar beet waste and other agricultural residues. The facility has a capacity of 150,000 cubic meters of biogas a day, cutting the plant's natural gas consumption by 50 percent during beet processing.[67] **Lowering consumption of natural gas reduces the company's exposure to fluctuating prices in the fossil fuel market,** and the company plans to use the alternative fuel to meet the needs of its soybean processing plant. This is part of a $35 million investment from IFC and other investors.[68]

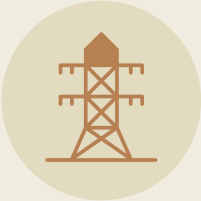
To secure a supply of biomass, projects could stay close to the supply and install smaller-scale model facilities covered by a mini-grid, while replicating this design would allow for lower costs as an aggregated project. However, aggregating supply is done best on a large scale and storage may require more space than the power production equipment itself.[69]

Quality is also an important consideration—substandard feedstock and mishandling of source agricultural residue can lead to equipment underperformance or failure.[70] This is complicated by changes that are out of the developers' control: severe climate changes and seasonal abnormalities can affect project performance, but hedging/insurance products for the sector do not exist.

BOX 5

Three approaches to developing biomass projects

To date, there are three proven approaches to developing biomass projects requiring various levels of stakeholder engagement and partnerships:



Integrate energy production directly with a biomass supplier as demonstrated by Biokala.

Have a public agency provide biomass feedstock and charge electricity producers a capacity charge. This separates the variables of electricity production and feedstock supply, allowing arbitrage between gas and biomass production according to the price of the fuel. This would require a government agency to regulate.

Identify business models for biomass energy that are relevant to the Ivoirian context, such as centralized feedstock collection from a wider area or aggregation of smaller plants each with a smaller collection radius, as well as both off- and on-grid solutions. Suggest (but do not restrict) the optimal size of biomass projects.

DEVELOP PILOT PROJECTS

As demonstrated by a recent tender on cocoa and cotton biomass, private actors are willing to make proposals to build and manage power plants.[71] However, the IPP must have clear information about both the supply chain and power plant because the two are deeply interdependent, and the public sector is unwilling to take the supply risk. Therefore, supply chains need to be proven through pilot projects before tenders can become viable and truly competitive. Transparent public-private partnership pilot projects could structure and prove the needed waste value chains, and demonstrate the viability of biomass projects in Côte d'Ivoire, encouraging more entrants into the market. However, these projects are difficult due to long timelines and scarce resources, and are likely to need concessional financing and project preparation support to share risks and achieve bankability.

Considering these difficulties, pilot projects may not currently be ideal priorities. However, they are worth considering as a component within a larger approach, as they provide an opportunity to develop standardized tender documents and power purchase agreements. Piloting biomass projects, with government support, will demonstrate business models and should aim to involve multiple stakeholders willing to share experiences throughout the process.

EXPAND USE OF MUNICIPAL SOLID WASTE AND ALTERNATIVE FEEDSTOCK

Commercial and municipal solid waste also present an opportunity for biomass projects. According to World Bank estimates, Côte d'Ivoire could generate up to 11 million tons of municipal waste a year by 2025—a 20 percent increase from 2015. Only between 30 percent and 40 percent is currently collected, mostly in the Abidjan area.[72] Generating energy from waste could reduce the need for landfilling while preventing illegal dumping. However, the infrastructure for waste management remains underdeveloped and there is very little private sector involvement.

Waste-to-energy projects need to be aligned with other forms of treatment, such as recycling and composting, which may be more economically and environmentally beneficial. Alternative uses of biomass (such as firewood and charcoal) that may put long-term supply at risk should also be considered. While technical knowledge for project development is available, additional operations and maintenance capacity is needed.

BOX 6

Photo © Dominic Chavez / IFC

Accounting for the informal sector

For any biomass project, the primary sources of feedstock include forest products, agricultural waste, and municipal solid waste. In the case of Côte d'Ivoire, biomass studies focus on agricultural products, which is the main driver of its economy. Any structured study on biomass mobilization will need to consider the feedstock supply chain. Apart from sugar, palm, and rubber—where industrial operations can guarantee production levels—agriculture is generally practiced on a small scale by families, which makes it difficult to guarantee volumes. Modeling a strategy for producing and mobilizing biomass on agricultural products means operating within the informal sector. The following considerations are useful when developing a strategy:

- How to guarantee biomass supply over time in quantity and quality from a sector largely operating in the informal sector.
- The actors who should be participating in production and mobilization strategy.
- How to discern the value of biomass to produce energy in cases of speculation.
- All steps necessary to protect and improve crops, land, the environment, the wellbeing of people, sustainability, and shared development.

Working Group Contributors

The following organizations participated in the Biomass Working Group:

- Holding Group EOULEE
- SODEN
- Investment Promotion Centre in Côte d'Ivoire
- Ministry of Environment
- Direction Générale de l'Energie
- CI-Energies
- EU
- Finergreen
- Eranove
- LONO

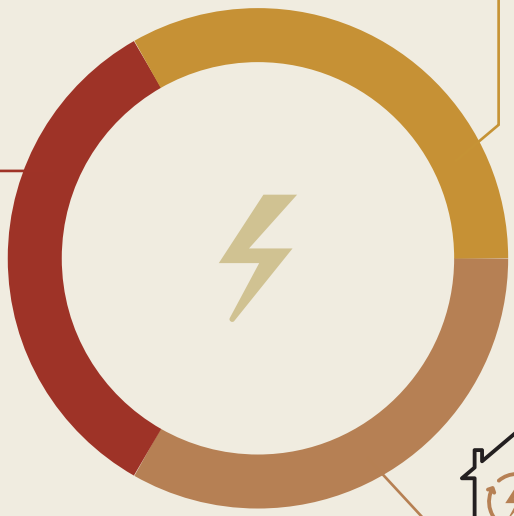
Variable Generation: Solar and Wind

There is considerable interest from the private sector in developing variable renewable energy (wind and solar) resources in Côte d'Ivoire.[73] The current availability of dispatchable power (hydro, gas, oil, biomass) makes it possible to manage variable renewable generation, allowing such resources to play a greater role in the country's future energy mix. However, to ensure a stable supply of electricity and prevent forced outages, the minute-to-minute rise and fall in electricity consumption needs to be managed and offset using additional supply (known as ancillary services).[74] Traditionally, thermal and hydro generators provide ancillary services, but solar and wind could contribute.

Within this context, the following sections discuss several submarkets for variable renewable energy currently emerging in Côte d'Ivoire. To differentiate between various timescales and address immediate needs, all three submarkets must play a role in reaching Côte d'Ivoire's energy goals. These three submarkets are: utility-scale generation and grid integration, off-grid renewable energy, and mini-grid and distributed generation. Each section reviews the sector's status (including relevant policies and projects), identifies challenges, and presents potential solutions.

BOX 7

Various scales of electricity generation



Off-grid

Off-grid operations are generation systems (such as solar home systems) that are not connected to the grid. They are standalone installations that can power homes and businesses in remote locations or areas with poor grid reliability.

Utility-scale generation

Energy-producing projects that generate power from solar or wind and feed that electricity into the grid via a utility, usually involving a power purchase agreement. Projects are typically larger than 1 MW, but Côte d'Ivoire has some installations in the pipeline that will generate over 25 MW. The key factor is the ability of the system to connect to the grid.

Mini-grid and distributed generation

Mini-grid systems are typically under 10 MW, but are defined by their limited transmission and distribution networks.

Utility-Scale Generation and Grid Integration

The main approach to electrification in Côte d'Ivoire is expanding distribution networks and connecting new consumers to the centralized grid. The power grid plays a central role in transmitting power from generation projects and distributing electricity to households, commercial enterprises, industry, and public sector entities. Therefore, strengthening the grid and enhancing the flexibility of the power system are paramount to increasing renewable energy penetration. Whether the source of energy is dispatchable (fossil fuel, hydro, or biomass) or variable (wind, solar), it must be connected to the grid when generating and resilient to shocks such as adverse weather.

CURRENT STATUS

Grid

The Ivorian transmission grid is 5,093 kilometers long and based on two high-voltage levels: 90 kilovolts (about 2,800 kilometers) and 225 kilovolts (about 2,288 kilometers). It also connects with neighboring countries—the West African Power Pool links Côte d'Ivoire with Guinea, Liberia, and Sierra Leone. Côte d'Ivoire is increasingly considered to be a reliable exporter and it has made further commitments to export electricity in future. The distribution grid consists of 30 kilovolts and 15 kilovolts, for a total length of 23,128 kilometers, as well as 220 volt and 380 volt (18,807 kilometers) lines. CI-Energies operates the country's power grid under a government concession for which it receives remuneration.[75]

In 2016, transmission losses on the high-voltage grid were estimated at 6 percent, while distribution technical and non-technical losses were about 16 percent, and total energy losses were 22 percent. These are considered high according to industry standards, but are among the lowest in the subregion. Still, they have improved gradually, dropping from 25 percent total energy losses in 2010. High grid losses in Côte d'Ivoire are partly due to illegal connections to the network and damaged equipment, which increases the sector's expenses. Distribution losses dropped 22 percent from 2010 to 2015 as a result of efforts to limit fraud.[76]

Côte d'Ivoire's service rate, calculated by dividing the number of households with electricity by the total number of households, is 33 percent. This is relatively low in comparison to countries with a similar per capita income. The coverage rate, which measures the number of individuals living in areas served by the electrical network as a proportion of the total population, is 78 percent.[77] This means that a large portion of inhabitants in the country's electrified areas are not connected to the network, even though they are close to it. One explanation could be the relatively high service connection fees, which are about $250 in rural areas,[78] in a country with a poverty rate of 46.3 percent.[79] In rural areas, these high initial service connection fees explain the even higher deficits. Other potential explanations include the lack of subdivisions, the uncoordinated physical arrangement and proximity of homes in settlements, lack of infrastructure (streets, plumbing, etc.), low investment in network extension, and general difficulties faced by CI-Energies in accessing some areas. For example, the district of Abidjan (13 communes and over 6 million inhabitants) has 75 slums, containing more than 50 percent of the city's population.

The government is planning to expand access to unelectrified communities, and there are several international projects to increase the extent and resilience of the country's grid. This is particularly important given Côte d'Ivoire's power exports and its increased focus on renewable energy. Solar installations and mini-grids can support the government's efforts to achieve universal access to electricity. The National Program for Rural Electrification (PRONER), launched in 2014, aims to increase the penetration rate of electricity to 80 percent by 2020 and the coverage rate to 100 percent of the population. Another promising governmental program is the *Electricity for All program*, which was started in 2014 and has a target of 200,000 new rural and urban grid connections per year through a dedicated funding vehicle— the Fund for E4All—which would help eliminate high upfront connection charges.

Solar

Solar PV can be harnessed in a range of ways, both on-grid and off-grid. It can provide lighting and electricity to a single home off-grid, or be incorporated into mini-grids that can scale from several kW to many MW, and achieve higher economies of scale at utility level. Project lead times are among the shortest of any power generation technology.[80]

Côte d'Ivoire has good potential for solar power electricity production, with an average of six hours of sunshine a day. Solar potential ranges from 2–6 kWh/m^2/day, with an annual potential for PV installations of about 10,325 terawatt hours—many times higher than current consumption.[81]

FIGURE 8: Direct normal solar irradiation in Côte d'Ivoire

Source: © 2017 The World Bank, Solar resource data: Solargis.

The country's south has good solar resources, but the north receives the most sun (see Figure 8).[82] There is less demand in the north, but solar could be used to increase the number of resources available to communities that depend on a sole source of power.

Solar PV plants could displace some hydro and thermal generation during the day for use later at night, given that the peak load (1,350 MW) occurs after sunset.

Solar PV may be feasible at multiple levels in Côte d'Ivoire:

- **Auto-consumption standalone systems:** These are smaller systems primarily for households or businesses' own generation, consumed in the building where it is produced, without selling back to the utility. In general, they include a solar panel and battery to run lights and/or cellphones. Increasingly, these systems are being used to power larger commercial enterprises and light manufacturing. In some cases, they can be complemented by other energy sources such as biomass.
- **Auto-generation systems:** These are larger projects that produce power locally and sell excess power to mini-grids or the primary grid.

There is a pressing need to address the country's low rates of electricity access and poor-quality supply. Over time it has become easier to rapidly scale up solar PV for distributed generation in support of improving access.[83] Figure 9 shows how African PV project costs have dropped over time. Furthermore, the Ivorian national plan for power generation includes several on-grid, utility-scale solar PV projects. The government intends to select most of these projects on a competitive basis through calls for expressions of interest, followed by tenders. But projects can also be developed as unsolicited proposals.

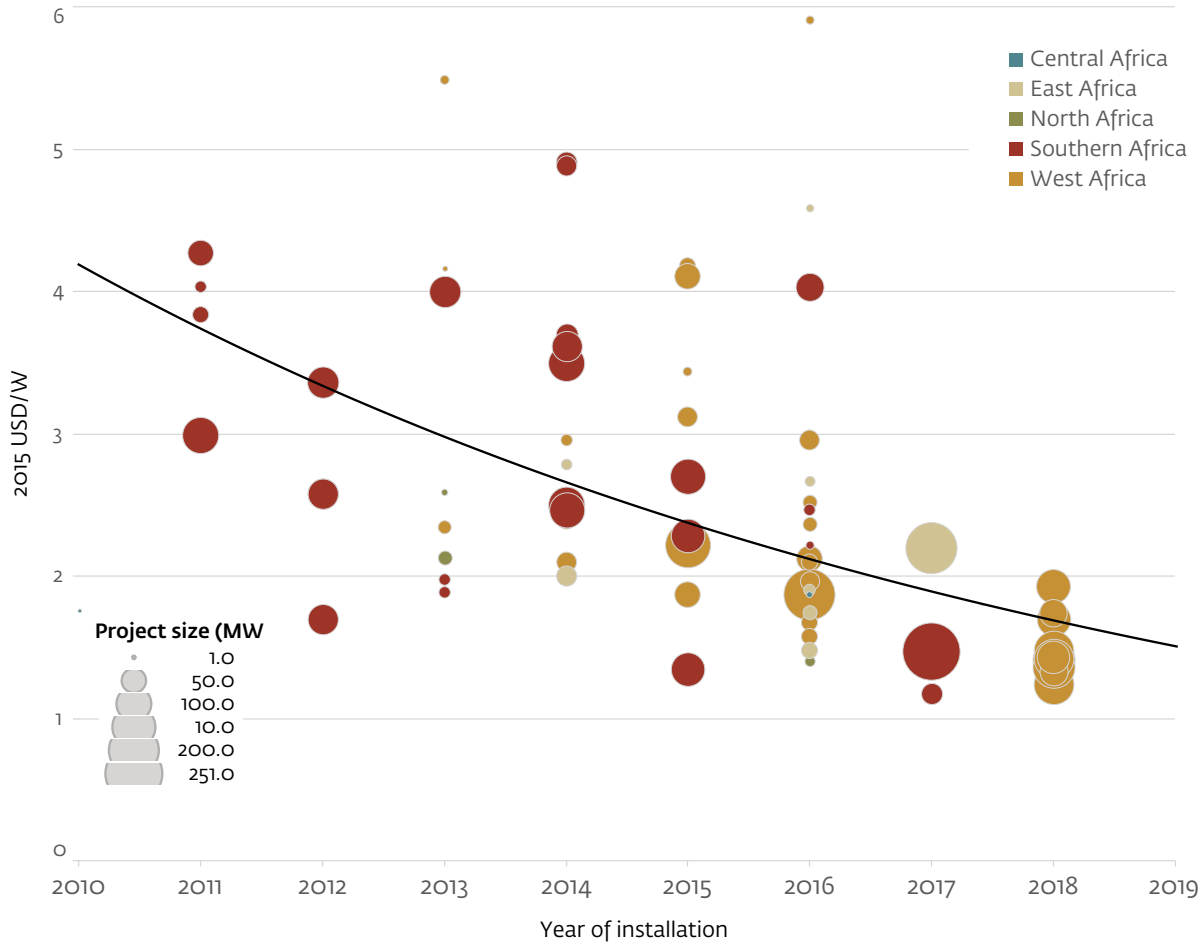
There are several solar investments under way in Côte d'Ivoire. Existing projects can help demonstrate value and prove business models. The Moroccan developer Nova Power is building a 25 MW solar PV plant in Benguébougou, in the northern Korhogo region of Côte d'Ivoire, with a total investment of $40 million. The plant is scheduled for completion by the end of 2018. The Ministry of Petroleum, Energy and Renewable Energy Development recently stated that the maximum price at which the facility should supply its power is 70 CFA/kWh ($0.12/kWh).[84] The concession contract for the project was signed by the Ministry and Nova Power in November 2016.

The EU's Energos 2 project is providing support to the tender offer process for the selection of IPPs in renewable energy, including pre-feasibility and feasibility studies, coordination/support of the tender offer process, and legal and financial support for developing power purchase agreements. The French Development Agency and KfW are also considering support for tender processes and private sector engagement.[85]

Other solar projects planned or under way include:

- A 15–25 MW grid-tied solar PV project in Odienné, the sunniest part of the country.[86]
- KfW, the German development bank (€27 million), and the EU (€10 million) are building a 38 MW solar power plant in Boundiali and are preparing a concessional loan for the government. The plant will be operated by CI-Energies.[87]

FIGURE 9: Operating and proposed utility-scale solar PV project installed costs in Africa (2011-2018)



Source: IRENA (2016). Solar PV in Africa: Costs and Markets.

Wind

There are some promising wind resources in the country, but measurements of potential have been limited to civil aviation. Côte d'Ivoire possesses a moderate-to-low wind regime with wind speeds in the range of 5–6.5 meters per second (m/s) in several inland regions, including Bafing, Lôh-Djiboua, and Haut Sassandra, as well as coastal regions including Sud-Comoé and Grands-Ponts. These regions are considered to have good potential for competitive wind projects utilizing modern large-rotor turbines on tall towers. To date, no detailed wind maps have been generated for the country; the development of a high-resolution mesoscale map would aid in this process. Figure 10 illustrates average wind speeds from the Global Wind Atlas.[88]

No wind power projects have been built in the country, although there are known private sector developments under way in Touba and Ehania. The EU is preparing to support the identification of wind energy potential as part of its Energos 1 program.

CHALLENGES FOR UTILITY-SCALE GENERATION AND GRID INTEGRATION

The main difficulty for utility-scale developers lies in their access to financing solutions. Other challenges include:

- Higher costs for new technologies and geographies.
- Increasing tariffs.
- Securing imports of equipment and value-added tax (VAT) exemptions in an efficient and timely manner.
- Structuring projects in a way that attracts commercial finance, even at initial stages in project development.

Grid code compliancy and system integration of variable renewable energy

Increased system flexibility—whether through fast-response dispatchable plants, stronger transmission, or improved system operation—allows variable resources such as solar and wind to play a greater role in the country's energy mix. Modern grid-code compliant solar and wind equipment can support the grid and enhance reliability. Challenges hindering scale include:

- Ensuring tariffs reflect costs (especially for rural areas that are unconnected to the grid and face higher costs than urban grid connections).
- Securing imports of equipment and VAT exemptions in an efficient and timely manner.
- Structuring projects in a way that attracts commercial finance, even at initial stages of project development.

International experience demonstrates that small shares of variable renewable energy, typically between 5 percent and 10 percent of annual generation, have no noticeable effect on the power system's integrity and do not require additional storage to be built. If the share of variable energy is less than 30 percent, the cost of integration is between $1 and $10 per MWh, even in "inflexible" systems.[89]

However, as the share of solar and wind energy in total generation increases, their variable, non-dispatchable nature can pose additional challenges for the system. It is likely that additional grid issues will emerge, such as transmission congestion driven by weather conditions. Concentrated deployment of renewable energy may result in network "hotspots" where grid-related challenges are magnified.

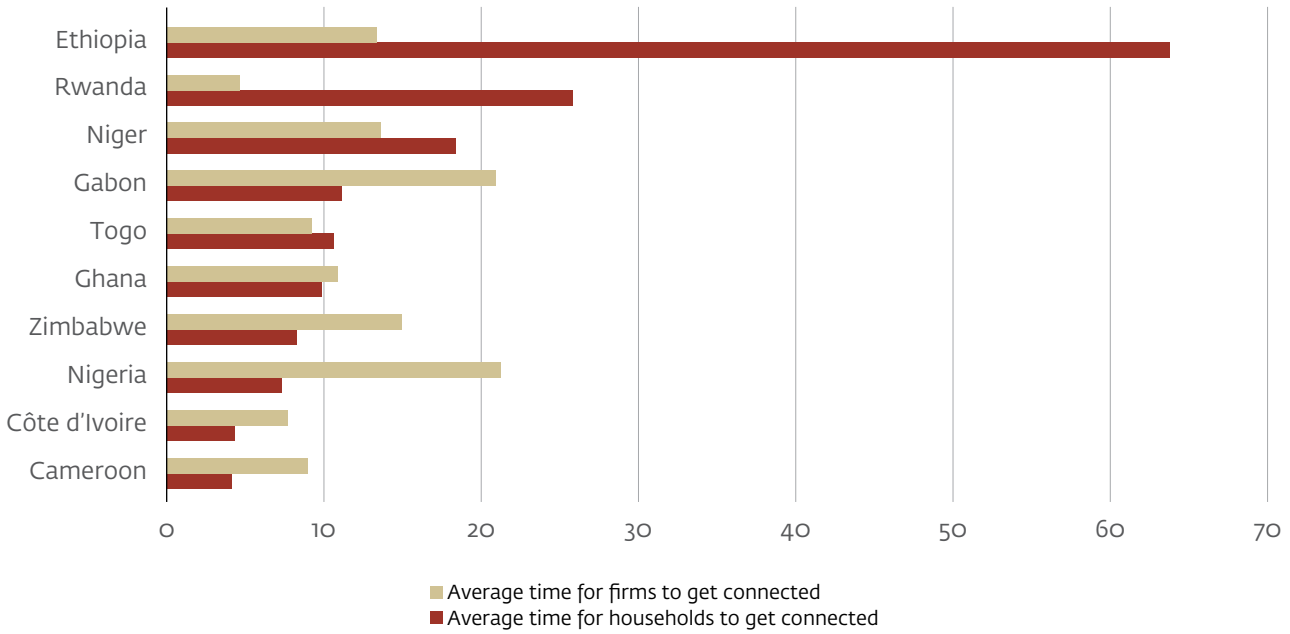
Grid codes provide the rules for interconnection of individual power plants to ensure they are "good citizens on the grid." For variable renewable energy, grid codes help to ensure the fair treatment of generator owners and operators concerning grid connection while maintaining system stability and reliability. The renewable energy grid code should be regularly revised to ensure its relevance to the system needs and the progress in meeting the renewable energy target using mini-grid approaches.

Low electricity access levels

Electricity access stands at 62 percent nationally, although it is much higher in urban areas (84 percent) than in rural areas (37 percent, but rising). There are also significant variations across income categories, presenting additional challenges and opportunities.

Côte d'Ivoire's main approach to electrification is to expand distribution networks and connect new consumers to the centralized grid, known as densification. The aim is to connect all villages located less than 20 kilometers from the

FIGURE 10: Average number of weeks to get connected to electricity



Sources: Survey estimates; World Bank 2018[90]

national grid. This means there are 849 villages with over 500 households each to be electrified in the next two years. This will require substantial grid rehabilitation and upgrading.[91]

Lag in transmission and distribution network investments

Transmission and distribution networks need an update and are overloaded. Historically, rehabilitation and reinforcement funding availability has been scarce, but there have been recent efforts to leverage existing funds over the past five years. Development partners including the World Bank, the EU, the AfDB, the French Development Agency, China, and the West African Development Bank have committed $1.5 billion dollars to support the government's efforts. The World Bank Electricity Transmission and Access Project has allocated $115.6 million to upgrade and reinforce priority transmission lines and $95.4 million to rehabilitate, reinforce, and extend distribution networks.[92] While this investment represents a step in the right direction, more public sector contributions are needed to achieve the government's overall transmission and distribution goals.

Need for solar PV support and regulatory structure

The country's NDC calls for 400 MW of solar development by 2030 (8 percent of the generation mix), but supportive policies for this target have been limited.[93] Legislation does not stipulate feed-in tariffs, dispatch obligations, or any incentives for PV and other renewable energy. PV projects are treated like conventional generation projects, so they must negotiate a power purchase agreement with the Ministry. Large PV projects can get some benefits stipulated in the Civil Code and Investment Code, but small renewable energy projects are not eligible. Electricity law allows projects of national interest to receive support, so some biomass and PV projects can get fiscal benefits on a case-by-case basis, but these are reported to be difficult and time consuming to obtain.[94]

Gaps in bankability of utility-scale PV projects

Large-scale solar PV systems are becoming increasingly competitive against fossil-fuel fired generation, but upfront costs are still very high.[95] The bankability of such IPP projects depends on the legal, regulatory, and contractual framework that provides adequate and predictable revenue streams over a relatively long period of time. While Côte d'Ivoire has a favorable regulatory framework for conventional-generation IPPs, the environment could be improved for IPPs working in solar PV.

Variability of PV generation

Energy storage allows for PV-based distributed/local generation and integration into the national grid, but, despite rapidly falling costs, energy storage systems are expensive and the significant upfront investment required is difficult to overcome without government support or low-cost financing.[96] Energy storage systems require expertise to operate effectively and their services are often not properly valued within existing energy market regulations. That said, it remains an option in light of recent projects that are proving viability. For example, existing World Bank work in Burkina Faso and Guinea-Bissau and potential projects in Senegal, Madagascar, and Central African Republic are striving to implement storage solutions for solar energy.

Lack of clear project development procedures

Côte d'Ivoire does not yet have a centralized source of easily accessible information on project development procedures and regulations. A lack of transparent regulations creates uncertainty and increases risk. Issues related to land ownership, which the country has experienced in the past, may also present challenges.[97]

POTENTIAL SOLUTIONS

Institutionalize existing governmental efforts to improve on-grid energy access

While electricity access rates remain low, there is a relatively high coverage rate. As such, one of the best solutions to improve access is to enhance grid densification. The government has taken steps to improve densification through PRONER and the Electricity for All program. PRONER represents the government's strong commitment to electrify all localities with over 500 inhabitants in the coming years and maintain an annual rate of electrification of 500 new localities until 2020. This program is expected to require capital investments of $675 million over a five-year period.[98]

For low-income households, Electricity for All would finance the cost of both a grid connection and a standardized internal house-wiring kit. Electricity for All is funded by the state, development partners and, given the significant funding needs, potentially by commercial loans from the capital market. This Fund is designed to bring access to electricity to around 1 million low-income households over five years. Given its current mandate, CIE will be the main implementing vehicle for the "last mile"; responsible for customer connections and

collecting revenues, via tariffs, from newly connected clients under the program.[99]

To solidify the long-term achievement of energy access, the government could clarify Electricity for All's funding structure and work to institutionalize it to allow for scaling up. The Ministry of Petroleum, Energy and Renewable Energy Development and donors could collaborate on establishing and financing the necessary framework, including through organizing a fundraising roadshow.

Leverage lessons learned to reduce technical losses

Addressing technical losses through system-wide analyses to improve the functioning of the transmission and distribution network is key and Côte d'Ivoire could leverage the experience of other countries in the region that have implemented effective solutions. For example, with IFC's support Kenya Power & Light Company has improved its performance and expanded its grid in a more efficient manner. Kenya Power & Light Company, which owns and operates a wide electricity transmission and distribution system with over 2.6 million customers, has helped Kenya achieve one of the best connection rates in East Africa. But technical and commercial losses remained high. To address this challenge, IFC provided a system-wide analysis to quantify the breakdown of losses and develop a long-term investment plan to reduce losses and improve efficiency. The opportunities IFC identified will save the company approximately $8.8 million each year and avoid over 23,000 tons of carbon.

Ensure a clear and transparent regulatory framework, as well as general principles and procedures for capacity allocation; and support innovation and technological advancement

The government, with support from CI-Energies, could explore options for improving technical grid stability and integrating variable renewable energy. To support these advances, the grid will need to be evaluated for its ability to transmit and export power. A high-quality translation of the Market Rules into English would help international market players. In addition, a study could be undertaken, including the following:[100]

- Improved guidelines about grid connection to the transmission and distribution system, with clarity on which connection costs (and eventual grid reinforcement costs) must be paid by the developers and by the grid company.
- A fair and transparent methodology for setting charges that enable IPPs connected to the distribution network to sell their power back to the grid.

The power of auctions[101]

Auctions reveal the true prices of developing a technology in a country, reflecting costs more accurately than perceptions created by low bid prices in other markets. They also allow the government to identify bottlenecks in equipment supply, ensure that products and services meet minimum standards, and avoid ad-hoc, unsolicited bids for renewable energy projects. For example, across Sub-Saharan Africa, competitive auctions are increasingly taking the place of feed-in tariffs, demonstrating the expanding power of auction-based approaches.

Facilitate access to land for sites to improve tender process and bankability

In previous tenders, multiple bidders sought similar sites, which caused concern over land prices. For future tenders, the Ministry of Petroleum, Energy and Renewable Energy Development could clarify land titles before tenders for key sites and secure the land before the tender. The Ministry would also need to ensure that it is suitable for the development of a renewable energy project, considering factors such as land size, environmental concerns, grid access, and geotechnical risks. Community engagement is an important part of this process—the government will need to clearly communicate the proposed use of the land to the community. Intergovernmental cooperation with other Ministries in charge of Agriculture and Rural Development and Environment (to assess environmental risks) can support this process. Other relevant actors include the land registration authority, and the Agence de Developpement d'Infrastructures Industrielles.

Elements that can be added to the existing frameworks to improve project financial viability include:

- Guaranteed dispatch of solar generation.
- A preferential offtake tariff and an indexation formula that addresses inflation and foreign exchange risks.
- Instruments to support the offtaker's payment obligations.
- Clarity on who bears the risk of connecting the facility with the grid and transmitting power.

Take a programmatic approach to scale up solar power

The government—particularly the Ministry of Petroleum, Energy and Renewable Energy Development—could build on its recent experience with IPP tenders to develop a structured tender process for solar, and later wind and biomass. This could integrate the principles of Scaling Solar (see box 10) to help achieve the best possible prices. Such a program should clearly set out government targets and timelines, and help structure financing and incentives. This could include a standardized auction process and project documents, as well as some pre-arranged loans and guarantees, developed through support from CI-Energies and donors such as the EU, KfW, and the French Development Agency. The government could draw lessons from these donors and IFC's infrastructure group. CI-Energies Generation and Transmission Master Plan is a good starting point for confirming the size of projects, the sites to be developed, and the timing of the tender to be in line with grid reinforcement investments.

Energy auctions—success in Argentina[102]

Less than 2 percent of Argentina's electricity comes from renewable energy. Sixty percent of electricity is generated from fossil fuels. Argentina's government is moving swiftly to change that, with goals to produce 20 percent of electricity from renewable sources by 2025, with intermediate targets of 8 percent by 2018 and 16 percent by 2021. In 2016, Argentina embarked on a series of energy sector reforms to establish a bankable, best practice power purchase agreement regime and energy auction. The country aimed to achieve competitive electricity generation costs and increase investment in the sector.

IFC supported the government in designing an improved bidding auction process. They were able to do so by applying the following bidding process best practices:[103]

- Determine clearly defined limits on capacity installed for each transmission node being auctioned to avoid future curtailment issues.
- Adhere to renewable energy quotas to avoid distorted incentives.
- Recognize that requiring local content could create perverse incentives.
- Avoid making price caps public and use the average price from previous rounds as the cap for new rounds.
- Incorporate international arbitration.
- Conduct bids in US dollars, if possible.
- Adjust tariffs so they can drop over time.

Following this process, Argentina successfully completed two energy auctions in October and November 2016, awarding more than 2,400 MW to local and international bidders. The successful projects were primarily for solar (306 MW) and wind (721 MW).[104] The auctions are expected to usher in $3.5 billion in financing over the next two years.[105]

Scaling Solar in Africa

A recent Scaling Solar bid in Senegal has yielded two bids for utility-scale solar plants with a total capacity of 60 MW, which will produce electricity for under $0.05 per kWh (Senegal's cheapest utility energy source).[106] This success follows the first Scaling Solar auction in Zambia, which delivered a groundbreaking $6.015 tariff, the lowest tariff in Sub-Saharan Africa at the time. Scaling Solar is now developing over 1 GW of solar power in partnership with four African countries—Ethiopia, Madagascar, Senegal, and Zambia.[107]

Auction prices reflect the situation in a country (levels of experience, quality of the solar resource, number of providers in the market and their experience), so very low prices may not be replicated in Côte d'Ivoire, at least in the short term.

Launch a wind resource study

Wind generation is not included in the Master Plan due, in part, to a lack of detailed understanding of the country's wind resources. It is known that certain areas of the country have a wind resource averaging 6 m/s or higher, which is sufficient for a competitive wind plant using modern low wind turbines on tall towers. As a first step, the government could initiate a wind mapping exercise to locate areas with high potential (assessing grid capacity in the area, logistics for transport and installation, road infrastructure, and environmental concerns). Once data is collected, it could either be shared with developers to assess viability, or the government could secure the land and have developers bid on a particular site.

Working Group Contributors

The following organizations participated in this Working Group:

- Association Ivoirienne des Energies Renouvelables (AIENR)
- PHAESUN/S-Tel
- E2IE (Entreprise Ivoirienne d'Integration Energetique)/Alturdyne Power System (part of Pinegrove Holdings)
- Biotherm
- Nova Power
- Greenwish
- Engie
- EOULEE/Gaia
- Direction Générale de l'Energie
- CI-Energies
- EU
- KfW
- Finergreen

Off-Grid

Meeting Côte d'Ivoire's energy needs and goals requires a variety of systems and models, and interest in renewable energy technologies extends beyond the grid. While densification remains the lowest hanging fruit for expanding grid access in the country, there is potential for decentralized solutions such as isolated off-grid renewable energy production. Installing individual small-scale power units such as standalone solar systems present a viable solution in remote areas located too far from the national grid and with population density too low to justify the construction of mini-grids. Although off-grid installations make a limited contribution to the 42 percent target, they can have a big impact on achieving rapid electricity access.

One promising off-grid solution is solar home systems, which are much cheaper than connecting to the grid in most cases.[108] Given the declining costs of solar panels, the modularity of rooftop systems, and the development of new business models, standalone solar is an option for communities without a grid connection or those wanting guaranteed low prices for self-generated electricity. Finally, solar kits are much cheaper than connecting to the grid in most cases. Primarily focusing on grid connection will incur a huge cost for Ivorian society, which could potentially be invested in other priority sectors such as education.

Still under preparation, the World Bank's Regional Off Grid Electrification Project (ROGEP)[109] will provide financial support and technical assistance to off-grid technologies. ROGEP's $200 million funding to provide comprehensive support across 19 countries, including Côte d'Ivoire, through market studies, technical assistance; promotion of private investments and inclusive supply chains, complemented by entrepreneurship support, a risk mitigation facility and access to finance including working capital for equipment importers and debt financing for end-users, can help address gaps and enable growth in the sector. The Lighting Africa program, part of Lighting Global,[110] is supporting ROGEP by working with governments and the private sector to make quality-verified off-grid solar lighting and energy products more readily available in the country. It is working closely with ROGEP's implementing agency, the Economic Community of West African States (ECOWAS) Centre for Renewable Energy and Energy Efficiency (ECREEE), to draw new actors to the market and help existing players increase their sales.

GIZ is conducting a feasibility study to provide a three-year project, due to start at the end of 2018, with €5 million in technical assistance. This will include vocational education and training for renewable energy and energy efficiency for the private sector, additional modules on PV, and training for electricians to become renewable energy specialists. GIZ is also considering a three-year training program (resulting in a technical diploma) to introduce new professions like PV technicians.[111]

CHALLENGES

Confusion surrounding appropriate progression of technologies

While solar kits can provide socioeconomic benefits beyond electricity, they are seen by some as provisional pre-electrification solutions—not a replacement for the grid. The government has stated that grid connection is ultimately the primary approach for electrification. End users will outgrow the level of energy provided by the kits, and therefore need grid connected electricity to be able to access all the services they need. But developers view solar kits as potentially transformational, as mobile phones have been. Clarity is being sought on the regulatory approach for off-grid solutions, and the government's vision for these technologies either as provisional measures or as long-term energy solutions for the country.[112]

Need for financing structures and incentives

Developers are trying to identify innovative approaches to financing standalone solar projects, including developing bankable business models (with and without guarantees and external technical assistance). Financing various solar projects will require a mix of concessional and commercial finance.

Traditionally, most small-scale renewable energy business models were based on equity financing. But, as the market for off-grid renewable energy grows, capital needs are changing. Larger players are looking to raise debt and innovative business models are increasingly being used. For example, developers are installing renewable energy systems on customers' property, with a variety of payback mechanisms (turnkey, build-operate-transfer, rental, rent-to-own) and co-benefits (renewable energy credits and tax breaks).[113]

Côte d'Ivoire's solar PV sector faces challenges relating to regulatory support, electricity prices, client base and awareness, qualified PV companies, and available financing.[114] In the case of small-scale rural electrification projects, transaction costs

are very high because projects are disaggregated. The risks for investors are also high, especially because financial institutions have little experience with rural electrification. For the market to gain experience, it must be allowed to develop. As a first step, this will require a supportive regulatory environment.

POTENTIAL SOLUTIONS

Develop an off-grid strategy

As part of a broader electrification strategy, the government could consider off-grid energy solutions in order to improve their viability. This should reflect a plan for solar home systems that includes direct sales and pay-as-you-go business models, that are also aligned with the ROGEP intervention. The strategy could be informed by a study that builds on the experience of more developed off-grid markets and defines the benefits and best practices for business models, including:

- A cost benefit analysis of different product and service offerings versus electricity supply through the grid. The study could also capture the positive outcomes of using renewable energy solutions.
- A satisfaction survey to get feedback from customers—this should cover smaller autonomous solar systems (those used in homes, schools, and health centers, for example), as well as income-generating solar systems in multiple payment models.
- Best practices/policies implemented in other countries that successfully integrated solar home systems into their off-grid strategy (such as Kenya and Ethiopia). This could include an analysis of success factors and whether they could be transferred to Côte d'Ivoire.
- A survey and map of areas where solar home systems have been rolled out, and where they are needed.

Clarify VAT and customs duties for solar home system providers, and explore incentives to promote off-grid solutions through tax waivers

By providing more clarity on tax mechanisms, the government can ensure increased private sector uptake. Inconsistencies mean that companies may not be taking advantage of tax incentives. One option would be to publish an information note that sets out the tax treatment of solar home systems, particularly when they are sold on credit.

East Africa: An off-grid market approach[115]

The diffusion of solar energy in most Sub-Saharan African countries has been driven by government and donor-supported projects. But this is shifting—there is a transition towards market-based diffusion and private sector involvement for private consumers, institutions, and villages, and from off-grid to mini-grids and large-scale grid-connected PV plants. This transition has been supported by enabling frameworks such as innovative financing schemes, exemptions from VAT and import taxes, standardized power purchase agreements, and feed-in tariffs. Some of the most developed markets in East Africa include:

- Kenya: The country's strong early lead in installed capacity, local industry, and PV business development has had positive policy spillover effects on neighboring countries.
- Tanzania: Like Kenya, Tanzania's solar home systems account for between 75 percent and 80 percent of total installed solar energy capacity. Large-scale institutional PV has mostly been driven by direct government and donor procurement for rural schools, health clinics, and public buildings—and is expected to continue to grow due to telecommunications and tourism.

The adoption of solar has been driven by a decline in prices for PV modules, making it increasingly competitive compared to conventional technologies; prolonged international donor support for solar PV, which has stimulated both supply and demand in the market; and conducive framework conditions provided by national governments through procurement and tax incentives.

In addition, the purchasing power of rural consumers has improved, as has transport infrastructure, proximity of PV supply, and consumer demand. Local champions (by training local PV technicians and implementing the first demonstration projects) also play an important role.

A final point is the game-changing influence of mobile payments, which have seen considerable success in East Africa. Côte d'Ivoire has high mobile payment penetration rates. For example, in 2015, 99 percent of secondary school fee payments were made digitally, with 94 percent done via mobile money. Within the electricity sector, companies such as Orange have already implemented mobile payment enabled solar kits in rural communities.[116]

This includes when VAT is payable on credit sales, the ability to charge differentiated prices for products sold on credit or not, and how to obtain customs duty and VAT reductions on the solar component of home systems. The Investment Promotion Centre in Côte d'Ivoire and the USAID/Power Africa Transactions and Reforms Program could play a role as well.

The government could also establish customs duty reductions or waivers for solar home system providers and quality-certified products for developers. This would promote increased investment by reducing the costs, allowing developers to offer lower prices. The duties could apply to the whole system (not just solar panels), and would need to be clearly established and applied.

BOX 12

Innovative business models[117]

Global business models for providing small-scale renewable electricity include:

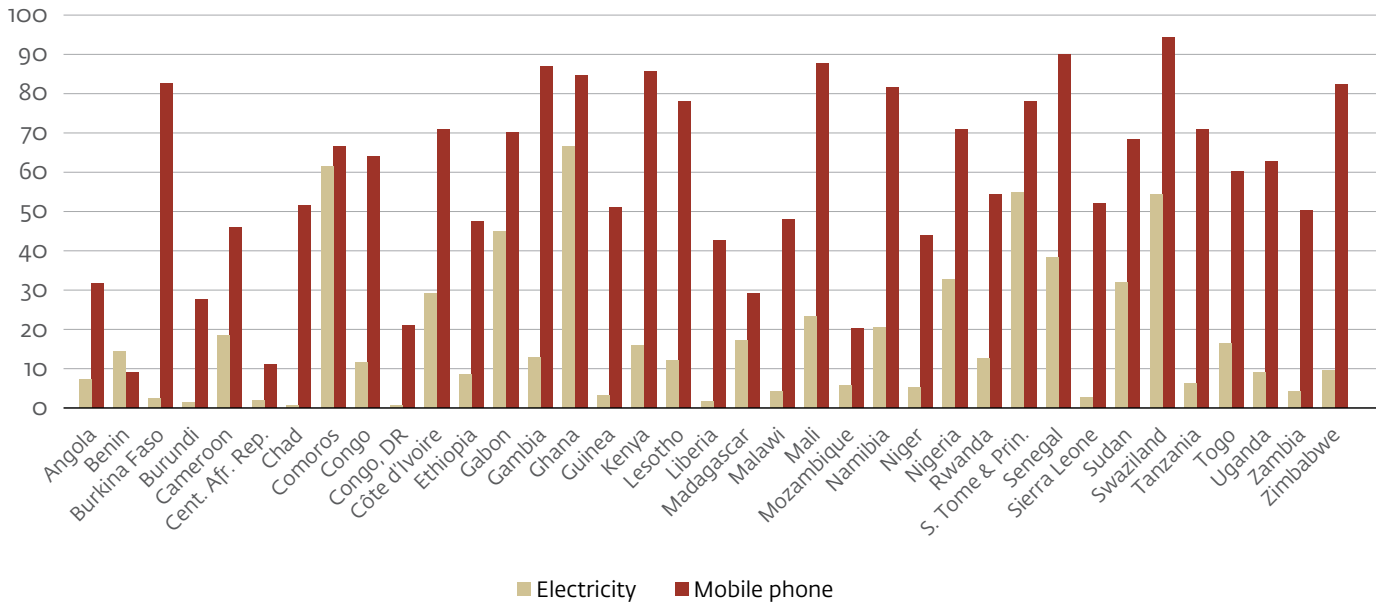
- Retail/over-the-counter model: Suitable for very small renewable energy systems. The user buys the solar lantern or kit from a private company and fully owns the system. Public funds, multilateral or bilateral aid, and the private banking sector can offer loans to support such purchases.
- Pay-as-you-go consumer financing: These are smaller household systems that can provide for basic lighting and energy usage. Users pay a daily or monthly amount over a period of between one and three years, after which they own the system. Alternatively, providers include basic appliances and recoup the cost of those appliances over time along with the cost of the solar/battery system itself. These approaches were originally developed with concessional financing, but now they are primarily commercial ventures.
- Consumer financing (via partner financial institution): A consumer financing model based on a partnership between a renewable energy supplier and a financial institution (serving, for example, a cooperative). The supplier provides products and associated services while the financial institution provides the consumer financing and collects repayments.
- Energy service (utility) model: The company provides the equipment to the end-user, who pays for the service rendered. The company owns the system and the operating company will need capital to buy the necessary equipment.

Photo © Power Africa / M-KOPA

M-KOPA: A replicable pay-as-you-go model

Kenyan company M-KOPA Solar combines solar and mobile technology to provide affordable, clean energy to off-grid villages in East Africa. M-KOPA was established in 2011, one year after a Shell Foundation Review found that 15 percent of Kenyans are connected to the national grid, while 96 percent are connected to mobile phones.[118] Customers pay a small deposit for a solar home system that usually retails for $200 and includes a solar panel, three ceiling lights, a radio, and charging outlets for mobile phones. The balance is repaid in small instalments on a pay-as-you-use basis through M-PESA, a widely available mobile payment platform. The payments are cheaper than the equivalent daily cost of alternative fuels and, after one year, customers own their systems. They then have cost-free energy for the lifetime of the product (typically four years). The company has a 95 percent repayment rate from its customers, even though most households are below the $2/day poverty line. By January 2018, the company had electrified more than 500,000 homes in Kenya, Tanzania, and Uganda.[119]

FIGURE 11: Electricity access and mobile phone ownership, Sub-Saharan Africa, 2016 (% of rural households)



Source: Survey estimates; World Bank 2018[120]

Develop a national quality assurance process to help buyers identify which products performed as advertised

In some cases, different technologies are needed quickly, at a lower cost, and with customization. For example, some markets modify the standard solar kit to add more lights or a radio. Developers often create product mixes based on extensive consumer testing in new markets to find the right product/price fit in each country.[121] The burgeoning national solar home system industry should develop within a new assurance process that guarantees the quality of products and service rather than focusing on kWh price regulation. Giving developers a year to do such market research, testing, and assurance will ensure that the products available in the market reflect the needs of Ivorians.

The assurance process should be based on internationally developed projects where possible to ensure that Côte d'Ivoire adopts the best approach with high-quality products and does not create costs for companies specific to the Ivorian market. International quality assurance standards have already been developed for smaller systems such as plug-and-play solutions, and can be adopted at the national level. Standards should also be harmonized with neighbors, particularly for larger systems, to ensure they are sustainable in the long term. One option would be for the Ministry of Petroleum, Energy and Renewable Energy Development to provide a waiver for kits that have a single additional component (as long as that component is already part of an accredited solar kit sold in the country) or a single component removed.

This program should be voluntary in the short term—competition with electrification should be the primary objective. It should also include a transition phase, which is usually included when new regulatory texts are adopted, that allows existing operators to obtain accreditation. For example, a 2020 effective date would give everyone a chance to certify new products.

Standards should support banks in supplying credit to developers by helping to identify those providing the best quality product. Quality assurance could also facilitate customs clearance, if it is integrated with waivers for qualified equipment.

Develop a labor skill standard for solar installers

The Ministry of Petroleum, Energy and Renewable Energy Development could identify quality service providers to provide clear signals to consumers. This service review should include companies' recommendations for the proper disposal of equipment at the end of its life. To allow rapid development of

this market, any accreditation system should be voluntary. This type of accreditation is less relevant for pay-as-you-go companies that provide plug-and-play products certified by entities such as Lighting Global. Additional actors include CI-Energies, project developers with possible support from development partners. This could be aligned with ECREEE's support for the establishment of regional entrepreneurship development facilities and implementation of regional certification schemes.

Define policies to facilitate access to solar home systems for low-income customers

In defining policies, possible subsidy mechanisms and the risks associated with their implementation could be explored, along with the staggering of payments beyond three years, using results-based finance, conducting consumer awareness campaigns, or putting in place a financing scheme like the Electricity for All program. The Ministry of Petroleum, Energy and Renewable Energy Development could develop a national program for off-grid community-based systems focused on the needs of local communities can help expand entrepreneurial activities. Private sector players advocate for this approach, recommending support programs for solar street lights, youth centers with electrified activities, solar mills, hairdressers, cold storage, and the resale of treated water.

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- ANARÉ
- E2IE (Entreprise Ivoirienne d'Integration Energetique)/Alturdyne Power System (part of Pinegrove Holdings)
- Ministry of Environment
- Direction Générale de l'Energie
- Oikocredit
- EDF
- AIENR
- Climate Economic Analysis for Development, Investment and Resilience/USAID

Photo © SE4ALL

BOX 14

Mini-grids in Myanmar

Yoma Micro Power is a Myanmar-focused micro-power plant operator, which recently closed a $28 million investment from IFC, Norfund, and Yoma Strategic Holdings—an equity and debt facility. Due to the rapid reduction in the cost of solar panels and batteries, solar-powered mini-grids have emerged as a viable alternative for rural electrification that can be deployed rapidly and financed with private capital. Investor Yoma Strategic Holdings is developing micro power plants and mini-grids in Myanmar, launching a 10-site pilot project in Sagaing Region, and aiming to develop more than 2,000 micro power plants by 2022. These power plants were initially proposed to provide electricity to anchor tenants like telecom tower operators. The mini-grid provides electricity to the surrounding communities, including households, schools, and other businesses. Powering such anchors first provides a model that may be replicable in other regions and countries.[127]

Mini-Grids and Distributed Generation

To date, the only existing solar installations are either isolated mini-grids or standalone off-grid systems in the case of remote villages, and rooftop systems installed by industrial companies and wealthier residential users (both connected and unconnected to the main grid).[122] Most grid-connected rural electrification projects have been implemented with government support. Public lighting projects using solar street lamps are ongoing. The Strategic Action Plan for the Electricity Sector has plans to retrofit existing rural diesel grids with PV by 2030.

The Master Plan for Rural Electrification indicates that all electrified villages in Côte d'Ivoire are located less than 20 km from the grid and hence will be connected to the national grid. In total, there are remaining 849 villages of over 500 households to be electrified in the next two years. Only around 100 of these villages are isolated, with small populations, and these will be electrified with off-grid solutions.[123] Solar PV mini-grids have the potential to support the electrification plans in these villages.

There are several mini-grid projects under way, including:

- Several ongoing public lighting projects using solar street-lamps.
- The Strategic Action Plan for the Electricity Sector has plans to retrofit existing rural diesel grids with solar PV. The plan also aims to complete at least 12 pilot projects in rural areas involving household applications and isolated PV grids.[124]
- The European Investment Bank has signed a $25 million financing plan for the installation of off-grid solar systems to strengthen energy access in Africa.[125]
- The USAID Power Africa Transaction and Reforms Program has recruited a consultant to support the Ministry of Petroleum, Energy and Renewable Energy Development in the development of a mini-grid strategy for Côte d'Ivoire, as part of its Beyond the Grid program.
- KFW is preparing to support the rehabilitation of transmission lines in a "Green Corridor" as a prerequisite to connecting solar power plants in the north of Côte d'Ivoire.[126]

CHALLENGES

Financial sustainability of the sector

Tariffs have not been able to maintain pace with inflation and have not reflected the real costs of energy. This has potential effects on the long-term financial sustainability of the energy

sector, and has important implications for the integration of renewable energy projects given the level of tariffs that the government is willing to accept.

Complex nature of distributed generation

Distributed generation provides many benefits resulting from the proximity of generation and consumption. However, it also introduces complexity to a traditional centralized model of generation and transmission, creating challenges for utilities and transmission system operators. For example:

- Third-party sales of electricity may displace the utility's role with retail customers.
- Utilities may need to upgrade distribution infrastructure to accommodate two-way power flows.
- The utility needs to manage variability of generation at the distribution level.
- Distributed resources change the load curve of a utility.

These challenges may generate opposition from existing players, including owners of hydropower infrastructure and IPPs benefiting from the current system.

POTENTIAL SOLUTIONS

Develop a mini-grid policy

Distributed generation is a central issue across the region, and merits additional analysis and research to better understand how to support this growing area. Developing a relevant policy could support this process. Potential components include:

- Defining sites where mini-grids should be developed, or site selection criteria.
- Creating licensing requirements and application procedures for different types and sizes of mini-grids.
- Developing operational requirements including minimum standards of installations, quality of service, safety, environmental requirements, and provisions for connecting customers.
- Connecting mini-grids to the national distribution network.
- Developing commercial arrangements, tariff policies, and subsidy arrangements.

BOX 15

Photo © ESMAP

In Niger, the World Bank Group is supporting the Public-Private Infrastructure Advisory Facility

The Solar Energy Access Project has been launched for private sector-based delivery of electricity services in rural areas, via a public-private partnership. This will include a technical, economic and financial assessment (including ability to pay) of five concession areas, a framework for the development of rural electrification (including selection of contract type), and capacity building.

Analyze tariff, subsidy, and operating models to determine the right approach

This approach can be applied to 96 mini-grid sites identified by CI-Energies and further sites to be developed. This will require political vision and a compensation mechanism to ensure that operators do not lose money because of the social tariff. Relevant analysis could include:

- Willingness to pay for electricity in rural areas.
- Demand analysis and demand-side management options.
- System dimensions and modular approaches to mini-grid generation capacity.
- Generation technology options, including hybrid systems.
- Appropriate tariff options including fixed monthly fees and time-based tariffs.
- Household connection and domestic installation costs.
- Support measures to develop productive uses of electricity.
- Payment collection approaches.
- Regulation options, quality assurance frameworks, and licensing procedures for mini-grids of different sizes.
- Compensation mechanisms in the case of the expansion of the national grid.

Subsidy and financing models for mini-grid construction, expansion, and operation.

Photo © SE4ALL

BOX 16

Setting optimal tariffs for mini-grids

Setting optimal tariffs helps ensure that mini-grids earn a reasonable rate of return and recover costs, keep customer rates affordable, and are politically feasible. The most common tariff structures are:

- Uniform national tariffs: All customers in the same category pay the same tariff.
- Avoided-cost tariffs: Customer bills stay the same or below previous bills, while improving services (although determining costs can be difficult to determine). This approach can be effective for mini-grid customers, who are likely to pay more for electricity than national-grid customers.
- Cost-reflective tariffs: Allow operators to recover capital and operating costs and receive a defined, reasonable return. This can vary by technology and is set with a regulator.[128]

Photo © Russell Watkins / UK Aid / Department for International Development

Tanzania's tiered regulatory approval process and support for developers to set cost-reflective tariffs[129]

Tanzania's electricity regulator has adopted a dual approach that allows it to conserve resources used to review and approve tariffs. Projects smaller than 100 kW do not need regulatory approval for tariffs, unless more than 15 percent of customers file a complaint. For projects larger than 100 kW, developers propose a cost-reflective tariff to the regulator for approval or modification. Developers size their projects in response to this oversight.

The lessons emerging from this approach include:

- Mini-grid tariffs demand separate consideration from national uniform tariffs, due to higher costs of service.
- To successfully encourage private investment, mini-grid developers must be able to make a profit. If developers are unable to charge cost-reflective tariffs, subsidies may be needed.
- There are many options in designing a regulatory structure to oversee mini-grid tariffs and there is no one best approach. Regulators may find it helpful to conserve their efforts by reviewing only large projects or small projects with persistent complaints from customers. That said, mini-grids tariffs are generally lower than what many customers currently pay for lighting and energy.
- Social tariffs are possible for mini-grid customers, but generally require a small surcharge on national tariffs.

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- E2IE (Entreprise Ivoirienne d'Integration Energetique)/Alturdyne Power System (part of Pinegrove Holdings)
- Climate Economic Analysis for Development, Investment and Resilience/USAID
- IVERTECH
- AIENR
- Engie
- CI-Energies
- Direction Générale de l'Energie
- EU
- BioTherm

Cross-cutting Issues: Finance, Policy, and Regulation

Status

Côte d'Ivoire is making considerable progress in developing and supporting financial and political infrastructure for renewable energy technologies. The Ministry of Petroleum, Energy and Renewable Energy Development expects to publish a draft strategy soon, and CI-Energies has established a project pipeline categorized by technology. A decree was published in November 2016 to support an energy efficiency strategy.[130] Two essential elements of this decree concern the labeling of equipment and the banning of incandescent lamps sales, which will be mandatory by 1 January 2019 at the latest.

Photo © Merklit Mersha / USAid

International institutions are also contributing. The EU's Energos 2 program will provide guarantee funds under its external investment plan and is developing a multi-building audit as part of its project on energy saving in public buildings, with additional funding from the French Development Agency.[131]

GIZ is conducting a feasibility study for a three-year project, due to start at the end of 2018, with €5 million in technical assistance. This will include vocational education and training for renewable energy and energy efficiency for the private sector, additional modules on PV, and training for electricians to become renewable energy specialists. GIZ is also considering a three-year training program (resulting in a technical diploma) to introduce new professions like PV technicians.

KfW is considering a guarantee mechanism for renewable energy as part of the G20's Compact with Africa, which aims to promote private investment in Africa, in collaboration with other development partners (the AfDB and the European Investment Bank). KfW is supporting several reforms under the Compact with Africa (with a total value as high as €95 million), which are under discussion with the government. This may include:

- Doubling the "Green Corridor" Dabo Bouaké transmission line (up to €25 million in co-financing). This upgrade is needed to connect solar projects in the north of the country.
- Conducting studies on the approach to renewable energy.

- Electrifying rural areas. This may include different solutions (grid extension, mini-grid, solar home systems), but will emphasize private sector involvement.

Other projects include:

- Reducing grid transmission and distribution losses as part of the World Bank and the West African Development Bank-funded project to reduce grid losses.
- Replacing 250-watt lamps with more efficient 160-watt lamps as part of a project on efficient public lighting.
- Distributing 5 million low-energy lamps in residential areas.

There are also planned projects that are still to be implemented, including energy audits and energy control in hotels, hospitals, and government buildings, and the labeling of household appliances.[132]

Challenges

DEVELOPING EXPERIENCE IN THE RENEWABLE ENERGY SECTOR

There are many actors interested in renewable energy in the country, including investors who buy and hold industrial assets in the region, investment banks seeking well-structured projects in need of financing, project developers and equipment suppliers, agriculture-processing companies seeking a use for their waste products, and industry federations concerned about energy provision reliability and cost.

Discussions with these stakeholders have revealed their interest in accelerating renewable energy investment in the country, particularly solar, biomass, and hydro technologies. However, several factors constrain private investment:

- Developers of biomass and waste management projects do not yet have in-country experience.
- Investors are waiting for a pipeline of well-structured projects that are ready for financing.
- Many local banks do not yet have sufficient knowledge and credit appetite to invest in the renewable energy sector.

Private banks are showing greater interest in investing in renewable energy in the country, but sectoral understanding and transactional experience needs to be increased. Local banks need more reliable information and training on business models and finance options. Lack of information has led to a perception of higher risks for renewable energy, affecting financing costs. But these perceptions and the high cost of financing will reduce as the country demonstrates success in the sector.

MAINTAINING A NEUTRAL, COMPETITIVE PROCESS

There has been considerable developer interest in Côte d'Ivoire. Globally, renewable energy development is best managed through technology-neutral competitive processes (see box 10 on Scaling Solar), which emphasize outcomes rather than picking technologies. An important consideration is the broader policy environment that contributes to project development and operating costs—these have remained high while technology costs have reduced.

Renewable energy producers are interested in selling excess power back to the grid, and there is an opportunity for distributed generation to serve customers with specific electricity needs, such as within the mining and agribusiness sectors. The Electricity Code of 2014 provides a basis for liberalizing the sector, but ongoing negotiations to extend CI-Energies' distribution concession, as well as the need for secondary legislation, mean that developers are not yet able to create commercial power purchase agreements with third-party off-takers.[133]

Creating a track record and standardizing the process will help encourage development. To attract investors, an overall development and implementation plan is needed. This could take the form of a tendering process that ensures effective competition, a reliable off-taker for cost recovery, or standardized contract frameworks and cost-reflective tariffs. Policies need to address land tenure challenges and the government can further support large renewable energy installations by identifying and allocating land suitable for development. The proposed revisions to the Investment Code in 2018 can further help to incentivize renewable energy development. In addition, developers need the latest information on available incentives, grid connection policies, and new approaches for aggregating projects at a portfolio level.[134]

IDENTIFYING APPROPRIATE INVESTMENT PROMOTION INCENTIVES

Côte d'Ivoire can learn from the approaches, policies, and measures used in other countries to support investment in renewable energy, such as:

- A preferential off-take tariff and guaranteed purchase of renewable energy during a relatively long period (such as

10 years). The tariff can be set and applied to all similar projects (feed-in tariff) or set through competitive selection (auctions and tenders).

- Grid laws and regulations such as grid codes describing connection procedures and operational requirements for renewable energy plants.
- Fiscal benefits for renewable energy, including accelerated depreciation and exemptions from various taxes.
- Access to finance through investment grants and subsidies for renewable energy projects (for example, from a "green" fund); low-interest or zero-interest loans; loan guarantees; green mortgages, which cover the value of the property and energy-efficient upgrades or installation of renewable energy systems; improving permit and licensing procedures; and raising awareness and providing guidance to developers through a web portal or investor guidebook, for example.

Developers could benefit from a centralized source of accurate information about project development. Conflicting information about government regulations and policies (for imports, tariffs, and project development), available financing from banks and other financial institutions, as well as appropriate technologies and how to best develop them can often make projects challenging.

Potential Solutions

MAP EXISTING SOURCES OF FUNDING AVAILABLE FOR RENEWABLE ENERGY IN CÔTE D'IVOIRE, INCLUDING CONCESSIONAL AND GRANT FUNDS

Donors working in partnership with the government can identify the types of financing available (grants, subsidies, debt, equity), details for accessing funding, applicable project types, and the project stages that funders are willing to support. Financial barriers should be explored and ways to address these identified.

EXPLORE FEASIBILITY OF TARGETED GUARANTEES

Possible guarantees include partial risk guarantees, co-guarantees, and sovereign guarantees for different types of actors and projects, ranging from start-ups, to small and medium-sized businesses, to utility-scale investments. Guarantees for small-scale projects (between €0.5 million and €10 million) could address the lack of financing solutions for auto-consumption and energy-efficiency projects. Development finance institution-funded tools implemented by local banks could also be developed. Relevant government actors include the Ministry of Petroleum, Energy and Renewable Energy Development and Ministry of Economy.

Photo © Sameer Halai / USAid

BOX 18

Off-grid solar financing in Togo

The Africa Guarantee Fund, which helps financial institutions increase their financing to small businesses in Africa, has provided a 50 percent pro rata credit enhancement to debt financing of $4 million from Togo-based bank Union Togolaise de Banque to off-grid solar company BBOXX.[135]

MAINTAIN AN UPDATED INVESTMENT PROSPECTUS FOR CÔTE D'IVOIRE'S RENEWABLE ENERGY SECTOR IN CONSULTATION WITH THE PRIVATE SECTOR

Building on the work of the ECOWAS Centre for Renewable Energy and Energy Efficiency,[136] this prospectus should promote renewable energy investment in Côte d'Ivoire by allowing investors to quickly understand the investment opportunity in the country. It would contain a profile of the sector and the investment opportunities it presents, a mapping of important stakeholders, descriptions of the projects in need of funding and their investment requirements, the resource potential of sites available for development, details of commissioned projects including cost and investment structures, and information on risks and their mitigation. ECREEE and other development partners are important potential actors.

DEVELOP CAPACITY BUILDING/TRAINING ON THE RENEWABLE ENERGY SECTOR TO INCREASE FAMILIARITY WITH THE TYPES OF PROJECTS, AND THEIR TECHNICAL, FINANCIAL, AND REGULATORY ASPECTS

Building the capacity of banks to work with renewable energy projects can enable them to more effectively appraise risks by focusing on different market segments, associated business models, and financing options. This can be followed by technical assistance from the Ministry of Petroleum, Energy and Renewable Energy Development and development partners such as IFC to support project evaluation and potential financing solutions.

In addition, the following actors could benefit from tailored support from the Ministry of Petroleum, Energy and Renewable Energy Development, CI-Energies developers, and development partners such as GIZ:

- **For government staff** on project financing and legal and technical aspects related to renewables, including international best practice.
- **For developers** to structure their projects to attract financing, leveraging existing sources of support available.
- **For solar technicians,** including hands-on training. Installation and after-sales service is critical, especially as larger systems are deployed. Development centers could coach young people on how to develop these technologies, which could help increase employment in the sector. This would complement the training that solar home system

BOX 19

Select donor programs in Côte d'Ivoire

- The French Development Agency, PROPARCO, and the EU have launched the Africa Renewable Energy Scale-Up Facility initiative, which includes a guarantee fund component (€10 million) to guarantee part of the investment in funds invested by PROPARCO in companies operating in the off-grid, mini-grid, and decentralized renewable energy generation sector in Africa. This accompanies the initiative's study component (€12 million) to support public authorities in market analysis, defining a regulatory framework, determining a tendering process, and establishing an off-grid and on-grid project pipeline.[137]
- The French Development Agency's Sustainable Use of Natural Resources and Energy Finance initiative provides concessional financing to encourage financial institutions to fund renewable energy and energy-efficiency projects. This funding comes with technical assistance and analysis to validate the viability of projects and their eligibility for the program. These projects are then presented to the Sustainable Use of Natural Resources and Energy Finance banks for financing. To date, the facility has been deployed to partner banks in Benin, Côte d'Ivoire, and Senegal (€30 million).[138]

Photo © Ambika Adhikari / USAid

Capacity building in green finance

To accelerate investment in renewable energy, IFC plans to launch a new capacity building and training program for banks in Côte d'Ivoire. This will help these banks better appraise risks by focusing on different market segments, associated business models, and financing options.

IFC will first survey banks to assess their level of experience in renewable energy investments. Based on the results, it would then partner with the Ministry of Petroleum, Energy and Renewable Energy Development, the Ministry of Finance, and the Investment Promotion Agency to host a tailored training program for bank CEOs and board members. The results of the Roadmap would be presented, together with technology overviews, business models, and financial solutions. This would lead to more targeted individual portfolio reviews with certain banks to set a target for green/renewable energy lending tailored to their current portfolio.

developers already provide—which is currently not well publicized. Promoters could partner with the government to increase training programs, combining classroom and "in-the-field" training experiences.

DEVELOP AND IMPLEMENT AN ONGOING RENEWABLE ENERGY POLICY MONITORING FRAMEWORK BASED ON ECOWAS EXPERIENCE

ECOWAS member states have resolved to compile annual national reports on their national energy plans, as well as a summary of the main activities implemented to achieve the objectives during the previous year. ECOWAS will monitor the status of renewable energy and energy-efficiency policies and programs, and issue an annual regional inventory report. The next report is due in mid-2018.

The ECOWAS Centre for Renewable Energy and Energy Efficiency has undertaken a survey across Africa to assess positions on renewable energy. It used this information to develop the ECOWAS Renewable Energy Policy, which will allow for future monitoring of progress.[139] This is an example of monitoring that could be made more systematic in the future and greatly inform Côte d'Ivoire's future policies.

CREATE A RENEWABLE ENERGY AND ENERGY-EFFICIENCY AGENCY AND ONE-STOP SHOP FOR INVESTMENT PROMOTION

Lack of consistent information is a challenge and a barrier to development. A one-stop shop for renewable energy information would be helpful for new and existing developers, including forums to allow developers to share information. To prepare and maintain this platform, and to provide further information, the Ministry of Petroleum, Energy and Renewable Energy Development with support from The Investment Promotion Centre in Côte d'Ivoire could consider creating a coordinated renewable energy and energy-efficiency agency (or designating one within an existing agency). The agency, which would have a team experienced in the sector, would act as a one-stop shop for support and information for developers and financiers looking to invest.

This agency could have a variety of functions, listed in order of increasing responsibility:

- Provide access to data or steer actors towards relevant sources of information, including applicable laws and regulations, and guidance to developers as they obtain permits and licenses for project development.

Photo © Russell Watkins / UK Aid / Department for International Development

Energy one-stop shops

One-stop shops can come in many forms. There have been independent national advocacy organizations formed to help lobby on all issues affecting the off-grid space. Examples include the Kenya Renewable Energy Association[140] and Rwanda's Energy Private Developers:[141]

- The Kenya Renewable Energy Association is an independent non-profit association supporting renewable energy business in Kenya. It provides information on renewable energy markets, market actors, and technologies; conducts training, capacity building, and quality assurance activities; and networks and lobbies on behalf of the industry.
- Energy Private Developers is a business-group platform coordinating and advocating for the business community investing in energy. It connects the private sector with the government to achieve successful public-private partnerships in the energy sector, and with international investors interested in developing domestic energy projects.

Both are supported by the Global Off-Grid Lighting Association.

Photo © Russell Watkins / UK Aid / Department for International Development

- Provide training and capacity building, awareness raising, and sector consultation.
- Provide an initial governance and institutional support framework for studies.
- Provide a governance structure that involves multiple relevant ministries to improve inter-ministerial coordination.
- Raise funding for programs.
- Identify appropriate investment incentives.
- Run or provide a window for tender processes and the development of pilot projects.

Working Group Contributors

The following organizations participated in this Working Group:

- ECOWAS Centre for Renewable Energy and Energy Efficiency
- Schneider Electric
- African Legal Support Facility
- ANARÉ
- Fenix International
- Green Invest Africa
- PHAESUN/S-Tel
- BNETD
- AIENR
- E2IE (Entreprise Ivoirienne d'Integration Energetique)/Alturdyne Power System (part of Pinegrove Holdings)
- Climate Economic Analysis for Development, Investment and Resilience/USAID
- ADERCI
- Finergreen
- KfW
- Oikocredit (financing aspects mainly)
- BioTherm
- GIZ

Next Steps

Under the leadership of the Ministry of Petroleum, Energy and Renewable Energy Development, producing this Roadmap and having the accompanying discussions with stakeholders has been one of the first comprehensive engagements by a country to attract private investment for its NDC. This approach has shown the benefits of consistent and constructive dialogue with the private sector, by capturing their needs and ideas on how to expand renewable energy in the country. A variety of technologies are available to support Côte d'Ivoire's ambitious goals. Determining which of these technologies should be scaled and when remains a key step. Developers and banks want to grow this sector and this process has further strengthened their interest.

The private sector actors convened through this process have signaled their interested in engaging with the government and other donors. While donors have developed an energy sector coordination platform among themselves and the government has already undertaken a range of activities in the sector, there is no consistent platform for engagement with the private sector on energy. As a first step, partnering with a local industry body and other donors could provide an effective approach for hosting this as part of a broader private sector engagement platform. The platform could then in the medium term maintain a sustained and coordinated dialogue with the public sector and donor community on clean energy as they continue to develop and implement solutions to attract private investment.[142]

IFC stands ready to support these efforts and champion this process.

Annexes

Resources

HYDROPOWER

IFC

- Hydroelectric Power: A Guide for Developers and Investors.[143]
- Hydro Advisory website.[144]
- IFC Performance Standards,[145] which include Land Acquisition and Resettlement.[146]
- The IFC Good Practice Note (Environmental, Health, and Safety Approaches for Hydropower Projects[147]) includes the effects of hydro projects on human settlements. The note discusses how to minimize impacts as well as how to manage involuntary resettlement if required.

World Bank

- Global Practices on Hydropower and Dams.[148]
- The Good Practice Handbook (Environmental Flows for Hydropower Projects: Guidance for the Private Sector in Emerging Markets[149]) includes information on environmental flows to help manage the effects on ecosystems and people.

Other

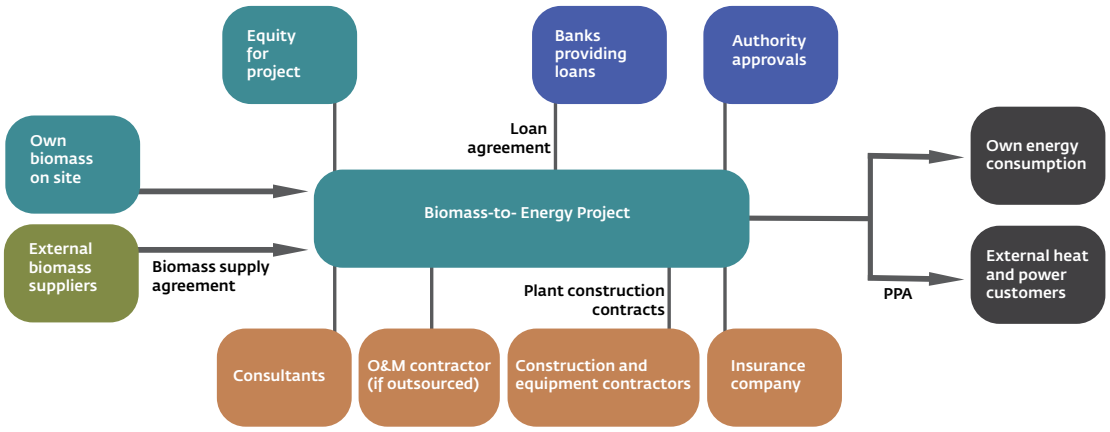
- Société d'Etat pour le Développement Minier de Côte d'Ivoire.[150]
- The master plans developed by CI-Energies on generation-transmission, distribution, automation-telecontrol, and rural electrification create a planning framework for investments in the sector for the period 2014 to 2030. They include plans for developing generation capacity by technology, and year-by-year projections for commissioning specific hydro sites. These master plans are expected to be updated in 2019.

BIOMASS

IFC

- The IFC resource guide (Converting Biomass to Energy: A Guide for Developers and Investors),[151] which is excerpted below:

FIGURE A1: Main Contracts for a Biomass-to-Energy Project



World Bank

- The World Bank tool to assess the financial feasibility of biomass projects includes training materials to help the agricultural community think about how to develop biomass projects.[152]

Other

- The French Agricultural Research Centre for International Development is studying the energy potential of various agricultural sectors in the region, including Côte d'Ivoire.
- The ECOWAS Regional Biomass Energy Program[153] carries out studies on energy recovery in the sustainable production of cocoa pods.
- The Global Bioenergy Partnership[154] brings together bioenergy stakeholders to coordinate and implement targeted international research, development, demonstration, and commercial activities related to production, delivery, conversion, and use of biomass for energy, with a focus on developing countries. The partnership is developing sustainability criteria, as well as indicators and a methodological framework for measuring reductions in greenhouse-gas emissions.
- The Food and Agriculture Organization conducted a study on biomass, which includes a mapping of organizations in the industry: Vision Bioénergie Durable 2030 (Projet TCP/IVC/3503) and the Plan d'Action National de la Bioénergie Durable (both available from the Ministry of Environment. The organization includes an overview of the sector on its country page).[155]

Variable generation: solar and wind

GRID-TIED

World Bank

- The World Bank Group Energy Systems Management Assistance Program has experience mapping wind in several African countries.
- Standard documents are available from the World Bank Group's Scaling Solar program (which can also be adapted to wind).

Other

- Global Wind Atlas.[156]
- Global Solar Atlas.[157]
- The Global Wind Energy Council[158] is a wind industry trade association, providing a representative global forum for the sector. Its focus is on policy analysis, trends, and outreach to emerging markets.
- The International Solar Energy Society[159] is a United Nations-accredited nongovernmental organization that brings together industry leaders, scientists, and politicians to create international structures that facilitate cooperation. The society supports its members through actions such as encouraging fundamental and applied research in solar energy.

OFF-GRID

IFC

- IFC is developing a pay-as-you-go Market Attractiveness Index for companies to consider when evaluating market opportunities. This includes the following criteria: an enabling mobile environment, an enabling government environment, the ability to raise finance, access to finance from local financial institutions, market opportunity, and operational considerations. The index is expected to be developed in 2018.
- IFC/the World Bank has recently completed a study[160] with cost-benefit analyses and other analyses of African off-grid solar markets.

World Bank

- Lighting Global's Quality Assurance Program[161] has established Quality Standards, a product-testing process with test labs and other resources. This program was previously administered by Lighting Africa and ECOWAS.

Other

- There is a framework for testing product component families[162] to address the challenges of re-certifying solar kits after minor changes. This framework allows developers to certify a set of interchangeable components sold on a component-level basis or as mix-and-match kits.
- The Centre for Renewable Energy and Energy Efficiency has created a Regional Certification Scheme to develop the skills of solar installers in eight ECOWAS countries (not including Côte d'Ivoire). This will be delivered through 21 pre-selected training institutions.
- ANARÉ announced a decree (2016-787) on October 12, 2016,[163] that relates to the conditions and modalities of solar home system distribution activities.
- The Solar Multi-functional Platforms Programme for the Fight against Poverty (PTFM) in Burkina Faso could provide a replicable model.

GRID, MINI-GRID, AND DISTRIBUTED GENERATION

IFC

- IFC's recent report on the operational and financial performance of mini-grid[164] distributed energy services companies.

Other

- The Power Africa Transaction and Reforms Program is drafting Best Practices of Rural Electrification Concessions in Africa—including criteria for choosing asset-based concessions (defined by the generation and distribution system, and generally limited to a village or a trading center) versus geographical concessions (defined as a set area and top-down from the government).
- The U.S. National Renewable Energy Laboratory has conducted these types of studies.

FINANCE AND POLICY

IFC

- IFC has a Global Toolbox showing instruments available from multilateral development banks to support private investment in Africa, including a number of funds supporting clean energy such as the AfDB's Sustainable Energy Fund for Africa and the European Investment Bank's Global Energy Efficiency and Renewable Energy Fund.[165]

World Bank

- World Bank 2016 Joint Report on Multilateral Development Banks' Climate Finance.[166]

Other

- The EU Energy Initiative Partnership Dialogue Facility and Africa-EU Energy Partnership have produced the report Mapping of Energy Initiatives and Programs in Africa (report and high-level initiatives).[167]
- Project preparation facilities support governments, investors, and developers of power projects by helping to expedite the technical, financial, legal, and regulatory processes involved in energy deals:[168]
    - The Power Africa Toolbox[169] offers transaction assistance and information on finance, policy or regulatory reform, capacity building, and legal assistance—including those in Côte d'Ivoire.[170] Power Africa's Project Preparation Facilities Toolbox[171] shows 13 early-stage project preparation facilities operating in Sub-Saharan Africa's energy sector—most of the facilities include Côte d'Ivoire as a target country. Power Africa has a map of African energy projects,[172] including both fossil and renewable energy sources.
    - NDC Partnership Funding and Initiatives Navigator.[173]
    - The landscape of financing can be shown graphically in a financial-flow structure, showing needs and available funding.[174]
- The Centre for Renewable Energy and Energy Efficiency has developed an Investment Prospectus[175] for investors. It outlines energy investments in the country (including government and donor programs) and detailed individual descriptions of pipeline projects.[176] The center is considering developing business-to-business meetings in the next year.
- Sustainable Energy for All completed a rapid assessment gap analysis for Côte d'Ivoire in 2012; if this could be updated it would provide a strong complement to the investment prospectus.[177]
- The Commercial Law Development Program and Power Africa have developed handbooks for Understanding Power Project Financing,[178] Understanding Power Purchase Agreements,[179] and Understanding Power Project Procurement,[180] focused on investors in Africa.
- Côte d'Ivoire's Electricity Code.[181]
- Similar legislation has recently been passed in other countries, including Nigeria and Morocco. Lessons should also be drawn to identify best practices regarding feed-in tariffs in Europe.
- Details on existing investment incentives and the electricity code and eight associated decrees (and ordinances) are available from the Investment Promotion Centre in Côte d'Ivoire and ANARÉ websites, respectively.
- The International Renewable Energy Agency promotes renewable energy by facilitating access to information, including technical, economic, and renewable resource potential data. The agency also shares experiences on best practices and lessons learned regarding policy frameworks, capacity-building projects, and available finance mechanisms.

Project Portfolio

Although Côte d'Ivoire's renewable energy experience has been primarily in large hydro generation, several projects are under development. Some projects are in the stage of pre-feasibility and feasibility studies, and others are in the funding stage. During the 2012 national energy seminar, the Ministry of Petroleum, Energy and Renewable Energy Development identified the following projects moving forward:

- Use of municipal waste and agricultural residues:
  - *The SITRADE project* related to the production of electricity from solid waste in the District of Abidjan: 8.3 billion CFA, of which 1.3 billion CFA will come from the state.
  - Energy production from waste treatment discharged from Anyama: 263 billion CFA, which private parties will finance.
- Producing electricity from the sun and wind:
  - *Electrification of rural sites using a solar PV system:* 7.15 billion CFA, of which 1.8 million CFA will be financed by the state.
  - *PCCI 01 solar plant* (PV plant): 95 billion CFA to be privately funded.
  - *Promotion of renewable energy for rural communities* (promotion of renewable energy for decentralized electrification in view of the creation of activities that generate revenue in rural zones): 1.63 billion CFA, of which 400 million CFA is from the state.
  - *Pilot public-lighting project by a PV system:* 2 billion CFA from the state.
  - *6 MW wind project:* 4 billion CFA, 1 billion CFA of which is from the state.
  - *Cogeneration:* 7.5 billion CFA, 2.1 billion CFA of which is from the state.
- Developing small hydroelectric plants:
  - *Hydroelectric plant of Drou:* 16 billion CFA, 600 million CFA of which is from the state.
  - *300 kW hydroelectric plant on the Agnéby river:* 800 million CFA, 320 million CFA of which is from the state.
  - *Hydroelectric planning of Aboisso-Bia:* 8.6 billion CFA, to be financed by private parties.

Laws and Regulation for Clean Energy

In 1985, law 85-583 established the legal framework for the promotion of clean energy. This law organized the production, transmission, and distribution of electricity up to March 2014. It liberalized electricity production and promoted the installation of several IPPs. However, the 1985 law did not include a clear provision to encourage investment in renewable energy. The legislation did not consider rural electrification and other aspects related to security and the environment, nor did it address the sector's regulation. Furthermore, the law did not provide any punitive measures to address electricity fraud, which was a major problem until recently.

In 1990, decree 90-1390 established a public-private partnership with CI-Energies. As a result, CI-Energies became the concessionaire for the national electricity public service and was charged with the production, transmission, import, export, and distribution of electricity. In 2005, the government renewed this concession for 15 years.

This decree includes several important limits:

- The concession contract does not set any clear performance objectives for the concessionaire, which rents state-owned assets while ensuring a fixed remuneration.
- The state carries the commercial risk and responsibility for investments in this type of contract.
- The concessionaire carries limited responsibility for maintenance and renewal operations, which means it can delay maintenance to the point of renovation if desired. As a result, production equipment and infrastructure are functioning below their capacity.
- The grid is constantly overloaded because of obsolescent operations, transmission, and distribution lines.
- The state subsidizes the electricity price by adopting social prices.
- The management framework of this contract does not prioritize economic efficiency.

A new electricity code was enacted in 2014, which further liberalized production. According to this code, private operators may enter different segments of the electricity sector, including transmission, distribution, commercialization, import, and export. The 2014 code has the following objectives:[182]

- Ensure energy independence and a secure electricity supply.
- Develop new and renewable energy.
- Promote access to electricity for all, especially in rural areas.
- Encourage energy efficiency.
- Create investor-friendly economic conditions.
- Protect the rights of consumers and operators.
- Encourage competition.

The new code contains several innovations. It clearly establishes different legal systems for accreditation, agreement, authorization, declaration, and release. It also reduces monopoly, with the state now acting as a system operator and perhaps a market operator. As a result, the code acknowledges the principle of opening most segments of the electricity sector up to competition. Nonetheless, the government and new entrants will agree upfront on conditions regarding electricity production, transmission, distribution, import, export, and marketing. The parties will also agree on an authorization or prior declaration for producers who reach a capacity limit.

The law grants third-party access to grids and raises the possibility that eligible clients may choose their supplier. It also establishes general price-setting principles for the electricity sector, namely:

- Financial sustainability in and development of the electricity sector.
- Equity and non-discrimination for consumers.
- Proper accounting for costs, anticipated profits, and charges resulting from the obligations of public service.
- Financial sustainability and profitability for the operator.

Finally, the law promotes the development of new and renewable energy projects by introducing special fiscal and customs incentives for operators. In addition, it includes measures to control fraud and other crimes in the electricity sector.

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