IDEV

Independent Development Evaluation
African Development Bank

*From **experience** to **knowledge**...*
*From **knowledge** to **action**...*
*From **action** to **impact***

Impact Evaluation of the AfDB-supported Kenya Last Mile Connectivity Project, Phase I

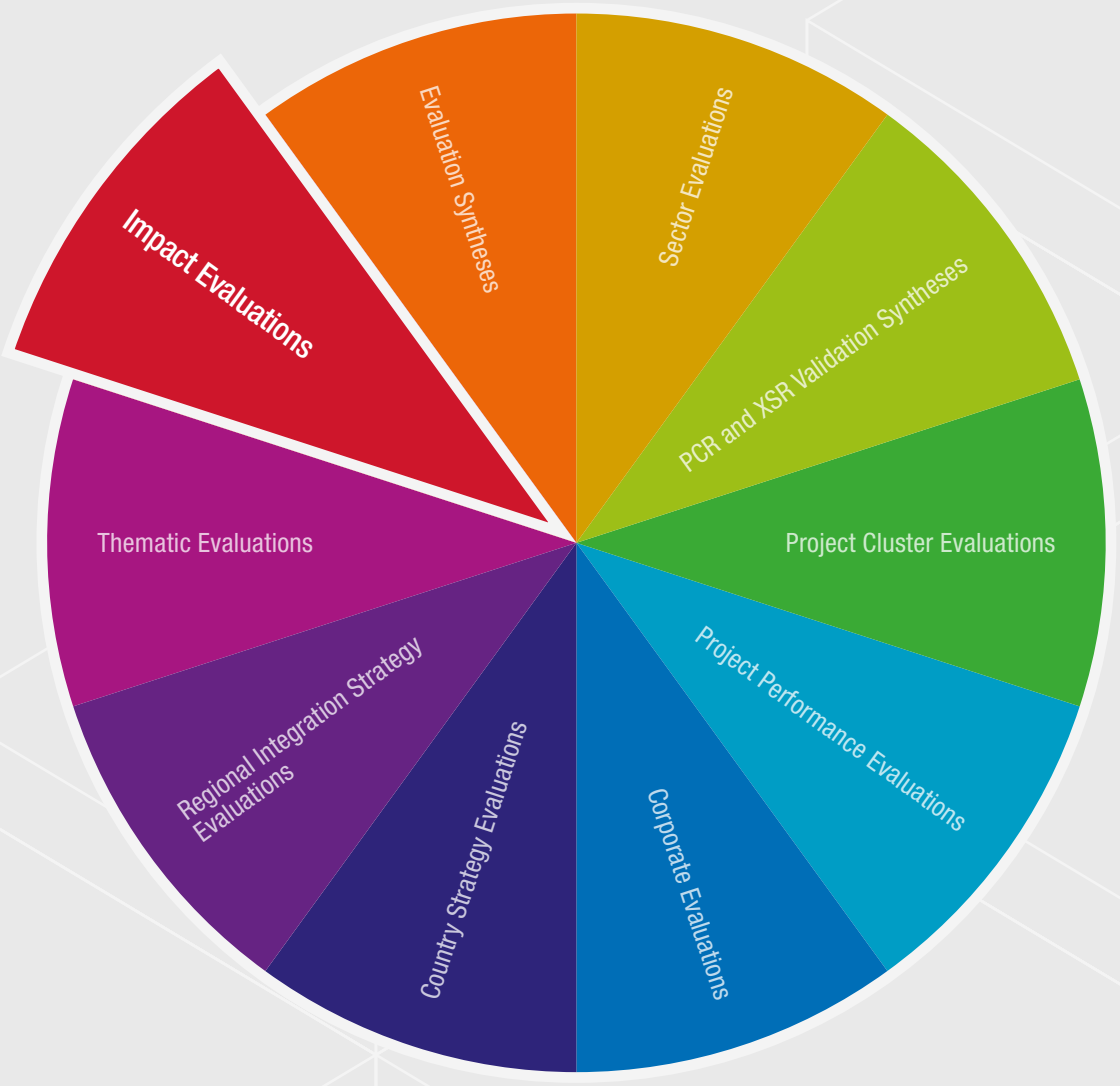
Summary Report

AFRICAN DEVELOPMENT BANK GROUP

March, 2022

An IDEV **Impact Evaluation**

IDEV conducts different types of evaluations to achieve its strategic objectives



IDEV

Independent Development Evaluation
African Development Bank

*From **experience** to **knowledge**...*
*From **knowledge** to **action**...*
*From **action** to **impact***

Impact Evaluation of the AfDB-supported Kenya Last Mile Connectivity Project, Phase I

Summary Report

AFRICAN DEVELOPMENT BANK GROUP

March, 2022

An IDEV **Impact Evaluation**

ACKNOWLEDGEMENTS	
Task manager:	**Eustace Uzor,** Evaluation Officer, IDEV.1
Team member:	**Racky Balde,** Evaluation Officer, IDEV.1
Consultants:	**Giulia Zane; Dana Kassem, EED Advisory**
Internal peer reviewers:	**Andrew Ajuang Anguko,** Chief Quality and Methods Advisor, IDEV.0; **Eric Kere,** Senior Evaluation Officer, IDEV.2; **Girma Earo Kumbi,** Chief Evaluation Officer, IDEV.2
External peer reviewers:	International Initiative for Impact Evaluation (3ie): **Sebastian Martinez** and **Chandan Jain**
Internal Bank Reference Group:	**Alemayehu Wubeshet-Zegeye,** RDGE.1; **Ihcen Naceur,** PESA; **Yang Liu,** ECMR.2; **Amira Mosad Elmissiry,** SNDR.1; **Carlos Mollinedo,** PEVP; **Arkins Mwila Kabungo,** PEVP; **Dennis Munuve,** Sustainable Energy Fund for Africa
Knowledge management and communications officers:	**Jacqueline Nyagahima,** Principal Knowledge Management Officer, IDEV.3; **Aminata Kouma,** Evaluation Knowledge Assistant, IDEV.3; **Kate Stoney,** Senior Communication Officer, IDEV.3
Other assistance/contributions provided by:	**Henda Ayari,** Team Assistant, IDEV.1
Special thanks to:	All Bank staff at Headquarters and RDGE for their contribution and great collaboration during the evaluation. With special recognition to **Nnenna Nwabufo,** Director General,RDGE; **Angelique Umubyeyi,** Principal Country Program Officer,RDGE; **Daisy Amolo Atieno,** Executive Assistant to Director General, RDGE; **Paul Mutha,** Protocol & Liaison Officer, RDGE; and the entire team of the AfDB's office in Kenya. Members of households, community members, and business, who served as samples for this study. Members of the Kenya Power and Lighting Company (KPLC), especially **Bernard Ngugi,** Managing Director; **Charles Mwaura,** General Manager Network Management; **Ekrah Waithira Maina,** Head, Geographic Information System/FDB; **Christine Achieng Omollo**; **Kennedy Omolo Owino**; **Robert Bore**; **Daniel Otieno Akendo**; **Joel Changwony**; **Amos Murigi Njoroge**; **Beatrice Chepngetich Soi**; **Mark Ndirangu Irungu**; and **Peter Mungai Thumbi**. We are grateful for making critical data and surveys available to the team. **Jared Biwott, Nicholas Bundotich, Japhet Omari, George Tarus, John Kyalo,** KPLC LMCP Project Managers, Phases I-IV; **Edward Gakunju,** General Manager, Business Development, Rural Electrification and Renewable Energy Corporation; **Sumit Kumar,** KPLC Project Manager; **Mugwe Kiragu,** Energy Sector Engineer, European Investment Bank; **Laurent Farge,** Head of Kenya, Energy Program, Agence Française de Développement (AFD). All stakeholders met at national and local levels for sharing constructive and insightful thoughts on the project.
Division manager:	**Rufael Fassil,** IDEV.1
Evaluator-General:	**Karen Rot Münstermann (acting)**

Impact Evaluation of the AfDB-supported Kenya Last Mile Connectivity Project, Phase I – Summary Report
IDEV Impact Evaluation, March, 2022

About the AfDB

The overarching objective of the African Development Bank Group is to spur sustainable economic development and social progress in its regional member countries (RMCs), thus contributing to poverty reduction. The Bank Group achieves this objective by mobilizing and allocating resources for investment in RMCs and providing policy advice and technical assistance to support development efforts.

About Independent Development Evaluation (IDEV)

The mission of Independent Development Evaluation at the AfDB is to enhance the development effectiveness of the institution in its regional member countries through independent and instrumental evaluations and partnerships for sharing knowledge.

Independent Development Evaluation (IDEV)
African Development Bank Group
Avenue Joseph Anoma, 01 BP 1387, Abidjan, 01 Côte d'Ivoire
Phone: +225 27 20 26 28 41 | E-mail: idevhelpdesk@afdb.org | idev.afdb.org

Photo Credits: IDEV evaluation team, AfDB Projects on Flickr | Design & layout: GK Graphics (www.gkgraphics.in)

Contents

Contents

List of tables

Abbreviations and Acronyms

ADF	African Development Fund
AFD	Agence Française de Developpement
AfDB	African Development Bank Group
CIESIN	Centre for International Earth Science Information Network
CFL	Compact Fluorescent Light
CSP	Country Strategy Paper
DP	Development Partner
ECMR	Macro-Economics Policy Forecasting and Research Department
EIB	European Investment Bank
EPC	Engineering, Procurement, and Construction
EPRA	Energy and Petroleum Regulatory Authority
FE	Fixed Effects
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GIS	Geographic Information System
GoK	Government of Kenya
GPOBA	Global Partnership on Output-Based Aid
IDA	International Development Association
IDEV	Independent Development Evaluation Department
IPR	Implementation Progress Report
KCSE	Kenya Certificate of Secondary Education
KES*	Kenya Shilling
KII	Key Informant Interview
KPLC	Kenya Power and Lighting Company
LMCP	Last Mile Connectivity Project
LV	Low Voltage
MDB	Multilateral Development Bank
MoEP	Ministry of Energy and Petroleum
MSMEs	Irrigation Services and the Promotion of Small Businesses
MTP	Medium-Term Plan
NDEA	New Deal on Energy for Africa
OLS	Ordinary Least Squares
PAP	Pre-Analysis Plan
PAR	Project Appraisal Report
PBT	Profit Before Tax
PEVP	Power Energy Climate Change and Green Growth
PIU	Project Implementation Unit
PME	Protective Multiple Earthing
PRG	Partial Risk Guarantee
RBLF	Results-Based Logical Framework
RCT	Randomized Controlled Trial
RD	Regression Discontinuity
RDD	Regression Discontinuity Design
RDGE	East Africa Africa Regional Development and Business Delivery Office
REREC	Rural Electrification and Renewable Energy Corporation
RMC	Regional Member Country
SDG	Sustainable Development Goal
SEZ	Special Economic Zone
SME	Small and Medium Scale Enterprise
SNDR	Delivery, Performance Management and Results Department
ToC	Theory of Change
TV	Television
TYS	Ten-Year Strategy of the African Development Bank
UA	Unit of Account
USD**	United States Dollar
VAT	Value-added Tax

As on 28 February 2022

*1 Kenya Shilling (KES) = 0.01 United States Dollars (USD)

**1 Unit of Account (UA) = 1.39 United States Dollars (USD)

Executive Summary

Introduction

This summary report presents the findings, conclusions, lessons, and recommendations of an impact evaluation of the Last Mile Connectivity Project (LMCP, or the project) Phase I financed by the African Development Bank Group (AfDB, or the Bank) under the Thirteenth African Development Fund (ADF-13) in the Republic of Kenya. The project loan was approved by the AfDB Board of Directors in November 2014 for a value of UA 90 million excluding the Government of Kenya's (GoK) contribution of UA 9.20 million. The project became effective in March 2015 with a planned completion date of December 2019. However, the closing date for the project was extended to December 2022 due to challenges such as contractor non-performance for two lots and the recent COVID-19 pandemic.

The main objective of the project was to support the Government of Kenya's aim to provide universal electricity access for all Kenyans by 2022, particularly for low-income groups in peri-urban and rural areas.

Access to energy is considered vital for economic development. It is, therefore, a major goal for the international community, the Bank, and its Regional Member Countries (RMCs). In line with the United Nations (UN) Sustainable Development Goal 7 (SDG7) which calls for "affordable, reliable, sustainable and modern energy for all," the Bank aims to achieve universal energy access in Africa by 2025 through its High 5 priority area on "Light Up and Power Africa" and the New Deal on Energy for Africa (NDEA). Likewise, increasing energy access is a cornerstone of Kenya's development strategy to transform its economy into that of a middle-income industrialized country.

The project maximized the use of existing electricity infrastructure by connecting households and businesses located within a 600-meter radius of suitable distribution transformers operating below full capacity. Specifically, the project extended the low-voltage (LV) network throughout Kenya, with counties that have low electrification rates prioritized. Broadly, the evaluated project, Phase 1 of the LMCP, planned to connect 284,200 households, 30,000 commercial customers, and public facilities (health centres and schools) around project transformers across all 47 counties in Kenya.

Altogether, this translated to providing electricity access to 1,571,000 people. The project prioritized customers in counties with low electricity penetration rates and the connection fee was subsidized.

The project had four components, namely: (i) construction of a low-voltage network (UA 96.25 million) comprising of 12,000 kilometres of low-voltage distribution lines (415V and 240V) to households and businesses, and the installation of energy meters for the connection of targeted beneficiaries; (ii) project supervision and management (UA 2.6 million); (iii) capacity building and re-establishment of the Kenya Power and Lighting Company (KPLC) tree seedlings nursery (UA 0.25 million); and (iv) project audit (UA 0.1 million).

What was Evaluated?

Independent Development Evaluation (IDEV) conducted an impact evaluation of LMCP Phase I in Kenya. The LMCP was implemented across 45 counties in four phases, with the Bank financing Phases I and II. The evaluation estimated the causal impact of the intervention by comparing households within the 600 meters eligibility border

(treatment group) with households outside the 600 meters eligibility border (control group). The report presents the average effect of the project on eligible households in targeted communities (treatment group) that connected to electricity through the project relative to ineligible households (control group) that were not connected through the project.

Purpose and Objectives of the Evaluation

This evaluation aims to inform the mid-term review of the Bank Group's Strategy for the NDEA (2016-2025) by identifying lessons and potential areas for improvement. It intends to provide credible evidence-based findings on the impact of the LMCP and recommendations for future energy operations. It also examines project design and implementation issues that may hinder households from deriving the benefits from access and use of on-grid energy, namely: affordability, reliability, and adequacy of electricity. Overall, the evaluation will provide evidence on the first years of implementing the NDEA in the context of Kenya and show how similar innovative programmes can be scaled to increase energy access in other RMCs. The evaluation's objectives are: (i) to estimate the impact of LMCP Phase I on pre-specified direct, intermediate, and final outcomes; (ii) to identify factors that affect the performance and development outcomes of the project; (iii) to generate lessons and provide recommendations for increasing the impact of ongoing and future electricity access projects financed by the Bank. The overarching evaluation question was: "What are the causal impacts of the Bank-supported LMCP Phase I in Kenya?"

Methodology Used

A mixed-methods approach, comprising of quantitative and qualitative methods, was used to address the evaluation questions. In the quantitative studies, an attempt was made to estimate the impacts of the project on key variables of interest (electricity access, jobs creation, earnings from self-employment, education, health, firm productivity, productive use of electricity, income and consumption, subjective well-being, migration, awareness of current events, investments, and savings) using household surveys. Quantitative data was collected through household surveys in 5,290 households (2,721 treatment households and 2,569 control households) in 157 transformer communities across six counties in Kenya. This was complemented with Geographic Information System (GIS) data, 155 Key Informant Interviews (KIIs), six Focus Group Discussions (FGDs), 55 business surveys and semi-structured interviews with key energy stakeholders in Kenya. To establish evidence of the project's impact without bias, the evaluation compares the impact on the project beneficiary households and businesses with a counterfactual, defined as what would have happened to the same households and businesses at a similar time had the project not been implemented.

In the absence of baseline data for the LMCP Phase I, a quasi-experimental impact evaluation method was used to estimate the causal impact of the project by controlling for confounding factors such as the non-random placement of LMCP transformers, take-up by beneficiaries, and geographical spillovers. The evaluation exploits the design of the LMCP Phase I to find a counterfactual. To be eligible for the program, households need to be located within 600 meters in cable distance of an LMCP Phase I transformer[1]. The evaluation compares households within the 600 meters with a control group outside the border using a regression discontinuity design. Furthermore, a qualitative analysis was conducted to provide further insights on contextual issues that are relevant to the design of the impact evaluation as well as the effectiveness and sustainability of the project.

The evaluation experienced the following limitations: (i) lack of baseline data to capture changes over time; (ii) potential recall bias and measurement error; (iii) imperfect compliance with the project design by contractors; (iv) lack of data on some components of the LMCP, in particular, tree planting and distribution

of energy-saving lightbulbs to households; v) results only show the average effect of all components of the project, requiring caution in interpreting income outcomes; (vi) differences in the timing of electricity connections and issues with customer connections that may reduce the extent of development impact for beneficiaries in some counties; and (vii) the COVID-19 lockdown in Kenya beginning from March 2021 delayed field data collection. The impact evaluation mitigated these challenges where possible. For instance, the first three limitations were addressed by the evaluation's identification strategy of a fuzzy regression discontinuity (RD) design instead of the sharp RD envisioned at the evaluation's inception. The assumption is that households on either side of the boundary are similar in every aspect, except their eligibility for the program. In addition, a balance test on a set of covariates was conducted and the variables were included as control variables. The fourth limitation could not be addressed since the data required was not available, while the remaining limitations were addressed by qualitative analysis.

Findings

The evaluation examined key variables of interest based on the Project Theory of Change (ToC, Annex 1). The estimated impact of the project on these outcomes are the following.

Finding 1: What difference did the LMCP make to connected households and businesses?

The evaluation finds positive results of the impact of the project on increasing access to and use of a reliable source of electricity for households.

The evaluation found that the project significantly increased beneficiaries' electricity connection to the national grid compared to the non-beneficiaries in the transformer communities surveyed. The project increased the rate of electrification by 85% as compared to the control group. Also, it increased the use of electricity from the grid for lighting by 83% and reduced the use of lighting from other sources by 17%.

The evaluation also found that the project had a statistically significant effect on reducing the ownership of other sources of electricity such as solar devices and rechargeable batteries by 51% and 12%, as compared to the control group. The effect on generator ownership was close to zero. Despite the reduction of the ownership of other sources of electricity, the evaluation did not find a significant difference in total energy spending between connected and non-connected households. Nevertheless, the qualitative evidence suggests that the reliability and quality of electricity vary substantially across locations.

The evaluation also found that the project somewhat increased the use of electricity by connected businesses and households, as compared to the control group. However, electricity was predominantly used for lighting and entertainment. The relatively high cost of electricity hampered a greater use of electricity for productive purposes and thus constrained potential for higher income earnings from self-employment.

Evidence from the evaluation shows that the intervention increased the connection of household-owned businesses to the national grid by 7%. Notably, the project increased the use of electricity for agricultural activities such as irrigation by 17%. The ownership of electrical appliances such as hairdryers, sewing machines, and security lights also increased by an additional type of appliance. Overall, the qualitative evidence showed that the most important benefits for small businesses are increased security due to lighting and longer opening hours. Others include an increased use of electrical appliances for their business. However, the evaluation finds no evidence of impacts on labour market outcomes such as business ownership and job creation. It also found no effect on the proportion of households owning a business and the proportion of households employed (excluding agriculture) as compared to the control group.

The impact of the project on some educational outcomes for children was found significant and positive. However, the project was not found to improve the respiratory health nor the self-reported well-being of beneficiaries, compared to non-beneficiaries. The project increased the probability of studying at night by 46% in treated households and equally increased the time spent studying during the night by 9.4 hours in the last three weekdays. This finding is consistent with the evidence that electrification allows students to study longer at night. The evaluation found that the project had a significant and positive impact on the Kenya Certificate of Secondary Education (KCSE) average grade but no effect on the Kenya Certificate of Primary Education (KCPE) average grade. Furthermore, the evaluation finds no evidence of impacts of the project on respiratory health due to exposure of household members to harmful indoor pollution[2], nor on self-reported subjective wellbeing, as compared to the control group.

Two factors may explain the lack of statistical significance in these findings. The first is the limited scale and scope of connected businesses, which may reduce the extent of benefits derived from connection to electricity. Indeed, the survey data reveals that small shops, restaurants, barbershops and milling shops are the predominant types of businesses operating in LMCP-connected communities. Another is the inability of the evaluation methodology to capture impacts of the project that affect the whole community (i.e., overall employment) as well as measurement error inherent in estimating income with survey data.

An additional factor is the finding of electricity-sharing by eligible (treatment) households with neighbouring non-eligible (control) households (see below under "unintended impacts"). This reveals the presence of spillovers in the benefits of the project to non-beneficiaries, which can explain some of the lack of difference between the two groups. If the control group's access to electricity de facto increased, leading them to report benefits (electricity use, well-being etc.), the difference between the two groups grows smaller.

The project was found to have a significant positive impact on household consumption, while the reported impact on household income was positive but not statistically significant. The project increased the monthly average consumption expenditure of treated households by 1,704 Kenyan Shillings (KES). The size of this effect was positive and statistically significant. The increase in consumption was led by an increase in the consumption of non-durable goods. This household consumption dynamic is expected in resource-constrained settings where durable items such as refrigerators and electric stoves require large capital outlays. In contrast, households in these settings can easily purchase non-durable items such as clothes, airtime, recreation, religious expenses, and other personal items. The evaluation finds that the reported impact of the project on households' average monthly income was positive (913 KES), but not statistically significant. The lack of statistical significance is likely due to the inherent difficulties in measuring income using survey data due to response errors (i.e., under-reporting of earnings) and the need for a large enough sample size to detect impact.

Moreover, the evaluation found no statistically significant effect of the project on asset ownership, household characteristics and wealth (fertility choices and housing quality for instance). Similarly, while households' savings decreased by 6% and borrowing increased by 7%, the estimated impacts are not statistically significant. These results are partly explained by the finding that the intervention did not increase wealth creation (i.e., new job and business opportunities in communities), and therefore, did not significantly increase the reported household income. While the evaluation finds that businesses operate for longer hours, this is yet to translate to higher income earnings, at least in the short-term. A possible explanation for this finding is that in small village economies with small-scale businesses, longer opening hours may not

necessarily translate into more consumers due to constrained consumer demand.

Finding 2: What are the impacts of the project on women and girls?

The project was found to have a positive impact on the time women spent on leisure activities but no impact on women's empowerment. Women in treated households spent one hour per day more on leisure activities than their counterparts in non-beneficiary households. Conversely, they decreased the time spent on sleeping/resting and working (outside the farm) by one hour, respectively. The evaluation did not find any significant impact of the project on women's likelihood to work, to have their own savings in a financial institution, to make financial decisions or on the proportion of girls enrolled in school. Similarly, the intervention did not affect the time women and girls spent on household chores, childcare, cooking, and fetching firewood and water. However, the qualitative evidence shows that the project improved women's safety, as they can walk outside at night without fear for their physical safety.

Finding 3: What were the unintended impacts?

The project increased the social capital of project beneficiaries in communities and increased awareness about current events. Qualitative interviews and quantitative analysis showed that the project generated a substantial amount of electricity sharing among neighbours. While this practice varied across communities, it was common for households connected to electricity to allow their neighbours to charge their mobile phones, watch television, and use electric appliances. During lifecycle events like funerals, for instance, it was usual for neighbours to share electricity with the bereaved family. This practice promoted beneficial social cohesion and increased social capital. Nevertheless, electricity sharing reveals the presence of spillovers in the benefits of the project to non-beneficiaries. Furthermore, the project led to a significant increase in the level of awareness and knowledge related to local politics, education, and health. This was driven by the increase in the ownership of electrical appliances such as televisions and radios among project beneficiaries.

Finding 4: Are development benefits from the project sustainable?

Despite good technical quality and strong partnerships with the Government and other development agencies, the sustainability of the development outcomes of the project was found to be highly unlikely in the near term. Timely and regular maintenance of the electricity transmission and distribution network is critical for the provision of affordable, reliable, and quality electricity for beneficiary households after completion. Currently, the evidence shows that the electricity supply is unreliable in some communities while the quality is inconsistent. This situation has been worsened by emerging challenges such as the decline in electricity sales and delays in revenue collection due to the COVID-19 pandemic. Moreover, the imbalance created by the high cost of maintaining and operating the extensive electricity network relative to the low revenue generated from last-mile connections is highly likely to affect the financial sustainability of KPLC.

The evaluation finds that 2 to 3 years after connecting households to the grid through the project, electricity consumption by beneficiaries has remained low. Beneficiaries feel insufficiently informed and involved in the project, creating mistrust. They mainly use the electricity for lighting and charging phones. A lack of resources may be the primary reason why beneficiaries do not use much electricity, since the qualitative study revealed that electricity is still costly. To a large extent, this is expected and unsurprising since the project targeted low-income households and businesses in peri-urban and rural areas. Consequently, the rising cost of electricity network maintenance and operation and the technical losses from extending low-voltage lines have grown faster than the revenues generated from last-mile connections. The unreliability of electricity supply

in some transformer communities also discouraged beneficiaries from purchasing electrical appliances. These factors played a key role in the deterioration of KPLC's finances, with net profits plummeting by 97% between 2016 and 2020. Thus, the worsening financial situation of KPLC is highly likely to affect the sustainability of the project and its development outcomes since the power utility may not have the resources required to maintain the electricity network in the near term. This would compromise the reliability and quality of electricity received by households and businesses.

The evaluation also finds that KPLC has limited capacity in financial recovery, debt restructuring, corporate governance and organizational efficiency. With limited manpower resources relative to the large number of project sites it supervises, it requires both financial support and technical assistance to adequately supervise project sites and contractors, to maintain the electricity network, and to stimulate the demand for electricity.

Lessons

The following are the main lessons from the impact evaluation of the LMCP Phase I in Kenya.

Lesson 1: A high cost of electricity relative to the household income of beneficiaries undermines access and the productive use of electricity.

Lesson 2: The financial sustainability of the electric utility company is a critical success factor for the quality and reliability of electricity provided to eligible households.

Lesson 3: An effective project communication strategy is key to increasing households' participation in electrification projects.

Lesson 4: Lack of baseline data hampers the assessments of project outcomes and impacts after completion.

Recommendations

IDEV makes the following recommendations:

Recommendation 1: Ensure the sustainability of project benefits. Priority areas of action to consider include:

- Strengthening the organizational and operational capacity of KPLC through non-lending instruments such as technical assistance from trust funds, special funds, and grants.
- Enhancing meaningful participation and engagement of community leaders and beneficiaries throughout the project cycle.

Recommendation 2: Stimulate and manage households' and businesses' demand for the productive use of electricity. Priority areas of action to consider include:

- Integrating complementary interventions into Bank electricity access programs to link electricity with income-generating activities such as irrigation services and the promotion of small businesses (MSMEs).

Recommendation 3: Improve future electrification projects' design and implementation. Priority areas of action to consider include:

- Ensuring that project design is based on actual engineering assessments and field data, and that the optimal transformer protection distance is applied.
- Improving analytical work, including detailed electricity demand studies based on willingness to pay and affordability analysis for electricity and alternate energy sources, to better inform the preparation and formulation of energy access projects and programs. ■

Management Response

Management welcomes the Independent Development Evaluation Department impact evaluation of the Last Mile Connectivity Project (LMCP, or the project) phase-I financed by the African Development Bank Group in the Republic of Kenya. The project was approved by the Bank's Board of Directors in November 2014 for a value of UA 90 million. The impact evaluation presents a positive impact of the project, identifies lessons learned, and provides recommendations for improvement in the design of future Bank interventions and the scale-up of similar innovative energy access operations in other Regional Member Countries (RMCs). Furthermore, the findings and recommendations will inform relevant sections of the mid-term review of the Bank Group's Strategy for the New Deal on Energy for Africa (NDEA, 2016-2025).

Introduction

The Independent Development Evaluation Department launched an impact evaluation exercise to assess the Bank's financed LMCP phase-I in Kenya (herein after called the project). The evaluation's objectives were to: (i) assess the impact of the project on pre-specified direct, intermediate, and final outcomes as outlined in the Project Appraisal Report (PAR); (ii) identify factors affecting performance and development outcomes of the project; and (iii) draw lessons and provide recommendations for ongoing and future electricity access projects financed by the Bank.

As per the PAR, households and businesses located within 600 meters radius of distribution transformers were considered eligible for electrification and the evaluation assessed the causal impact of the project by comparing the same with those outside that range and then presented the average effect on the connected households. Furthermore, the evaluation examined the project design and implementation issues that may hinder households' benefits and sustainability of the project's outcomes due to affordability, reliability, and adequacy of electricity and current unstable financial situation of the Kenya Power and Lighting Company (KPLC).

Overall, Management agrees with the evaluation's findings and recommendations. These have already informed Management's dialogue with the Energy Sector Institutions in Kenya on the Bank's strategic support aimed at improving the financial recovery of KPLC, including its debt restructuring and stimulating the demand for electricity. In alignment with the Evaluation's recommendations, Management identified and designed several key recommendations and agreed with Kenyan stakeholders in the context of the 5th Africa Energy Market Place (AEMP) held on 26-29 October 2021, on issues such as restructuring KPLC to make it more efficient in addressing identified corporate governance and organizational efficiency issues.

Management is committed to improving the design and implementation of future electrification projects in all RMCs, replicating lessons learned from LMCP and also supporting electrification projects with appropriate analytical studies covering willingness to pay, affordability, alternative energy sources, etc.

Findings

Delivery of planned outputs

The Evaluation concluded that the planned outputs of the LMCP were mostly delivered and the overall performance of the project was satisfactory. During the evaluation, the Project Progress Report (September 2020) showed that customer connectivity stood at 88% while construction of Low Voltage distribution network was 91%. All other outputs in the Result Based Logical Framework had been achieved at the time of the impact evaluation except the connection of commercial customers and the distribution of energy-saving compact fluorescent light bulbs to low-income households. However, despite the reduction of the ownership of other sources of electricity, the evaluation revealed no significant difference in total energy spending between connected and non-connected households. While the reliability and quality of electricity vary substantially across locations of the project area, in terms of benefit, the project increased the use of electricity for agricultural activities and ownership of electrical appliances such as hairdryers, sewing machines, and security lights, and improved security due to lighting and longer opening hours. Overall, Management agrees with the **satisfactory** assessment of the Evaluation. Furthermore, Management notes that the assessment is also justified by the impact of a contractor's non-performance for two Lots, where the outputs are not fully delivered. The project also had loan savings, and the Borrower requested to utilize the savings to connect additional customers to the national grid through a new procurement process to maximize the delivery of outputs. Management notes that customer connectivity under the project has increased since the Evaluation, to 209,700 customers connected (93% of planned connections as per Project Progress Report, Dec. 2021).

Delivery of planned outcomes

The Evaluation concluded that two of the three planned development outcomes of the LMCP were delivered. The objective of increasing electricity access was achieved, with the national electrification rate increasing from 32% in 2013 to 75% in 2019 according to estimates from the Power Africa Initiative. This figure exceeds the expected value of 44% by 2020 at project completion, thanks to the collaborative efforts of many partners working together in Kenya's energy sector. The contract value awarded to local contractors has exceeded the target set at Appraisal. Management welcomes the achievements recorded in increasing electricity access rate in Kenya, where the Bank was one of the pioneers to support the Government Last Mile Connectivity Program in 2014 through the LMCP phase-1 project, and later followed by other Development Partners. Management also notes that the share of women employed at KPLC (21.7%) has not reached the target of 30%, which is attributed to limited participation of women in the electricity sector, requiring broader interventions in education and training, which is beyond the scope of the Bank's infrastructure projects.

What difference did the Bank's support make to connected households and businesses?

The Evaluation concluded that the LMCP has brought positive results by increasing access to and use of a reliable source of electricity for households. However, the effect of the project on business ownership, earnings from self-employment or job creation was not significant. The project had a significant and positive impact on average household consumption, the time spent by children studying at night, and the test scores on the Kenya Certificate of Secondary Education, but no significant effect on the respiratory health or subjective wellbeing of project beneficiaries. The impact on household income was positive but not statistically significant. Management is encouraged by the positive findings of the evaluation on the impact of this project. Management also acknowledges that the expectation of a significant effect of the project on business ownership and earning from self-employment is a medium-term effect that comes after some years of people

getting access to electricity. Though, the evaluation found evidence that households' average monthly income has been positive, but not too significant, the project also increased the productive use of electricity by eligible and connected businesses and households such as increased use of electricity for agricultural activities (e.g., irrigation), and through increased economic activity. However, Management is committed to monitoring the impact of the project on households and businesses after completion of the project.

What are the impacts of the project on women and girls?

The Evaluation concluded that the project had a positive impact on the time women spent on leisure activities but no impact on women's empowerment. Whilst beneficiary women spent more time on leisure activities than their counterparts in non-beneficiary households, there is no significant impact of the project on women's likelihood to work, to have their own savings in a financial institution, to make financial decisions or on the proportion of girls enrolled at school. Similarly, the intervention did not affect the time women and girls spent on household chores, childcare, cooking, and fetching firewood and water, but improved women's safety as they can walk outside at night without fear for their physical safety. Management agrees with the Evaluation findings and takes note that the expectation of impact on women's empowerment requires broader interventions in women's empowerment through education, which is beyond the scope of the Bank's infrastructure projects.

What were the unintended impacts?

The Evaluation concluded that the project increased the social capital of project beneficiaries in communities and awareness about current events. Evaluation findings showed that the project generated a substantial amount of electricity sharing among neighbors. While this practice varied across communities, it was common for households connected to electricity to allow their neighbors to charge their mobile phones, watch television, and use electric appliances. This practice promoted beneficial social cohesion and increased social capital. Electricity sharing reveals the presence of spillovers in the benefits of the project to non-beneficiaries. Furthermore, the project led to a significant increase in the level of awareness and knowledge related to local politics, education, and health thanks to the increase in the ownership of electrical appliances such as televisions and radios among project beneficiaries. Management agrees with the Evaluation findings and had anticipated the same unintended development impact of the project as it is a common practice that connected households share electricity with their neighbors which promote beneficial social dynamics and increase social capital.

Are development benefits from the project sustainable?

The Evaluation concluded that despite good technical quality and strong partnerships with the Government and other development agencies, the sustainability of the development outcomes of the project was found to be highly unlikely in the near term. The above conclusions were arrived at due to the following: (i) the erratic nature of the electricity supply in some communities and the KPLC's lack of rapid response to address faults due to resource constraints, (ii) low electricity consumption resulting in low revenues for the utility which is attributed to low income of the beneficiaries, (iii) beneficiaries feel insufficiently informed and involved in the project, creating mistrust and lack of ownership; and (iv) the sustainability of the project and its development outcomes are doubtful due to KPLC's resource constraints and the maintenance of the electricity network is also affected by the lack of organizational efficiency.

Management agrees that worsening financial situation of any power utility will affect the sustainability of a project and its development outcomes. The GoK is actively addressing KPLC's financial situation. For example, the recently

commissioned report of the Presidential Taskforce on the review of Power Purchase Agreements, dated 29th September 2021, recommended a series of actions that can lead to the financial recovery of KPLC despite a reduction of consumer tariffs from the current average of KES 24 per kilowatt hour to KES 16 per kilowatt hour. The Government has also started implementation of some recommendations, addressing corporate governance and organizational efficiency issues in KPLC. The financial statement of KPLC for the year ended 30 June 2021 reported a 5% growth in energy sales, 2% growth in revenue, and 17% decrease in operating costs. These results were due to prudent cost management, enhanced collections, and accounting for revenue resulting in a reduction in provisions for trade and receivables, and reduced finance costs by 27%, following the partial conversion of overdrafts to a term loan, and continued repayment of commercial loans. All these are good signs of financial recovery. Bank's Management continues to monitor the implementation of the Taskforce recommendations and its outcomes. The issue of maintenance of the electricity network is part of the Bank's policy dialogue with the Kenyan authorities on allocation of sufficient maintenance resources to ensure that development outcomes are safeguarded.

In addition to the above, addressing the issues of power supply unreliability and inconsistent quality in some communities were not part of the scope of the LMCP. However, Management acknowledges more support should be provided to address these constraints. In that respect, the Bank is preparing to finance the Transmission Network Improvement project in Kenya which will partly address these issues. Management also agrees that the low revenue generated from last-mile connections is directly linked to the low consumption of electricity of newly connected households caused by the relatively high tariff. It has to be noted that low consumption among newly connected rural customers is common and it takes a long time (5 – 10 years) to reach a decent level of energy consumption when consumers own more home electric appliances and shift to more productive uses of electricity.

Lessons

The Impact Evaluation has listed the following main lessons from the LMCP Phase-I.

A high cost of electricity relative to the household income of beneficiaries undermines access and the productive use of electricity. Management sees this lesson as relevant. Striking the right balance between cost reflective tariffs required to ensure financial viability of the utility and charging affordable tariffs that ensure protection of low-income households to promote access to electricity and productive use, are important factors in achieving and sustaining project outcomes. It is important to mention that the retail tariffs approved in July 2018 and amended in October 2018 adjusted the previous tariffs downwards by: (i) expanding the lifeline tariff band from 10 kWh/month to 100 kWh/month; and (ii) reducing the lifeline tariff from KES 12/kWh to KES 10/kWh, which resulted in lower KPLC's revenues than anticipated, because the reductions shifted the majority of domestic/residential customers to fall into the lifeline tariff band and also allowed the wealthy domestic customers to benefit from the lower/subsidized lifeline tariffs. Following the current implementation of the Presidential Taskforce Report, the electricity energy charge rates for Domestic Customer (lifeline) and Domestic Customer (ordinary) have been reduced from KES 10 and KES 15.8/kWh to KES 7.7/kWh and KES 12.6/kWh respectively. Consequently, from January 2022, the overall domestic tariffs (including the levies and adjustments) have been reduced by 15.73% for Domestic Customer (lifeline) and 15.67% for Domestic Customer (ordinary), which is a reduction from KES 18.91/kWh to 15.94/kWh and from KES 25.93/kWh to KES 21.87/kWh respectively. As the majority of households who have been connected under the last mile connectivity projects are in the rural areas and have low incomes with consumption below 20 kWh per month, this tariff reduction will increase affordability of electricity and thus shift them from other dirty fuels such as kerosene and firewood. This means that poor households will spend lower monthly electricity bills beginning

January 2022. Management believes the ongoing institutional reform and the full implementation of the Presidential Taskforce recommendations will further lower the tariffs without straining the financial viability of KPLC.

The financial sustainability of the electric utility company is a critical success factor for the quality and reliability of electricity provided to eligible households. Management agrees with this observation. The reported power outages that lasted several days and the issues of electricity quality (e.g., poor voltage) supplied to grid-connected households are directly linked to insufficient operating and maintenance activities on the distribution network. These will obviously threaten the sustainability of the project's development outcomes. The Government of Kenya has initiated and is implementing a business turnaround and transformation strategy to expeditiously improve the financial and operational aspects of KPLC, while balancing social responsibilities to enhance business sustainability. Particularly, the turnaround strategy is aimed at improving overall business performance of KPLC by meeting customer expectations, growing sales, enhancing revenue collection and system efficiency, with prudent cost management. The financial statement of KPLC for the year ended 30 June 2021 (as indicated in section 6 above) has shown signs of financial recovery and gives assurance that the risks of threatened development outcomes will be mitigated. Management will closely monitor KPLC's operational and financial performance.

An effective project communication strategy is key to increasing households' participation in electrification projects. Management agrees with the feedback collected from the surveyed households. Insufficient communication and lack of awareness of potential beneficiaries left some people unconnected to the electricity grid and created mistrust, which resulted in the refusal of some beneficiaries to provide their data to project contractors during project implementation. This lesson from LMCP phase-1 has been addressed in the second phase of the LMCP funded by the Bank, where KPLC used media campaigns and local leaders to raise awareness about the project thus helping to increase project ownership and outputs. Management has noted this lesson and will advise power utilities in RMCs to develop similar communication mechanisms and strategies in future project designs, and if necessary, to allocate dedicated project funds.

Lack of baseline data hampers the assessments of project outcomes and impacts after completion. Management, in principle, agrees with this observation and the same will be factored in the Bank's future interventions. However, Management wishes to emphasize that the first phase of LMCP funded by the Bank is spread across all 47 counties covering 5,320 selected transformers in 290 constituencies. Project area selection criteria were based on the Government's policy that aims to address equity in terms of access, giving priority to those counties with low access to electricity. The selection was also based on data from KPLC regarding the potential to connect additional households within 600 meters of the existing transformers. However, due to the size of the project area and time limitations in commencing the program, KPLC did not collect baseline data (field data) from each household and community. The desktop studies were done through estimations.

Conclusion

Management appreciates the observations, and recommendations made by the Impact Evaluation. The outcomes of the Evaluation are valuable and will inform relevant sections of the mid-term review of the Bank Group's Strategy for the New Deal on Energy for Africa (NDEA, 2016-2025) and design of future similar operations to increase the impact of energy access in other RMCs. Responses to each of the three key recommendations are provided in the Management Action Record table below. ■

Management Action Record	
Recommendation	**Management Response**
Recommendation 1: Ensure the sustainability of project benefits.	
Priority areas of action to consider include: a. Strengthening the organizational and operational capacity of KPLC through non-lending instruments such as technical assistance from trust funds, special funds, and grants; and b. Enhancing meaningful participation and engagement of community leaders and beneficiaries throughout the project cycle.	**Agreed** – Management agrees with these recommendations. ▌The first sub-recommendation is already being undertaken. For example, in October 2021, the Bank provided a $1 million grant to KPLC from the SEFA Special fund for TA to help develop Super-ESCO (Energy Service Company) to improve efficiency and quality of electricity supply, and to diversify KPLC's revenue sources. PEVP during its business development mission to Kenya (end of July 2021), discussed similar support with KPLC's Board and Management, where they confirmed the need for additional TA and capacity building: E.g., loss reduction study, cost of electricity supply and tariff study; and implementation of an integrated national power sector plan, including the restructuring of existing KPLC loans. Further actions: KPLC and the Bank agreed that the loan savings of LMCP Phase-1 could be utilized to address agreed TA, capacity building and study requirements. **(PESD, December 2022).** ▌The second sub-recommendation is being undertaken under the second phase of the Bank-financed LMCP where KPLC is now using media campaigns and local leaders to raise awareness about the project. Further actions: For similar electricity access projects in other RMCs, Management will design a check list to verify and ensure the inclusion of active participation of community leaders and beneficiaries in the project design and implementation and PEVP will deepen collaboration with the Bank's E&S and CSO team. **(PESD, September 2022).**
Recommendation 2: Stimulate and manage households' and businesses' demand for the productive use of electricity.	
Priority areas of action to consider include integrating complementary interventions into Bank electricity access programs to link electricity with income-generating activities such as irrigation services and promoting small businesses (MSMEs).	**Agreed** – Management agrees with this recommendation. The consideration of productive uses in the context of energy access projects already feature prominently in the context of the Bank's work on decentralized energy access projects, notably mini-grids. Starting from 2023, Management will ensure that all electricity access projects will include some income-generating activities, with attention to women economic empowerment, as part of the project. Management will ensure this through its review and clearance processes of project documents (e.g., Project Screening Templates and Results Management Framework). **(PESD, starting from January 2023).**

Management Action Record	
Recommendation	**Management Response**
Recommendation 3: Improve future electrification projects' design and implementation.	
Priority areas of action to consider include: a. Ensuring that project design is based on actual engineering assessments and field data, and that the optimal transformer protection distance is applied. b. Improving analytical work, including detailed electricity demand studies based on willingness to pay and affordability analysis for electricity and alternative energy sources, to better inform the preparation and formulation of energy access projects and programs.	**Agreed** – Management agrees with these recommendations. Further actions include: ▌Each project design will be informed by a detailed feasibility study with baseline field data. As the transformer protection distances vary from country to country based on the country standards, Management will ensure compliance with the RMCs standards. **(PESD, Ongoing process, June 2022).** ▌In principle, a proper feasibility study should have analyzed and incorporated the electricity demand assessment based on willingness to pay and affordability analysis for electricity, including alternative energy sources for comparison purpose. Going forward, Management will ensure proper and acceptable analytical work are developed and if need be, the Bank will mobilize the required funds. **(PESD, Ongoing process, June 2022).**

Introduction

This Summary Report presents the findings from an impact evaluation of the Last Mile Connectivity Project (LMCP) Phase I financed by the African Development Bank Group (AfDB, or the Bank) under the thirteenth African Development Fund (ADF-13) in the Republic of Kenya. The loan was approved by the Board in November 2014 for a value of UA 99.2 million (USD 131 million) and became effective in March 2015, while project implementation began in 2016. The project's original closing date was extended from December 2019 to December 2022 due to challenges such as contractor non-performance for two Lots and the recent COVID-19 pandemic.

The main objective of the LMCP was to support the Government of Kenya's (GoK) aim to provide universal access to electricity by 2022, particularly for low-income groups in peri-urban and rural areas. The project's design is novel and aims to maximize the use of existing electricity infrastructure by connecting households and businesses located within 600 meters (in cable distance) of existing distribution transformers. This was achieved by extending the low-voltage (LV) network across Kenya's 47 counties, with those that have low electrification rates prioritized. In total, the project planned to connect 284,200 households, and 30,000 commercial customers as well as public facilities (health centres and schools) around selected transformers. The intervention is one of the largest electrification programs ongoing today and is expected to be replicated in other parts of Africa.

Purpose and Objectives of the Evaluation: The evaluation aims to inform the mid-term review of the Bank Group's 2016 – 2025 Strategy for the New Deal on Energy for Africa (NDEA), launched in 2016, by identifying lessons and potential areas for improvement. It intends to provide credible evidence-based findings on the impact of the LMCP and recommendations for future energy operations, including whether access to electricity improves the quality of life. The evaluation also examines the project's design and implementation issues that may hinder households from deriving the benefits from access and use of on-grid energy, such as affordability, reliability, and adequacy of electricity. Overall, the evaluation provides evidence on the first years of implementing the NDEA in the context of Kenya, and how similar innovative programmes can be scaled to increase energy access. The specific objectives are:

1. To estimate the impact of the LMCP Phase I on the direct, intermediate, and final outcomes;
2. To identify factors that affect the performance and development outcomes of the project;
3. To generate lessons and provide recommendations for increasing the impact of ongoing and future electricity access projects financed by the Bank.

Evaluation Questions: The overarching evaluation question is: "What are the causal impacts of the Bank-supported LMCP Phase I in Kenya?" The specific questions are:

1. Did the project increase access to a reliable source of electricity for households and businesses?
2. Did the project increase labour market participation and employment in rural communities?
3. Did the project improve education and health outcomes, particularly for girls?
4. Did the project lead to increased firm productivity and other outcomes, especially for small businesses?

5. What are the impacts of the project on income and consumption?

6. How did the electrification program contribute to the financial sustainability of the power utility, specifically on Kenya Power and Lighting Company (KPLC)?

In addition to these questions, the evaluation examined the unintended development outcomes, sustainability of development outcomes, other relevant development outcomes not captured by the project theory of change, and the lessons learned.

Evaluation Scope: The evaluation estimates the average impact (direct, intermediate, and final) of all components of the project on certain defined development outcomes. The primary focus was on the direct, intermediate and final outcomes realized among the project beneficiaries - the communities, business and households. That is, the impact estimation results reflect mainly the combined impact of all components of the project on households and businesses eligible for and connected to the LMCP Phase I. Separately, the evaluation examined the relevance, effectiveness, efficiency, and sustainability of the project and its development outcomes. Data for the evaluation was collected from 5,290 households (2,721 treatment households and 2,569 control households) in 157 transformer communities across 6 counties, namely: Baringo, Kakamega, Kericho, Kitui, Nakuru, and Taita Taveta. This was complemented with semi-structured interviews of key energy stakeholders in Kenya between March and June 2021.

The rest of the report is structured as follows: the next section provides the context for the evaluation, and an overview of LMCP Phase I. The section that follows provides the survey design and the empirical methodology while the main findings are presented in the subsequent section. The final section concludes with the lessons and recommendations. The Project Theory of Change at project appraisal is presented in Annex 1 while further technical details such as robustness checks and the survey questionnaire can be found in a separate Technical Annex. ■

The Last Mile Connectivity Project In Kenya

Project Context

Increasing energy access is a cornerstone of Kenya's development strategy to transform its economy into that of a middle-income industrialized nation. The Second Medium-Term Plan (MTP II, 2018-2022) prioritized 'modernizing [the] energy infrastructure network, increasing the share of energy generated from renewable energy sources, and providing energy that is affordable and reliable to businesses and homes' (GoK, 2013). The plan aims to increase electricity access to two million customers, households, and businesses, by extending and rehabilitating electricity transmission lines and the distribution network (GoK, 2013). Correspondingly, Kenya's National Electrification Strategy aims to achieve an electricity access rate of 100% by 2022 (MoEP, 2018).

Before the approval of the LMCP by the Bank in 2014, the rate of electrification in Kenya was low. Specifically, while the national electricity access rate was 32% in 2013, rural electrification stood at 19%. Also, its per capita consumption of 130 kWh per month was considerably lower than the Sub-Saharan Africa (SSA) average of 550 kWh. Given this, the GoK launched several connectivity programs and initiatives, including the LMCP and the World Bank's Global Partnership on Output-Based Aid (GPOBA), to provide affordable and reliable electricity to all Kenyans. These efforts have markedly increased the national access rate to electricity to 70% in 2019, with grid electricity representing 50.4%.

Last Mile Connectivity Project Phase I

The LMCP is a flagship mass electrification program that was launched by the GoK in 2015 to increase access to electricity by maximizing the use of existing distribution transformers. It is a multi-donor program that was rolled out in multiple phases and is currently at Phase IV. Notably, the Bank was the first Development Partner (DP) to approve financial resources for Phase I of the electrification program, following the Board's approval in October 2014 (AfDB, 2014). The project aligns with the NDEA which aims to '[i] increase on-grid transmission and grid connections that will create 130 million new connections by 2025…' (AfDB, 2017, p.3), and the strategic priorities of the Bank's Energy Policy (AfDB, 2012). It is also built on the five guiding principles of the Energy Policy, namely: (i) Ensuring energy security and increasing access for all; ii) Governance of electricity at the national level; (iii) Social and environmental responsibility; (iv) Fostering knowledge transfer; and (v) Mainstreaming the gender dimension. Furthermore, the LMCP tackles the key challenges that hinder access to electricity identified by the New Deal, namely, affordability by the end-users at the Bottom-of-the-Pyramid, and payment options for electricity connection and usage. Put together, the Bank's support to Kenya's national energy infrastructure through the LMCP is expected to spur inclusive growth and job creation, industrialization, and improved livelihoods.

LMCP Phase I had four components, namely: (i) construction of a low-voltage network (UA 96.25 million), comprising of 12,000 kilometres of low-voltage distribution lines (415V and 240V) to households and businesses, and the installation of energy meters for the connection of targeted beneficiaries; (ii) project supervision and management (UA 2.6 million); (iii) capacity building and re-establishment of KPLC tree seedlings nursery (UA 0.25 million; and (iv) project audit (UA 0.1 million). At project appraisal, the project planned to connect 284,200 households, 30,000 commercial customers, and public facilities (health centres and schools) around suitable existing transformers, translating to providing electricity access to 1,571,000 people.

The program was designed to connect households and businesses within a transformer protection distance of 600 meters (in cable distance). Extending transmission lines beyond this distance leads to a drop in voltage and a reduction in the quality of electricity, reducing customer demand and increasing commercial losses. Suitable transformers were identified based on their used capacity and their location. In principle, transformers that had a capacity of between 50-60% and could sustain the Burden of Peak load were eligible for maximization under the LMCP. At the design stage, the project targeted 5,152 transformers. However, after completion of the project's field survey and design by KPLC, the actual figure was revised down to 4,859 transformers in 2020 (Feedback Infra Private Ltd, 2020). As of 2021, the LMCP Phase I has reached almost 200,000 households out of the 284,200 foreseen. With the project extended to December 2022, more beneficiaries (households and businesses) will be connected to the grid for the first time.

A key design feature of the LMCP was the payment of a subsidized connection fee of KES 15,000 by project beneficiaries through the Stima Loan programme. Before the project, KPLC customers paid a standardized lump sum connection charge (including Value Added Tax, VAT) of KES 32,480 for a single-phase connection and KES 44,080 for a three-phase connection, respectively (AfDB, 2015b, 2015a). While the former was used for households, the latter was designed for businesses. The Stima Loan programme was a partnership between KPLC and Agence Française de Développement (AFD) that allowed for a deferred payment method for the connection fee of KES 15,000, with customers paying 20% of the fee upfront and the balance repaid over 24 months (AfDB, 2014b, 2014c). The subsidized connection fee was presented as a loan (Stima Loan) that is repaid as part of the prepaid tokens when beneficiaries purchase electricity, i.e., for each amount paid, up to 50% goes towards purchasing electricity units and the rest goes towards repaying the connection fee. Altogether, the subsidized connection fees under LMCP Phase I and the Stima Loan programme were intended to increase affordability and accessibility for customers, especially low-income groups. The connection subsidy was motivated by the high cost of connection and poverty incidence in Kenya, especially in rural and peri-urban spaces, which are key barriers to electricity demand.

The overall development objective of LMCP Phase I was to increase the national and rural electricity access rates from 32% and 19% in 2013 to 44% and 40% of the population in 2020, respectively. The project's Results-Based Logical Framework (RBLF) aimed to achieve the following outcomes: i) increased electricity connection rate, from a baseline of 2,330,962 customers in 2013 to 2,645,162 customers in 2020 – an additional 314,200 residential and commercial customers; ii) increased economic participation of the marginalized[3] by increasing the value of contracts awarded by KPLC to the marginalized from KES 199.4 million to KES 285 million in 2018; and iii) increased employment opportunities for women, by increasing the proportion of women employed by the utility from 20% in 2013 to 30% in 2018 (see AfDB, 2014b). In terms of output, the project aimed to connect 284,200 residential customers (households) and 30,000 commercial customers in 18 months (AfDB, 2014b; Feedback Infra Private Ltd, 2016b). Table 1

Table 1: Key indicators: Planned vs actual impact and development outcomes

Indicators	Value in 2013	Expected Value at Project Completion	Most Recent Value
Development **Impact:** - National Electricity Access - Rural electrification	 32% 19%	 44% (by 2020) 40%	 75% (2019) 61.69% (2019)
Outcome 1: Increased electricity connection rate - Number of customers	 2,330,962	 2,645,164 (by 2020)	 7,847,625 (November 2020)
Outcome 2: Increased economic participation of the marginalized - Value of contracts awarded by KPLC to the marginalized	KES 199.4 million	KES 285 million (by 2018)	KES 345 million (2020)
Outcome 3: Increased employment opportunities for women - Share of women employed at KLPC		30% (by 2018)	21.7% (November 2020) 2,259 females out of the total 10,412 employees.

Source: Zegeye (2020)

presents the key indicators of the LMCP and shows the level of achievement.

With its focus on low-income groups, the LMCP, as stated in in the PAR, is expected to improve living standards, especially socio-economic outcomes, the productivity of small businesses, and public facilities (schools and health centres), and to strengthen KPLC's technical capacity to manage the electricity distribution system, energy sector investments, and mitigate adverse social and environmental impact from project implementation. It is also expected to discourage rural-urban migration and reduce overall poverty by providing economic opportunities to the most vulnerable (youth, people with disabilities). ■


RESTORE 6 MONTHS
DAMAGE IN 1 USE
OLIVIA

Methodology

A mixed-methods approach, comprising of quantitative and qualitative methods, was used to address the evaluation questions. In the quantitative analysis, data was collected from 5,290 household surveys (2,721 treatment households and 2,569 control households) in 157 transformer communities across six counties in Kenya, namely: Baringo, Kakamega, Kericho, Kitui, Nakuru, and Taita Taveta. Data for the qualitative analysis was collected from six Focus Group Discussions (FGDs) from Kilifi and the counties above except Kitui. In addition, qualitative data was collected from 155 Key Informant Interviews (KIIs) in the transformer communities and 55 business surveys administered to LMCP-connected businesses in four counties. These analyses were complemented with semi-structured interviews with key energy stakeholders in Kenya as well as administrative and geospatial data on the location and cable connections of LMCP Phase I transformers provided by the KPLC to identify project beneficiaries (treated group) and non-beneficiaries (control group). The qualitative data provided contextual information that improved the design of the survey and provided insights that explained some of the evaluation's findings. The details of both quantitative and qualitative methods are presented in Annexes 1 and 3 of the Technical Annexes[4].

The evaluation designs and impact estimation methods: To estimate the causal impact of the project on beneficiaries without bias, the ideal experiment would have been to randomize electrification at the provincial level across the whole country, for example, at the sub-county level. However, public utilities often do not randomize the placement of transformers across regions. Consequently, there are two main identification challenges that we want to overcome. The first and more challenging problem is related to the endogenous choice of transformers to be included in the LMCP program. The second is related to the take-up of electricity, or the decision of eligible households to get a connection and use electricity or not. The challenge, therefore, is to identify a sample including both treated households and untreated households, comparable in every aspect except for their eligibility for the LMCP Phase I.

The evaluation exploited a unique design feature of the LMCP to find a counterfactual. To be eligible for the program, households need to be located within 600 meters in cable distance of an LMCP Phase I transformer. The identification strategy for the evaluation consists of comparing eligible households within the 600 m with a control group outside the eligibility border. To identify the impact of the program on beneficiaries, the evaluation exploited the spatial discontinuity in the eligibility for LMCP Phase I, namely, the sharp change in access to the subsidized connection at 600 m (cable) distance from the eligible transformers. This strategy relies on the assumption that households on either side of the boundary are similar in every aspect, except for their eligibility for the program.

To implement this evaluation design, administrative and GIS data from KPLC that shows the location of LMCP Phase I transformers and cables was used to identify which households are the beneficiaries, and which are the neighbouring households that were not eligible to benefit from the program. Through this process, a sample including both treated households and a comparable control group was identified. However, after analyzing the GIS data of LMCP Phase I cables and transformers, it became evident that the 600 m eligibility threshold was not strictly adhered to by project contractors. With the finding that around 29.8% of LMCP-recipient households are located beyond the transformer protection distance of 600 meters, the initial evaluation design of a 'sharp' regression discontinuity design was adapted to a 'fuzzy' regression discontinuity design. Compared to

the sharp RD design, the discontinuity in the fuzzy RD is in the probability of receiving LMCP Phase I. In practice, the evaluation conducts a 'donut hole' design which excludes observations just above the 600 m threshold (between 601 and 699 meters) that recorded the most manipulation. The fuzzy RD is implemented with a quadratic fit using a two-stage instrumental variables specification. This is equivalent to a two-stage least square regression model, with treatment assignment based on the running variable as the instrument. In the evaluation, this means that the household eligibility dummy, which is equal to 1 if a household is within 600 m of the transformer and zero otherwise, is used as the instrument for LMCP status. The estimated results are presented using the evaluation's primary methodology, the fuzzy RD model that determines the probability of receiving LMCP Phase I. In addition, estimated results from an Ordinary Least Squares (OLS) model were also presented for robustness checks.

Put differently, the evaluation estimated the causal impact of the intervention by comparing households within the 600 meters eligibility border (treatment group) and households outside the 600 meters eligibility border (control group). However, with 29.8% of LMCP-recipient households located outside the eligibility distance of 600 meters, the evaluation design excluded households between 601 and 699 meters that recorded the most manipulation from the control group. Annex 1 of the Technical Annexes provides details of the estimation strategy and balance checks while Annex 2 of the Technical Annexes presents the descriptive statistics for the evaluation's main outcome variables.

The sample size of the evaluation was 5,290 households, with 2,721 treatment households and 2,569 control households in 157 transformer communities across six counties in Kenya. At the evaluation's inception, power calculations were carried out to estimate the sample size required to implement the evaluation design and detect minimal program effects. For each of the six counties surveyed, the complete low voltage network map was obtained from KPLC, with attributes allowing the evaluation team to identify: (i) LMCP Phase I lines; (ii) pre-existing lines (identified as lines that were updated in the system before the beginning of the LMCP program and/or lines that have codes preceding the earliest LMCP line); and (iii) other lines, constructed after the beginning of the LMCP. In addition, the location of all LMCP transformers in the county, for all the three phases that have been implemented so far (AfDB I, AfDB II, and IDA) was obtained. With this information, the evaluation adopted a spatial based household sampling method using satellite data, in particular, the population distribution map of Kenya from the Centre for International Earth Science Information Network (CIESIN) - Colombia University in collaboration with Facebook Connectivity Lab and Digital Globe. The detailed protocols used to select transformers and the sample households for the evaluation are presented in Annex 3 of the Technical Annexes. The selection protocol yields a random sample of treatment and control households within a transformer community, but not a random sample of transformers. Overall, the sampling strategy was successful in selecting the right control and treatment households. Most houses selected as treated were indeed LMCP beneficiaries whereas the control households were mostly unconnected to the grid.

Data collection: The field data was collected between March and June 2021 using Computer-Aided Personal Interviewing (CAPI) with the survey questions programmed with SurveyCTO. Three questionnaires were used for the data collection: (i) a key informant questionnaire, in which an informed person within the community was asked to provide basic information about their village (access to services, power outages, etc.) and feedback on the LMCP program; (ii) a business questionnaire, where businesses connected through the LMCP were asked to qualitatively describe how they benefited from the program; and (iii) a household questionnaire that collected quantitative information on the program's outcomes of interest. An FGD guide was prepared and administered with groups of 10-15 participants including project beneficiaries and non-beneficiaries to better understand how the project

was implemented, the challenges encountered, and the perceived benefits. For each transformer community, a KII was completed, while 54 business surveys and six FGDs were conducted across the study sample. The structure of the KII and household questionnaires followed the model set by the World Bank Living Standards and Measurement Surveys (LSMS). The energy consumption modules were based on O'Sullivan and Barnes (2007) while the household questionnaire was adjusted following the instrument administered by Lee et al. (2020), which was tailored to a similar context. Finally, the specific language of survey questions was adjusted based on inputs from the evaluation team and through revisions based on two pilots and FGDs conducted in two counties, namely, Kiambu and Kilifi. In total, attempts were made to survey 3,161 treatment and 3,067 control households. The control group was smaller than the treatment group because it was impossible to identify the target number of control households in sparsely populated areas. The response rate was 86% for the treatment group and 84% for the control group. Therefore, the final sample included 2,721 treatment households and 2,569 control households.

Evaluation limitations and mitigation strategies: The evaluation had the following limitations: (i) there was no baseline data to capture changes over time; (ii) potential recall bias, selection bias, and endogenous placement of LMCP Phase I transformers; (iii) lack of data on some components of the project such as tree planting and distribution of energy-saving lightbulbs to households; (iv), measurement error; (vi) results show only the average effect of all components of the projects; (vii) the difference in the timing of connections across counties may decrease the extent of development impact for beneficiaries. As a case in point, while more than 50% of the overall sample was connected by 2017, in Kitui County, most of the connections took place in 2018 (over 45%); and (viii) the COVID-19 lockdown in Kenya beginning from March 2021 delayed field data collection. The impact evaluation mitigated these challenges where possible. For instance, the first three limitations were addressed by the evaluation's identification strategy of a fuzzy regression discontinuity (RD) design instead of a sharp RD envisioned at the evaluation's inception. The assumption is that households on either side of the boundary are similar in every aspect, except their eligibility for the program. In addition, a balance test on a set of covariates was conducted and the variables were included as control variables. While the fourth limitation could not be addressed since the data required was not available, the remaining were addressed by the evaluation's qualitative analysis. ■

Main Findings of LMCP Phase I

In this section, the report presents the main findings of the impact evaluation based on both quantitative and qualitative approaches employed during the evaluation process. We first present the achieved outputs and results based on the project's theory of change at appraisal (Annex 1). Subsequently, the detailed estimation results for all the outcome variables are presented based on the fuzzy regression discontinuity (RD) design. Results from the evaluation's main specification (fuzzy RDD) are paired with the Ordinary Least Squares (OLS) for robustness.

Finding 1: The outputs and direct outcomes in the project's Results-Based Logical Framework were mostly achieved.

Delivery of planned outputs

The planned outputs of the LMCP were mostly delivered and the overall performance of the LMCP Phase I was satisfactory. The most recent Quarterly Progress Report (September 2020) (Feedback Infra Private Ltd, 2020) shows that customer connectivity stands at 197,350 customers (88%) while 10,977.60 km of LV route length (91%) have been constructed. Apart from the connection of commercial customers and the distribution of energy-saving compact fluorescent light (CFL) bulbs to low-income households, the Implementation Progress Report (IPR) of the project showed that all other outputs in the RBLF have been achieved at the time of the evaluation (Zegeye, 2020). These include project supervision and provision of quarterly progress reports, gender mainstreaming at KPLC, and establishing a tree planting nursery.

Delivery of planned outcomes

Two of the three planned development outcomes of the LMCP were delivered (Table 1). The ultimate development objective of supporting the GoK to increase electricity access in Kenya was achieved, with the national electrification rate increasing from 32% in 2013 (AfDB, 2014) to 75% in 2019 according to estimates from the Power Africa Initiative. While this figure exceeds the expected value at project completion, the achievement can be attributed to many partners working together in Kenya's energy sector. The value of the contract awarded to local contractors has exceeded the target set at PAR. However, increasing the share of women employed at KPLC to 30% by 2018 was not achieved. As of May 2020, only 2,259 out of the workforce of 10,412 were women, representing approximately 21.7%.

What Difference did the Bank's Support make to Connected Households and Businesses?

Based on the theory of change (Annex 1), we categorized direct, intermediate and final outcomes to be examined in this evaluation for key variables of interest. The summary statistics of these outcomes for the treatment and comparison groups at the baseline are presented in Annex 2 of the Technical Annexes[5].

Impacts on direct energy outcomes: The average treatment effects of the project on direct energy outcomes are presented in Table 2.

Finding 2: Overall, the LMCP was effective in increasing access to electricity for beneficiaries. LMCP households are more likely to use and spend more on any source of electricity relative to households in the control group. The impact on electricity use was positive and statistically significant. However, while beneficiaries actively used on-grid electricity, the reliability of electricity varied significantly across counties.

Table 2: Average treatment effects of the project on direct energy outcomes

Outcome Indicator	Fuzzy RD		OLS	
Access to grid electricity	0.85***	(0.0691)	0.777***	(0.0122)
Use of grid electricity	0.83***	(0.0762)	0.735***	(0.0127)
Use of non-grid electricity for lighting	-0.17***	(0.0624)	0.0668***	(0.0104)
Ownership of solar devices	-0.51***	(0.104)	0.348***	(0.0177)
Ownership of rechargeable batteries	-0.12***	(0.0427)	0.0458***	(0.00696)
Ownership of electrical appliances	0.92***	(0.259)	0.847***	(0.0407)
Expenditure on electricity (in KES)	241.7***	(43.31)	193.2***	(7.867)
Cost of energy	319.3	(361.3)	-149.3***	(46.26)
Electricity used for business	0.07*	(0.0380)	0.0133**	(0.00577)
Electricity used for agriculture	0.17**	(0.0816)	0.00309	(0.0123)

Notes: Robust standard errors in parentheses, clustered at the transformer-community level. *** p<0.01, ** p<0.05, * p<0.1

The estimation results show that the average treatment effect of the project on direct energy outcomes of access and use of grid electricity are 0.85 and 0.83, respectively (Table 2). That is, households and businesses who participated in the project had significantly increased electricity access to the national grid (by 85%). They increased the use of grid electricity for lighting by 83% and reduced the use of electricity from other sources by 17% compared to the control group. The results also show that the LMCP increased the use of grid electricity for other daily activities such as charging mobile phones by 69.9%. The project significantly reduced the ownership of other sources of electricity such as solar devices (50.8%) and rechargeable batteries (12%). Furthermore, the evaluation found that treated households substitute away from off-grid electricity, increasing their spending on grid electricity by 241 Kenyan Shilling (KES). It is important to note, however, that the total household expenditure on energy was not reduced by the project. The impact on the cost of energy was positive and stood at 319 KES (Table 2).

The qualitative evidence shows that the reliability and quality of electricity vary substantially across locations. While respondents in Kakamega County reported that the reliability of electricity was inconsistent, with power outages lasting up to 3 months, counties such as Baringo and Kericho reported having a reliable electricity supply, with only occasional outages due to bad weather. Overall, 55% of the respondents experienced power outages that lasted a few days, while the number of outages in a typical week was an average of 2.3 times and their average duration was 292 minutes. In many instances KPLC was considered slow in responding to power outages.

Finding 3: The project increased the productive use of electricity by intended beneficiaries.

The evaluation found evidence that the project increased the productive use of electricity by eligible and connected businesses and households. Evidence from the evaluation shows that the intervention increased the connection of household-owned businesses to the national grid by 7% (Table 2). The project also increased the use of electricity for agricultural activities such as irrigation by 17%. This result is notable and may indicate future productivity gains in agriculture given that 90% of the communities surveyed are predominately engaged in agriculture, specifically, crop farming. The use of electrical appliances such as hairdryers, sewing machines, and security lights also increased by one type of electrical appliance. Overall, the qualitative evidence showed that the most important benefits for small businesses are increased security due to lighting and longer opening hours. Others include the use of electrical appliances for their business. However, more research and evidence are

required to shed light on how small businesses in resource-constrained environments use electricity and the types of appliances most used.

Impacts on intermediate energy outcomes: This impact evaluation attempts to capture the average treatment effects of the project on a set of intermediate outcomes. Table 3 presents the impact estimation results.

Finding 4: The evaluation did not find an effect of the project on business ownership, earnings from self-employment or job creation.

The evaluation found that the impact of the intervention on labour market outcomes such as business ownership, job creation and employment income was not statistically significant. The effect of LMCP Phase I on households' ownership of businesses and the proportion of household members in self-employment (excluding agriculture) and wage employment was found to be negligible. The project was also not found to affect female employment and the number of workers employed by household businesses. Two factors may explain the lack of statistical significance in these findings. The first is the limited scale and scope of connected businesses, which may reduce the size of benefits derived from electricity access. Indeed, the survey data reveals that small shops, restaurants, barbershops and milling shops are the predominant types of businesses operating in project communities. Another is the inability of the evaluation methodology to capture impacts of the project that affect the whole community (i.e., overall employment) and response errors in the income amount reported in survey data (Table A4.2 in Annex 4 of the Technical Annexes provides details of the findings).

Impacts on final energy outcomes: The average treatment effects of the project on final energy outcomes are presented in Table 4.

Finding 5: The intervention had a statistically significant and positive impact on the time spent by children studying at night, and the test scores on the Kenya Certificate of Secondary Education (KCSE). In contrast, the LMCP had no statistically significant effect on the respiratory health or subjective wellbeing of project beneficiaries.

Table 4 summarizes the average treatment effects of the project on the final outcomes outlined in the project ToC. As noted in the literature on rural electrification, the impact of households and businesses receiving an electricity connection takes time to materialize. The project experienced delays during implementation, with the final project completion date extended to December 2022. It is expected that more benefits from the project will accrue to beneficiaries after its completion and over the medium to long term.

The impact of the LMCP on some educational outcomes for children was found to be positive and significant. The LMCP increased the probability of studying at night in treated households (46%) and increased the time spent studying during the night by 9.4 hours in the last 3 weekdays (Table 3). This

Table 3: Average treatment effects of LMCP on intermediate energy outcomes

Outcome Indicator	Fuzzy RD		OLS	
Business ownership (BO)	-0.00287	(0.0717)	0.0151*	(0.00852)
Proportion employed	0.00388	(0.0768)	0.0123	(0.0158)
Earnings from self-employment (in KES)	605.5	(720.7)	103.9	(95.37)
Probability of studying at night	0.464**	(0.220)	0.0214	(0.0582)
Hours spent studying at night	9.432*	(5.024)	1.077	(1.377)
Awareness Index	1.772*	(0.951)	0.427***	(0.117)

Notes: Robust standard errors in parentheses, clustered at the transformer-community level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Average treatment effects of LMCP on final energy outcomes

Outcome Indicator	Fuzzy RD		OLS	
Kenya Certificate of Primary Education (KCPE) test scores (z-score)	0.0148	(0.282)	0.0287	(0.0571)
Kenya Certificate of Secondary Education (KCSE) test scores (z-score)	0.998**	(0.485)	0.124	(0.0874)
Health (Respiratory) Index	-0.0478	(0.0594)	0.00292	(0.00992)
Household consumption (in KES)	1,704**	(776.4)	40.35	(96.67)
Non-durable Consumption	1,525**	(726.3)	54.56	(87.94)
Household Income (in KES)	913.1	(1,186)	4.157	(194.5)
Subjective wellbeing	0.294	(0.456)	0.157**	(0.0761)

Notes: Robust standard errors in parentheses, clustered at the transformer-community level. *** p<0.01, ** p<0.05, * p<0.1.

finding is consistent with the evidence base that electrification allows students to study longer at night. Indeed, the results suggest that the impact of electrification on study hours is positive cs lighting. An explanation for this may be that while solar lighting also increases the hours of studying at night, it does not provide the same quality or length of lighting in the evening and night relative to grid electricity. Notably, the evaluation found that the project increased the test scores of students that took Kenya's Certificate of Secondary Education (KCSE) exam by almost 1 standard deviation. Conversely, the effect on the Kenya Certificate of Primary Education (KCPE) test scores was marginal and insignificant. The LMCP did not affect school enrolment rate.

The LMCP was not found to improve the respiratory health or the subjective well-being of beneficiaries. The effect on respiratory health due to exposure of household members to harmful indoor pollution was found insignificant. This finding suggests that access to grid electricity may not have changed the cooking technology choice of LMCP households given the high cost of buying and using electrical appliances for cooking. Despite the lack of quantitative evidence on health-related outcomes, the qualitative study reveals that the project has decreased the use of kerosene lamps and other traditional lamps that are harmful to young children. The LMCP was not found to significantly impact the self-reported subjective wellbeing of LMCP-connected households. Similarly, the evaluation did not find an impact of the project on general satisfaction with life, self-reported happiness, financial satisfaction, or perceived safety. This is despite the evidence that survey respondents reported working less, enjoying more leisure time, and consuming more. Given that the data for the evaluation was collected during the COVID-19 pandemic, it is likely that this affected respondents' general sense of well-being, and that increasing access to information through radio and television made them perceive life more negatively.

Finding 6: The LMCP was found to have a positive and statistically significant impact on average household consumption, however, the impact on household income was positive but not statistically significant.

The intervention was found to have a positive and statistically significant impact on household consumption. The LMCP increased the average consumption expenditure of treated households by 1,704 KES per month. The size of this effect is statistically significant and positive. The increase in consumption was led by the increase in the consumption of non-durable goods. Indeed, the LMCP increased the consumption of non-durable goods by 1,525 KES, whereas the impact on durable goods was insignificant (Table 4). These household consumption dynamics are expected in resource-constrained settings where durable items like refrigerators and electric stoves require large capital

outlays. In contrast, households in these settings can easily purchase non-durable items such as clothes, airtime, recreation, religious expenses, and other personal items. Moreover, the reported impact of the project on households' average monthly income was positive (913 KES), but not statistically significant (Table 4). Relative to the finding of Lee et. al. (2020) that the LMCP increased average monthly household income for connected households by USD 16.7, this evaluation found that the project increased household income by USD 27, 60% higher. That said, the lack of statistical significance in the impact of the LMCP on household income is likely due to the inherent difficulties in measuring income using survey data due to response errors (i.e., under-reporting of income) and the need for a large enough sample size to detect impact.

Impacts of the Project on Women and Girls

Finding 7: The LMCP was found to have a positive impact on the time women spent on leisure activities but not on women's empowerment nor on girls' school enrolment.

To examine how the project specifically affected women and female-headed households, we repeated the main analysis (Tables 2, 3, and 4) on the subsample of female-headed households for household-level results and on girls for educational outcomes. The results are presented in Annex 4 of the Technical Annexes (Tables A4.10-A4.12). We find that the program successfully increased access to electricity in female-headed households (Table A4.10), but similar to the results of the full sample, we find no statistically significant impact on income and employment (Table A4.11). We also find no increase in average consumption for this sub-sample of households (Table A4.12). While total food consumption remained positive but insignificant, the decline in average consumption was driven by decreases in the consumption of durable and non-durable goods. Furthermore, the project was found to have a positive impact on the time women spent on leisure activities but not on women's empowerment. Women in treated households spent one hour more on leisure activities than their counterparts in non-beneficiary households. At the same time, they have decreased the time spent on sleeping/resting and working (outside the farm) by 0.94 and 0.97 hours, respectively (Table 5).

Table 5 shows the impact of the project on women's empowerment outcomes, which was not statistically significant: the evaluation did not find any significant impact of the project on women's likelihood to work, to have their own savings in a financial institution, to make financial decisions, or on the proportion of girls enrolled at school. Similarly, the intervention did not affect the time women and girls spent in household chores, childcare, cooking, fetching firewood and water. Potential explanations for these findings are low statistical power because of the small sample size, or other factors such as credit constraints and lower-income that could be more likely in female-headed households. On the other hand, the impact

Table 5: Average treatment effects of the project on women's empowerment outcomes

Outcome Indicator	Fuzzy RD		OLS	
Woman Working	0.0148	(0.113)	0.00812	(0.0172)
Own Savings	-0.0900	(0.0737)	0.0166	(0.0103)
Financial Decision-Making Index	-0.161	(0.579)	0.0311	(0.0825)
Proportion Girls Enrolled	0.0358	(0.0321)	0.0150***	(0.00448)
Time used in sleeping and resting (hours)	-0.944*	(0.552)	0.131*	(0.0712)
Time used in leisure (hours)	0.897**	(0.376)	0.230***	(0.0591)
Time spent in working	-0.972**	(0.397)	0.00798	(0.0562)

Notes: Robust standard errors in parentheses, clustered at the transformer-community level. *** p<0.01, ** p<0.05, * p<0.1.

on educational outcomes for girls is positive and of similar magnitude to the impact in the full sample, with the small sample size reducing statistical power (Table 5). However, the project has improved women's safety. In qualitative interviews and focus group discussions, women reported being able to comfortably walk outside at night.

Unintended Development Impacts of the Project

Finding 8: The project increased the social capital of LMCP beneficiaries in communities.

Qualitative interviews and quantitative analysis show that the project generated a substantial amount of electricity sharing among neighbours, creating goodwill, and deepening social ties in the community. While this practice varied across communities, it was common for households with electricity access to allow their neighbours to charge their mobile phones, watch TV, and use electric appliances. During family events such as funerals, for instance, electricity was shared to support the bereaved family. Although this practice promoted beneficial social dynamics and increased social capital, it also revealed the presence of spillovers in the benefits of the project to non-beneficiaries (i.e, the control group). Methodologically, this limited the ability of the evaluation to detect the full effect of development outcomes on households that are eligible and connected to the LMCP, as ineligible households also enjoyed some of the benefits of the project, thereby reducing the differences between the two groups.

The intervention was found to have a positive and statistically significant impact on the level of awareness and knowledge about current events among LMCP beneficiaries. This was driven by the increased ownership of household electrical appliances such as televisions and radios by LMCP households. However, the exposure to information reduced the subjective well-being of LMCP-connected households.

The evidence on the project's impact on migration is mixed. The quantitative data did not find a significant impact of the LMCP on the migration of household members away from their communities. However, according to the qualitative evidence, the project has decreased migration. Indeed, on average, 58% of Key Informants noted that the availability of electricity reduced migration out of communities and increased immigration and investments into the communities instead. Evidence from focus group discussions and key informant interviews suggest that the most common reasons mentioned for internal migration into electrified communities were potential access to services (including electricity), increased investment in the area, and business opportunities.

Sustainability of Development Outcomes

As shown in the sections above, there is statistical evidence that the project results are generally positive, but their magnitude is not very large. But are these benefits sustainable in long-term? This section explores the extent of the sustainability of the benefits of the project.

Finding 9: Despite good technical quality and strong partnerships with the Government and other development agencies, overall, the benefits from the project are highly unlikely to be sustained in the near term due to project design issues related to inadequate engineering estimates and household data; the inconsistent and unreliable quality and supply of electricity in some communities; and poor financial performance of KPLC.

Technical sustainability

Evidence from stakeholder interviews shows that the transformer protection distance used by the project was technically suitable for the topography of the project sites. The transformer protection distance of 600m in cable distance was an optimal design for reducing power losses. Also,

the materials used for construction works were of proven standard and quality. Wolfram et al. (2021) conducted technical engineering assessments and measured the quality of construction materials used by the AfDB-financed LMCP Phase I (and Phase II) and the LMCP Phase III financed by the World Bank. The assessments found no significant difference in the overall construction quality, household installation quality, or reliability and safety with the LMCP Phases funded by the Bank. However, the study revealed that combining project supervision with independent monitoring generated improvements in household installation quality and electricity usage. This implies that there is scope for improving the quality of installation and construction in the Bank's future energy operations.

Furthermore, the evaluation's descriptive results showed that electricity supply is unreliable (frequent outages) in some communities while the quality of electricity is poor (low voltage) in others. Around 55% of respondents experienced power outages an average of 2.3 times in a typical week, with each lasting 292 minutes on average. This can be partly explained by the evaluation's finding that 29.8% of LMCP households were located beyond the transformation protection distance of 600 m due to contractor non-compliance. Being beyond the optimal transformer protection distance implies that LMCP customers will continue to experience voltage drops, thereby reducing the quality of electricity and customer demand, and KPLC will continue to incur technical and commercial losses.

The evaluation found that the quality of construction materials (i.e., LV conductors, poles, service cables, LV stays, meters) used for the LMCP and their installation were of high quality. A recent Randomized Controlled Trial (RCT) that examined the impact of donor conditionality and independent audits on the quality of LMCP construction materials by Wolfram et al. (2021) found no difference in the quality of the AfDB and World Bank project sites. This evidence of quality and reliable household installation under the LMCP suggests that it has the potential to deliver the socio-economic impacts of electrification over time if properly maintained. Additionally, the authors found that the Bank's turnkey approach to contracting delivered electricity connections faster than its comparator - the World Bank - without significant differences in the quality of construction and electrical installation works.

However, the project's design, inputs, and outputs (transformers, construction materials, and beneficiaries) were not based on engineering and household data collected from field assessments. Indeed, the Implementing Agency, KPLC, identified project beneficiaries and sites for LMCP Phase I with a combination of geospatial and administrative data from its offices at the county and regional levels. The lack of detailed project preparation led to several challenges during implementation. For instance, satellite data could not distinguish between residential and commercial customers. Thus, the lack of commercial customers in some project sites created gaps in the achievement of some outputs in the RBLF agreed at PAR. In addition, some businesses connected under LMCP Phase I were wrongly connected with single-phase meters instead of 3-phase meters. Consequently, several LMCP-connected businesses complained of low voltage, affecting their ability to operate some machines. The unreliability of electricity supply in certain area also discourages large investments.

In interviews, energy sector stakeholders in Kenya expressed an urgent need to build the institutional capacity of KPLC, the power utility, in financial recovery and debt restructuring, corporate governance and organizational effectiveness. They also urged the provision of technical assistance for designing a strategy to stimulate the demand for electricity by customers, especially the productive use of energy, and understanding the patterns of electricity consumption. In addition, with KPLC's limited manpower capacity relative to a large number of project sites it supervises (over 4,800 according to the LMCP Project Supervision Firm), interviewees felt that the power utility requires both financial support

and technical assistance to adequately supervise project sites and project contractors and maintain the electricity network. Consultations with the Bank's Kenya Regional Hub indicate that it is yet to decide on the form of technical assistance to provide to KPLC.

Financial sustainability

The imbalance created by the low revenue generated from last-mile connections relative to the high cost of maintaining and operating an extensive electricity network is likely to affect the financial sustainability of KPLC. The electricity consumed by LMCP beneficiaries has remained low after 2-3 years of connection to the grid. Beneficiaries are hindered by lack of financial resources, including household income, to invest in electrical appliances that increase the productive use of electricity. The qualitative data showed that the most important use of electricity, for both LMCP and non-LMCP beneficiaries, was lighting (96%), followed by charging phones and entertainment. This finding is unsurprising considering that the project targeted low-income households and businesses in peri-urban and rural areas. On the one hand, the high cost of electrical appliances hinders the purchase and use of electricity for productive activities. On the other hand, evidence that the quality and supply of electricity is inconsistent and unreliable in some communities may reduce the customer demand for electricity. Consequently, the revenue generated by the project is low.

At the same time, over the past few years, the power utility has faced financial challenges due to the increasing cost of maintaining and operating the rapidly expanding electricity network. The extension of the LV network constructed as part of the project significantly increased maintenance costs for KPLC. Similarly, the extent of system losses (technical and commercial) has increased with network expansion while the COVID-19 pandemic led to a decline in commercial activities, electricity sales, and long delays in revenue collection. The unstable financial situation of KPLC amidst rising costs and declining revenue suggests that it is unlikely to make timely network investments, grid enhancements, and finance service improvement programs. Consequently, the quality and reliability of the electricity provided to LMCP beneficiaries may not be sustained post-project completion, if the financial challenges are not resolved. Moreover, if network maintenance is not carried out in a timely and effective manner, the results achieved risk not being sustainable in the near term.

Kenya's ambitious electricity connectivity programmes, including the LMCP, have increased the technical and commercial losses faced by KPLC, worsening its financial situation over the past few years. The result has been a steady decline in its profitability and difficulty in meeting its financial obligations to Independent Power Producers (IPPs) under Power Purchase Agreements. Between 2016 and 2019 for instance, KPLC's net profits declined from KES 7,431 million to KES 261 million, a reduction of around 97%. Annex 5 of the Technical Annexes presents additional details on the financial situation of the KPLC since the implementation of the LMCP commenced in 2016, including the reforms introduced by its management to rein in cost and increase its profitability. Overall, interviews with energy sector stakeholders, including donors, revealed the urgent need to support KPLC in financial recovery and restructuring, as well as corporate governance. A detailed analysis of the technical and financial sustainability of the project and KPLC's finances is presented in Annex 5 of the Technical Annexes.

Beneficiary ownership and sustainability of partnerships

The reliance on project contractors for personal data collection, registration of project beneficiaries, and information dissemination on the LMCP delayed electricity connections. Contractors were required by KPLC to collect personal data from beneficiaries as a precondition for

accounts creation with KPLC. This process required the collection of National Identity Numbers (IDs), Personal Identification Numbers (PINs) or Certificates of Registration for Companies, mobile phone numbers of beneficiaries for Stima Loan agreement forms, and final registration in KPLC's Integrated Customer Management System (InCMS). Findings from qualitative interviews showed that contractors did not dedicate sufficient resources, especially manpower, to collect the data. In other instances, however, beneficiaries in rural areas simply did not have the data required to receive connections. The project also had difficulties in getting wayleaves – the right of way clearances for construction works (Feedback Infra Private Ltd, 2017b, 2018c, 2020b; GoK, 2018) - due to limited budget provisions in the national budget (AfDB, 2021).

Focus group discussions and key informant interviews indicated that information about the intervention received by potential beneficiaries was minimal and insufficient. Project contractors failed to adequately engage with targeted communities and provide sufficient information about the LMCP Phase I. Surveyed respondents reported that beneficiary registration took place in one day without prior notice, leaving out potential beneficiaries that were not present. This failure of communication created mistrust and resulted in the refusal of some beneficiaries to provide their data to project contractors. As a result, even if they got connected, they were not able to receive a meter and, therefore, electricity. It is worth mentioning, however, that KPLC and the Bank were aware of these issues and have implemented countermeasures to solve them in other phases of the LMCP program such as the Bank-financed LMCP Phase II. For instance, media campaigns and local leaders raised awareness about the LMCP program in subsequent phases.

At the same time, the strong partnership of the AfDB with the Government and other development partners is likely to produce sustained partnerships. The Bank adequately engaged with the GoK and development partners throughout the project cycle, including at the pre-appraisal stage (AfDB, 2015b). It has also conducted regular supervision missions with the production of implementation progress reports. Disbursements were processed in time within 60 days while the Project Task Manager provided advisory services to the Implementing Partner on key challenges such as the non-performance of the contractor awarded Lots 2 and 4.

There is a strong partnership between the Bank, the GoK (and the MoEP), and other development partners in the energy sector such as the World Bank, AFD, EIB, and Japan International Cooperation Agency (JICA). The Energy Sector Working Group in Kenya, currently chaired by AFD, is active with regular meetings and donors discussing common challenges, including sharing their pipeline of energy projects. This collaboration is evident in the additional financing leveraged from other donors for the financing of the subsequent phases of the LMCP. For instance, in addition to Phase I (314,200 households targeted) and II (312,500 households targeted) financed by the Bank, the World Bank financed Phase III (385,700 households targeted) while AFD, the EU and EIB financed Phase IV with 397,000 households targeted.

Implementation Challenges

Finding 10: The project's implementation experienced several challenges.

The high cost of obtaining an internal wiring certificate, a precondition for receiving a connection under the LMCP, affected the ability of project beneficiaries to receive electricity. All households in Kenya are required, by law, to engage a qualified electrical contractor registered with the Energy and Petroleum Regulatory Authority (EPRA) to conduct home wiring and issue a commencement of work certificate, completion of work certificate and a wiring certificate. Interviews with LMCP's Project Implementation Managers revealed that the cost of

the internal wiring certificate range from 500 KES (USD 5) to 1000 KES (USD 10). Wolfram, Miguel, Hsu, & Berkouwer (2021) found that households that got connected before the LMCP spent an average of 12,500 KES (USD 125) on all costs related to the internal wiring, including the certificate. In Kakamega for instance, an FGD participant stated: 'I was there when they [KPLC's contractors] dropped the wire to my house…I'm not connected because they did not install a meter in my house, and I have not done wiring as I cannot afford it'. Similarly, some respondents had poles inside their homesteads but were not connected due to the lack of a wiring certificate. To address this challenge, President Uhuru Kenyatta announced during the launch of the LMCP on May 27, 2015, that: 'The Ministry of Energy has also come up with designs that will enable households that do not have internal wiring in their houses to use electricity by providing a 'ready board'. The ready board has switches, sockets and bulb holders and those who do not have wiring in their houses will be able to use electricity soon as they are connected' (Kenya Presidency, 2015). While this foresight has increased the number of poor households connected to the grid, evidence from the field survey shows that ready boards are unsafe for households that plan to increase their electricity use, thus limiting their potential use of electricity.

Technical challenges created by Information Technology (IT) problems delayed last-mile connections. These include outages in the power interface system and delays in the validation of meters by contractors after installation (Feedback Infra Private Ltd, 2017c). Relatedly, it took considerable time for KPLC to release energy meters to contractors (Zegeye, 2018, 2020) while those issued to contractors had no corresponding data (plot number, customer names, meter numbers, village, etc) to match them with transformers and locations (project sites). This matching process delayed the last mile connection of beneficiaries to electricity (Feedback Infra Private Ltd, 2018).

The implementation of LMCP Phase I was plagued by contractor cash flow problems. Revisions to the budget allocation for the project in the national budget and considerable delays in processing contractors' invoices at the Ministry of Energy and Petroleum (MoEP) and the National Treasury considerably affected the completion of construction works (Asfaw, 2017). Similar delays were recorded in the processing of VAT and withholding taxes for the project (Feedback Infra Private Ltd, 2020a). Project suppliers and subcontractors were unwilling to provide their services given these financial challenges. For example, RKV Consortium, the contractor for Lot 3 demobilized from the project site, citing delays in payment (AfDB, 2018). The cash flow challenges faced by contractors worsened by the pegging of payment to the completion of both line works (LV installation) and metering (Zegeye, 2018). With the long delays in issuing meters by KPLC, the contractors could not hand over project sites and were not paid (Feedback Infra Private Ltd, 2020a).

The project completion timelines were affected by the inability of contractors to procure local and imported materials for construction works as planned. This situation was worsened by the COVID-19 pandemic which slowed imports due to worldwide national lockdowns and difficulties in virtually inspecting construction materials by KPLC's engineers. Furthermore, the overall implementation progress of the project was affected by the non-performance of contractors, especially AEE Power (Lots 2 and 4) and Neo Electric (Lot 7) (Feedback Infra Private Ltd, 2020a). The contract with AEE Power, which recorded the most physical and time slippage due to financial challenges, has been terminated by KPLC (Zegeye, 2020). However, the contract dispute remains unresolved following AEE Power's court injunction and appeal of an earlier court decision that upheld the contract termination.

In addition to the above challenges, the COVID-19 pandemic and the resulting lockdown, night-time curfew and travel bans imposed by the GoK have slowed down project activities or led to the outright

suspension of activities in LMCP sites. Findings from the latest quarterly report (Feedback Infra Private Ltd, 2020c) and implementation progress report (Zegeye, 2020) suggest that this will further lead to project extension and could cause an extension of the loan's disbursement deadline and financial claims by some contractors. Overall, the project has a disbursement ratio of 87.47% as of December 2020 and physical progress of 93%. The project's last date of disbursement was extended by the Bank to 2022 considering the COVID-19 restrictions which affected the completion of the metering process in households. This extension did not result in cost overruns but instead, the project recorded savings. The GoK has already requested to utilize the resources to complete the project outputs that are not on track. ■

Conclusions, Lessons, and Recommendations

Conclusions

The Bank's financing of the LMCP Phase I in Kenya is consistent with the NDEA aspiration of achieving universal access to energy in Africa by 2025, by increasing on-grid transmission and grid connections. The impact evaluation of the project demonstrated that last-mile connectivity programs are effective in increasing access to electricity, especially for low-income people in rural and peri-urban areas. As a result, the socio-economic conditions of beneficiaries (households and businesses) improved across several dimensions, including consumption, education, productive use of energy, awareness of current events, and the way people use their time. However, the project did not affect some other outcomes in the project theory of change such as income, school enrolment, asset ownership, labour supply, physical health, and general life satisfaction. Overall, the evaluation found a higher development impact of the LMCP Phase I than previous studies.

The limited use of electricity by project beneficiaries implies low revenue generation by KPLC for new last-mile connections. On the other hand, the rapid grid expansion driven by the LMCP Phase I has substantially increased the cost of operating and maintaining the electricity network. This imbalance between revenue and costs has had a negative and significant impact on the finances of KPLC. Consequently, KPLC's unstable financial situation is likely to affect the sustainability of the project's development outcomes, given the challenges it will experience in managing the electricity infrastructure and network after the planned project completion date. Delays in the project's implementation have led to the extension of the last disbursement date twice. These delays were caused by several factors such as difficulties in collecting customer data for connections, wayleave acquisition, metering, counterpart funding, and contractor payment. Others include contractor cash-flow challenges and non-performance, and more recently the COVID-19 pandemic restrictions. Despite these delays, the Bank's turnkey contracting approach delivered electricity connections faster than its comparator - the World Bank - without significant differences in the quality of construction and electrical installation works. As the interviews with energy sector stakeholders in Kenya showed, the high-level political support and stakeholder and donor partners' engagement enjoyed by the LMCP has been pivotal to its success.

Lessons

The following are the key lessons from this impact evaluation.

Lesson 1: A high cost of electricity relative to the household income of beneficiaries undermines access and the productive use of electricity.

- For rural poor households, a high cost of electricity (connection fee and consumer tariff) may be beyond their capacity to pay. Affordable schemes need to be worked out to reduce up-front costs and help rural households and businesses to be connected to electricity. The evaluation notes that the GoK under the Office of the President constituted a Taskforce on Review of Power Purchase Agreements ("Presidential Taskforce", Gazette Notice 3076) on 29th March 2021 to primarily address the high cost of electricity in Kenya. The Presidential Taskforce submitted its report on 20 September 2021, with several recommendations, including pathways towards the reduction of consumer power prices by

33% (from an average of KES 24 per kilowatt hour to KES 16 per kilowatt hour) within four months as well as reforming the organizational and operational structures of KPLC to restore its profitability. If implemented, this recommendation, and the replacement of internal wiring certificates with inexpensive 'ready boards' for low-income income households as a prerequisite for electricity connection, seem to be steps in the right direction, and could serve as lessons for other electricity access projects.

Lesson 2: The financial sustainability of the electric utility company is a critical success factor for the quality and reliability of electricity provided to eligible households.

- The evaluation found that more than half (55%) of 5,290 respondents surveyed in 157 transformer communities across six counties experienced power outages that lasted several days. Specifically, the number of outages in a typical week was an average of 2.3 times with an average duration of 292 minutes. The qualitative evidence suggests that the quality of electricity (voltage) varies substantially between communities. In Kakamega, respondents reported outages lasting up to three months and delays in KPLC response, while other counties such as Baringo and Kericho reported better quality of electricity, with only occasional outages due to bad weather. The unstable financial situation of electric utility company KPLC threatens to affect the sustainability of the project's development outcomes, especially the reliability (frequency of outages) and quality of the electricity (voltage) provided to eligible and connected households. This is likely to be worsened by the rising costs of operating and maintaining the vast electricity network.

Lesson 3: An effective project communication strategy is key to increasing households' participation in electrification projects.

- A lack of adequate communication and involvement of community leaders at the onset of the project was found to have led to some delays in project implementation and the non-participation of targeted households in some communities. Beneficiaries felt insufficiently informed about the intervention, which led to mistrust. Some households were reluctant to share their personal information with the contractors responsible for collecting and connecting beneficiaries to the grid. Moreover, lack of clarity on the payment for connection fees (KES 15,000) and the administration of the Stima Loan program, a Kenya Power initiative in partnership and the French Development Agency (AFD) designed to minimize the financial burden of paying the upfront connection fee, meant that eligible households could not take advantage of the loan repayable over 24 months to get connected to the electricity grid. Notably however, these aspects have been addressed by the subsequent phases of the LMCP (Phases II-IV).

Lesson 4: Lack of baseline data hampers the assessment of project outcomes and impacts after completion.

- The collection of reliable baseline data is a prerequisite for a realistic assessment of project results, especially for large flagship Bank projects that may be scaled up or replicated in other RMCs. Both the executing agency and the AfDB need to establish adequate benchmark information on conditions in project areas and to compare pre-project and post-project conditions.

Recommendations

IDEV makes the following recommendations:

Recommendation 1: Ensure the sustainability of project benefits. Priority areas of action to consider include:

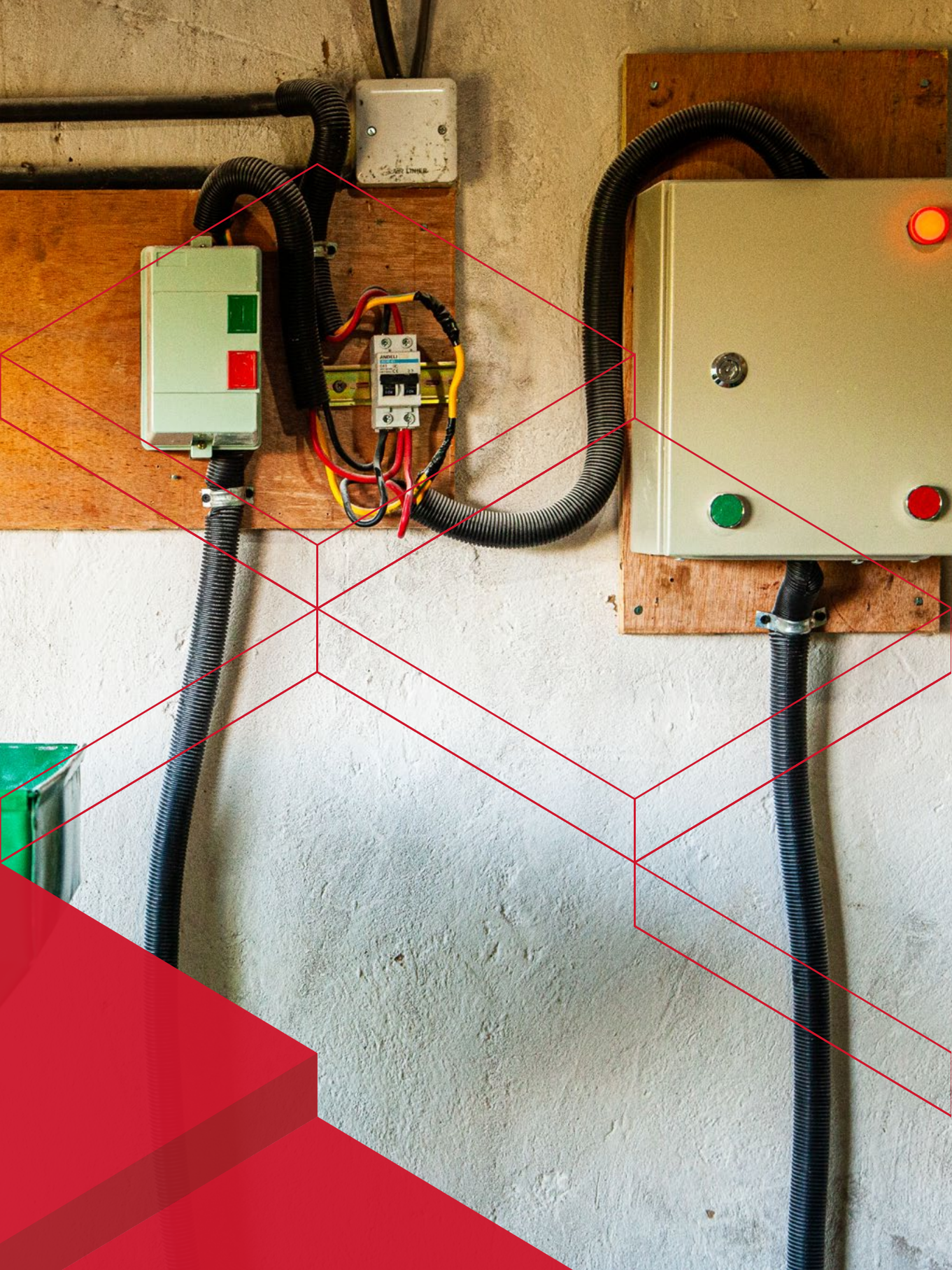
- Strengthening the organizational and operational capacity capacity of KPLC through non-lending instruments such as technical assistance from trust funds, special funds, and grants.
- Enhancing meaningful participation and engagement of community leaders and beneficiaries throughout the project cycle.

Recommendation 2: Stimulate and manage households' and businesses' demand for the productive use of electricity. Priority areas of action to consider include:

- Integrating complementary interventions into Bank electricity access programs to link electricity with income-generating activities such as irrigation services and promoting small businesses (MSMEs).

Recommendation 3: Improve future electrification projects' design and implementation. Priority areas of action to consider include:

- Ensuring that project design is based on actual engineering assessments and field data, and that the optimal transformer protection distance is applied.
- Improving analytical work, including detailed electricity demand studies based on willingness to pay and affordability analysis for electricity and alternative energy sources, to better inform the preparation and formulation of energy access projects and programs. ■



Annexes

Annex 1: Theory of Change for LMCP Phase I

Directly linked to the AfDB Energy Policy, the LMCP is an investment program mainly focused on the extension of the energy distribution network in Kenya. The activities financed included the expansion of the low voltage (LV) network through the construction of 12,000 km of lines and the installation of equipment (poles, meter boxes, etc.) necessary to connect about 300,000 new customers. The main outputs of the project were (i) the extension of the LV network and (ii) the number of new customers connected. The project's expected inputs, outputs, and outcomes are illustrated in Figure A1.1.

The anticipated direct outcome of the LMCP was to increase access to electricity through reduced connection fees. Indeed, without the LMCP program, households would either have to generate their own electricity (using a small diesel generator or solar panels), pay the full connection fee if available to them from KPLC, receive it through other electrification programs (e.g., Kenya OffGrid Solar Access Project (KOSAP)), or finally live without electricity.

The increased use of energy was expected to generate changes in the following intermediate outcomes:

Time use: the increased availability of light could increase changes in time use of household members. Children could spend more time studying during dark hours and adults could engage in productive activities such as production of goods for sale. Moreover, the increased use of electrical appliances could reduce the amount of time women dedicate to household chores, provided that beneficiaries are able to afford such appliances.

Employment: as the productive uses of electricity increase, new business opportunities should arise, increasing labour demand and thus employment. On the other hand, if women dedicate less time to household chores, they might be able to increase their labour supply, taking advantage of the increased job availability.

Knowledge: increased use of electrical appliances such as radio, TV, and mobile phones should allow beneficiaries to gain better access to information on current events. Information on job availability could also be available, further contributing to increases in employment.

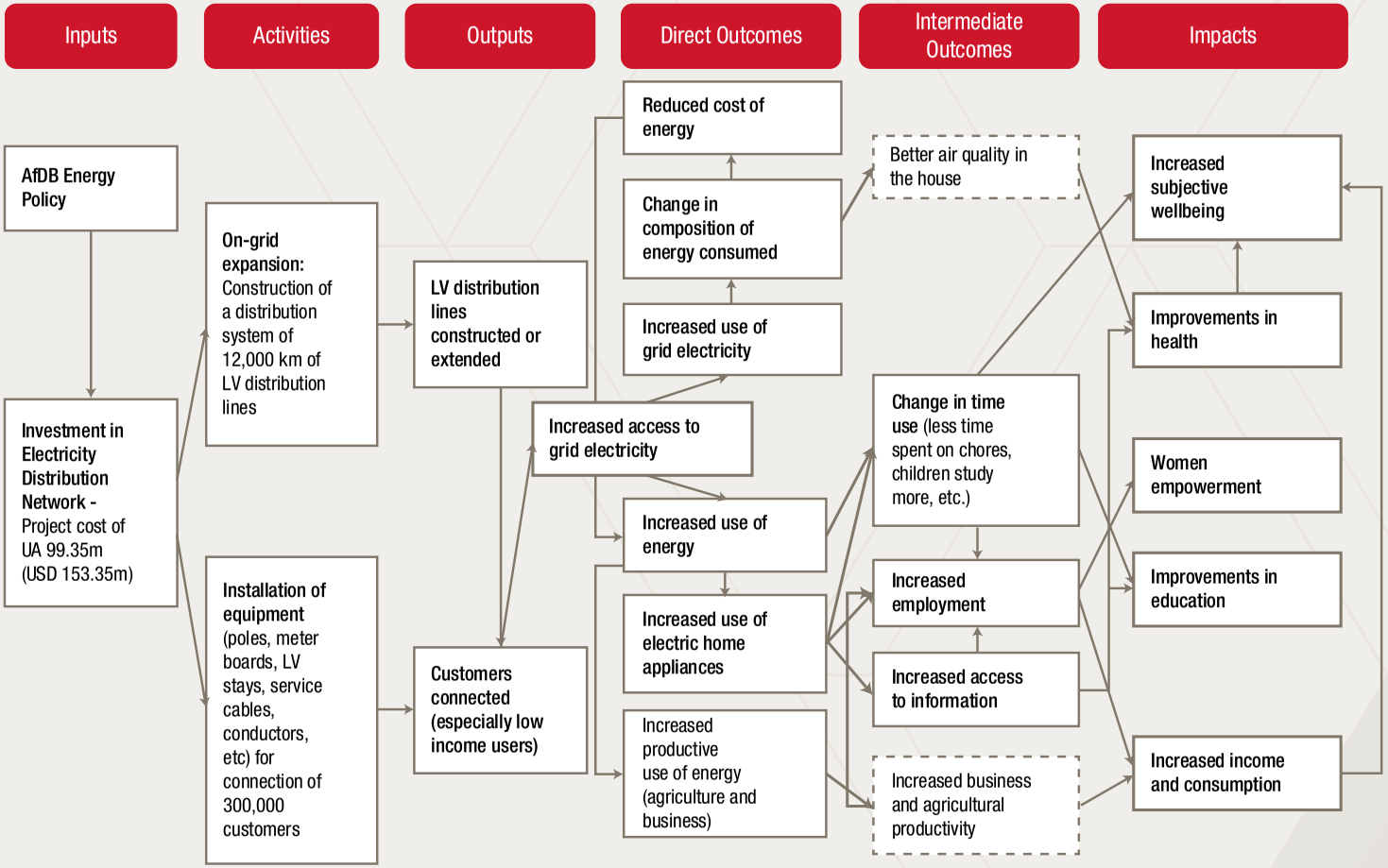
Productivity: increases in the productive use of electricity should generate increases in productivity for both business and agricultural activities.

Air quality: increases in the use of electricity for cooking and heating is expected to reduce the use of other sources of energy (kerosene and firewood for example) that pollute the environment, and hence improve air quality in the household.

According to the theory of change, these intermediate outcomes should translate into the achievement of the following final outcomes or impacts:

Health: electric lighting and cooking reduces exposure to harmful indoor pollution from kerosene lamps and cooking with firewood. Consequently, the program should lead to a reduction in the prevalence of respiratory

Figure A1.1: Theory of Change for the LMCP Phase I



illnesses. Increased access to health-related information through radio and TV could also contribute to improvement in health, albeit indirectly.

Education: theoretically, electricity can affect children's education through (i) longer study time because of better lighting, (iii) access to educational programs through the radio, and (iii) changing the incentives of parents to take the child out of school to work, both within the household (e.g., no need to send the child to collect firewood) and in the labour market.

Income and consumption: increased productivity for businesses and agricultural activities and increased employment should generate an increase in household income. Increases in income should generate increases in consumption, supported also by cost savings from other energy sources.

Women's empowerment: access to electricity could also increase the economic empowerment of the woman in the household if electricity increases female labour supply (Dinkelman, 2011).

Subjective wellbeing: increased income and consumption and improvement in health should lead to an increase in subjective wellbeing. Moreover, an increase in life satisfaction could also be induced by the fact that better lighting increases security and that electricity allows for the use of entertainment appliances such as TV and radio.

In addition to the variables described above, we also examine two additional sets of variables that, although not included in the theory of change, might be affected by the program.

Household structure: access to services might decrease migration away from the community or increase immigration. If this is the case, we might observe changes in household composition.

Investment and savings: access to electricity allows households to acquire durable electric appliances which can improve their productivity and wellbeing (e.g., TV, refrigerator, electric stove). In addition, having access to electricity can increase savings by (i) increasing income and therefore savings, (ii) decreasing spending on fuel and other energy sources such as firewood and kerosene, and finally (iii) increased access to mobile savings (e.g., M-Pesa) through better battery life and hence better savings management.

The casual pathways for the intermediate and final (impact) outcomes in the theory of change depend on some **assumptions**. At the input level, we expect that the GoK will allocate counterpart funding for the project and ensure the timely payment of contractors. Also, we assume that the project would be supervised by a dedicated Project Implementation Team (PIT) supported by external engineering consultancy forms to ensure the use of high-quality construction materials such as poles, LV cables and meters. We further assume that the project will benefit from the economies of scale, and reductions in the average costs of connection, while the newly connected customers are expected to effectively use electricity. The electricity supply should also be affordable, adequate, and reliable. **Contextual factors** include the Bank's staff resources, energy strategy, policy, initiatives, energy sector knowledge, and partnerships with other donors. Importantly, factors beyond the Bank's control such as Kenya's development priorities, challenges and needs, energy markets and power agreements as well as the ongoing global energy transition will play a key role in the project's implementation.

References

AfDB. (2012). Energy Sector Policy of the AfDB Group. Abidjan, Côte d'Ivoire: African Development Bank Group.

AfDB. (2014a). Kenya Country Strategy Paper (2014-2018). Abidjan, Côte d'Ivoire, African Development Bank Group.

AfDB. (2014b). Last Mile Connectivity Project: Kenya (Phase 1, Project Appraisal Report). Abidjan, Côte d'Ivoire: African Development Bank Group.

AfDB. (2015a). Kenya: Last Mile Connectivity Project - Additional Financing Preparation Mission Aide Memoire (11-14 August). Nairobi, Kenya, African Development Bank (AfDB).

AfDB. (2015b). Kenya: Last Mile Connectivity Project Additional Financing Pre-Appraisal Mission Aide Memoire (8-14 September). Nairobi, Kenya, African Development Bank (AfDB).

AfDB. (2017). The New Deal on Energy for Africa (Update on Implementation). Abidjan, Côte d'Ivoire:. African Development Bank Group.

Aevarsdottir, A. M., N. Barton, and T. Bold (2017). The impacts of rural electrification on labor supply, income and health: experimental evidence with solar lamps in Tanzania. Unpublished manuscript, June.

Almond, D. and J. J. Doyle (2011, August). After midnight: A regression discontinuity design in length of postpartum hospital stays. American Economic Journal: Economic Policy 3(3), 1–34.

Asher, S. and P. Novosad (2020, March). Rural roads and local economic development. American Economic Review 110(3), 797–823.

Bachas, P. and M. Soto (2021). Corporate taxation under weak enforcement. Forthcoming American Economic Journal: Economic Policy.

Burke, P. J., D. I. Stern, and S. B. Bruns (2018). The impact of electricity on economic development: A macroeconomic perspective. International Review of Environmental and Resource Economics 12(1), 85–127.

Burlig, F. and L. Preonas (2016). Out of the darkness and into the light? development effects of rural electrification. Working Paper.

Chakravorty, U., K. Emerick, and M.L. Ravago (2016). Lighting up the last mile: The benefits and costs of extending electricity to the rural poor. Resources for the Future Discussion Paper , 16–22.

Cohodes, S. R. and J. S. Goodman (2014, October). Merit aid, college quality, and college completion: Massachusetts' adams scholarship as an inkind subsidy. American Economic Journal: Applied Economics 6(4), 251–85.

Dinkelman, T. (2011, December). The effects of rural electrification on employment: New evidence from South Africa. American Economic Review 101(7), 3078–3108.

Feedback Infra Private Ltd. (2016b). Quarterly Progress Report (January - March). Haryana, India.

Feedback Infra Private Ltd. (2017c). Quarterly Progress Report (July - September) (Vol. 6th). Haryana, India.

Feedback Infra Private Ltd. (2018a). Quarterly Progress Report (January - March 2018). Haryana, India.

Feedback Infra Private Ltd. (2018b). Quarterly Progress Report (July - September). Haryana, India.

Feedback Infra Private Ltd. (2018c). Quarterly Progress Report (October - December) (Vol. 11th). Haryana, India.

Feedback Infra Private Ltd. (2020). Quarterly Progress Report (January - March) (Vol. 16th). Haryana, India.

GoK. (2013). Second Medium-Term Plan (2013 – 2017) - Transforming Kenya: Pathway to Devolution, Socio-economic Development, Equity and National Unity. Nairobi, Kenya, The Presidency Ministry of Devolution and Planning.

Grimm, M., L. Lenz, J. Peters, and M. Sievert (2020). Demand for offgrid solar electricity: Experimental evidence from Rwanda. Journal of the Association of Environmental and Resource Economists 7(3), 417–454.

Kassem, D. (2020). Does electrification cause industrial development? grid expansion and firm turnover in Indonesia. Working Paper.

KNBS (2020) Comprehensive Poverty Report. Nairobi, Kenya.: Kenya National Bureau of Statistics (KNBS).

Lee, K., E. Miguel, and C. Wolfram (2020). Experimental evidence on the economics of rural electrification. Journal of Political Economy 128(4), 1523–1565.

Lipscomb, M., A. M. Mobarak, and T. Barham (2013, April). Development effects of electrification: Evidence from the topographic placement of hydropower plants in Brazil. American Economic Journal: Applied Economics 5(2), 200–231.

MoEP. (2018). Kenya National Electrification Strategy: Key Highlights. Nairobi, Kenya.: Ministry of Energy and Petroleum (MoEP).

O'Sullivan, K. and D. Barnes (2007). Energy policies and multitopic household surveys. World Bank Working Paper.

Rud, J. P. (2012). Electricity provision and industrial development: Evidence from India. Journal of Development Economics 97(2), 352 – 367.

Wolfram, C. D., Miguel, E., Hsu, E., & Berkouwer, S. B. (2021). Promoting Accountability in Public Projects: Donors, Audits, and Rural Electrification. Manuscript in Preparation, 1–18.

Zegeye, A. W. (2018). Implementation Progress and Results Report (IPR, May 18) - LMCP Phase 1. Nairobi, Kenya, African Development Bank (AfDB).

Zegeye, A. W. (2020). Implementation Progress and Results Report (IPR, June 5) - LMCP Phase 1. Nairobi, Kenya, African Development Bank (AfDB).

Zegeye, A. W. (2020). Implementation Progress and Results Report (IPR, December 17) - LMCP Phase 1. Nairobi, Kenya, African Development Bank (AfDB).

Endnotes

1 The 600 meters is called the “transformer protection distance”.

2 Despite the lack of quantitative evidence on health-related outcomes, the qualitative study revealed that the project decreased the use of kerosene lamps and other traditional lamps that were harmful to children.

3 While the Appraisal Report categorized the marginalized as ‘women, youth, and people with disability’, the Implementation Progress Report (IPR) instead reported the value of contracts awarded to local suppliers, labour and transport contractors.

4 Impact Evaluation of the AfDB supported Kenya Last Mile Connectivity Project, Phase I: Technical Annexes

5 Impact Evaluation of the AfDB supported Kenya Last Mile Connectivity Project, Phase I: Technical Annexes

IDEV

Independent Development Evaluation
African Development Bank

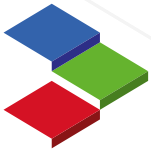
An IDEV **Impact Evaluation**

About this evaluation

This report summarizes the findings of an impact evaluation of the AfDB's phase 1 of the Last Mile Connectivity Project in Kenya. The project sought to increase access to electricity, particularly for low-income groups in peri-urban and rural areas, by maximizing the use of existing transformers of the Kenya Power and Lighting Company (KPLC). Approved by the Bank in 2014, at a value of about USD 131 million, the project was envisaged to extend the low-voltage electricity network to reach around 1.2 million people.

The evaluation aimed to inform the mid-term review of the AfDB's Strategy for the New Deal on Energy for Africa (NDEA) by estimating the causal impact of the project so as to generate lessons and provide recommendations to enhance the impacts of ongoing and future electricity access projects.

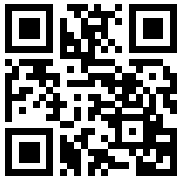
Overall, the project was found to be effective in increasing access to electricity for the beneficiaries. However, the reliability and quality of electricity varied substantially across locations, and there was a limited increase in the productive use of electricity. The evaluation also observed that the development outcomes for the project were unlikely to be sustainable in the near term. Some of the lessons that the evaluation draws are on: the productive use of electricity, the success factor for the quality and reliability of electricity, and increasing the participation of beneficiaries in electrification projects. The Bank was advised to ensure the sustainability of project benefits, stimulate, and manage households' and businesses' demand for the productive use of electricity, and improve the design and implementation of its future electrification projects.



IDEV

Independent Development Evaluation
African Development Bank

African Development Bank Group
Avenue Joseph Anoma, 01 BP 1387, Abidjan 01, Côte d'Ivoire
Phone: +225 27 20 26 28 41
E-mail: idevhelpdesk@afdb.org



Design & layout: GK Graphics (www.gkgraphics.in)

idev.afdb.org