



Powering Progress

EnDev Rwanda 2006–2026: experience, lessons, and legacy

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Acronyms

AC	alternating current
ACACIA	Accelerating Climate Action and Clean Cooking for Inclusive Mitigation and Adaptation in Rwanda
ACES	African Centre of Excellence for Sustainable Cooling and Cold Chain
ADENYA	Association pour le Développement de Nyabimata
AI	artificial intelligence
AIIB	Asian Infrastructure Investment Bank
API	application programming interface
ASCENT	Accelerating Sustainable and Clean Energy Access Transformation
AVSI Foundation	Association of Volunteers in International Service Foundation
BEST	Biomass Energy Strategy
BNR	National Bank of Rwanda
BRD	Development Bank of Rwanda
CaaS	Cooling as a Service
CEBGF	Cooking Energy Business Growth Fund
COVID-19	coronavirus disease 2019
DC	direct current
DFID	United Kingdom Department for International Development
EAQIP	Energy Access Quality Improvement Programme
EARP	Electricity Access Rollout Programme
ECOS	Energy and Construction Systems
EDCL	Energy Development Corporation Limited
EnDev	Energising Development
EUCL	Energy Utility Corporation Limited
EUCORD	European Cooperative for Rural Development
EUR	euro
EWSA	Energy, Water and Sanitation Authority
FCDO	Foreign, Commonwealth and Development Office
FONERWA	Rwanda Green Fund
GCCA+	Global Climate Change Alliance Plus
GeCCo	Global eCooking Coalition
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GoR	Government of Rwanda
ICS	improved cookstoves
IEC	International Electrotechnical Commission
IPP	independent power producer
ISO	International Organization for Standardization

KCRC	Kigali Collaborative Research Centre
KIST	Kigali Institute of Science and Technology
kW	kilowatt
kWp	kilowatt-peak
LED	light-emitting diode
LNOB	Leave No One Behind
LODA	Local Administrative Entities Development Agency
LPG	liquefied petroleum gas
MC-E4I	Mercy Corps Energy for Impact
MEIS	Monitoring and Evaluation Information System
MHPP	micro-hydro power plant
MINEMA	Ministry in charge of Emergency Management
MININFRA	Ministry of Infrastructure
MoE	Ministry of Environment
MSME	micro, small and medium-sized enterprise
MW	megawatt
NDBP	National Domestic Biogas Programme
NGO	non-governmental organisation
OMIS	Off-grid Monitoring Information System
PAYGo	pay-as-you-go
PE	polyethylene
picoPV	pico-photovoltaic
PPA	power purchase agreement
PPP	public-private partnership
ProGres	Profile Global Registration System
PUE	productive use of energy
PURE.Ag	Productive Use of Renewable Energy in Agricultural Value Chains
PV	photovoltaic
RAB	Rwanda Agriculture and Animal Resources Development Board
RBF	results-based financing
RBF4R	Results-Based Financing for Refugees Project
RDB	Rwanda Development Board
RE4R II	Renewable Energy for Refugees II Project
ReCIC	Reducing the Climate Impact of Cooking in Rwanda through Improved Cooking Energy Systems
REF	Renewable Energy Fund
REFIT	Renewable Energy Feed-in Tariff
REG	Rwanda Energy Group
RES	Rural Electrification Strategy
RSB	Rwanda Standards Board
RURA	Rwanda Utilities Regulatory Authority
RVO	Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland)
RWF	Rwandan franc
RWI	Rheinisch-Westfälisches Institut für Wirtschaftsforschung

SACCO	savings and credit cooperative
SAIP	Sustainable Agriculture Intensification for Improved Livelihoods, Food Security and Nutrition Project
SCALE.up	Sustainable eCooking Access to Leverage Electricity Uptake in Rwanda
SDG	Sustainable Development Goals
SE4All	Sustainable Energy for All
SME	small and medium-sized enterprise
SMGF	Société Mutuelle de Garantie et de Financement
SMS	short message service
SNV	Netherlands Development Organisation
SOLCO	Solar-Electric Cooking Partnership
SPV	special purpose vehicle
SREP	Scaling-Up Renewable Energy Programme
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
USAID	United States Agency for International Development
USD	United States dollar
VG	Village Grid
VG RBF	Village Grid Results-Based Financing Project
VGf	viability gap funding
WFP	World Food Programme

Icon Glossary

	Biogas Digesters		Grid		Portable Solar Device
	Cooking Energy		Hydro		Productive Use of Energy
	CO2 Savings		Leave No One Behind		Results-Based Financing
	Economic Development		Mini-Grid		Solar
	Electrification		Nano-Grid		Solar Home/Stand Alone System

FOREWORD

One of the strongest lessons emerging from these two decades is that energy transformation is a process of learning and adaptation.



Rwanda's energy journey over the past two decades is a story of ambition, partnership, innovation and sustained commitment to national transformation.

At the beginning of this journey, Rwanda's energy sector faced significant challenges. Electricity access was very limited, particularly in rural areas, generation capacity was constrained, and the majority of households depended on traditional biomass for cooking. These challenges required more than investment in infrastructure alone. They required new approaches to financing, technology, regulation, private-sector participation, institutional capacity and, above all, strong partnerships aligned with Rwanda's development priorities.

The Government of Rwanda has provided the strategic leadership and policy direction that have enabled this transformation. Over time, our approach has evolved from expanding access to electricity towards ensuring that modern energy becomes a foundation for economic opportunity, improved livelihoods, productive enterprises and better public services. The progress recorded in electricity access and generation capacity demonstrates what can be achieved when national vision is matched by sustained investment, innovation and effective collaboration.

It is within this national journey that the Energising Development (EnDev) Programme has made an important contribution. Since its initial activities in Rwanda and the establishment of its consolidated country portfolio in 2009, EnDev has worked

alongside the Ministry of Infrastructure, national institutions, private-sector actors, civil society and development partners, continuously adapting its support to Rwanda's changing energy priorities. The experience documented in this publication is particularly valuable because it demonstrates that energy development is not achieved through a single intervention or technology. It is built progressively through complementary actions.

The Private Sector Participation in Micro-Hydro Power Project helped demonstrate that private companies could develop, finance and operate grid-connected renewable energy infrastructure. Through technical assistance, blended finance, partnerships and support to the enabling environment, it contributed to opening new pathways for private investment in renewable generation. The Village Grid Results-Based Financing Project subsequently demonstrated that innovative financing mechanisms could help private companies enter Rwanda's emerging mini-grid market. Importantly, the experience also showed that financial incentives alone are not sufficient. Successful energy infrastructure development requires technical capacity, appropriate financing, clear regulation, sound planning, productive demand and effective coordination among government, developers, financiers and development partners.

As access expanded, the focus naturally moved beyond connection itself. The Productive Use of Energy initiatives demonstrated how electricity can become an economic asset—enabling enterprises

to invest in equipment, increase productivity, create employment and strengthen local economies. The experience of rural entrepreneurs reminds us that the ultimate value of energy infrastructure lies not only in the electricity delivered, but in what people and businesses are able to do with it.

The publication also captures an equally important dimension of Rwanda's energy transition: clean cooking. From domestic biogas to improved cooking technologies and eCooking, the interventions documented here demonstrate the importance of addressing affordability, consumer awareness, local manufacturing, market development and the enabling environment. The progress achieved is encouraging, while the remaining challenge of universal access to clean cooking calls for continued innovation and collaboration.

One of the strongest lessons emerging from these two decades is that energy transformation is a process of learning and adaptation. Some approaches have scaled successfully; others have revealed limitations or conditions that must be addressed before wider adoption. These experiences are not setbacks. They are valuable contributions to the knowledge required to design more effective, resilient and sustainable energy programmes in the future.

This is particularly important as Rwanda moves into a new phase of its energy development. Our priorities are increasingly concerned not only with access, but also with reliability, affordability, sustainability, productive use, clean cooking, private investment, local capacity and the ability of the energy system to support Rwanda's ambitions for industrialisation, urbanisation and inclusive economic growth.

The Government of Rwanda therefore deeply values partnerships that go beyond the financing of individual projects and contribute to the development of markets, institutions, skills, technologies and lasting national capabilities. The experience of EnDev illustrates the importance of such long-term partnership: testing new approaches, learning from implementation, adapting to changing circumstances and progressively strengthening the foundations of the energy sector.

As EnDev's work in Rwanda comes to a close, its most important legacy is not limited to the individual projects presented in this publication. Its legacy is also found in the institutions strengthened, businesses supported, markets tested, technologies demonstrated, partnerships established and lessons generated along Rwanda's energy transition.

On behalf of the Ministry of Infrastructure, I would like to express our appreciation to the EnDev partnership, the Government of Germany, the Netherlands, Norway and Switzerland, the European Union and other co-financing partners, as well as GIZ and all implementing partners, private-sector actors, financial institutions, civil society organisations and communities who contributed to this journey.

We look forward to building on these achievements and lessons as Rwanda continues to pursue universal access to sustainable modern energy and to transform energy access into greater opportunity, productivity and prosperity for all.

– Jean Bosco Mugiraneza
Director General for Energy
Ministry of Infrastructure
Republic of Rwanda

FOREWORD

EnDev's work in Rwanda has been characterised by a focus on emerging markets and niches, with a commitment to leaving no one behind.



It is with great pleasure that I present this publication, which marks the culmination of the EnDev journey in Rwanda's energy sector, a journey characterised by remarkable progress and impactful collaborations. Rwanda has emerged as a global leader for realizing modern energy access, showcasing the power of high ambition, firm commitment and strategic partnerships.

Working with Rwanda has been a particularly enriching experience, thanks to the dedication of the Ministry of Infrastructure (MININFRA) and its subsidiaries, who have been steadfast partners demonstrating clear vision and strong ownership. Furthermore, the private sector's ambition to grow and the close collaboration among implementing partners have been integral in delivering many impactful projects in Rwanda.

The strength of the Energising Development (EnDev) programme lies in its systems approach, which focuses on creating an enabling environment alongside partners such as MININFRA, the Rwanda Energy Group (REG), and the Rwanda Standards Board (RSB). We have actively engaged with private sector companies in both the clean cooking and electrification sectors, and have worked with the Energy Private Developers (EPD) association to deliver tangible impacts on the ground. Our efforts have enabled Rwandans to benefit from improved household energy access, to power small and medium-sized enterprises, and to foster business ideas that empower both women and men. The emerging transition to electric cooking has also

positively influenced gender dynamics in homes, while improved cookstoves have delivered on their promise of better health and more efficient cooking.

EnDev's work in Rwanda has been characterised by a focus on emerging markets and niches, with a commitment to leaving no one behind. Through innovative financial instruments such as results-based financing (RBF), we have paired financial support with comprehensive technical assistance. As access to energy increased over the years, our focus has shifted towards ensuring sustainable energy solutions in hard-to-reach markets – solutions that will endure long after the EnDev programme concludes.

This work was made possible by the trust and support of our EnDev donors – first and foremost the consultative group consisting of Germany, the Netherlands, Norway, and Switzerland – as well as the EU Delegation to Rwanda, which co-financed our largest improved cooking project. We also extend our gratitude to the many other donors whose support has been invaluable.

This publication encapsulates the achievements, lessons learned, and stories of transformation that have emerged from our efforts in Rwanda. I invite you to explore these reflections, which underscore the importance of collaboration and innovation in driving sustainable energy access.

– Nathan T. Moore
Country Programme Manager
Energising Development (EnDev)

FOREWORD

Rwanda's ambitious goals for universal energy access, clean cooking, renewable energy, and climate resilience will continue to require strong partnerships and innovative interventions.



Rwanda's remarkable progress in expanding access to sustainable energy has been made possible through strong partnerships between Government, development partners, and the private sector. Since 2016, the collaboration between the Energy Private Developers (EPD) and the Energising Development (EnDev) Programme has demonstrated the value of long-term technical assistance in strengthening energy markets, building private sector capacity, and advancing sustainable energy access.

On behalf of EPD, I extend our sincere appreciation to EnDev for its unwavering partnership and commitment over the years. Our collaboration has been particularly impactful through the Results-Based Financing Projects on solar-home systems and the Reducing Climate Impact Cooking (ReCIC) Project, which strengthened the capacity of businesses producing and promoting clean cooking technologies, particularly efficient and sustainable cooking appliances. These initiatives have supported enterprise growth, encouraged innovation, enhanced market confidence, and reinforced the critical role of the private sector in delivering clean and affordable energy solutions to Rwandan communities.

While the EnDev Programme in Rwanda is coming to a close, the need for continued market development, technical assistance, and private sector support remains greater than ever. Rwanda's ambitious goals for universal energy access, clean cooking, renewable energy, and climate resilience will continue to require strong partnerships and innovative interventions. We therefore hope that this conclusion marks

not the end of our collaboration, but the beginning of a new chapter. EPD hopes to welcome EnDev back to Rwanda with new programmes that will continue supporting the country's energy transition and sustainable economic development.

We sincerely thank the entire EnDev team for their dedication and lasting contribution to Rwanda's energy sector. EPD remains committed to building on this strong foundation and working with all partners to accelerate universal access to sustainable energy for all.

– Serge Wilson Muhizi
Chief Executive Officer
Energy Private Developers
Rwanda



INTRODUCTION

EnDev – Powering Progress: Reflections on Two Decades of Energy-Sector Partnership in Rwanda



In 2009, Rwanda's energy landscape presented an immense challenge: electrification rates stood at just **6 per cent**, and the vast majority of households relied on traditional biomass for cooking and kerosene for lighting. Less than two decades later, the country has achieved an electrification rate of over **88.4 per cent** as of July 2026.

This remarkable transformation has been nationally led. It reflects the Government of Rwanda's long-term strategic vision, sustained public investment, innovative partnerships, and an unwavering commitment to universal electrification. Rwanda established the policy direction and co-defined priorities with development and implementing partners and the private sector, aligning interventions with national development strategies for inclusive development.

But behind these figures lies a broader story of opportunity. Improved access to reliable energy has enabled individuals and families to improve their quality of life, businesses to grow, public services to expand, and communities to build greater resilience. While important challenges remain – particularly in achieving universal access to clean cooking – Rwanda's progress demonstrates how sustained commitment and adaptive partnerships can accelerate change.

Following its initial activities that began in 2006, the Energising Development (EnDev) Programme

established a consolidated country portfolio in Rwanda in 2009 and has accompanied the country on this journey ever since. EnDev's work in Rwanda reflects the country's own energy transition – from expanding access to unlocking the wider benefits of reliable energy. Working alongside the Ministry of Infrastructure (MININFRA) and other government institutions, private-sector actors, civil society organisations, and development partners, EnDev has continuously adapted its support to the country's evolving priorities. Its portfolio has progressed from widening access to electricity to supporting productive uses of energy and advancing cleaner cooking solutions.

EnDev is a global partnership that supports access to climate-friendly, affordable, inclusive and sustainable energy services. The programme, in its current form, is funded by Germany, the Netherlands, Norway and Switzerland, with additional co-funding for activities in Rwanda, including from the European Union. In Rwanda, EnDev has been primarily implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Throughout its history, EnDev has worked with various co-funding partners, implementing organisations, public institutions and private-sector actors.

At its heart, the EnDev programme combines market-based approaches with inclusive development principles to ensure that vulnerable and underserved

populations are not left behind. Across more than two decades of implementation, EnDev has developed and tested innovative approaches, including results-based financing (RBF), that have since been applied across different countries and technologies.

Supporting Rwanda's energy transition

This publication traces how EnDev's portfolio evolved alongside Rwanda's energy transition over the last 20 years. Its chapters explore the approaches tested, the results achieved and the lessons learnt, while capturing the stories of opportunity across three thematic areas: from access to empowerment; turning energy into opportunities; and clean cooking for climate and health.

The theme *from access to empowerment* reflects on the expansion of electricity generation and household access and explores how it laid the foundations for a more inclusive energy sector. The **Private Sector Participation in Micro-Hydro Power (PSP Hydro) for Rural Development** initiative catalysed private investment in micro-hydropower, adding vital generation capacity to Rwanda's grid. RBF initiatives for **solar lighting and village grids** complemented national electrification efforts. Later, **pro-poor subsidies** ensured that the most vulnerable households could also benefit from energy access. **Grid Densification 1.0** targeted poor households in already electrified areas, followed by **Grid Densification 2.0**, which introduced a gender-responsive lens to address disparities in energy access and ensure that women-headed households were not left behind. Rwanda Energy Group (REG) and its subsidiaries, the Energy Development Corporation Limited (EDCL) and the Energy Utilities Corporation Limited (EUCL), guided the alignment and delivery of these interventions.

The second theme, *turning access into opportunities*, focuses on how access to energy can support livelihoods, enterprise development, and local economic growth. The **Productive Use of Energy (PUE)** initiative, implemented in collaboration with the Association of Volunteers in International Service (AVSI) Foundation, demonstrated how electricity could power economic growth and community development at mini-grid sites. **Cooling as a Service (CaaS)** tested innovative models for reducing post-harvest losses in horticulture

value chains. The **Productive Use of Renewable Energy in Agricultural Value Chains (PURE.Ag) Project** brought together Mercy Corps Energy 4 Impact (MC-E4I), the European Cooperative for Rural Development (EUCORD), MoneyPhone, and agricultural cooperatives. It combined solar-powered irrigation and agro-processing with financing, including loan arrangements designed around farmers' production cycles, unlocking new possibilities for smallholder farmers to increase productivity and income.

Finally, *clean cooking for climate and health* addresses one of Rwanda's most persistent challenges. Among its first activities in Rwanda, EnDev supported the **National Domestic Biogas Programme**. Later, through the European Union-co-funded **Reducing the Climate Impact of Cooking (ReCIC) Project**, it worked with SNV on market development and quality assurance. **Results-Based Financing for Refugees (RBF4R)**, implemented with Practical Action, supported access to higher-tier cooking solutions in refugee camps, with assistance tailored to different levels of vulnerability. More recently, the **SCALE.up eCooking** pilot with REG and the Kigali Collaborative Research Centre (KCRC) examined how households used electricity for cooking, how this affected their energy consumption and costs, and whether the market was ready to grow. Together, these initiatives demonstrate the potential of clean cooking to improve health, protect the environment, and strengthen household wellbeing – particularly for women and girls, who bear the greatest burden associated with traditional cooking practices.

As EnDev's work in Rwanda concludes at the end of 2026, the partnerships, institutions, market approaches, and lessons developed over the past two decades continue to inform Rwanda's journey towards universal access to sustainable modern energy.

EnDev Rwanda: At a glance



804,000

people with access to
thermal energy solutions
(cooking).

-CO₂

19,600

tCO₂e mitigated.



72,640

people with access to
electricity.



11

social institutions with
access to modern energy
services.



10,628

people in vulnerable households
reached since 2023.



254

MSMEs with access to
modern energy services.



1 Private Sector Participation in Micro-Hydro Power for Rural Development Project

Strengthening renewable electricity generation through public-private collaboration



1.1 Opening electricity generation to the private sector

In the early 2000s, Rwanda's energy sector faced significant constraints that limited economic growth and rural development. Electricity generation capacity remained low, access rates were among the lowest in the region, and the sector was predominantly state-owned, with limited private-sector participation. Between 2004 and 2006, prolonged droughts further reduced hydropower production, triggering widespread load shedding¹ and exposing the vulnerability of the country's energy system. Subsequent data highlight the scale of the challenge at the time. In 2009, only 6 per cent of Rwanda's population had access to electricity, with access in rural areas significantly lower.²

Several structural barriers hindered the sector's expansion. Small-scale renewable energy projects struggled to attract investment because of high upfront costs, limited access to commercial finance, and the absence of proven business models. The regulatory and institutional framework

for independent power producers (IPPs) was still evolving, creating uncertainty for potential investors. At the same time, local private developers had limited technical and financial capacity to develop and operate energy infrastructure.

In response to the energy crisis, the Government of Rwanda introduced a new Energy Policy in 2004, reaffirming the role of private-sector investment and management in developing the energy sector within a regulatory framework that protected consumers while enabling investors to recover costs.³ This policy marked a strategic shift towards a more market-oriented energy sector and laid the foundation for stronger public-private collaboration.

Building on this policy direction, national institutions – including the Ministry of Infrastructure (MININFRA), the Rwanda Utilities Regulatory Authority (RURA), the Rwanda Energy Group (REG) and its subsidiary Energy Development Corporation Limited (EDCL), as well as the Rwanda Development Board (RDB) – strengthened the enabling environment for private investment. These efforts focused on developing

1. Energypedia, 'Rwanda Energy Situation', accessed 18 May 2026. 

2. World Bank, Rwanda: *Extending Access to Energy—Lessons from a Sector-Wide Approach* (Washington, DC: World Bank, 2013). 

3. United Nations Economic Commission for Africa and RES4Africa Foundation, *Regulatory Review of the Electricity Market in Rwanda: Towards Crowding-in Private Sector Investment* (Addis Ababa and Rome: United Nations Economic Commission for Africa and RES4Africa Foundation, 2022). 

legal and regulatory frameworks, establishing licensing procedures, and introducing targeted incentives to attract local and international investment in small-scale hydropower projects.

It was within this context that the EnDev Private Sector Participation in Micro-Hydro Power for Rural Development (PSP Hydro) Project was launched in 2006. The initiative represented Rwanda's first structured effort to mobilise commercial private-sector participation in micro-hydropower development.

The project addressed a critical market gap: the absence of private investments in small-scale hydropower generation. Through a public–private partnership (PPP) approach, PSP Hydro supported IPPs to develop, finance and operate micro-hydropower plants (MHPPs), supplying electricity to the national grid through long-term Power Purchase Agreements (PPAs). By leveraging private capital, technical expertise, and management capacity, the project aimed to increase private-sector involvement in a field previously led primarily by the public sector.

EnDev also worked with national stakeholders to strengthen the broader policy and regulatory environment for renewable energy development. This included support to improve regulatory oversight, standardise PPAs, strengthen environmental standards for power generation, and introduce feed-in tariff mechanisms. Together, these measures helped build investor confidence and establish a stronger foundation for private investment in renewable energy.



1.2 Combining investment support with market development

The PSP Hydro Project was designed to catalyse private-sector participation in Rwanda's small-scale hydropower sector. It worked closely with national institutions to ensure that developers operated within a clear regulatory framework and complied with the required technical, environmental, and financial standards. The project aimed to demonstrate that privately developed renewable electricity generation could become a commercially viable business model, while reducing reliance on state-led infrastructure development.

Infobox | Generation as a foundation for access

Most EnDev interventions focus directly on expanding access to modern energy services for households, social institutions and businesses. PSP Hydro took a different but complementary approach by supporting electricity generation. The project helped private developers add renewable generation capacity to Rwanda's national grid.

This made the PSP Hydro Project unusual within the wider EnDev portfolio: it worked further upstream in the electricity system, addressing the supply, financing and regulatory conditions needed to support long-term electrification. By demonstrating that private companies could develop and operate grid-connected hydro plants, the project contributed to the broader foundation on which electricity access and productive use depend.

The project focused on three interlinked areas:

- providing targeted technical and financial support to private developers;
- strengthening institutional and sectoral capacity; and
- facilitating the transition of selected public hydropower plants to private management, where this could improve operational efficiency and commercial viability.

Private companies received support throughout the project development cycle, including assistance with company registration, environmental and social impact assessments, and the acquisition of key licences, permits and agreements. These included PPAs with REG, concession agreements with MININFRA, generation licences from RURA, environmental approvals, and water-use permits.

In parallel, the project provided technical oversight to ensure compliance with the required standards. Developers submitted detailed project proposals supported by comprehensive technical studies, including hydrological, topographical, geological, and geotechnical assessments. Once these

requirements were fulfilled, projects progressed through a structured implementation process comprising grant agreements, financial close, phased disbursement, progress reporting, site visits, and commissioning support. Independent audits conducted at project completion reinforced financial accountability and compliance.

The project evolved through distinct phases, reflecting the growing maturity of Rwanda's renewable energy market and the increasing capacity of the private sector.

Phases One and Two: establishing a market for private hydropower development

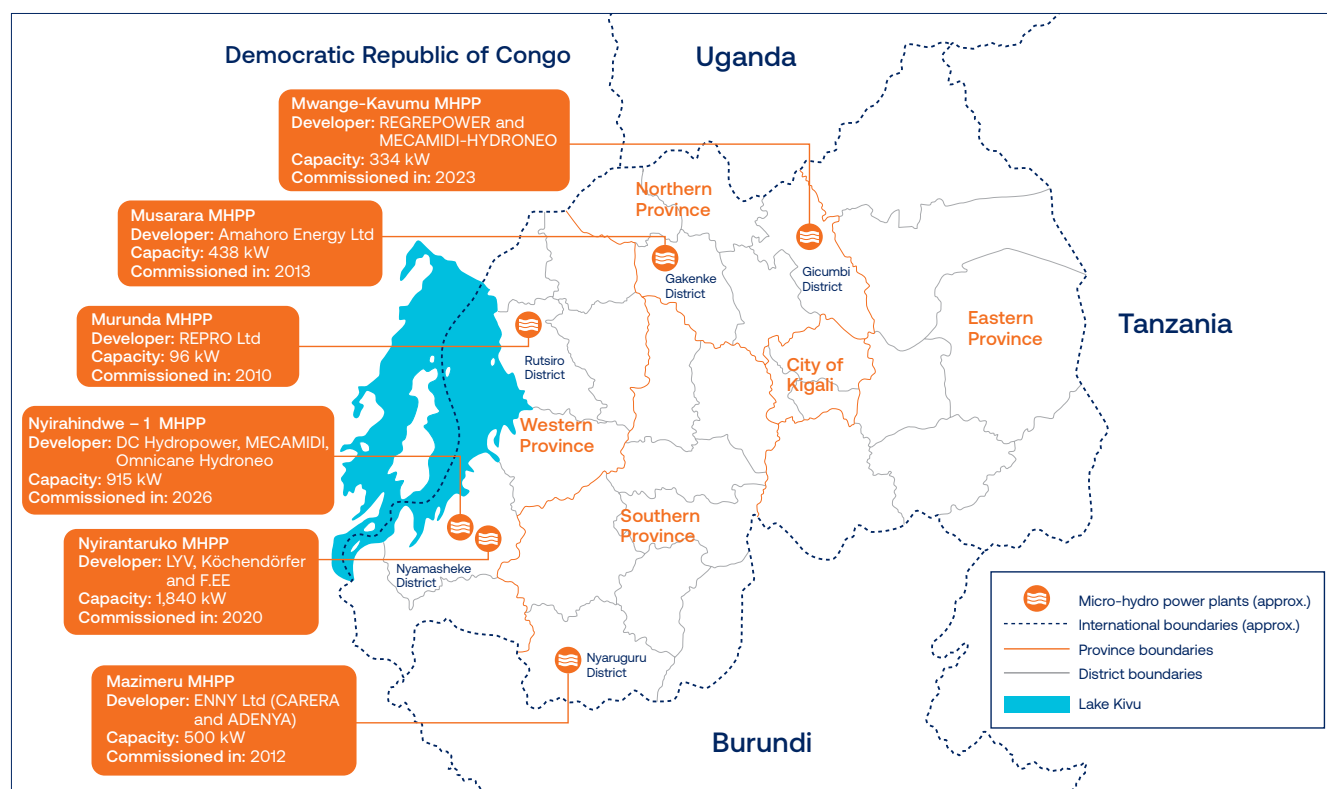
The first two phases, implemented between 2006 and 2014, focused on opening the emerging hydropower market to private developers. At this stage, most local private developers had limited experience in energy infrastructure, while commercial banks remained cautious about financing

renewable energy projects. The project, therefore, concentrated on reducing barriers to entry.

Developers received support to prepare bankable business plans and access financing through a blended structure. Financing typically comprised approximately 50 per cent grant funding from EnDev, 35 per cent bank loans, and 15 per cent equity contributions from the developers. This approach played a critical role in de-risking investments and demonstrating the commercial viability of small-scale hydropower.

During these phases, three hydropower projects were successfully commissioned. The first was Murunda MHPP in Rutsiro District, Western Province. With an installed capacity of 96 kilowatts (kW), it became Rwanda's first privately operated micro-hydropower plant. This was followed by the Mazimeru MHPP in Nyaruguru District, Southern Province, with an installed capacity of 500 kW, and the Musarara MHPP in Gakenke District, Northern Province, with an installed capacity of 438 kW.

Micro-hydro power plant project sites supported by the EnDev PSP Hydro Project



Phase Three: introducing competitive project development

As the sector matured, PSP Hydro transitioned towards a more structured and competitive delivery model. Phase Three, which began in 2014, marked a strategic shift towards closer collaboration with EDCL, while the project increasingly assumed a facilitation and technical backstopping role.

A key innovation was the introduction of a competitive greenfield tendering process, implemented jointly with EDCL. Prequalified companies were invited to bid for more than 60 sites for which feasibility studies had already been completed. The call for expressions of interest attracted 20 companies, of which 10 were shortlisted to participate in the tendering process.

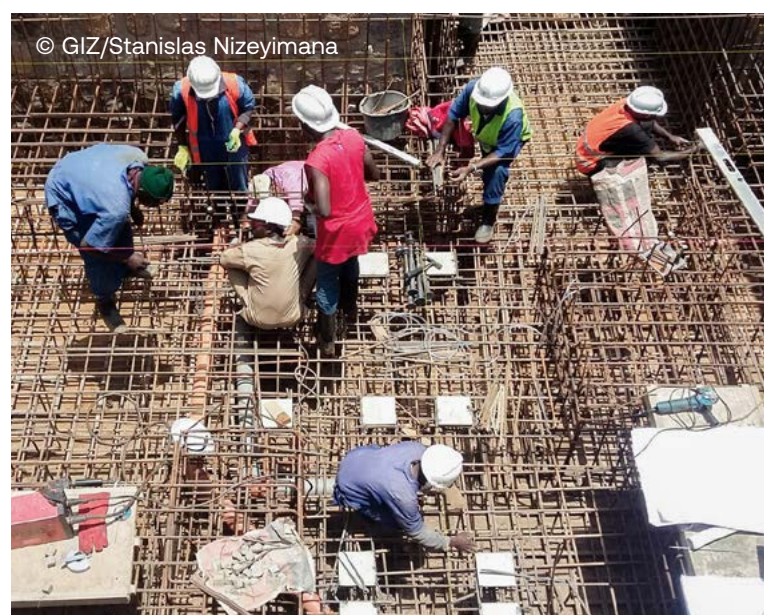
Developers submitted legal, technical, and financial proposals through a competitive evaluation process. Successful bidders were awarded project sites and entered into PPAs with the national utility. To strengthen financial viability, EnDev provided Viability Gap Funding (VGF), with grant levels determined through detailed analysis of the capital and operational expenditure projections submitted by developers. The competitive approach improved transparency and enabled grant support to respond to each project's verified financing gap.

The first project completed under this phase was the Nyirantaruko MHPP in Nyamasheke District, Western Province. Commissioned by the national utility in 2020, the plant has an installed capacity of 1,840 kW. This was followed by the Mwange-Kavumu MHPP in Gicumbi District, Northern Province, with an installed capacity of 334 kW. Nyirahindwe 1 MHPP in Nyamasheke District, also in the Western Province, was subsequently commissioned in June 2026 with an installed capacity of 915 kW.

Infobox | Viability Gap Funding (VGF)

VGF is grant support that closes the gap between a project's development costs and the level of commercial return required to attract private investment.

Under PSP Hydro, hydropower projects could be economically justified and technically feasible but remain commercially unattractive because of high upfront costs and long payback periods. EnDev assessed each project's capital and operating costs and calculated the minimum VGF required to make the investment financially viable. This tailored approach limited unnecessary subsidy while retaining the developer's commercial responsibility for the investment.



1.3 Results and impact of the PSP Hydro Project

Adding renewable electricity to the national grid

The PSP Hydro Project contributed to Rwanda's renewable energy sector by strengthening private-sector participation, mobilising commercial finance, supporting infrastructure, and improving the enabling environment for investment in small-scale hydropower development.

Beginning with the commissioning of Murunda MHPP in 2010, the project demonstrated that private companies could develop and operate grid-connected renewable energy infrastructure in Rwanda. Subsequent investments expanded generation through Mazimeru, Musarara, Nyirantaruko, Mwange-Kavumu and Nyirahindwe 1. Together, the six supported plants represent approximately 4.1 megawatts (MW) of installed generation capacity connected to the national grid.

The development of small-scale hydropower complemented Rwanda's wider investments in renewable energy, including solar, and supported the diversification of the country's electricity supply.

Electricity generated by PSP Hydro-supported plants feeds directly into the national grid rather than serving isolated off-grid communities. According to the World Bank data, Rwanda's electricity generation capacity increased from approximately 76 MW in 2009 to 467 MW in 2026,⁴ while electricity access rose from less than 10 per cent to 88.4 per cent as of July 2026 over the same period. PSP Hydro contributed to this wider national expansion by increasing the supply of grid-connected renewable electricity generated in rural areas. Although the project did not directly connect households, schools, health centres or businesses, it strengthened the national electricity system that supports wider access and productive uses of energy.

Unlocking local commercial financing

One of the project's most significant contributions was its role in mobilising local commercial finance for renewable energy infrastructure.

At the outset, Rwanda's financial sector had limited experience of financing hydropower projects. Developers were expected to mobilise funding through a combination of equity, grants, and commercial loans, but access to credit remained a major constraint. Early efforts involved the Development Bank of Rwanda (BRD), which financed consultancy services to support the preparation of bankable business models, although it did not ultimately provide direct project financing.

Through blended-finance mechanisms and sustained engagement with financial institutions, PSP Hydro helped demonstrate the sector's commercial potential. For the first time, Rwandan commercial banks began extending loans to micro-hydropower developers, signalling growing confidence in renewable energy investments and the de-risking mechanisms demonstrated by EnDev.

Bank of Kigali, I&M Bank Rwanda, and Guaranty Trust Bank Rwanda were among the institutions that financed hydropower projects. Although lending conditions remained stringent and generally required substantial collateral backed by assets in Rwanda, this entry of commercial lenders marked an important shift in the financial sector's willingness to support renewable energy infrastructure.

Strengthening the enabling environment

PSP Hydro also contributed to strengthening Rwanda's regulatory and institutional framework for private-sector participation in energy generation. Working with national stakeholders, the project supported the development and standardisation

Infobox | How blended finance opened the door to commercial lending

Hydropower developers faced two interconnected barriers: projects required substantial upfront investment, while local banks had limited experience of assessing their technical and commercial risks.

PSP Hydro combined grant funding, commercial loans, and developer equity. The grants did not replace private investment. They reduced specific financing constraints so that developers could contribute their own capital and mobilised commercial lending.

As supported plants entered operation, developers and financial institutions gained practical experience and greater confidence in financing privately developed hydropower in Rwanda.

4. World Bank, *NELSAP: Regional Rusumo Falls Hydroelectric and Multipurpose Project: Project Information Document (PID)*, Report No. 59451 (Washington, DC: World Bank, 2011); World Bank, *Scaling Up Access to Electricity: The Case of Rwanda* (Washington, DC: World Bank, 2014); World Bank, *National Energy Compact for the Republic of Rwanda* (Washington, DC: World Bank, 2026).

of licensing procedures, model PPAs, and environmental and regulatory requirements for hydropower development. In addition, feed-in tariff mechanisms improved revenue predictability and reduced investment uncertainty.

These measures helped reduce transaction costs, improve transparency, and strengthen investor confidence. They also supported more efficient project preparation and implementation, creating a more stable enabling environment for renewable energy investment.

Advancing efficient private management of hydropower assets

Beyond developing new infrastructure, PSP Hydro contributed to the transfer of selected small-scale hydropower assets from public to private management. In 2015, five publicly owned MHPPs were transferred to private operators. This transition demonstrated the potential for private management to improve operational efficiency, plant performance, and long-term financial sustainability, particularly for smaller hydropower facilities.

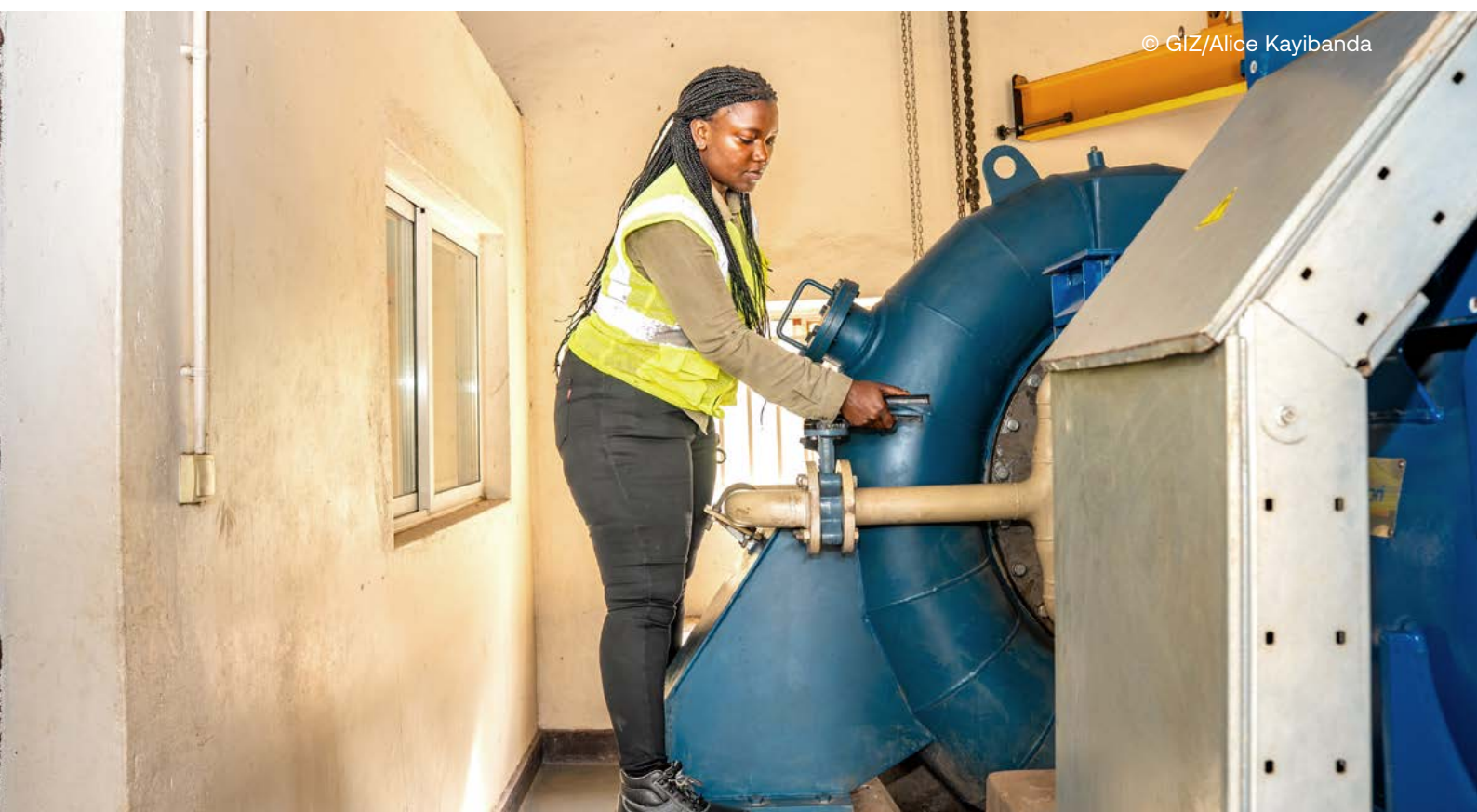
More broadly, the project showed that private companies could successfully develop, finance, and operate energy infrastructure within Rwanda's evolving regulatory environment while public institutions retained their regulatory and oversight responsibilities.



‘Since 2006, EnDev has played an important role in advancing Rwanda’s energy transition by strengthening private sector participation in renewable energy generation.

Through the PSP Hydro Project, public-private partnerships have enabled small and medium-sized companies to develop and operate micro-hydropower plants through targeted technical and financial support. Together, with strong national commitment and partner collaboration, these efforts have contributed to Rwanda's remarkable progress in expanding electricity access from 6 per cent in 2009 to more than 86 per cent today, while positioning energy as a driver of economic growth and rural development.’

– Mr Theoneste Higaniro,
Director of Energy Generation and
Transmission Department, EDCL/REG



Building capacity across the sector

PSP Hydro's results extended beyond the plants it financed. Through project preparation, competitive tendering, regulatory support, audits and technical oversight, the project strengthened the capacity of developers, financial institutions, and public-sector partners.

Developers gained practical experience in preparing feasibility studies, managing construction, complying with regulatory requirements, and operating grid-connected infrastructure. Public institutions gained experience in structuring tenders, assessing proposals, negotiating PPAs, and overseeing privately implemented generation projects. Financial institutions also gained experience in evaluating the commercial and technical risks associated with renewable energy infrastructure.

Adapt to regulatory and institutional change

Phase Three coincided with significant institutional reforms in Rwanda's energy sector, including the restructuring of the former Energy, Water and Sanitation Authority (EWSA) into REG and its subsidiaries, including EDCL.

Although these reforms ultimately strengthened the sector, they created short-term regulatory uncertainty. A major challenge arose when the Renewable Energy Feed-in Tariff (REFIT) expired in March 2015 without an immediate replacement mechanism. This created uncertainty around tariff structures and affected the financial viability of several projects, requiring developers to revisit financial assumptions and contractual arrangements.

To address this, the project worked closely with REG and EDCL to develop a harmonised interim solution for all tender participants. Financial models were reassessed and VGF requirements adjusted across the project lots. This collaborative and flexible approach allowed project development to continue.

Long infrastructure-development cycles will inevitably encounter policy or institutional change. Projects must therefore combine clear rules with sufficient flexibility to adjust financing and contractual arrangements without compromising transparency or fairness.

Strengthen governance through project-level safeguards

As projects increased in scale and complexity, the need for stronger governance mechanisms became evident.

Developers were required to establish special purpose vehicles (SPVs) for individual projects. This created a clear legal, financial, and operational separation between each project and its parent company, improving transparency and safeguarding project assets. The use of SPVs also strengthened financial reporting and compliance, increasing confidence among lenders and other stakeholders.

Clear project-level governance is particularly important when public grants, private equity and commercial loans are combined. It makes fund use easier to trace, protects the underlying assets, and improves project bankability.



1.4 Lessons from the project

Align grant design with market maturity

During the first two phases, grant financing was designed on the assumption that local companies already had the technical and managerial capacity required to develop hydropower projects. In practice, many developers were entering the sector for the first time and faced significant technical, operational, and financial management challenges. This affected project preparation and increased compliance risks.

In response, the project introduced a more targeted VGF model during Phase Three. Grant allocations were determined through detailed verification of the capital and operational expenditure projections submitted through the competitive bidding process. This linked grant support more closely to each project's verified financing needs, improving transparency and accountability while reducing the risk of misallocation.

Financial support must therefore evolve with the market. Early-stage developers may require broader assistance to enter a new sector, while a more mature market can support competitive instruments that target specific financing gaps.

Leverage partnerships through joint ventures

Joint ventures between local and international companies proved particularly effective in improving project delivery. Local partners contributed knowledge of Rwanda's regulatory environment, operational context, and community dynamics, while international partners brought specialised technical expertise and access to global best practices.

Several PSP Hydro-supported projects were developed through such partnerships:

- Nyirahindwe MHPP: DC Hydropower, Rwanda, and MECAMIDI, France
- Nyirantaruko MHPP: LYV, Rwanda, and Köchendorfer and F.EE, Germany
- Mwange-Kavumu MHPP: REGREPOWER, Rwanda, and MECAMIDI, France
- Mazimeru MHPP: ADENYA, Rwanda, and CARERA, Germany

These partnerships reduced operational risks and facilitated knowledge transfer. Their value extended beyond the delivery of individual plants by contributing to the development of a more capable domestic private sector.

Invest in commercial capacity for long-term sustainability

PSP Hydro demonstrated that sustainable sector development requires more than infrastructure financing. Strengthening the commercial and administrative capacity of participating companies proved equally important.

The project used external audits not only as a compliance mechanism, but also as a practical capacity-development tool. Audits provided developers with recommendations for improving financial management systems, accounting practices, and internal controls. For example, recommendations from an audit of the Muhembe Project led to a comprehensive overhaul of accounting procedures, resulting in stronger financial governance and improved reporting standards.

Infrastructure investment is unlikely to remain sustainable if the companies responsible cannot manage finance, maintain accurate records, or comply with contractual obligations. Technical and financial support should therefore be accompanied by continuous organisational capacity development for projects to remain commercially viable in the long run.





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Success story

A current for change: How private hydropower helped transform Nyabimata

In the hills of Nyabimata Sector in Nyaruguru District, access to electricity was once a major barrier to development. Households relied on limited energy sources, businesses faced high operating costs, and public institutions such as schools and health centres functioned without reliable electricity.

For Hubert Heindl, a German renewable energy investor with longstanding ties to Rwanda, the challenge was clear: rural development required more than short-term interventions. Communities needed reliable energy infrastructure that could support economic and social development over the long term.

Working with the local farmers' organisation, the Association pour le Développement de Nyabimata (ADENYA), Hubert helped establish Energie de

Nyaruguru (ENNY Ltd), an SPV created to develop a micro-hydropower plant in the area. The initiative became one of the earliest private hydropower projects supported by EnDev's PSP Hydro Project.

Construction of the 500 kW Mazimeru MHPP began in 2009 in Bigugu Cell, Nyabimata Sector. The plant was commissioned in 2012 and connected to Rwanda's national grid.

PSP Hydro provided technical support for preparing technical assessments and the business plan, alongside grant funding. Private equity and a commercial loan from the Bank of Kigali provided additional financing.

At the time, securing financing for renewable energy projects remained difficult. Rwanda's private energy

market was still emerging, and commercial banks had limited experience financing hydropower investments.

For Hubert, the collaboration with EnDev provided more than financial support:

- ▶ ‘The collaboration with EnDev introduced a blended finance approach that combined public grants with private investment. At the same time, the public-private partnership (PPP) model allowed us to focus on technical implementation while EnDev supported engagement around regulatory and institutional processes.’

The project was among Rwanda's first privately implemented hydropower projects within the country's liberalised energy market. Beyond adding renewable electricity generation capacity to the national grid, the investment demonstrated that private developers could successfully deliver energy infrastructure in rural Rwanda.

Hubert and his team also focused on the plant's long-term performance and reliability, including the installation of durable German turbine technology.

- ▶ ‘Our commitment to the project helped demonstrate that private investment could support both reliable renewable energy generation and long-term market development. We deliberately shared our business experience and operational approaches with national stakeholders as new regulatory systems were being established.’

The impact extended beyond the hydropower plant. Connecting the facility to the national grid required the national utility to expand electricity infrastructure into the surrounding area. This brought the grid closer to nearby communities and enabled households to apply for electricity connections.

Public services also benefited. Nyabimata School and the local health centre gained access to electricity, while the nearby Nshili Tea Factory transitioned from diesel generators to grid electricity. According to Hubert, access to electricity also helped connect the remote areas more closely with the region's wider development:

- ▶ ‘Through EnDev's support, we demonstrated the reliability of micro-hydropower and helped extend the national grid into a remote and rural area. This created social, economic, and



Hubert Heindl

infrastructural benefits linked to access to clean and renewable energy.’

More than a decade after commissioning, the ENNY Project continues to demonstrate how public-private collaboration can support renewable energy development in underserved areas. Looking ahead, Hubert believes future renewable energy programmes should continue strengthening the broader investment environment for private developers:

- ▶ ‘Future support could focus more strongly on strategic market instruments, such as guarantees that improve access to loans and affordable financing, alongside mechanisms that strengthen dialogue and regulatory stability for private developers.’

ENNY's experience reflects a central objective of PSP Hydro: to show that private-sector participation in electricity generation can contribute not only to the national energy system, but also to wider rural transformation. ■

2 Village Grid Results-Based Financing Project

Building Rwanda's early private mini-grid market



2.1 Opening new pathways for rural electrification

When EnDev introduced the Village Grid (VG) Results-Based Financing (RBF) Project, Rwanda's mini-grid sector was still in its early stages of development. Privately run mini-grids, operating independently of the national grid, had not yet been established in the country. This made mini-grids a new area for private-sector participation in off-grid electrification.

At the same time, Rwanda was undergoing major energy-sector reforms. In 2014, the former state-owned utility, the Energy, Water and Sanitation Authority (EWSA), was transformed into the Rwanda Energy Group Ltd (REG), a commercially operated state-owned enterprise. In 2016, the Ministry of Infrastructure (MININFRA) published the Rural Electrification Strategy (RES), while the Rwanda Utilities Regulatory Authority (RURA) introduced a simplified licensing regime for off-grid renewable systems. These reforms provided a supportive framework for private investment in mini-grid development.

Rwanda's electricity access expanded significantly during this period. Between 2014 and 2020,⁵

national electricity access increased from 19 per cent to 59 per cent. This progress reflected the Government of Rwanda's commitment to universal access and its efforts to combine grid expansion with off-grid solutions.

However, off-grid electrification continued to face several barriers. Many rural households had limited ability to pay for electricity services. Demand in off-grid areas remained low, particularly where productive uses of electricity were underdeveloped. Private companies had limited experience in mini-grid development, while financial institutions were hesitant to finance a sector they did not yet understand. Regulatory procedures were still evolving, and companies often struggled to access affordable finance for project preparation, construction, and operation.

Against this backdrop, the EnDev Village Grid RBF Project sought to test whether results-based incentives could help private companies enter Rwanda's mini-grid market. The project aimed to support first movers, demonstrate technical and financial viability, and generate practical experience for companies, financial institutions, and public-sector actors involved in rural electrification.

5. Rwanda Energy Group, 'Electricity Access', accessed 25 May 2026. ↗



2.2 Testing RBF for private mini-grid development

The Village Grid RBF Project formed part of the EnDev RBF Facility, co-funded by the United Kingdom Department for International Development (DFID). Rwanda was among the first countries to pilot the RBF approach under this facility. The project was implemented by GIZ, with Urwego Finance (formerly Urwego Opportunity Bank) serving as fund manager from 2014 until the end of its contract in 2019.

The project aimed to increase off-grid electricity connections through privately developed mini-grids in areas where the national grid extension was not planned in the short to medium term. Rather than financing infrastructure directly, the project tested whether performance-based incentives could encourage private investment in rural electrification, while reducing delivery risks for public funders.

This approach shifted implementation responsibility to the private sector. Developers were free to determine how best to achieve the agreed results, while the project provided financial incentives, technical assistance, and coordination support. The model was designed to encourage private-sector ownership, reduce delivery risks for public funders, and reward companies that successfully extended electricity access to underserved rural communities.

The project also recognised that the long-term viability of mini-grids depends not only on household connections but also on productive and institutional demand. From the outset, the VG RBF therefore considered electricity access for micro-, small-, and medium-sized enterprises (MSMEs), as well as social institutions. This focus later informed EnDev Rwanda's broader work on productive energy use and contributed to the design of the Productive Use of Energy Project. ([Read more about the PUE Project, page 74](#)).

Combining financial incentives with technical assistance

Although the RBF mechanism was built around financial incentives, implementation quickly showed that incentives alone would not be sufficient in such a nascent market. International companies were cautious about entering Rwanda's mini-grid

Infobox | What is Results-Based Financing (RBF)?

RBF is a funding approach in which payments are made only after pre-agreed results are achieved and verified. It shifts the focus from inputs to outcomes, driving efficiency and accountability in project implementation. In the energy access sector, RBF can encompass supply-side and demand-side incentives.

Supply-side subsidies: Companies or organisations receive financial support based on successfully delivering energy products. Payments are tied to measurable outcomes, such as the number of units sold or connections established, encouraging market expansion.

Demand-side subsidies: Companies receive financial incentives for each verified sale of an energy product or service, provided they pass on a mandatory price reduction to end users. This helps bridge the affordability gap and makes energy solutions accessible to more people. By aligning incentives with measurable results, RBF helps to unlock markets, build sustainable business models, and ensure impact.

sector because the regulatory environment was still evolving. Local companies, meanwhile, had little or no experience in developing, financing, and operating mini-grids.

EnDev therefore complemented the RBF mechanism with targeted technical assistance. In collaboration with other development partners, EnDev supported the Government of Rwanda in improving investment conditions for mini-grid development. It also supported companies in preparing bankable project proposals, estimating demand, developing financial models, and modelling tariff structures.

This combination of RBF and technical assistance was critical. The financial incentive helped reduce the viability gap, while technical support helped companies prepare projects that could meet regulatory, technical, and commercial requirements.

Structuring the RBF mechanism

The VG RBF combined performance-based incentives with independent verification. The general principle of the RBF model was that payments were made against predefined and independently verified results, primarily the number of household connections achieved.

Private developers first applied for support and were assessed against technical, financial, and regulatory criteria. Successful applicants then secured financing, constructed and commissioned the mini-grid, and connected customers. They received an initial incentive after successful commissioning and verification, followed by additional operational incentives linked to maintaining active customer connections and service quality over one year. The RBF contract could also be used to help leverage additional financing during project implementation.

The mechanism brought together four key actors: EnDev as the project implementer and provider of incentives; Urwego Finance as the local fund manager responsible for contracting and disbursements; independent verification agents who verified company claims before payments were released; and private developers who built and operated the mini-grids.

EnDev also worked closely with MININFRA, REG, the Energy Development Corporation Limited (EDCL), RURA, and other development partners. This coordination was essential, as the mini-grid sector required clear institutional procedures, regulatory alignment, and strong communication between government, companies, and financiers.

Selecting eligible companies and sites

The project targeted private-sector developers interested in investing in Rwanda's emerging mini-grid market. Through six calls for proposals issued between 2014 and 2017, companies submitted applications demonstrating the technical, financial, and commercial viability of their proposed projects.

Eligible projects included new hydro- and solar-powered mini-grids of up to 100 kW, and the rehabilitation or expansion of existing systems. Applicants were also required to demonstrate that proposed sites were located in off-grid areas and met all relevant regulatory and environmental requirements.

Designing the incentive structure

The incentive structure was designed to reduce the financial risks associated with developing mini-grids while ensuring that the companies retained

The EnDev Rwanda Village Grid RBF model



commercial ownership and accountability. Total incentives, including commissioning and quarterly payments, could not exceed 70 per cent of capital expenditure, requiring developers to finance the remaining share through equity or debt. This balance between private investment and performance-based incentives helped improve project viability without over-subsidising development.

Addressing the pre-commissioning challenge

Because RBF payments were made only after verified results, participating companies had to pre-finance project development and construction. This proved to be one of the most significant barriers.

Rwanda's financial sector was becoming increasingly diversified, but commercial banks still mainly financed traditional sectors with short-term lending needs. Mini-grid developers faced several challenges, including limited understanding of the

energy access sector among financial institutions, high collateral requirements, high interest rates, and limited availability of long-term financing.

To address this barrier, EnDev engaged with the Scaling-Up Renewable Energy Programme (SREP) and the Renewable Energy Fund (REF), implemented through the Development Bank of Rwanda (BRD). The REF included a direct financing window for mini-grid developers and was intended to provide bridge financing before RBF incentives were disbursed.

Although implementation timelines did not fully align and no VG RBF mini-grid received REF financing during the project period, this coordination was important. It demonstrated the need for complementary financing instruments and informed later efforts to combine RBF with debt financing for off-grid energy access.





2.3 Results and impact of the VG RBF Project

Demonstrating private-sector participation in mini-grids

The VG RBF Project demonstrated that private companies could develop and operate mini-grids in Rwanda. Four companies successfully commissioned projects, resulting in one hydro mini-grid, two solar AC mini-grids and 22 solar DC nano-grids.

The project generated strong private-sector interest. Across six calls for proposals, 52 mini-grid applications were received. Applicants included both local developers and international companies registered in Rwanda. Although many had limited experience in mini-grid development, application quality improved over time.

This improvement reflected two important developments. First, the project's support helped companies strengthen their project proposals and business models. Second, during the early stages of implementation, Rwanda's evolving off-grid policy and regulatory framework initially increased the attractiveness of the mini-grid sector, encouraging more experienced companies to enter the market. This momentum later declined as national grid expansion reduced the number of viable off-grid sites.

Expanding electricity access for households, enterprises, and institutions

The VG RBF supported access to electricity for rural households, enterprises, and social institutions. Customer surveys conducted using the EnDev Survey Tool – a web-based application for creating, managing, processing, and analysing surveys – showed that electricity access improved living conditions.

Many households reported better lighting, improved phone charging, increased reading time for students, and greater safety. The surveys also showed that most customers reported lower household energy spending after connection, with average energy expenditure falling by 63 per cent among surveyed customers. However, a small share of customers also reported increased energy-related spending, reflecting that electricity can enable new uses and higher levels of service.



'When electricity arrived in our village, it brought reliable lighting, cleaner living conditions, and access to electrical appliances. But it also connected us in ways we had never imagined.'

Today, my family gathers every evening to watch the news together, and neighbours often join us. Through our television, we stay informed about what is happening across Rwanda and beyond. Our home has become a place where people gather to share information, exchange ideas, and simply enjoy each other's company. Electricity has brought us not only light, but also a stronger sense of connection with one another and with the wider world.'

**– Théogène Dusingizimana,
Rwimbogo Village, Gatsibo District.**

Beyond household access, the project supported electricity for small businesses and social institutions. Business owners reported longer operating hours after gaining access to electricity. This was particularly important because household electricity consumption in mini-grid areas is often low and concentrated in the evening. Enterprises, by contrast, can create daytime demand and strengthen the financial viability of mini-grid operations.

Supporting early mini-grid developers

The project supported four companies with different technologies and business models.

Energy and Construction Systems (ECOS)

developed the Nyakiramba mini-grid, an 11-kW hydropower plant in Muhanga District, Southern Province. Commissioned in December 2016, it was the first mini-grid supported by the VG RBF Project. The mini-grid connected households, enterprises



© GIZ/Alice Kayibanda

Testimonial

Electricity gave me the confidence to become an entrepreneur

At 21 years old, Rebecca Nzayisenga balances family life while running two businesses in Rutenderi, Gatsibo District. Reliable electricity allowed her to turn an idea into a livelihood.

Before the village mini-grid was installed, Rebecca relied on a small solar kit that provided only limited lighting. Running a business after dark was difficult, and opportunities to expand were limited.

With access to reliable electricity, she opened a retail shop and invested in a poultry business with 200 chickens. Today, she keeps her shop

open later into the evening, increasing her income while balancing work with caring for her young child. Electricity has also made everyday life at home easier by letting her use appliances such as an iron and a rice cooker, saving time on daily tasks.

Reflecting on the change, Rebecca says:

► 'Electricity has done more than provide light. It has helped me start my business, increase my income, and build a better future for my family.'



and social institutions. ECOS became one of the first private companies in Rwanda to construct and operate a commercial hydro mini-grid, including a distribution grid that aligned with the national Electricity Access Rollout Programme (EARP) Reticulation Guidelines.

The project also supported ECOS in accessing financing from Société Mutuelle de Garantie et de Financement (SMGF) Limited, a local SME fund, by using the RBF contract as a form of guarantee. This demonstrated how RBF contracts could help reduce perceived financing risks for lenders.

However, the mini-grid later ceased operations after repeated flooding severely affected its functionality. Although EnDev supported partial rehabilitation after the initial damage, the developer lacked the financial capacity to fully restore and sustain the system. Insufficient electricity demand further weakened the business case. The national grid was later extended to surrounding households, and the site now primarily serves as a training and educational facility.

MeshPower developed and extended 22 solar DC nano-grids in remote villages in Eastern Rwanda. These easy-to-install systems connected households and small businesses, and offered an innovative solution for smaller remote villages where conventional mini-grids were less suitable. MeshPower's solar DC nano-grids used smart load and metering technologies, allowing for web-based management of generation and distribution.

Some of the nano-grids later ceased operations after the national grid expanded into areas previously served by the systems. This experience illustrates both the benefits and risks of off-grid electrification in a rapidly evolving national electrification context.

Absolute Energy developed the Rutenderi mini-grid, a 50 kWp solar hybrid PV-diesel system in Gatsibo District. Commissioned in May 2020, the project combined electricity with a rural development approach. Absolute Energy worked with partners, including the Interuniversity Centre for Sustainable Development at the Sapienza University of Rome, the AVSI Foundation, and Energy 4 Impact, to identify and support local businesses.

The project placed particular emphasis on productive energy use. Supported activities included grocery shops, bakeries, popcorn production, grain milling, welding, and carpentry.

Equatorial Power developed the Gakagati mini-grid, a 120 kWp solar PV AC system in Nyagatare District. The company applied a business model combining renewable energy access, productive use, and clean water services. The system used the 'Infinity Grid' technology developed by Zola Electric, a modular decentralised system with generation hubs that can be scaled as community demand increases.

The initial project plan foresaw connecting a large number of rural customers, but implementation faced challenges linked to the COVID-19 pandemic, including delays, reduced mobility, and disruptions to project delivery.



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Reflection

Building a business for rural electrification

When Absolute Energy Rwanda began developing the Rutenderi mini-grid in Gatsibo District, the goal extended beyond bringing electricity to an off-grid community. The company sought to demonstrate that renewable energy mini-grids could also stimulate local economic activity and improve livelihoods in areas where extending the national grid was not yet feasible.

The Rutenderi mini-grid was designed to provide reliable electricity to households, businesses, public institutions, and community services, while supporting Rwanda's ambition to achieve universal access to electricity. From the outset, productive use of energy formed part of the project's vision, recognising that electricity creates the greatest impact when it enables people to earn an income while improving their quality of life.

Developing the project was not without challenges. Limited access to affordable finance, high upfront infrastructure costs, uncertainty around future electricity demand, and an evolving regulatory framework made it difficult to establish a commercially viable business model.

Support from the Village Grid RBF Project helped Absolute Energy strengthen its approach. The company improved project preparation for the Rutenderi mini-grid, including technical planning, customer engagement, and operational systems. The RBF mechanism also rewarded verified customer connections, helping to reduce early-stage project risks while encouraging efficient implementation and high service standards.

Reflecting on the experience, Mark Mugisha, Country Manager of Absolute Energy Company Uganda and Rwanda, says:

► 'Working with EnDev reinforced our understanding that energy access is not only about electrification, but also about economic transformation, social inclusion, and long-term community development.'

To improve the long-term sustainability of the mini-grid, the company connected households alongside businesses and public institutions, creating a more stable demand for electricity. Community engagement and customer education also formed an important part of the project, helping customers understand how to use electricity efficiently and encouraging timely payment for services.

Today, the Rutenderi mini-grid demonstrates how private-sector investment, supported by results-based financing, can expand electricity access while creating opportunities for local development. For Absolute Energy, the project reinforced the role of reliable electricity as a foundation for stronger rural businesses, improved services, and more resilient communities.





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Success story

Powered by opportunity: Juvénal Rafiki's journey in Rutenderi

Five years ago, Juvénal Rafiki made a decision that changed the direction of his family's future. After learning that a mini-grid operated by Absolute Energy had been installed in Rutenderi, he saw electricity not simply as a household service, but as an opportunity to build a stronger livelihood. He moved his family and business to the village.

Today, Juvénal combines farming and livestock production with several small enterprises. As his activities grew, he invested his own resources in the equipment needed to expand and diversify his business.

His working day starts early. Before sunrise, he organises his employees, who begin work at 7.00 a.m. Some focus on planting and harvesting, while others care for the livestock. Juvénal personally checks the animals each morning for signs of

illness and adapts the day's activities to the farm's changing needs.

Reliable electricity has become central to how his businesses operate. Juvénal initially began producing animal feed for his own livestock, with the ambition of eventually selling it commercially. Access to electricity enabled him to invest further and expand the range of services he could provide.

Today, his enterprise uses two refrigerators, a meat-cutting machine, and a multifunctional milling system. The mill removes grain husks for animal feed, processes rice and mills cereals for people in surrounding communities. These electricity-powered activities have become an important source of income and account for much of his electricity consumption, with his monthly bill reaching approximately RWF 300,000.

The benefits extend beyond his business. Electricity provides reliable lighting at home, allowing his children to study in the evenings. Refrigeration has improved food preservation, while cleaner cooking has helped reduce exposure to smoke.

As the enterprise has grown, so has its contribution to the local economy. Juvénal now supports his family of seven while employing eight permanent workers and 10 to 15 seasonal workers, creating income opportunities in the community.

Reflecting on the importance of electricity, Juvénal says:

► ‘Without electricity, there is insecurity, and everyone feels it. Without electricity, no business is possible. I always dreamt of building a

profitable business, and electricity made that dream achievable. With my refrigerators, I can safely store and manage food products, which has completely changed how I run my business.’

For Juvénal, moving to Rutenderi was more than a change of location. Reliable electricity let him invest in his ideas and build a thriving business that now provides services to surrounding communities and creates jobs for local people. His experience shows how access to electricity can translate into productive investment, stronger livelihoods and wider economic opportunities within rural communities. ■



2.4 Lessons from the project

The VG RBF Project was one of Rwanda’s earliest attempts to use results-based incentives to support private mini-grid development through supply- and demand-side incentives. It generated important lessons on how RBF can be applied in infrastructure-based energy access markets, where investment risks, financing needs, and regulatory requirements are more complex than in product-based markets.

RBF can help build confidence in nascent markets

The VG RBF helped raise the profile of Rwanda’s mini-grid sector. By supporting some of the country’s first privately developed mini-grids, the project demonstrated that private companies could play a role in rural electrification.

The project strengthened confidence among public institutions, development partners, financial institutions, and companies. It provided an early platform for testing regulatory procedures, business models, verification systems, and financing approaches.

A strong enabling environment is essential

Mini-grid development depends heavily on the enabling environment. Developers need clarity on site eligibility, licensing, technical standards, tariffs, and future grid arrival. Without this clarity, private investment becomes difficult to justify.

During implementation, the VG RBF Project contributed to sector dialogue and, together with other development partners, contributed to the development of the Rural Electrification Strategy, the regulatory framework for mini-grids, and the National Electrification Plan. EnDev also published off-grid sector status reports in 2016, 2017, and 2018, providing in-depth market analysis of Rwanda’s off-grid solar home system and mini-grid sectors. This showed that RBF is most effective when embedded in broader policy, planning, and regulatory processes.

RBF must be combined with technical assistance and flexibility in early-stage markets

The VG RBF Project’s ability to respond to changing conditions and unanticipated challenges was critical to its successful implementation.

While RBF provides a financial incentive, it is rarely sufficient as a stand-alone instrument in nascent infrastructure markets. Mini-grid developers required support to prepare feasibility studies, estimate demand, develop financial models, navigate regulatory procedures, and engage with financiers. The technical assistance provided by the project helped companies become capable of delivering results. This was particularly important because both local and international companies were operating in a sector that was new in Rwanda.

The project also used a flexible incentive structure. The maximum subsidy amount per company, and the maximum share per project – 70 per cent of capital expenditure – were designed to enable company participation while ensuring that developers remained financially accountable by contributing the remaining 30 per cent of project costs. Since mini-grid financial models are complex and rely on numerous assumptions, the VG RBF Project worked closely with companies to develop realistic, conservative business models.

Incentive levels tended to remain close to the 70 per cent ceiling because of the broad range of market barriers, including early-stage market development, a lack of proven business models, low demand at many sites, high operating costs, and limited access to affordable pre-financing.

Future mini-grid RBF schemes should therefore include adequate resources for technical assistance and flexibility from the start.

Building local fund-management capacity

Contracting Urwego Finance as the fund manager created value beyond administrative fund management. With support from the VG RBF Project, including a dedicated advisor and staff training, the bank developed capacity to manage RBF procedures, contract companies, administer disbursements, and engage with energy-sector actors.

Over time, Urwego Finance became a trusted RBF knowledge broker and strengthened its role in the energy access sector. This demonstrated the value of building local institutional capacity rather than managing RBF funds entirely through project structures.

Future RBF projects can build on this lesson by selecting fund managers with both financial management capacity and a genuine interest in the energy sector. Where such capacity does not yet exist, targeted support can help create institutions that continue to serve the market beyond the project period.

The verification system must be rigorous but manageable

The VG RBF required strong verification because payments were tied directly to results. Companies submitted claims using specific formats, while independent verification agents checked customer connections and technical compliance. During commissioning, agents verified all customer connections on site to confirm they were operational. Subsequent operational incentives were verified through phone and field sampling.

The process required intensive data checking and close coordination between the project, Urwego Finance, and the independent verification agents. While demanding, the verification system enabled the project to confirm results credibly and maintain accountability.

This process showed that RBF verification must be robust enough to protect public funds but simple enough for companies to comply with. Clear procedures, rigorous training, standardised data formats, continuous supervision, and regular communication ensured the project's smooth implementation.

Pre-financing remains a critical barrier

The requirement for companies to finance construction before receiving RBF payments created a major implementation challenge. Many commercial banks were reluctant to lend to mini-grid developers due to limited familiarity with the sector, high perceived risks, and uncertainty around revenue models.

The project's cooperation with SREP and REF, implemented through BRD and providing credit and direct financing options for mini-grids, highlighted the importance of combining RBF with appropriate debt or bridge-financing instruments. This upstream coordination supported complementarity between financial instruments and reduced the

risk of overlapping funding approaches. It also showed how future energy access interventions can combine market development, debt financing, and performance-based incentives.

The project also collaborated with technical assistance partners, including SNV and Energy 4 Impact, which supported hydropower applicants in developing technical and financial feasibility studies and project proposals.

Productive use is central to the sustainability of mini-grids

Ensuring sustainable financing for mini-grids is critical to their long-term operational viability, particularly in contexts of limited electricity demand.

Household electricity demand alone is insufficient to sustain mini-grid operations, including maintenance, system expansion, and the provision of reliable energy access to end users. Household consumption is typically concentrated in the evening, while daytime demand remains limited unless productive uses are actively developed.

Promoting productive use of energy can improve load balancing, increase revenue for operators, and strengthen the local economic value of mini-grids. Businesses and enterprises can create stronger demand and improve the financial viability of mini-grid systems. Future mini-grid interventions should integrate productive-use support from the outset.

Mini-grid planning must account for grid expansion

The VG RBF experience showed that rapid grid expansion can fundamentally affect mini-grid viability. Several planned projects had to be withdrawn because of the risk of grid encroachment, while the national grid later replaced some installed systems.

This does not diminish the value of mini-grids, but it highlights the need for clear planning, coordination, and regulatory provisions. Developers need confidence that selected sites will remain viable long enough to recover their investments.

As Rwanda's grid expanded and the share of off-grid electrification in national planning declined, the mini-grid market became less attractive to private

Infobox | What the Village Grid RBF demonstrated

The Village Grid RBF Project showed that results-based incentives can help private companies enter nascent off-grid mini-grid markets. However, beyond payments for verified connections via the RBF, the success of such interventions depends on technical assistance, access to pre-financing, clear regulation, reliable electrification planning, productive electricity demand, and strong coordination between government, companies, financiers, and development partners.

investors. Regulatory uncertainty, combined with a shrinking pipeline of viable sites, contributed to reduced investor interest and the withdrawal or redirection of several developers. Although EnDev continued to support the Village Grid RBF Project after the grant agreement with Urwego Finance ended, these market conditions limited opportunities to develop additional sites. By 2023, EnDev Rwanda had halted new mini-grid activities as the remaining potential sites were considered too uncertain for many mini-grid developers.

Adaptability is essential in complex markets

The VG RBF operated in a changing policy, market, and financing environment. The project had to adapt to evolving regulations, shifts in national electrification planning, financing constraints and, later, the COVID-19 pandemic. The pandemic delayed equipment imports, restricted movement, and reduced customers' ability to pay for electricity services.

This reinforced a broader lesson: RBF schemes must be designed with enough flexibility to adapt to changing market conditions. Regular stakeholder consultations, adaptive incentive structures, and realistic implementation timelines are essential.

3 Solar Lighting Results-Based Financing Project

Accelerating Rwanda's off-grid solar market



3.1 Expanding access beyond the grid

Before off-grid solar products, such as solar lamps and solar home systems, became widely available in Rwanda, many rural households without electricity relied on unsafe, expensive, and low-quality sources of lighting. Kerosene wick lamps and cooking fires were commonly used after dark.⁶

Grid access remained limited and unevenly distributed, particularly in rural areas. Before Rwanda accelerated its electrification efforts, national electricity access was low, and rural households were especially underserved. The national grid also faced infrastructure constraints, limited generation capacity, and periods of load shedding. For many remote households, grid extension was therefore unlikely to provide a near-term solution.

Ntarama Sector in Bugesera District illustrated this wider access challenge. Before off-grid electrification reached the area, residents relied heavily on diesel and kerosene, which represented a considerable expense for households living on very low

incomes, many of whom earned less than USD 1 per day.⁷

Off-grid solar products offered a faster pathway to basic electricity access. At the time, solar lamps and solar home systems could provide cleaner lighting, reduce dependence on kerosene, mitigate fire and health risks, improve study conditions for children, and increase household safety. For private companies, Rwanda represented a growing market, but reaching rural customers required investment in product imports, distribution networks, consumer awareness, customer financing, and after-sales service.

The potential was clear, but the market faced several barriers. Quality products were not widely available outside urban centres, and many customers were unfamiliar with solar technologies or uncertain about product performance. Meanwhile, private companies faced high market-entry costs, limited working capital, and weak rural distribution channels. Low-quality products also risked undermining consumer trust, while affordability remained a major constraint for households.

6. Michael Grimm, Anicet Munyehirwe, Jörg Peters, and Maximiliane Sievert, 'A First Step up the Energy Ladder? Low Cost Solar Kits and Household's Welfare in Rural Rwanda', *The World Bank Economic Review* 31, no. 3 (2017): 631–49. ↗

7. Rwanda Energy Group, 'Off-grid Electrification Helping to Achieve Rwanda's Energy Targets', 6 May 2019. ↗

Against this backdrop, EnDev Rwanda introduced the Solar Lighting Results-Based Financing (RBF) Project to support the development of the off-grid solar lighting product market. The project aimed to stimulate commercial sales of quality solar lamps and solar home systems, reduce market-entry risks for companies, and expand access to basic electricity services in rural areas.



3.2 Using RBF to build the solar product market

The Solar Lighting RBF Project also formed part of EnDev's broader RBF Facility and was co-funded by the United Kingdom Department for International Development (DFID). It was implemented by GiZ, with Urwego Finance (formerly Urwego Opportunity Bank) serving as fund manager between 2014 and 2019.

The project used the same core RBF principle as the Village Grid RBF: companies received incentive payments only after achieving pre-agreed results and having them successfully verified. However, while the Village Grid RBF supported private developers to build and operate mini-grids in selected off-grid locations, the Solar Lighting RBF supported companies to expand the commercial market for quality portable solar products and solar home systems directly to households across rural areas.

The Solar Lighting RBF therefore provided incentives for verified sales of eligible solar products, while allowing participating companies to determine how best to expand their businesses and reach rural customers.

As with the Village Grid RBF Project, the main actors were EnDev as project implementer and provider of incentives, Urwego Finance as fund manager, independent verification agents, and private companies as suppliers and recipients of RBF incentives.

[\(Read more about the RBF mechanism in the Village Grid RBF Project chapter, page 28\).](#)

Engaging private companies through a commercial model

Unlike the Village Grid RBF, which focused on a limited number of project sites, the Solar Lighting RBF relied on private companies to expand sales across rural Rwanda. The project therefore gave

Infobox | How Solar Lighting RBF differed from Village Grid RBF

Both projects used the RBF mechanism, but they addressed different markets.

The Village Grid RBF supported private developers to build and operate mini-grid infrastructure at selected off-grid sites.

The Solar Lighting RBF supported companies to sell household solar products across rural markets.

This allowed the Solar Lighting RBF to scale more quickly, but made its success more dependent on stock availability, distribution networks, product quality, customer financing, and sales data systems.

participating companies considerable flexibility in how they reached customers, developed their businesses, and responded to local market conditions.

The Solar Lighting RBF was open to private firms, private individuals, registered associations, cooperatives, and non-governmental organisations pursuing a commercial approach. Charities and government organisations were not eligible as direct recipients, although they could partner with eligible companies.

Companies applied to the project and entered into Service Level Agreements with Urwego Finance. Since some participating companies were already active in Rwanda's solar market, only products sold after the agreement had been signed were eligible for incentives. This avoided double counting and ensured that RBF payments supported additional sales generated under the project.

Participating companies could use the incentives to strengthen rural distribution networks, increase stock, improve customer outreach, expand after-sales services or support consumer financing. The project accepted different commercial models, including upfront sales, instalment payments, pay-as-you-go (PAYGo), and fee-for-service approaches.

This flexibility enabled companies to adapt their business models according to customer demand, purchasing power and local operating conditions.

Supporting quality and reducing market-entry barriers

The Solar Lighting RBF Project aimed to expand the market without compromising product quality. To qualify for support, solar lighting products had to meet Lighting Global certification requirements. This protected consumers from low-quality alternatives and helped build confidence in solar technologies at a time when many rural households were purchasing them for the first time.

EnDev and other relevant stakeholders also advocated for import tax exemptions for solar lighting products, as import duties had been identified as a barrier for suppliers. The Government of Rwanda responded by waiving import taxes on solar lighting products, reducing import costs and improving product availability.

By combining financial incentives with product-quality requirements and policy engagement, the project addressed both company-level barriers and wider constraints affecting the development of Rwanda's off-grid solar market.

Managing claims, verification, and incentives

Independent verification was central to the Solar Lighting RBF Project. Companies submitted sales claims through Urwego Finance, which were reviewed and independently verified before incentive payments were released.

The project ensured that sales were genuine, products were eligible, customer information was complete, and systems remained in use. This was particularly important for PAYGo and installment-based sales, where customers could default before completing payment. In such cases, if a system was repossessed, the incentive associated with that customer was deducted from the company's subsequent claim.

This approach protected the integrity of the RBF mechanism while recognising the realities of rural consumer financing. It also encouraged participating

Infobox | What is a Service Level Agreement?

If a company's application was successful, it signed a Service Level Agreement with Urwego Finance, witnessed by EnDev.

The Service Level Agreement was a volume-based contract that established the maximum results a participating company could achieve during the contract period. It also specified eligible products, applicable incentive levels, and the rights and obligations of each party.

Signing a Service Level Agreement did not guarantee funding. Companies received incentive payments only after eligible results had been independently verified by an independent verification agent. If no eligible sales or installations were made or claimed, no incentive payments were disbursed. Likewise, companies were not penalised for achieving fewer results than the maximum volume set out in the agreement.

companies to maintain accurate customer records and strengthen internal data management systems.

The maximum incentive per solar system was capped at EUR 20, equivalent to providing Tier 1 household electricity access under the Sustainable Energy for All (SE4All) Global Tracking Framework 2015. This relatively modest incentive was designed to stimulate market expansion while limiting the risk of over-subsidisation and market distortion.

Adapting to policy and market challenges

During implementation, Rwanda's off-grid solar market evolved rapidly. Supply-side support enabled companies to expand their rural distribution networks, while government policies increasingly recognised off-grid technologies as part of the national electrification strategy.

The Government of Rwanda's introduction of the National Electrification Plan and the Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems strengthened the sector's

policy and quality framework. However, the introduction of new standards and changes in product eligibility also required companies and the project to adapt.

Initially, the Solar Lighting RBF had subsidised both certified solar lanterns and solar home systems. During implementation, the Ministerial Guidelines restricted the importation of solar lanterns, although suppliers were permitted to sell existing stock. As a result, the project transitioned towards promoting solar home systems exclusively, which provided a higher level of electricity access and aligned more closely with Rwanda's evolving off-grid electrification priorities.



3.3 Results and impact of the Solar Lighting RBF Project

Strengthening Rwanda's off-grid solar market

The Solar Lighting RBF helped expand Rwanda's commercial off-grid solar market. By reducing risks for companies and rewarding verified sales, the project supported suppliers to enter rural areas, expand distribution networks, and increase the availability of quality solar products.

The project attracted a broad group of market actors. Nineteen companies participated in the project, of which 14 actively sold eligible products and submitted claims for incentive payments. The participants included both established companies and new entrants to Rwanda's solar lighting and solar home system markets.



Companies generally regarded the project as an efficient and transparent support mechanism. During project reviews, some described the project as one of the sector's most effective support schemes because it provided a transparent framework in which participating companies could compete on a fair and equal basis.

The claiming process was generally well understood, although some smaller companies faced challenges in collecting complete and accurate customer information.

Expanding sales and product availability

The Solar Lighting RBF Project contributed to a significant increase in the availability of solar products in Rwanda. Sales of both solar lamps and solar home systems grew strongly during the implementation period.

The project supported the sale of more than 100,000 solar products across Rwanda, comprising 27 per cent 'picoPV systems', 35 per cent solar lamps and 38 per cent solar home systems. PicoPV systems are the smallest category of solar power systems, providing basic electricity through a small solar panel, a rechargeable battery and one or more LED lights, sometimes with additional features such as phone charging or a radio. Solar lamps are primarily designed for lighting and generally do not provide other electricity services. Solar home systems offer a higher level of electricity service and can power multiple lights and other small appliances.

This growth demonstrated the commercial potential of off-grid solar products and helped move the sector from fragmented distribution towards a more structured market for quality-certified solar technologies.

Supporting PAYGo and instalment-based models

The project contributed to the expansion of PAYGo and instalment-based sales, which accounted for more than 90 per cent of products sold by participating companies.

These models allowed households to access solar systems without paying the full purchase price upfront. They were particularly important because companies themselves largely assumed the role of



consumer finance providers, rather than relying on separate financial institutions.

PAYGo platforms also enabled companies to monitor customer payments and system performance remotely. This helped companies manage default risks, identify technical faults, and provide after-sales support more efficiently.

At the same time, the experience showed that flexible payment models could only partially address affordability. PAYGo reduced the immediate financial burden on households, but customers still needed sufficient and stable income to complete their payments.

Revealing the limits of supply-side incentives

The project succeeded as a market-expansion instrument. It helped companies establish operations, build distribution capacity, and increase sales. However, it also demonstrated that supply-side incentives alone could not make solar home systems affordable for the poorest households.

The relatively low incentive ceiling helped avoid over-subsidisation and market distortion. It encouraged companies to build operations and expand sales without depending on high subsidies. However, because the incentive primarily supported company growth rather than directly reducing the household purchase price, its ability to reach customers with very low and unstable incomes remained limited.

As companies expanded into lower-income customer segments, affordability challenges became increasingly visible, and default rates rose.

This experience demonstrated the limits of supply-side incentives in addressing affordability barriers and directly informed the next stage of EnDev Rwanda's RBF approach. While the Solar Lighting RBF Project helped establish the commercial market, the follow-on Pro-Poor RBF introduced targeted demand-side subsidies to reduce the price paid by eligible low-income and poorest households. [\(Read more about the Pro-Poor RBF Project in the following chapter\).](#)



3.4 Lessons for off-grid solar market

Supply-side incentives can accelerate market entry

The project demonstrated that modest incentives can help companies enter rural markets, build stock, expand distribution networks, and strengthen customer outreach. This was particularly relevant for companies introducing solar home systems and PAYGo models in Rwanda.

By rewarding verified sales, the project reduced the risk of investing in rural customer acquisition. It also helped attract new companies and strengthen competition in the off-grid solar market.

Quality standards protect consumers and strengthen the market

In an emerging market, poor-quality products can quickly undermine consumer trust. The Solar Lighting RBF Project addressed this risk by linking incentives to certified products.

This served two purposes. It protected consumers from unreliable systems and positioned off-grid

solar technologies as a credible electrification option. It also helped raise quality expectations across Rwanda's off-grid solar sector.

Verification requirements must match company capacity

The project showed that company capacity strongly affects participation in RBF schemes. Larger, more established companies generally adapted well to the claiming and verification process because they had stronger customer record-keeping and data management systems.

Meanwhile, smaller companies sometimes struggled to collect complete and accurate customer information. RBF projects should therefore balance



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verification rigour with proportionate reporting requirements and targeted support for companies with weaker administrative systems. Verification must remain sufficiently robust to protect public funds without creating avoidable barriers for capable smaller or locally based suppliers.

RBF is better suited to higher-value products

The project also showed that RBF verification can be less efficient for very low-cost products such as basic solar lamps. Tracking customers, checking sales records, and processing claims require time and resources. For low-cost products, these transaction costs can be high relative to the product and incentive value.

Solar home systems were better suited to the RBF model because they were higher-value products

and often linked to customer records, payment plans and after-sales service. PAYGo systems further simplified tracking because customer, payment and performance data were already embedded in the business model.

RBF schemes should therefore assess whether the product value and available data justify the cost and complexity of verification.

Market expansion does not automatically reach the poorest households

The project helped establish a commercial solar market, but it did not fully address affordability for the poorest households. The comparatively low incentive ceiling reduced the risk of market distortion but limited the project's ability to lower retail prices for households with extremely low and unstable incomes.



As companies gradually expanded into poorer customer segments, affordability challenges and default risks became more pronounced. This demonstrated that market expansion and social inclusion are connected but pursue distinct objectives.

Supply-side incentives can help companies establish operations and expand commercial markets. However, once affordability becomes the principal barrier, programmes require targeted demand-side measures that reduce the price paid by households that would otherwise remain excluded from access to electricity.

Local fund management can strengthen the sector

As in the Village Grid RBF, Urwego Finance played a central role in managing contracts, claims, disbursements, and communication with participating companies.

The project's investment in strengthening the institution helped build local RBF management capacity and contributed to the development of energy finance knowledge within Rwanda's financial sector.

RBF projects should therefore view fund management not only as an administrative function but also as an opportunity to strengthen local financial-sector capacity.

Adaptive Learning supports market development

The Solar Lighting RBF Project generated important data on sales, customer profiles, product uptake, payment models, and market behaviour. The project and Urwego Finance organised annual incentive reviews with other relevant stakeholders.

These reviews assessed incentive levels, project processes, company feedback, and changing market conditions. They enabled the project to refine implementation procedures, respond to emerging challenges, and maintain regular dialogue among the principal market actors. The process also reinforced trust between the project, Urwego Finance, companies, and verification actors.

Infobox | What the Solar Lighting RBF Project demonstrated

The Solar Lighting RBF demonstrated that results-based incentives can successfully stimulate the growth of a commercial off-grid solar market.

It helped companies expand rural sales, strengthen PAYGo and instalment-based models, and increase the availability of quality-certified products.

It also revealed an important limitation: building a market does not automatically make products affordable for the poorest households. Reaching these customers required a more targeted subsidy approach.

Beyond project implementation, EnDev also produced Off-Grid Status Reports for Rwanda, which shared market intelligence with government institutions, companies, development partners, and other stakeholders. Although these reports were not a formal requirement of the RBF mechanism, they strengthened sector coordination and supported evidence-based policy and programme design.

4 Pro-Poor Results-Based Financing Project

Making off-grid solar home systems affordable for low-income households



4.1 Moving from market expansion to inclusion

The Pro-Poor Results-Based Financing Project was informed by EnDev Rwanda's earlier Solar Lighting RBF Project, implemented between 2014 and 2019. The Solar Lighting RBF had supported local and international companies registered in Rwanda to overcome market barriers, expand their operations, and sell quality-certified solar lighting products and solar home systems. It helped strengthen Rwanda's off-grid solar market and enabled companies to reach households that could afford commercially sold or moderately subsidised products.

However, the experience also revealed an important limitation. Supply-side incentives could help companies enter the market, expand distribution networks, and increase sales, but they were less effective in reaching households facing severe affordability constraints. Many low-income households remained unable to purchase solar home systems, even where products were available, and PAYGo or instalment payment models were offered.

At the time, only 36 per cent of Rwandan households had access to electricity, and many remote communities were not expected to connect to the national grid within the next five years. The Government of Rwanda

had also introduced the Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems, which strengthened quality, safety, and reliability standards for off-grid solar products. However, the guidelines also restricted the importation of smaller solar kits and positioned solar home systems as the only alternative off-grid solution, contributing to higher product costs. For the poorest households, quality solar home systems remained financially out of reach.

This posed a clear challenge to Rwanda's ambition of achieving universal energy access. Ensuring that poorer households were not left behind required additional measures to reduce the final price paid by consumers while preserving private-sector delivery, product quality, and market competition.

Against this backdrop, EnDev shifted from a supply-side market-expansion approach to a pro-poor demand-side subsidy model. The Pro-Poor RBF introduced targeted subsidies that reduced the purchase price of solar home systems for eligible low-income households. Participating companies continued to supply quality solar products through commercial channels, but they were required to pass the full value of the subsidy directly to eligible customers.

The Pro-Poor RBF therefore marked the next stage in Rwanda's off-grid solar RBF journey. The Solar

Lighting RBF helped build the market; the Pro-Poor RBF tested how that market could reach poorer households that remained excluded because of affordability.



4.2 Designing a demand-side subsidy for off-grid solar

The Pro-Poor RBF Project was funded by the United States Agency for International Development (USAID) Power Africa and the United Kingdom Foreign, Commonwealth and Development Office (FCDO). It was implemented from November 2019 to March 2021, in close collaboration with the Energy Development Corporation Ltd (EDCL), a subsidiary of Rwanda Energy Group (REG).

The pilot was developed around EnDev's Leave No One Behind commitment and built directly on lessons from the Solar Lighting RBF Project. Its central objective was to address one of the most persistent barriers to energy access: affordability.

The project targeted low-income households living in off-grid areas, while leveraging existing private-sector companies and their distribution networks to deliver quality solar home systems. It sought to reach households least likely to access electricity through conventional commercial channels, without replacing the market with free distribution. This distinction was central to the project design.

Eligible households did not receive products for free. Instead, the subsidy reduced the purchase price, while beneficiaries contributed the remaining share. This co-payment approach was intended to strengthen ownership, reduce the risk of market distortion, and support the long-term use and maintenance of the systems.

From the outset, the project was designed as a pilot with future scale-up in mind. Implementation focused on five districts in Rwanda's Southern Province – Ruhango, Nyanza, Nyamagabe, Gisagara, and Huye.

Building on the RBF mechanism while changing the subsidy logic

The Pro-Poor RBF used the same core results-based financing principle as the Village Grid RBF

Infobox | Balancing quality and affordability

For many lower-income households, affordability became the main barrier to accessing electricity. As higher-quality solar home systems became the standard for eligible products, they also became more expensive.

The Pro-Poor RBF Project addressed this challenge through targeted demand-side subsidies that reduced the purchase price of certified solar home systems, making quality products more affordable for eligible lower-income households and improving their access to electricity.

and the Solar Lighting RBF; however, the intended beneficiary of the incentive changed.

Under the preceding projects, incentives primarily supported enterprises. Companies could use incentive payments to expand distribution networks, build stock, reduce risks, and grow sales. The objective was market acceleration.

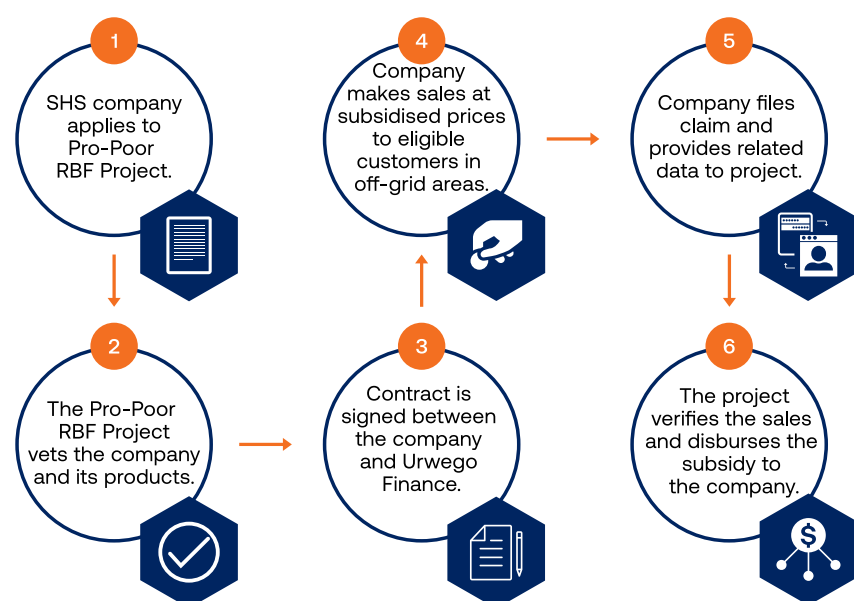
Under the Pro-Poor RBF, the incentive was designed to benefit the household directly. Companies still received the RBF payment after verification, but they were required to pass its full value to the eligible customer through a reduced purchase price. The objective was affordability and inclusion.

The RBF mechanism therefore evolved from supporting market expansion to making quality solar home systems that complied with the Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems affordable for poorer households, while retaining private companies as the delivery channel. [\(Read more about Village Grid RBF on page 28 and Solar Lighting RBF on page 40.\)](#)

Aligning with national priorities and ensuring product quality

The project was implemented through a multi-stakeholder partnership. The Government of Rwanda and development partners were consulted extensively during its design. This helped to draw on existing expertise, align the intervention with

The EnDev Rwanda pro-poor approach overview



Infobox | Raising quality standards in Rwanda's off-grid solar market

The Government of Rwanda introduced the Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems to regulate the quality, safety, and reliability of off-grid solar systems sold across the country.

The guidelines set minimum service and performance requirements for solar home systems, helping ensure households received reliable, safe, fit-for-purpose energy services. They also protected consumers from substandard products, strengthened confidence in the off-grid solar market, and aligned Rwanda's solar sector with recognised international technical standards.

For the Pro-Poor RBF, compliance with the guidelines was a prerequisite for participation, ensuring that affordability did not compromise product quality.

national electrification priorities, and build stakeholder ownership from the outset.

Private-sector companies supplied and installed solar home systems; Urwego Finance (formerly Urwego Opportunity Bank) managed contracts, fund administration and subsidy disbursement; and government institutions, particularly EDCL, supported implementation.

To ensure quality and consumer confidence, only multi-light solar home systems that complied with the Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems were eligible for support. Eligible products included systems certified under Lighting Global requirements.

The guidelines established an important regulatory framework for Rwanda's off-grid solar sector. They promoted quality assurance, improved reliability, strengthened consumer confidence, and supported the sustainable expansion of solar energy services. They also prohibited the importation of solar lanterns, further shifting the market towards solar home systems.

By linking subsidies to approved products, the project ensured that affordability did not come at



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the expense of quality. This was particularly important for low-income households, for whom a failed or unreliable system would represent a significant financial loss.

Targeting households facing the greatest affordability barriers

The project targeted low- and middle-income households without electricity access in off-grid areas across the five selected districts of the Southern Province.

At the time of implementation, beneficiary identification relied on Rwanda's household socio-economic classification system, known as *Ubudehe*. Households were categorised into four groups, ranging from *Ubudehe 1*, representing the most vulnerable households, to *Ubudehe 4*. The classification considered factors such as household income, employment, occupation, and land ownership and was administered by local government authorities.

The Pro-Poor RBF specifically targeted households classified under *Ubudehe* Categories 1 to 3,

with particular attention to those facing the greatest affordability constraints and those least likely to access electricity through conventional market channels.

Although the *Ubudehe* classification system has since evolved and is no longer used as the principal mechanism for determining social protection beneficiaries, it provided an important targeting framework during project implementation.

Engaging private companies and preserving consumer choice

The Pro-Poor RBF Project worked through commercially operating private solar companies, building on existing market structures and distribution networks. This approach preserved consumer choice and competition while enabling eligible households to access subsidised solar home systems through established commercial channels.

Working with several suppliers and distributors, the project enabled eligible households to choose from different solar home systems that complied

with Rwanda's Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems. Households were therefore not limited to a single supplier or product, while companies continued to compete on service, pricing, and customer support.

As with the Village Grid and Solar Lighting RBF Projects, participation was open to companies that met defined eligibility requirements. These included legal registration, compliance with tax and social security obligations, adherence to government reporting requirements, a product end-of-life management policy, and a cooperation agreement with EDCL. Successful applicants also signed a Service Level Agreement with Urwego Finance.

This approach helped ensure that participating companies were sufficiently formalised and capable of delivering quality products, after-sales service, and customer support.

Bridging the affordability gap

The Pro-Poor RBF provided an incentive for each solar home system sold to an eligible household. Participating companies received the incentive only after the sale and installation had been independently verified.

The entire incentive had to benefit the end user through a reduction in the purchase price. Households paid the remaining share, referred to as the customer contribution, and could choose a system according to their needs and ability to pay.

Importantly, all beneficiaries, including those from the lowest-income households, were required to contribute a portion of the purchase price. This co-payment mechanism aimed to reduce the risk of market

'The Pro-Poor Project achieved amazing success rates in a short time, proving the need for affordable and sustainable energy solutions. With the support of Power Africa and additional leading organisations, we established a vast impact during a very challenging time. In order to reach national scale impact, affordability is a key element, and projects such as the Pro Poor RBF make this goal one step closer.'

– Ignite Energy Access

distortion, encourage ownership, and promote the long-term use and maintenance of the systems.

The customer paid the subsidised purchase price directly to the supplier, while participating companies were reimbursed for the subsidy amount through Urwego Finance following successful independent verification of the sale and installation.

Two factors determined the incentive level:

1. the *Ubudehe* category of the end user's household; and
2. the type of solar home system being purchased.

The *table below* illustrates the two incentive levels applied by the project: absolute and relative. Participating companies always received the lower of the two incentive amounts. For example, if a *Ubudehe* 2 household wished to purchase a EUR 200 solar home system, an absolute incentive of EUR 70 would apply rather than the relative incentive of 68 per cent, equivalent to EUR 136, because it was the lower amount. The household would pay the remaining customer contribution of EUR 130.

Subsidy calculation

<i>Ubudehe</i> category	Absolute subsidy level	Relative subsidy level
<i>Ubudehe</i> 1	EUR 90	87%
<i>Ubudehe</i> 2	EUR 70	68%
<i>Ubudehe</i> 3	EUR 50	49%

Strengthening transparency through digital eligibility systems

A key innovation of the Pro-Poor RBF was the development of a web-based Eligibility Tool by EnDev to support project implementation.

The Eligibility Tool allowed companies to check household eligibility by verifying whether a household qualified for a subsidy, pre-register a customer by reserving an eligible household for a defined period while the sales contract was being signed and the solar home was being installed, and confirm the subsidy once the contract had been signed and the installation completed.

For project managers, the tool also enabled real-time monitoring of implementation and management of the available incentive budget. Following the completion of the Pro-Poor RBF Project, the Eligibility Tool was handed over to EDCL, where it continues to support Rwanda's national subsidy programme under the Renewable Energy Fund (REF) Window 5 and the Accelerating Sustainable and Clean Energy Access Transformation (ASCENT) programme.

Connecting the Eligibility Tool with OMIS: The Eligibility Tool was linked to the Off-grid Monitoring Information System (OMIS) through a two-way information exchange. It used data from OMIS to perform customer eligibility checks, while all information collected through the Eligibility Tool was stored in a dedicated dataset within OMIS.

This enabled programme administrators to manage RBF-specific information while maintaining a single national repository of off-grid electrification data.

OMIS is owned and managed by EDCL. Its development was funded by Power Africa and supported by EnDev. OMIS is an online information system developed to track off-grid electrification across Rwanda. It consolidates electrification data from solar companies and mini-grid developers and provides dashboards and analytical tools to support evidence-based decision-making. The system supports:

- tracking national electrification progress and market development;
- evidence-based policy and planning; and
- the design and development of targeted electrification programmes.

Infobox | Why digital systems matter

Digitising eligibility checks and reporting improves project management for both participating companies and implementing organisations. As projects become more complex – for example, by targeting several beneficiary groups – the need for digital systems increases to ensure reliable processes, effective monitoring, and faster processing.

When designing digital tools, projects should consider:

- Local and company-level data protection regulations and policies
- Compatibility with the devices used by company agents
- Network coverage and reliability, and
- The availability of local technical capacity for troubleshooting, maintenance, and system improvements.

OMIS consists of a central database that stores all information and a series of dashboards that analyse and present the data. Information is uploaded through several channels, including manual Excel uploads, the Eligibility Tool, and the Monitoring and Evaluation Information System (MEIS) managed by the Local Administrative Entities Development Agency (LODA).

For the Pro-Poor RBF, OMIS enabled the project to verify whether a household had previously purchased a solar home system or already had access to electricity, thereby reducing the risk of duplicate subsidies.

Linking OMIS with the LODA MEIS: OMIS is connected through an application programming interface (API) to the MEIS managed by LODA, a subsidiary of the Ministry of Local Government. LODA's MEIS contains demographic and socio-economic information on households across Rwanda, including household members, national identification numbers, and *Ubudehe* categories.

When customer information is uploaded to OMIS, the system uses the customer's national identification

number to retrieve the corresponding household identification number and *Ubudehe* category from the LODA MEIS database. (Refer to the graph below).

This information is essential for verifying household eligibility, monitoring electrification progress at the household level, and supporting the design of targeted electrification programmes.

How the systems worked together: The integration of the Eligibility Tool, OMIS, and the LODA MEIS created a comprehensive digital verification system for the Pro-Poor RBF Project.

- OMIS served as the central repository for all project data.
- The Eligibility Tool used information from both OMIS and LODA MEIS to verify household eligibility.
- RBF sales were recorded via the Eligibility Tool and stored in a dedicated dataset within OMIS, enabling cross-validation of subsidy claims.
- Participating companies could claim incentives only for sales registered through the Eligibility

Tool and reported to OMIS. This encouraged companies to report regularly and accurately.

- Linking sales reporting with RBF claims strengthened data quality, encouraged companies to report consistently and accurately, and improved the robustness of the verification process.



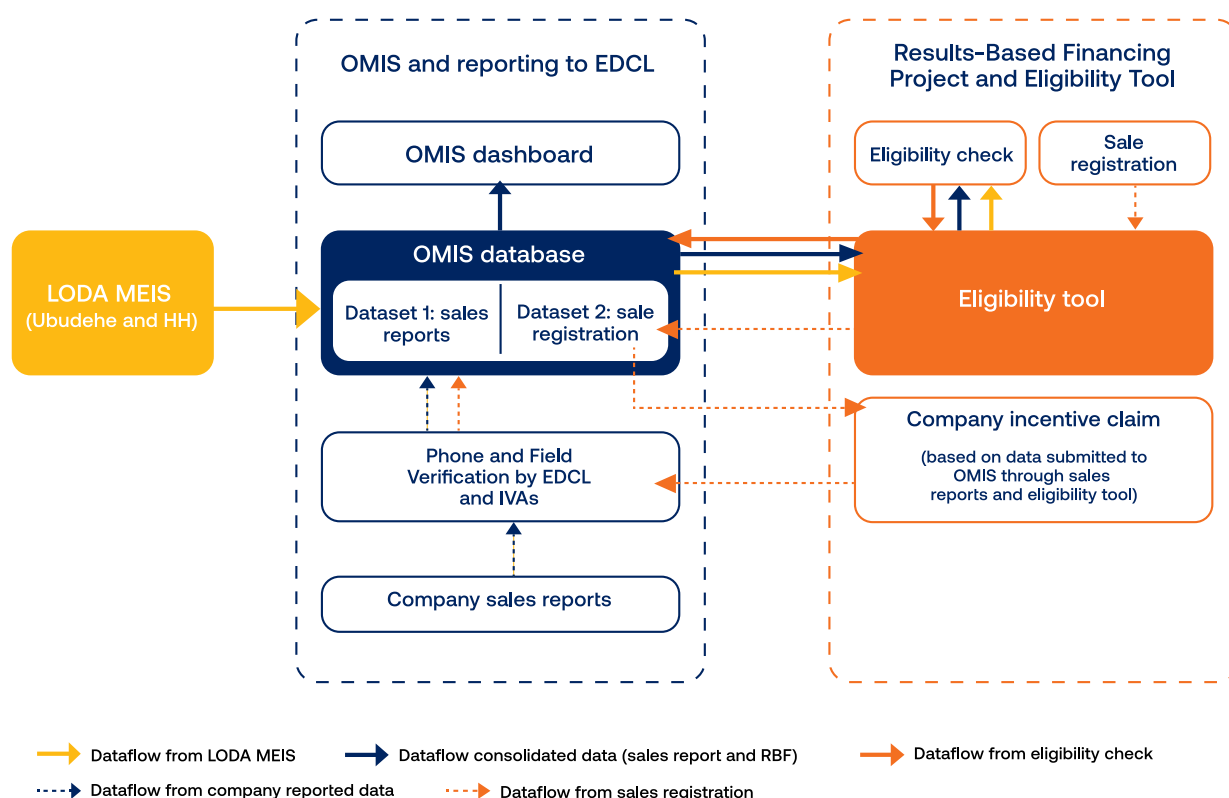
4.3 Results and impact of the Pro-Poor RBF Project

Expanding electricity access among low-income households

The Pro-Poor RBF pilot demonstrated that targeted demand-side subsidies can significantly improve access to electricity among households that would otherwise remain excluded from the off-grid solar market.

Implemented through six participating solar companies, the project expanded access to solar home systems for low-income households across the five

Relationship between the OMIS and the RBF Eligibility Tool



selected districts. The project successfully reached a high proportion of the most vulnerable households, with 71 per cent of supported households classified under *Ubudehe* 1, the lowest socio-economic category at the time.

Combined with PAYGo and instalment payment models, the targeted subsidy enabled vulnerable households to access modern electricity services while preserving consumer choice. Eligible beneficiaries could select from a range of approved products offered by different suppliers. This helped improve affordability without compromising quality or market competition.

The project demonstrated that low-income households can participate in market-based energy initiatives when affordability barriers are addressed appropriately.

Expanding the addressable market for solar companies

The project also generated positive outcomes for participating solar companies. By reducing the financial burden on customers, the subsidy mechanism expanded the addressable market for quality solar products and enabled companies to reach customer segments previously considered commercially difficult to serve.

Participating PAYGo companies reported increased system utilisation and significantly lower default rates among subsidised customers. This indicated healthier customer portfolios and stronger business performance. It also reinforced one of the project's core findings: affordability constraints, rather than a lack of electricity demand, were a principal barrier to market growth among low-income households.

Creating the foundation for Rwanda's national subsidy programme

The most significant contribution of the Pro-Poor RBF extended beyond the immediate project results.

The project provided practical evidence that targeted demand-side subsidies could accelerate access to electricity while maintaining a competitive market-based delivery model. Based on these results, the Government of Rwanda expanded the

‘Through the Pro-Poor Results-Based Financing Project, which we implemented in partnership with GIZ, we helped more than 2,000 households gain access to electricity in less than two months. This showed us that there is still a significant demand for affordable electricity, especially among underserved communities. It also showed what we can achieve when we work together and make the right financing solutions available. We remain committed to expanding access to clean energy and reaching even more households.’

– Solektra Rwanda Ltd





© GIZ/Alice Kayibanda

Testimonial

Electricity provided the stability I needed to invest in my future

For years, Alice Mukamazimpaka, a 51-year-old widow from Mayebe Village in Ruhango District, relied on a battery torch and a small solar lantern to light her home. Even charging her mobile phone meant walking several kilometres to find electricity and paying for a partial charge before returning home because she could not afford to wait.

Like many rural households, Alice depended entirely on farming for her family's livelihood. Although she wanted to improve her home and invest in her future, the cost of a quality solar home system was beyond her means.

When the private company Bboxx brought solar power under the Pro-Poor RBF Project to her community, the targeted subsidy and instalment payment plan enabled Alice to purchase a three-light solar home system through affordable monthly payments. Four years later,

she completed her instalments and owned the system outright.

Today, her home has indoor and outdoor lighting. Her child can study in the evenings, and Alice can charge her phone at home instead of travelling long distances. The outdoor light has also improved security around her home and given her the confidence to invest in a cow – something she had previously avoided for fear it would be stolen in the dark.

Reflecting on her experiences, Alice says:

► 'Thanks to the project, I am happy because electricity has changed my life over the years. I never imagined that something as simple as having light outside my home would give me the confidence to keep a cow. In future, I would like the package to be more affordable so that I can install more light points throughout my house.' ■

approach nationally through the Renewable Energy Fund (REF) funded by the World Bank.

Building on the EnDev pilot, the government established a dedicated REF financing window to address household affordability constraints, allocating USD 15 million to support implementation. The REF Programme scaled the Pro-Poor RBF approach with some adaptations and successfully expanded from five districts to all 30 districts nationwide.

In 2020, an additional USD 15 million was subsequently allocated through the World Bank-funded Energy Access and Quality Improvement Project (EAQIP), further accelerating national implementation.

The foundations established by the Pro-Poor RBF also informed subsequent nationwide RBF schemes. Under the World Bank- and Asian Infrastructure Investment Bank (AIIB)-funded ASCENT Programme, Rwanda continues to channel substantial investments towards expanding access to off-grid electricity, clean cooking, and productive use of energy.

In addition to the national scale-up, the EDCL RBF implementation team, which is currently part of the ASCENT implementation structure, benefited from comprehensive capacity-building support provided by the EnDev team. This included a series of on-the-job training sessions covering key aspects of project management and implementation.

This scale-up represented an important shift in Rwanda's energy access strategy. What began as a pilot intervention evolved into a nationally adopted mechanism for extending modern energy services to low-income households.



4.4 Lessons for designing pro-poor energy access programmes

As one of Rwanda's first large-scale demand-side subsidy projects for off-grid electrification, the Pro-Poor RBF generated important lessons for future energy access initiatives.

Affordability is key to the energy access challenge

Affordability remains one of the most important barriers to electricity access among low-income households.

Before the Pro-Poor RBF Project's intervention, companies were already using PAYGo and instalment models to make solar home systems more accessible. However, unsubsidised payments were still unaffordable for many off-grid households, particularly those in *Ubudehe* Category 1.

The pilot demonstrated that targeted subsidies can help close this affordability gap. Under the project, companies sold a larger share of solar home systems to vulnerable households, including those in *Ubudehe* Category 1. This showed that poor households are not necessarily unwilling to adopt solar technologies. Rather, many require a price level and payment structure that reflects their actual purchasing power.

Quality and affordability should go hand in hand

The Pro-Poor RBF demonstrated that expanding access to modern energy should not come at the expense of product quality and that quality standards and affordability should be addressed together.

Rwanda's Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems strengthened the quality, safety, and reliability of products available on the market, helping protect consumers and build confidence in off-grid solar technologies. However, higher-quality systems also represented a greater financial commitment for many low-income households.

Rather than lowering product standards to improve affordability, the project reduces the price paid by eligible households while maintaining compliance with the national quality requirements. This ensured that vulnerable households could access reliable, durable solar home systems without compromising consumer protection. Such subsidies can also serve as a transitional measure towards greater economies of scale, with the long-term aim of enabling markets to offer quality products at more affordable market prices.

Subsidy design must balance affordability and market sustainability

Determining the appropriate subsidy level was one of the most important design considerations.

The Pro-Poor RBF showed that subsidy mechanisms must be carefully calibrated to reduce

affordability barriers without creating market distortions. Before defining subsidy levels, interventions need to understand customer purchasing power, product pricing, willingness to pay, and prevailing local market conditions.

The project demonstrated the value of combining relative and absolute subsidy ceilings. This made solar home systems more affordable for low-income households while reducing the risks of over-subsidisation and retail price inflation.

The experience also highlighted the need for flexibility. Market conditions, customer behaviour, and affordability levels evolve over time. Subsidy mechanisms should therefore be reviewed regularly and adapted where necessary. Dynamic subsidy approaches, such as gradually adjusting subsidy levels as markets mature or tailoring support to reach more vulnerable households, can help sustain both market growth and social impact.

Strong local ownership improves implementation

The active engagement of government institutions, local authorities, and development partners was critical to the design and implementation of the Pro-Poor RBF Project.

Engaging national stakeholders from the outset strengthened ownership, improved coordination, and reduced implementation bottlenecks. Clearly defined institutional roles and formalised cooperation agreements supported smoother delivery and ensured alignment with Rwanda's broader national electrification priorities.

The experience demonstrated that subsidy programmes are more effective when embedded within existing institutional structures. This is particularly important for initiatives that rely on government data systems, local targeting mechanisms and long-term scale-up through national financing windows.

Broad private-sector participation strengthens market development

The project showed that strong market-based subsidy interventions benefit from the participation of diverse companies using different business models, distribution channels, and customer engagement approaches.

'Pro-Poor has increased our sales by 40 per cent in the regions covered by the project. This means that 40 per cent of over 5,000 households might never have gotten access to electricity ever. Such funding to support customers' economic shortfalls is what is required to accelerate electricity access without compromising on the quality of the customer experience. If this can be scaled, there would be hope for achieving SDG 7.'

– BBoxx Ltd

By working with several suppliers and distributors, the project preserved consumer choice, encouraged competition, and avoided over-reliance on a single company or product.

Companies also played an important role in consumer awareness. Through their sales agents and distribution networks, they helped households understand the subsidy mechanism, the benefits of quality-certified solar home systems and the available financing options. This extended the project's reach while reducing transaction costs.

At the same time, company participation requirements must remain proportionate. Excessively complex administrative procedures can exclude smaller or locally based companies, reduce competition and limit project reach. Transparent, manageable requirements are essential to maintain a level playing field while protecting project integrity.

Digital systems can strengthen targeting and accountability

The Eligibility Tool demonstrated how digital systems can improve beneficiary targeting, budget management and verification. By linking subsidy claims to government electrification and socio-economic data, the project reduced the risk of duplicate support and strengthened transparency.

EnDev's investment in robust, well-designed digital infrastructure also generated longer-term value from a cost-efficiency perspective, as the systems continue to be used.

However, digital tools depend on reliable underlying data, secure data-sharing arrangements, functional networks, and local technical capacity. Future programmes should therefore treat digitalisation not only as a technical investment, but also as an institutional and data-governance undertaking.

Piloting new approaches can pave the way for national scale-up

The Pro-Poor RBF demonstrated the value of testing new approaches at a manageable scale before expanding nationally.

The pilot generated practical evidence on targeting, subsidy levels, company participation, verification, and digital eligibility systems. This evidence built

confidence among government institutions and development partners and contributed to the decision to establish a nationwide solar home system subsidy programme.

Starting at pilot scale allowed the approach to be tested, refined, and validated before national adoption. This created a stronger foundation for scale-up under the REF and subsequent energy access programmes.



5 Grid Densification I & II Results-Based Financing Project

Grid access that leaves no one behind: from a pro-poor to a gender-responsive approach



5.1 Making grid access affordable for last-mile households

Between 2010 and 2020, Rwanda recorded one of the fastest electrification expansions globally, ranking eleventh worldwide and third in Africa.⁸ Under the second National Strategy for Transformation and the Energy Sector Strategic Plan 2024–2029, the Government of Rwanda aims to achieve universal electricity access by 2029.

However, grid expansion alone does not guarantee connection for all households. In many already electrified communities, some households remain without electricity because they cannot afford the upfront costs of connection, internal wiring, or additional poles when their homes are located beyond the standard connection distance. These households are often among the poorest and most marginalised.

Traditional electrification programmes have often focused on extending the grid to new rural areas. While this remains important, it can leave gaps in communities where electricity infrastructure is already present but not yet accessible to all households. Grid densification addresses this gap by connecting households that remain unconnected in already electrified areas. In these cases, existing

low-voltage networks create significant potential to expand access for poor households without major infrastructure investment.

Rwanda Energy Group Ltd (REG) plays a central role in expanding, maintaining, and operating the country's electricity infrastructure. REG operates through two subsidiaries: the Energy Development Corporation Ltd (EDCL), which is responsible for energy project development and the execution of grid densification projects, and the Energy Utility Corporation Ltd (EUCL), which is responsible for utility service delivery. REG also monitors project performance, supports service improvements, and ensures compliance with national regulations and standards.

Under existing arrangements, the Government of Rwanda's funding supports grid connections for households located within 37 metres of the nearest service pole. In these cases, households contribute a connection fee. However, households located beyond this radius often require additional poles or low-voltage line extensions, which significantly increase the cost of connection. Customers must also pay for internal household wiring. For poor and vulnerable households, these combined costs can become a decisive barrier to electricity access, even when the national grid is already nearby.

8. World Bank, 'Ingredients for Accelerating Universal Electricity Access: Lessons from Rwanda's Inspirational Approach', 10 April 2024. 

Against this backdrop, EnDev Rwanda supported two grid densification interventions, referred to as Grid Densification I and Grid Densification II. Both were designed from a Leave No One Behind perspective. The first phase, implemented between 2018 and 2020, focused on households in extreme poverty that had remained unconnected despite living in already electrified areas. The second phase, implemented between 2025 and June 2026, introduced a more gender-responsive approach, focusing specifically on women-headed households and households located beyond the 37-metre connection threshold.

Together, the two interventions demonstrate how targeted support can close the remaining electricity access gap in communities where the grid already exists, but where affordability and location continue to exclude vulnerable households.

Infobox | What is grid densification?

Grid densification connects households in areas where national grid infrastructure already exists, but where some households remain unconnected.

It is often a cost-effective way to expand electricity access because low-voltage lines are already nearby. However, proximity to the grid does not guarantee connection. Internal wiring costs and the need for additional poles or line extensions can still place electricity beyond the reach of poor households.

Targeted grid densification support helps address these household-level barriers and close access gaps within already electrified communities.

Why Leave No One Behind matters in energy access



Drawing on the United Nations' **Leave No One Behind (LNOB)** principle, EnDev defines LNOB as a commitment to address discrimination, exclusion, and inequality affecting vulnerable groups through context-specific approaches and measurable results.

For EnDev, those left behind are people who – for social, economic, legal, geographic or other reasons – cannot yet access or fully benefit from energy markets. While EnDev has long supported energy access for vulnerable populations, **LNOB** became one of its **two strategic focus areas** for the **2023–2025** programming cycle, alongside Higher Tier Cooking.

In Rwanda, EnDev's LNOB work has focused on **three key target groups**.



Poorest of the poor

People living in extreme poverty are among the least likely to gain energy access without targeted support. This focus informed interventions such as Grid Densification I and the Pro-Poor RBF, **page XX**.



At-risk communities in fragile contexts

Some of the most vulnerable people are those affected by conflict. Many are refugees or members of host communities. Energy is essential in such settings, yet refugees, IDPs, and host communities are among those furthest left behind in terms of energy access.⁹ Among them, women and girls are particularly affected. This focus informed the RBF4R intervention, **page XX**.



Women and girls

Socio-economically disadvantaged women and women-headed households are disproportionately affected by poverty and limited energy access. Due to their roles in household chores such as cooking and fuel collection, women and children experience greatest health risks from polluting energy sources. This focus informed the gender-responsive design of Grid Densification II.

9. UN Women and UNIDO, 2023



5.2 Grid Densification I

The EnDev Grid Densification I Project formed part of the second round of the Sub-Saharan Africa Grid Densification Challenge Fund, funded by the United Kingdom through the Foreign, Commonwealth and Development Office (FCDO). The project was implemented by GIZ in partnership with REG/EDCL between 2018 and 2020.

The intervention aimed to connect poor households in already electrified areas to the national grid. Low-voltage lines were already available in the target communities, meaning that no major grid extension was required. In most cases, households required only an electricity meter, a short service wire, and safe internal wiring. The project therefore focused on the critical last-mile barrier by supporting the costs and technical requirements that continued to prevent connection.

Poorly installed wiring can create safety risks, while certified wiring can be unaffordable for low-income households. To respond to this challenge, the project supported either certified internal wiring for at least one room or the installation of ready boards – a preconfigured, pre-wired electrical distribution system with sockets, switches and electrical outlets, and protective devices – depending on household needs and housing conditions.

For the poorest households, the project also provided energy-efficient LED lamps. These helped reduce electricity consumption and made monthly electricity use more affordable after connection. The project therefore addressed both initial connection and the practical conditions needed for households to use electricity safely and affordably.

Eligible connections had to meet clear technical and social criteria. Low-voltage lines had to be available, no additional service poles were required, and safe internal wiring had to be ensured. Target areas also had to have been connected to the national grid for at least one year, while beneficiary households had to have lived in the area for at least one year. EDCL was responsible for ensuring that beneficiaries were selected through a fair, transparent, and non-discriminatory process based on objective criteria.

Under the project design, 20 per cent of supported households were classified as *Ubudehe* Category

1, representing the most vulnerable households. These households received ready boards with LED lamps. The remaining 80 per cent were households in *Ubudehe* Categories 2 and 3, who received LED lamps alongside grid connection support. This differentiation allowed the intervention to respond to different levels of vulnerability while maintaining a standardised and verifiable implementation model.

The project used a results-based financing (RBF) mechanism. EDCL implemented the connections, while GIZ reimbursed eligible results only after verification. Statistical sampling was used to select households for verification, and independent verification agents conducted phone and field-based checks. Linking payments to completed, verified household connections strengthened accountability and ensured financing translated directly into household-level access.



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Results and impact of Grid Densification I

Grid Densification I supported the connection of almost 15,000 households to the national grid. A private company contracted by EDCL implemented the connections between February 2019 and February 2020.

The project reached households across all five provinces of Rwanda and covered 16 of the country's 30 districts. Beneficiaries included poor households in rural, urban, and peri-urban areas, including Kigali City. This broad geographic coverage demonstrated that grid densification is not only a rural electrification issue. Poor households can remain excluded wherever connection and wiring costs exceed their ability to pay, including in urban and peri-urban communities where the surrounding network is already well developed.

The intervention demonstrated that RBF can be applied effectively in the grid sector when results are clearly defined, technically verifiable and linked to household-level access. Through the RBF mechanism, the project strengthened accountability while enabling EDCL to connect households that were unlikely to access electricity without targeted support.

By combining ready boards, internal wiring support and energy-efficient LED lamps, the intervention enabled poor households to use electricity safely and affordably once connected.

Grid Densification I therefore demonstrated that inclusive electrification requires attention not only to infrastructure but also to the household-level costs that determine whether poor families can use electricity safely and sustainably. Extending infrastructure brings the grid within reach; targeted support determines whether poor households can make the final connection and benefit from it in practice.



5.3 Grid Densification II

In 2023, EnDev Rwanda halted new mini-grid activities. As national grid expansion reduced the number of viable mini-grid sites, EnDev sought to retain available resources within the electrification sector while responding more directly to its LNOB

objective. GIZ and REG therefore collaborated to develop a second grid densification intervention.

Grid Densification II began in 2025 and was completed in June 2026. Building on the experience of the first phase, the project introduced a more targeted and gender-responsive approach. It focused on women-headed households and households located beyond the 37-metre radius from the nearest service pole.

The gender-responsive design responded to persistent inequalities in electricity access. Although Rwanda's electricity sector has made significant progress, access remains uneven. Grid-installed capacity and the electrification rate have both increased substantially since 2017. However, grid electricity remains concentrated in higher-income and urban areas, while rural households remain comparatively underserved. Women-headed households are also less likely to have electricity access than male-headed households.

Grid Densification II therefore addressed two key barriers affecting vulnerable households: unaffordable internal wiring and the additional infrastructure required to reach households beyond the 37-metre service radius. At least 55 per cent of supported households were expected to be women-headed – a target ultimately exceeded – contributing to national efforts to reduce the gender gap in electricity access.

Infobox | Why gender-responsive electrification matters

Women-headed households continue to face greater barriers to electricity access and remain less likely to be connected to the national grid than male-headed households. According to the 2022 Rwanda Population and Housing Census, 63.9 per cent of male-headed households had access to electricity, compared with 54 per cent of women-headed households.

By targeting women-headed households, Grid Densification II sought to reduce this access gap and promote more inclusive electrification.

Households were selected in coordination with district officials. This local coordination supported transparent beneficiary identification and aligned the intervention with local electrification priorities.

The project combined three support packages, with beneficiary selection guided by specific targets for each.

First, all supported households received internal wiring, comprising a small distribution board, two lights, two switches, and two sockets. This package addressed one of the main affordability barriers for last-mile households.

Second, the project supported low-voltage line extensions and additional service poles for clusters of unconnected households beyond the 37-metre service-pole radius. Without this support, these households would have had to cover the additional costs of line extension themselves, effectively excluding them from standard subsidised connection arrangements.

Third, the gender package provided a full waiver of the RWF 56,000 connection fee for women-headed households. By pairing targeted beneficiary

selection with direct connection fee waiver support, this measure translated the project's gender objective into a practical affordability intervention.

The approach of working in already grid-serviced areas was designed to be cost-efficient, with an average cost of less than 150 EUR per connection. Rather than calculating each household incentive through a case-by-case engineering assessment, the RBF structure used the cost of a model household. This standardised approach reduced administrative complexity while addressing distance-related costs through a capped subsidy.

The project was initially linked to another EnDev intervention, the Sustainable Electric Cooking Access Leveraging Electricity Uptake in Rwanda (SCALE.up) Project, with the aim of promoting electric cooking among newly connected households. Under this concept, households purchasing an electric cooking appliance would have received a RWF 7,500 top-up on their prepaid electricity meter. However, delays in implementing the SCALE.up eCooking RBF meant that the project timelines did not align, and the top-up was not provided under Grid Densification II. [\(Read more about the SCALE.up Project, page 152\).](#)

The three support packages under Grid Densification II

Package	Support provided	Target	Calculation of RBF incentives
 Internal wiring support (for all households)	Internal wiring comprising either a small distribution board, two lights, two switches and two sockets.	 All households	Average cost of internal wiring for a household with two rooms.
 Low-voltage line extension	Low-voltage line extensions and additional service poles for clusters of currently unconnected households. These households also benefit from internal wiring support.	20% of total target	Funding to connect clusters of households, with the budget calculated to cover, for example, 60 households within 1 km of the nearest service pole.
 Gender package	100 per cent connection fee waiver.	55% minimum of total target	Connection fee of RWF 56,000.



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Results and impact of Grid Densification II

Grid Densification II expanded reliable electricity access for vulnerable households that remained unconnected despite living in already electrified areas. By addressing internal wiring costs, connection fees, and the additional infrastructure costs required beyond the 37-metre threshold, the project reduced energy poverty and extended the benefits of modern energy access to underserved communities.

The project also strengthened social inclusion. More than 2,000 of the 3,450 supported connections were to women-headed households, exceeding the minimum target of 55 per cent. By linking affordability support with a clear equity objective, the intervention became more responsive to households facing the greatest risk of being left behind.

Implementation showed that structural and cultural barriers also make it more difficult for women-headed households to access electricity. Single mothers and widows often lacked the financial means and time to initiate connection requests. Land titles required for connection were

not always registered in their names, while some women reportedly refrained from requesting access because of the stigma associated with their social status. These findings demonstrated that gender-responsive electrification requires active engagement and administrative assistance alongside targeted technical and financial support.

By explicitly identifying women-headed households as a priority group, the intervention encouraged implementing teams, local authorities, and community members to recognise gender disparities in electricity access. REG reported that women, including some who were not directly connected through the project, felt a sense of empowerment through the project's design, realising that access to energy was increasingly understood as a right and opportunity for all households, regardless of the gender of the household head.

Access to electricity improved daily living conditions for beneficiary households. Community members reported better lighting, making evening activities safer and more comfortable. Improved indoor and outdoor lighting enhanced security at night, while children could read and complete schoolwork after

dark. Households also gained greater access to information and communication through radios, televisions, and mobile phones.

For a small number of beneficiaries, around 3 per cent, electricity also created new opportunities for income generation and local entrepreneurship. Some beneficiaries established or expanded businesses that depend on a reliable power supply, including mobile phone charging services, small retail and convenience shops, hair salons, barber shops, refrigeration services, and cold-drink businesses. Although limited in scale, these examples demonstrate the potential for electricity access to support income-generating activities when accompanied by greater awareness of and opportunities for productive use.

Access to electricity also reduced many households' reliance on kerosene lamps, candles, and other traditional lighting sources. This transition lowered exposure to smoke and harmful emissions, improved indoor air quality, reduced expenditure on traditional lighting fuels, and supported cleaner household energy use.

Overall, Grid Densification II demonstrated that targeted electrification can do more than expand physical access. By addressing affordability, distance and gender-related exclusion together, the project improved household wellbeing and created new opportunities for safety, education, communication, and livelihoods.



5.4 Lessons from Grid Densification I & II

Grid densification can close access gaps at relatively low cost

The two Grid Densification Projects confirmed that many unconnected households live in areas where electricity infrastructure already exists. In these cases, the challenge is not the absence of the grid, but the household and infrastructure costs required to complete the final connection.

Grid densification is therefore a cost-effective approach to expanding electricity access. By leveraging existing low-voltage networks, interventions can connect vulnerable households without



‘When I first heard that the project would target women-headed households, I was surprised. Today I am proud to have been part of the team implementing this project and cannot thank GIZ enough. I am confident that the women who were connected have improved their household welfare through better lighting and new income opportunities. These empowered women have become role models, inspiring other women and encouraging men in their communities to support and match their progress.’

– Epiphanie Dukuzumuremyi,
Engineer, EDCL/REG
Implementation Team

requiring major infrastructure investments, reducing connection costs while maximising the number of households reached. This makes densification particularly relevant for closing the final access gaps on the path towards universal electrification.

However, the projects also showed that proximity to the grid and even a connection to the front door does not automatically translate into access. Electrification planning must therefore consider not only where infrastructure is located, but also whether households can afford the final steps needed to connect.

Internal wiring is a major affordability barrier

Both projects highlighted the importance of internal wiring. For many last-mile households, the cost of safe and compliant internal wiring can be a greater barrier than the connection fee itself.

Poor-quality wiring also creates safety risks and can prevent households from using electricity effectively. By supporting ready boards or basic internal

wiring packages, grid densification interventions can make electricity access safer, more affordable, and more practical for vulnerable households.

Small distance barriers can create structural exclusion

The 37-metre threshold illustrates how this relatively small distance can create a significant access barrier. Households located beyond the standard service radius may live in otherwise electrified communities but remain unconnected because additional poles or low-voltage line extensions are unaffordable.

Grid Densification II demonstrated that targeted RBF can cost-effectively address these small pockets of structural exclusion by financing line extensions and additional service poles for clusters of households.

Gender-responsive targeting strengthens inclusive electrification

Grid Densification II demonstrated that gender-responsive electrification requires more than setting participation targets for women-headed households. Meaningful inclusion depends on pairing these targets with concrete affordability measures, active engagement, and support to overcome administrative and social barriers.

The intervention raised awareness of the electrification gap between male- and female-headed households among implementing teams, district officials, and communities. Explicitly framing the project as gender-responsive helped make a previously overlooked inequality visible and encouraged stakeholders to consider how standard connection processes may affect households differently. This



increased awareness was itself an important outcome of the intervention.

The connection fee waiver under the gender-responsive package was also an important design feature. Combined with internal wiring support and the prioritisation of women-headed households, it helped ensure that the benefits of electrification reached this group, while promoting greater equity in access to electricity and the opportunities it enables. The project exceeded its minimum target for women-headed households, while REG identified a considerably larger number of potentially eligible households during project scoping. This indicates that the intervention addressed only part of the existing need and provides a basis for other implementers and donors to expand similar support.

Early engagement with local authorities improves implementation

The projects highlighted the importance of involving local authorities from the outset. Close collaboration with district and sector officials, village leaders, and community representatives strengthened beneficiary identification, facilitated community mobilisation, and increased public acceptance.

Their involvement also helped address documentation challenges and resolve implementation issues more efficiently. Local authorities were particularly important in identifying vulnerable households that might otherwise have remained invisible within standard connection processes.

This experience demonstrates that local ownership is central to transparent and inclusive beneficiary targeting.

Standardised RBF design improves administrative efficiency

Grid Densification II demonstrated the value of a standardised incentive design. By calculating subsidies based on a model household rather than undertaking case-by-case engineering assessments, the project reduced administrative complexity while continuing to address the main cost barriers faced by eligible households.

This approach simplified implementation, reduced verification requirements, and improved administrative

efficiency. It also made the incentive structure easier to apply across different project sites.

Efficient implementation depends on strong operational planning

Grid Densification I faced implementation delays linked to the rainy season, material transport challenges, and the COVID-19 lockdowns. These



‘Before starting the GIZ-implemented Grid Densification Project, I realised that my institution was extending the grid and stopping at customers’ meter points without lighting as many households as possible. This practice left many households unable to access electricity because some could not afford the cost of internal wiring. For me, it was like knocking on a door but not being able to enter. Thanks to GIZ, together we have been able to target poor and vulnerable groups, including women-headed households.

At the beginning, I was not sure that so many women-headed households would be identified and connected. Now that it has been done, it has opened our eyes and serves as a wake-up call for us as public institutions, as well as for local government. I am sure that future energy projects, such as biomass and clean cooking, will now be designed to provide direct support to women-headed households because planners in the energy sector, who are predominantly male, tend to overlook the challenges they face.’

– Olivier Ayubusa Turikumana,
EDCL/REG Project Manager and Grid
Densification Project Implementation
Team Lead

disruptions slowed household connections and placed pressure on implementation teams.

Grid Densification II reinforced the importance of efficient operational planning. Decentralised storage facilities located closer to project sites reduced transportation time, minimised logistical bottlenecks, and enabled field teams to respond more quickly, particularly in remote areas.

Implementation by EDCL's in-house technical teams also demonstrated the potential to reduce costs, strengthen quality control, build institutional capacity, and accelerate delivery by reducing reliance on external contractors.

Together, these experiences highlight the importance of realistic timelines, early procurement, efficient logistics, and strong institutional capacity for successful grid densification programmes.

Inclusive electrification should be linked to productive and efficient energy use

Grid densification increases access, but long-term sustainability also depends on how newly connected households use electricity. Without complementary strategies, household consumption may remain low, limiting load growth and reducing the broader economic benefits of electrification.

The planned link between Grid Densification II and the SCALE.up eCooking intervention showed the potential of combining grid access with electric cooking and appliance adoption. Although this link was not realised in this case because the project timelines did not align, the linkage remains possible and could yield significant circular benefits for women, households, and utilities.

The fact that only around 3 per cent of Grid Densification II beneficiaries reported using electricity for income-generating activities also points to an opportunity for future interventions. Grid densification could be paired with targeted information and awareness activities on productive uses of energy, helping newly connected households identify practical opportunities to use electricity for livelihoods.

Future grid densification interventions should consider productive use of energy, efficient appliances, and clean cooking strategies as complementary components from the outset. This would enable newly connected households to move beyond basic access towards meaningful and productive electricity use.





All photos © GIZ/Saleh Ruzindaza

Success story

More than a connection

On the hills of Rwamagana District, in Rwanda's Eastern Province, fourteen widowed women live side by side in modest government-built homes. Each lost her husband during the 1994 Genocide against the Tutsi. Together, they rebuilt their lives and formed a close-knit community that continues to support one another through everyday challenges.

Yet, despite living only 300 metres from the national electricity grid, connection was a distant prospect. The cost of extending the network, installing internal wiring, and paying the connection fee placed grid access out of reach. Solar home systems provided lighting, but often became unreliable during the rainy season, leaving homes in darkness.

Recognising these barriers, district authorities identified the community for support through the gender-responsive Grid Densification Project, implemented by REG with support from EnDev under its Leave No One Behind approach. REG extended the

low-voltage network to the settlement and provided internal wiring for each home. As women-headed households, the residents also received a full waiver of the electricity connection fee.

Today, reliable electricity has transformed daily life in ways that reach far beyond switching on a light.

For Beatrice Muhimakazi, who lives with her son, the greatest change has been a renewed sense of connection. Before electricity reached her home, she sometimes went for days without reliable lighting, and even a simple activity like charging a mobile phone required extra time and expense. After being connected, she saved part of her limited income from daily labour and bought a television.

The television has become much more than a household appliance. Neighbours gather to watch the evening news and other programmes, turning her home into a place where people come together.

Laughing, Beatrice reflects on the new rhythms in her home:

► ‘Since I got this TV, I am not sleeping as much anymore.’

Behind the humour lies something more profound. For a woman who has lived through personal loss, the television has brought companionship, conversation, and a renewed sense of belonging.

The project also reached other households in nearby communities, including Clementine Bamporiki, who lives with her husband and children in a village close to Beatrice’s community.

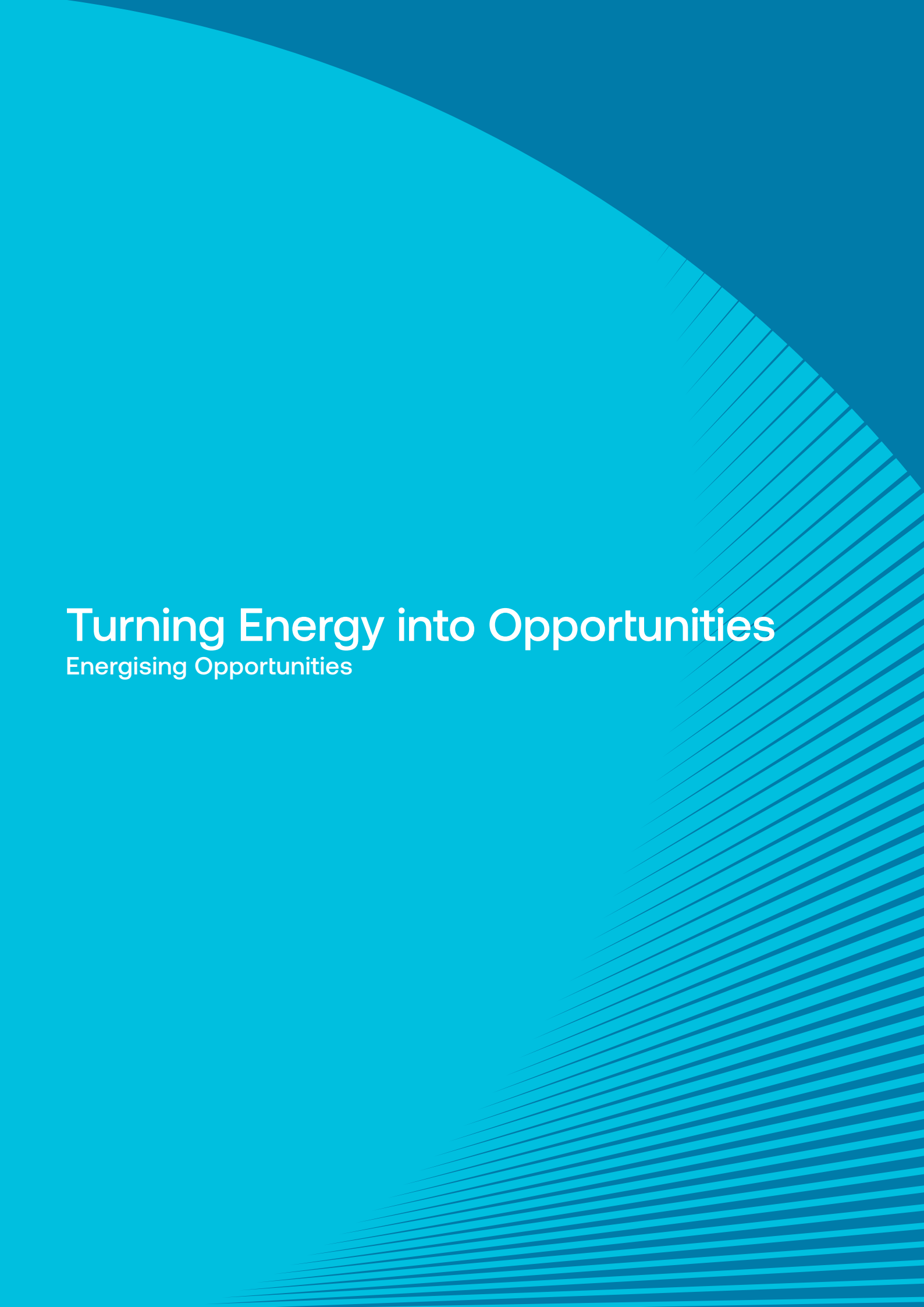
Before electricity arrived, Clementine’s family relied on a battery-powered radio for news and entertainment, while her children completed their homework using mobile phone torchlight. Charging the family’s phones meant making regular visits and payments to a local charging kiosk, adding to the family’s daily expenses.

Today, their evenings look very different. Bright electric lighting allows her children to study comfortably after sunset, and friends from nearby homes that remain unconnected sometimes join them.

Reliable electricity has also changed the way Clementine thinks about the future. She plans to open a small business selling chilled milk and hot tea to her community, using electricity not only to improve her family’s living conditions but also to create a more stable source of income.

Beatrice and Clementine's experiences show that extending the electricity grid is about far more than physical infrastructure. For households that have long remained unconnected, electricity can strengthen community ties, support children’s education, restore dignity, and create new livelihood opportunities. In communities such as these, leaving no one behind means ensuring that the benefits of development reach households that have waited the longest.





Turning Energy into Opportunities

Energising Opportunities



6 Productive Use of Energy (PUE) Project

Strengthening mini-grid sustainability through rural enterprise development



6.1 Unlocking demand for sustainable mini-grids

Rwanda's Energy Sector Strategic Plan¹⁰ combines grid expansion, off-grid solar systems, and renewable energy mini-grids to achieve universal access to electricity by 2029. Mini-grids play a particularly important role in reaching remote rural communities where grid expansion remains technically challenging or economically unviable. Through the Village Grid Results-Based Financing (VG RBF) Project, EnDev supported the development of renewable energy mini-grids that provide higher-tier electricity to households and businesses, particularly in rural areas. [\(Read more about the Village Grid RBF Project, page 28\).](#)

However, expanding electricity access through mini-grids alone does not guarantee sustainable energy systems. While productive use uptake was considered during the VG RBF Project design, electricity consumption levels often remained low. As a result, electricity demand frequently fell below the levels required for mini-grid operators to generate sufficient revenue to cover operational and maintenance costs.

Low demand presented a significant challenge to the long-term viability of rural mini-grids. Electricity consumption during daytime hours remained particularly limited, as most households used electricity primarily in the evening for lighting, phone charging, and other basic needs. Without productive users consuming electricity during the day, many operators struggled to achieve the utilisation rates needed for financial sustainability.

This challenge reflects a broader reality across rural electrification programmes: access to electricity generates the greatest impact when it is linked to income-generating activities and local economic development. Promoting productive use of energy is therefore essential for increasing daytime electricity utilisation, improving demand patterns, and strengthening the business case for rural mini-grid operations.

At the same time, many rural communities possess untapped entrepreneurial potential. However, lack of access to productive equipment, constrained financing opportunities, and insufficient business development support limited entrepreneurs' ability to translate electricity access into business growth and economic opportunity.

10. Republic of Rwanda, Ministry of Infrastructure, *Energy Sector Strategic Plan 2024–2029* (Kigali: Ministry of Infrastructure, 2024).

Productive use of energy offered an opportunity to address both challenges simultaneously. By enabling entrepreneurs to adopt solar-powered equipment, businesses could improve productivity, diversify services, increase incomes, and create employment opportunities. In turn, higher electricity consumption would strengthen demand for mini-grid services and improve the financial sustainability of rural energy infrastructure.

To unlock this potential, EnDev, through a collaboration between GIZ and the AVSI Foundation, implemented the Productive Use of Energy (PUE) Project from January 2020 to July 2022. Building on existing mini-grid investments, the project sought to stimulate demand by supporting entrepreneurs' use of electricity for income-generating activities, particularly during daytime hours. In doing so, the intervention aimed to increase electricity consumption, strengthen mini-grid utilisation, and contribute to local economic development.

The project was implemented at existing mini-grid sites all over Rwanda:

- Jurwe, operated by ECOS in Muhanga District, and Mudasomwa, operated by HOBUKA in Nyaruguru District in the Southern Province;
- Gahira, operated by RENERG in Nyamasheke District in the Western Province; and
- Gakagati, operated by Equatorial Power in Nyagatare District; Rushonga, operated by NESELTEC in Kirehe District; and Rutenderi, operated by Absolute Energy in Gatsibo District, all in the Eastern Province.



6.2 Enabling rural enterprises to use electricity productively

While access to electricity creates new opportunities for rural development, entrepreneurs often face significant barriers to adopting productive electrical equipment. Limited access to finance, insufficient business skills, and a lack of suitable technologies frequently prevent businesses from starting or expanding their operations despite the availability of electricity.

To address these barriers, the PUE Project adopted an integrated enterprise development approach that

Infobox | Why productive use matters

Mini-grids often experience low electricity demand because households primarily consume electricity during the evening. Supporting productive uses of energy helps increase daytime electricity consumption, strengthen mini-grid revenues, and enable entrepreneurs to turn electricity access into income-generating opportunities.

While PUE alone cannot guarantee the financial viability of mini-grids, it remains an important instrument for improving demand, supporting operators, and stimulating local economic development.

combined business incubation, technical support, and co-financing for purchasing productive equipment.

Before implementation, AVSI Foundation conducted a detailed feasibility assessment across the six mini-grid sites to understand the local socio-economic context, identify viable business opportunities, and assess the economic potential of productive uses. The assessment informed the development of ten business plans tailored for different productive activities and helped ensure that project support responded to market opportunities. The project adopted a community-based approach, engaging local government stakeholders and market actors to ensure interventions aligned with local priorities and needs.

To identify promising entrepreneurs, the project organised business idea competitions. Recognising the important role of women's economic participation in rural development, the selection process incorporated affirmative action measures to encourage female entrepreneurship and increase women's access to productive assets.

Selected entrepreneurs participated in business management training and received one-on-one coaching designed to strengthen business planning, financial management, marketing, and operational performance.

To overcome affordability barriers, entrepreneurs received matching grants that covered part of the cost of electrical equipment. Beneficiaries contributed between 30 and 50 per cent of appliance costs, ensuring ownership while reducing the upfront investment required to adopt productive technologies.

The project also sought to strengthen longer-term access to finance by collaborating with a financial institution to develop a dedicated appliance-financing loan product. In parallel, partnerships were established with six electrical equipment suppliers to improve access to quality electrical machinery and ensure businesses could procure appropriate technologies. Where technical issues disrupted electricity supply, the project also provided financial support to mini-grid developers to help maintain service continuity.

Supported businesses represented a diverse range of productive activities. These included secondary-sector enterprises such as carpentry, welding, bakery, tailoring, shoemaking, cassava leaf processing, and electronic repair, as well as tertiary-sector service-oriented businesses, including beauty salons, printing services, bars, canteens, a mini-cinema, digital services and a chick hatchery. Many of these services had previously been unavailable within the target communities, requiring residents to travel considerable distances to access them.

By supporting productive enterprises rather than household consumption alone, the project aimed to create a virtuous cycle in which business growth increased electricity demand, while reliable electricity enabled further enterprise development and local economic activity.

asset. Entrepreneurs expanded existing businesses, introduced new services, improved productivity, and generated additional income while simultaneously increasing electricity consumption within mini-grid communities.

Strengthening rural economies

The project supported both new and existing electricity-powered businesses and enterprises, increasing access to products and services that had previously been unavailable or difficult to obtain locally, while reducing the need for residents to travel to larger towns.

These businesses also created and sustained jobs while generating additional income opportunities for entrepreneurs and their families. Entrepreneurs expanded their customer base, improved productivity, and diversified their services by adopting electrical equipment and strengthening business management practices.

Increasing electricity demand

The intervention demonstrated the important role productive users play in strengthening mini-grids. Unlike most households, which primarily consume electricity during the evening, productive enterprises create demand throughout the day and often require higher electricity loads.

By increasing productive electricity consumption, supported businesses contributed to higher utilisation rates and stronger revenue streams for mini-grid operators. The project, therefore, demonstrated the close relationship between local economic development and the long-term sustainability of rural energy infrastructure.

Advancing women's economic participation

Women accounted for 41 per cent of appliance beneficiaries, reflecting the project's deliberate efforts to support women's entrepreneurship and participation in productive economic activities.

This enabled women-led businesses to access productive equipment, thereby improving productivity, increasing income, and expanding economic opportunities within their communities. EnDev's gender strategy recognises that women-owned enterprises



6.3 Results and impact of the PUE Project

Turning electricity access into economic opportunities

The project demonstrated that rural electrification delivers its greatest value when electricity access is linked to economic opportunity.

Through business development support, matching grants, and access to finance for productive equipment, the project helped transform electricity from a household service into a productive economic



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Testimonial

Tailoring a better future

In Remera Sector, Nyaruguru District, tailoring has become a pathway to growth for entrepreneur Claudine Uwimana.

Before receiving support through the PUE Project, Claudine relied on manual sewing equipment and had limited capacity to produce more modern clothing designs. Accessing specialised tailoring services often required long-distance travel, and opportunities to expand her business remained limited.

Through the project, Claudine received a matching grant that enabled her to acquire two electric sewing machines. She also participated in business skills training and received regular coaching to strengthen her business management skills.

The new equipment has improved her productivity and has enabled her not only to offer a wider range of clothing designs to her customers but also to provide services to other tailors in the community.

Reflecting on the changes, Claudine says:

► 'My income is increasing day by day compared to the time when I used only a manual sewing machine.'

Claudine's experience demonstrates how access to productive equipment, combined with business support, can help women entrepreneurs strengthen their businesses and expand economic opportunities within rural communities. ■

tend to face greater barriers to accessing electricity than their male counterparts. Women often operate small businesses that require little more than lighting and a few small electrical appliances, such as sewing machines or hair dryers. Without targeted support, they tend to be overlooked in PUE interventions. The project demonstrated that gender-responsive selection measures can help address these barriers and enable women entrepreneurs to benefit from productive energy investments.

Strengthening the ecosystem for productive energy use

The project also highlighted the broader ecosystem conditions required for productive use initiatives to succeed and thrive. Access to finance, business support services, quality equipment suppliers, and reliable electricity infrastructure all proved essential

in enabling entrepreneurs to invest confidently in productive activities.

Most importantly, the project demonstrated that productive use of energy should not be viewed as an optional complement to rural electrification. Rather, it is a critical component of sustainable mini-grid development, helping convert electricity access into economic growth, employment creation, and stronger local energy systems.



6.4 Lessons for future productive energy programmes

Although the project demonstrated the potential to strengthen both mini-grid sustainability and rural enterprises, implementation also generated important lessons for future productive energy programmes.



What Worked

Matching grants reduced investment barriers

Access to productive electrical equipment was one of the main barriers preventing rural entrepreneurs from expanding or establishing electricity-based businesses. The matching grant approach proved effective in reducing upfront investment costs, enabling entrepreneurs to acquire appliances that would otherwise have remained unaffordable.

The cost-sharing mechanism also encouraged beneficiary ownership and commitment, strengthening the sustainability of supported businesses.

Training and coaching strengthened business performance

Business skills training and one-on-one coaching helped entrepreneurs improve financial management, business planning, and day-to-day operations.

Combining productive financing with business development support contributed to stronger performance and increased the likelihood of sustaining productive activities beyond the project period.

Affirmative action increased women's participation

The business assessment methodology incorporated gender-responsive evaluation criteria by awarding additional points to women-owned businesses and supporting greater gender equity and inclusion. The introduction of affirmative action measures during the selection process increased the participation of women entrepreneurs.

This demonstrated that targeted support measures can help address barriers that often limit women's participation in productive economic activities and strengthen the contribution of electrification to women's economic empowerment.

Partnerships with suppliers ensured access to quality equipment

Collaboration with approved equipment suppliers helped ensure beneficiaries could access reliable and appropriate electrical appliances. This reduced the risk of poor-quality equipment undermining business performance and strengthened confidence in productive use investments.

Key lesson

Access to electricity alone does not guarantee productive energy use. The greatest impact is achieved when entrepreneurs can access a combination of reliable electricity, productive equipment, business development support, and financing tailored to local market realities.

Digital tools strengthened monitoring and data management

The use of Kobo Toolbox, a digital database, improved beneficiary tracking, project monitoring, and data management.

The system enabled more efficient collection and management of beneficiary information, while supporting evidence-based project implementation and reporting.

Challenges and Solutions

Appliance diversion reduced local electricity demand

Some beneficiaries sold or relocated supported appliances outside the mini-grid service areas. This reduced local electricity consumption and limited the project's contribution to increasing demand within target communities.

In response, AVSI Foundation introduced grant and business agreements that legally required beneficiaries to use supported appliances within the designated project sites, thereby strengthening accountability and protecting project objectives.

COVID-19 disrupted implementation and beneficiary participation

The COVID-19 pandemic affected project implementation and led some trained entrepreneurs to drop out before completing the support process.

Productive use interventions should therefore incorporate flexibility and contingency planning to maintain implementation momentum and respond effectively to unexpected external shocks.

Limited uptake of the appliance financing product

Although a dedicated loan product was developed, only two beneficiaries successfully accessed loans. Collateral requirements and land title conditions remained significant barriers for many rural entrepreneurs.

Financial institutions should be engaged from the earliest stages of project design to ensure that financing products reflect the realities and capacities of rural entrepreneurs.

Access to quality equipment remained a challenge

Affordable and reliable electrical appliances were often difficult to source in rural areas. Larger machinery was generally available only in major urban centres, creating additional transport costs and logistical challenges for beneficiaries.

Future interventions should explore approaches such as bulk procurement or leasing models to improve access to productive equipment in rural markets.

Mini-grid delays affected project implementation

Delays in mini-grid construction and commissioning disrupted implementation schedules and created uncertainty among participating entrepreneurs.

PUE interventions should ideally commence only once mini-grids are fully operational to minimise delays, avoid setbacks, and build community trust.

Strong community engagement increased beneficiary commitment

Beneficiaries who were actively involved throughout all project phases demonstrated greater commitment to and ownership of supported businesses.

Early, continuous community engagement strengthens ownership, improves participation, and supports long-term sustainability.



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Success story

From electricity access to economic opportunity

How two EnDev interventions helped transform enterprises in Rutenderi

Nestled among the fertile farmlands of Rwanda's Eastern Province, Rutenderi is a community of around 4,000 people. The area is known for its agricultural production, with farmers cultivating bananas, maize, beans, and rice across the surrounding landscape. Yet for many years, limited access to reliable electricity constrained opportunities for local businesses and entrepreneurs.

Economic opportunities for entrepreneurs in Rutenderi remained limited while electricity was unavailable. Although small diesel generators provided a solution for some businesses, high fuel costs and frequent breakdowns limited growth and profitability. That began to change in 2019.

Through EnDev's Village Grid RBF project, a solar mini-grid was installed in Rutenderi. A private

Rwandan company, supported through the project, developed the mini-grid, which now serves households, businesses, and social institutions in Rutenderi. For the first time, the community gained access to reliable electricity capable of supporting productive economic activities.

Among the first entrepreneurs to experience the benefits was Joseph Singirankabo.

A foundation for growth

Before the mini-grid arrived, Joseph relied on a diesel generator to power his milling business. Fuel costs were high, maintenance was frequent, and mechanical failures often disrupted operations, leaving customers waiting for flour.

The introduction of reliable electricity transformed his business. The new electricity source was clean, available around the clock, and significantly more affordable than diesel. Joseph reduced his electricity costs to around one-third of what he had previously spent on fuel, while his earnings increased by approximately 20 per cent.

Reliable electricity also enabled him to think beyond his existing business. A few months after connecting to the mini-grid, Joseph opened a bakery next to his mill, creating additional employment opportunities and expanding the range of services available within the community.

His experience demonstrated the potential of rural electrification. Yet, electricity access alone was only the beginning. To fully unlock the economic potential of the mini-grid and strengthen its long-term sustainability, local entrepreneurs needed support to invest in productive equipment and develop businesses that could make greater use of electricity.

Building on the opportunity

Recognising this challenge, EnDev, through a collaboration between GIZ and the AVSI Foundation, launched the PUE Project. The initiative aimed to help entrepreneurs transform electricity access into income-generating opportunities through business training, coaching, and matching grants for productive equipment.

For Jean Baptiste Ndagijimana, the project provided an opportunity to bring a long-held ambition back home.

After spending several years working in a hatchery in Kigali, he dreamed of establishing a similar business in Rutenderi. The arrival of the mini-grid created the conditions for such a business to operate, while the PUE Project helped make the investment possible.

Through a matching grant, Jean Baptiste acquired an electric egg incubator that would otherwise have remained beyond his financial reach. He also received business skills training and regular coaching to help establish and manage the enterprise.

Today, his hatchery is profitable and well known within the community.

► 'I received business skill training and regular coaching from the project staff. This helped me manage my business more effectively. It is now well known in my community, and people like the chicks from my farm.'

Turning electricity into enterprise

Meanwhile, for carpenter Anastase Maniragaba, the mini-grid initially changed everyday life.

When electricity first arrived in Rutenderi, he used it primarily for household purposes such as lighting, phone charging, and listening to the radio. It was only later, when the PUE Project came to his village, that he began to see electricity as a tool for growing his business.

Anastase learnt about the matching grant mechanism and was able to access a grant covering 70 per cent of the cost of two electric woodworking machines: a planer and a processing machine. He invested his own savings to cover the remaining cost, allowing him to transition from manual tools to electric equipment.

The impact was immediate. The new machinery significantly improved the efficiency of his workshop and enabled him to serve more customers. As his income increased, Anastase invested in improving his home by installing modern doors, cupboards, and beds. He also used electricity to weld a new iron-sheet roof, improving his family's living conditions.

The benefits extended beyond his household. Business growth enabled him to employ three workers, while four neighbouring carpenters now pay to use his machines because they do not yet have access to similar equipment themselves.

► 'With the additional income, I have upgraded my home and improved my roof. My business is not just surviving; it is growing.'

His ambitions continue to grow alongside his business. Looking ahead, Anastase plans to increase his electricity capacity and add a milling machine to expand his business further.

A more vibrant local economy

The experiences of Joseph, Jean Baptiste, and Anastase illustrate how access to electricity and its productive use can work together to strengthen rural economies. While the mini-grid provided the foundation, the PUE Project helped entrepreneurs invest in productive equipment, expand their businesses, create jobs, and introduce services previously unavailable in the community. As businesses grew, communities gained access to more

local goods and services, while increased electricity consumption helped sustain mini-grid infrastructure. In Rutenderi, the combination of reliable electricity and entrepreneurial support helped turn energy access into economic opportunity.

Although operational challenges later affected some mini-grids, prompting several beneficiaries to relocate their productive equipment after obtaining connections to the national grid, this transition represented a positive step towards a more permanent and reliable source of electricity. The mini-grids were always intended as a transitional solution to facilitate access to a more sustainable long-term energy solution. ■



7 Cooling as a Service (CaaS) Project

Testing solar-powered cold storage for Rwanda's horticulture value chains



7.1 Reducing post-harvest losses through climate-friendly cooling

Rwanda's agricultural sector remains central to the country's economy, food security, and rural livelihoods. Smallholder farmers account for a large share of agricultural production, yet many continue to face limited market access, inadequate infrastructure, and high post-harvest losses. These challenges are particularly acute in horticulture value chains, where fruits and vegetables are highly perishable and vulnerable to spoilage during harvesting, transport, aggregation, and retail.

Post-harvest losses reduce income for farmers, traders, and market sellers. They also undermine food availability, increase pressure on already constrained household incomes, and limit the growth potential of Rwanda's agricultural sector. A 2018 post-harvest loss assessment of tomatoes in Rwanda, conducted under the United States Government's Feed the Future initiative, found that damage and defects increased significantly along the value chain. Mechanical damage rose from 33 per cent at the farm level to 68 per cent at the retail market level. Overall, 21 per cent of tomatoes were discarded at the farm level, 11.5 per cent at collection points, 10 per cent at wholesale markets,

and 13.6 per cent at retail markets. This means that 56 per cent of tomatoes were discarded on their journey from farm to market.

Cold storage is widely regarded as one potential solution to post-harvest losses. Cooling facilities are often expected to strengthen farmers' bargaining power, extend the shelf life of perishable products, and improve market access. Consequently, the role of cooling technologies across agricultural value chains has received increased attention in recent years. In Rwanda, the African Centre of Excellence for Sustainable Cooling and Cold Chain (ACES) has played an important role in promoting sustainable cooling technologies and strengthening knowledge and innovation within the cold chain sector.

At the same time, the implementation of cold storage infrastructure has revealed both opportunities and limitations. While cold chains are indispensable for high-value export markets, such as flowers, French beans, and avocados, where buyers demand stringent quality standards, their application in local and regional markets is far less straightforward. The viability of cold storage depends strongly on the characteristics of the value chain, the products being handled, market demand, and the underlying business model.

Experience in Rwanda illustrates this complexity. A mapping exercise conducted in 2021¹¹ found that almost half of the 41 cold rooms located near farms and production hubs remained underutilised or non-functional. Similarly, an assessment undertaken by GIZ EnDev found that farm-based cold storage facilities are often used for only two to three months per year. These findings do not diminish the potential of cooling technologies; rather, they highlight the importance of designing cold-chain solutions that address specific market needs and deliver sustainable value for users.

Meanwhile, access to cold storage infrastructure remains limited, particularly during peak harvest periods and in areas with insufficient transport and market infrastructure. In the absence of adequate storage options, market sellers often sell produce quickly at reduced prices or discard goods altogether. Traditional cooling and coping methods do not sufficiently address the gap, especially for farmers and traders seeking to access higher-value markets or extend the shelf life of their products.

Against this backdrop, EnDev Rwanda, in collaboration with the Rwandan private company Izuba Power Ltd, piloted the Cooling as a Service (CaaS) Project between January 2022 and July 2023. The project was supported through the EnDev Innovation Window funded by the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO). Through a grant agreement with Izuba Power Ltd., EnDev tested a business model that was new to Rwanda's agricultural cold-chain sector: solar-powered cold storage offered as a service.

Rather than requiring farmers, traders or aggregators to invest in their own cold rooms, the model allowed users to pay only for the storage space they needed. The project, therefore, aimed to make cooling accessible to users who would otherwise be unable to afford conventional cold storage infrastructure. In doing so, it sought to reduce food waste, improve food security, and test whether innovative cooling technologies and service models could contribute to more resilient horticulture value chains.



All photos © GIZ/Paul Toussaint Nzenze (Bold Image)

Infobox | What is Cooling as a Service (CaaS)?

CaaS shifts investment costs away from farmers and traders by allowing users to pay only for the storage space they need. This model aims to make cold storage more accessible to market actors who otherwise cannot invest in conventional cooling infrastructure.

11. Republic of Rwanda, Ministry of Environment, *Rwanda's Climate Adaptation Monitoring, Evaluation, and Learning System in the Agriculture Sector* (Kigali: Ministry of Environment, 2023), 21. ↗

Although the project did not achieve the expected levels of utilisation, it generated valuable insights into the opportunities and limitations of cold-chain investments in Rwanda. These lessons now provide an important foundation for future interventions seeking to combine productive energy use, agricultural development, and climate-friendly cooling solutions.

7.2 Piloting an innovative cooling model

Testing solar-powered cooling as a service

The CaaS Project installed solar-powered cold storage units at two selected market sites: Kimironko Market in Gasabo District, Kigali City, and Rubavu Market in Rubavu District, Western Province. Each site received one solar-powered cold storage unit with a capacity of 250 crates.

The two cold rooms were installed with the same technical configuration. The chilling units and the solar photovoltaic systems were supplied by the German company Phaesun/SelfChill, while the containerised cold rooms were imported from Kenya. Each five-tonne cold room has a power capacity of 3.85 kW and uses R600a, a natural refrigerant, with a very low global warming potential.

The CaaS Project selected the SelfChill technology for its modular design, climate-friendly refrigerant, and maintenance advantages. Most units function independently and can be adapted to local requirements. The modular structure also simplifies maintenance, as individual components can be replaced when faults occur, unlike many conventional systems in which larger sections of the equipment must be replaced when a single component fails.

As solar-powered refrigeration was still relatively new in Rwanda, and Cooling as a Service remained a nascent business model, the project invested substantially in technical training and awareness-raising. The German SelfChill team trained 14 technicians on the solar cooling and refrigeration technology used in the installed units. Additional training was provided to government representatives involved in decision-making, academia, and private-sector stakeholders, including technicians, engineers, and students from partner institutions whose curricula include refrigeration or solar cooling.

The training introduced participants to solar energy and refrigeration technologies, solar cooling concepts, natural refrigerants with reduced ozone depletion and low global warming potential, market development and system design. This capacity-building component aimed to strengthen local knowledge of solar cooling technologies and support future uptake of climate-friendly refrigeration solutions.

In parallel, the project provided awareness-raising, training, and business development support to market sellers and agricultural stakeholders. These activities focused on best post-harvest practices and the use of cold storage in reducing fruit and vegetable losses. Market sellers were encouraged to test the cold rooms and explore how cooling could help preserve unsold produce, maintain quality, and reduce spoilage.

Introducing a pay-as-you-store model

The project tested a pay-as-you-store model under which users paid RWF 400 (approximately USD 0.35) per 20-kg crate per night. The fee structure was designed to ensure that the pilot units could remain operationally viable at an estimated break-even utilisation rate of 17 per cent under the market-seller business model.

The model sought to increase access to cooling for market actors who could not afford their own cold-storage equipment. Rather than investing in expensive infrastructure, users would pay only for the storage space they required. The initial focus was on reducing food waste at market sites and supporting local market sellers, wholesalers, and farmers.

As implementation progressed and uptake remained limited, the project explored additional business models. Potential rental and leasing arrangements for aggregators and exporters emerged as more promising alternatives to daily storage by individual market sellers. Several potential business cases were identified, including one aggregator and three exporters, and different rental and leasing models were analysed to assess whether larger users could generate more stable demand for cold storage services.

The analysis showed that even under these alternative business models, investment costs remained too high to be fully recovered through cold room revenues alone. This highlighted that subsidies are likely to remain necessary, at least during the early stages of market development.

Adapting to low utilisation

Despite awareness-raising campaigns and efforts to encourage adoption among market sellers and identify aggregators and larger suppliers within the markets, utilisation of the cold rooms remains low; however, both units continue to operate at their respective sites. This trend persisted even when storage services were offered at reduced prices or free of charge.

The analysis of these utilisation challenges revealed that the technologies and business models tested under the pilot did not, in large part, fully address the challenges identified during project design. However, the project generated valuable lessons on the conditions required for cooling technologies to become viable business solutions.

The training activities were well received. However, this did not translate into significantly higher utilisation rates. Resistance to behaviour change remained, particularly among market sellers with limited commercial experience or low awareness of the relationship between temperature control and produce quality. Some sellers even believed that low temperatures could reduce freshness, colour, and taste.

This experience demonstrated that awareness-raising alone is insufficient when the underlying business case is weak or when users do not clearly perceive the commercial value of cooling services.



7.3 Results and strategic insights from the CaaS Project

Testing an innovative model in a challenging market

The CaaS Project introduced Rwanda's first service-based model for solar-powered cold storage within local agricultural markets. Although utilisation remained below expectations, the pilot offered important insights into the technical, behavioural, and commercial conditions required for cold storage to contribute effectively to reducing post-harvest losses.

Strengthening awareness and technical capacities

The project introduced market sellers, farmers, aggregators, and transporters to the role of cold storage in reducing post-harvest losses. Awareness-raising campaigns encouraged sellers to test the cold rooms and explore how cooling could help preserve produce quality and reduce spoilage.



All photos © GIZ/Paul Toussaint Nzenze (Bold Image)



Identifying stronger business models

The project initially assumed that market sellers, wholesalers, and farmers would use cold storage to preserve unsold produce and reduce losses. However, implementation revealed that the business case for daily storage by small-scale market sellers was limited.

In Rubavu, for example, market sellers often purchased produce in small quantities from wholesalers. At the end of the day, only small volumes remained unsold, making storage impractical and expensive under a fixed daily crate fee.

The pilot, therefore, showed that cold storage may be more viable where users handle larger volumes, have more predictable demand, or serve markets where quality preservation creates additional value. Aggregators and exporters, in particular, appeared to offer stronger business cases through rental and leasing arrangements, especially when cold storage supports access to higher-value markets.

Informing future programming

Although the project did not achieve the expected utilisation levels, it generated valuable learning for future cold-chain and productive-use interventions.

The pilot confirmed that cooling technologies must be demand-driven and closely aligned with specific value-chain needs. Cold storage is not a universal solution for all agricultural products or all market actors. It works best where production volumes, market demand, product value, and the need for preservation justify the cost of cooling.

The CaaS experience helped EnDev Rwanda refine its understanding of how productive energy technologies should be designed, targeted and supported. These insights informed the subsequent PURE.Ag Project, particularly the need to assess business cases more carefully before technology deployment and to integrate cold-chain solutions into broader agricultural market systems.



7.4 Lessons for future cold-chain interventions

Technology alone is not enough

The CaaS Project generated one clear overarching lesson: technology alone is not enough. Solar-powered cold storage can help reduce post-harvest losses, but only when it responds to a clearly identified market problem, serves users with sufficient demand, and fits within the wider agricultural value chain.

The project demonstrated that the key question is not simply whether a cold room can be installed. More importantly, it is necessary to determine which products require cooling, when in the value chain, at what volumes, for which users, and which specific market challenges cooling is intended to address.

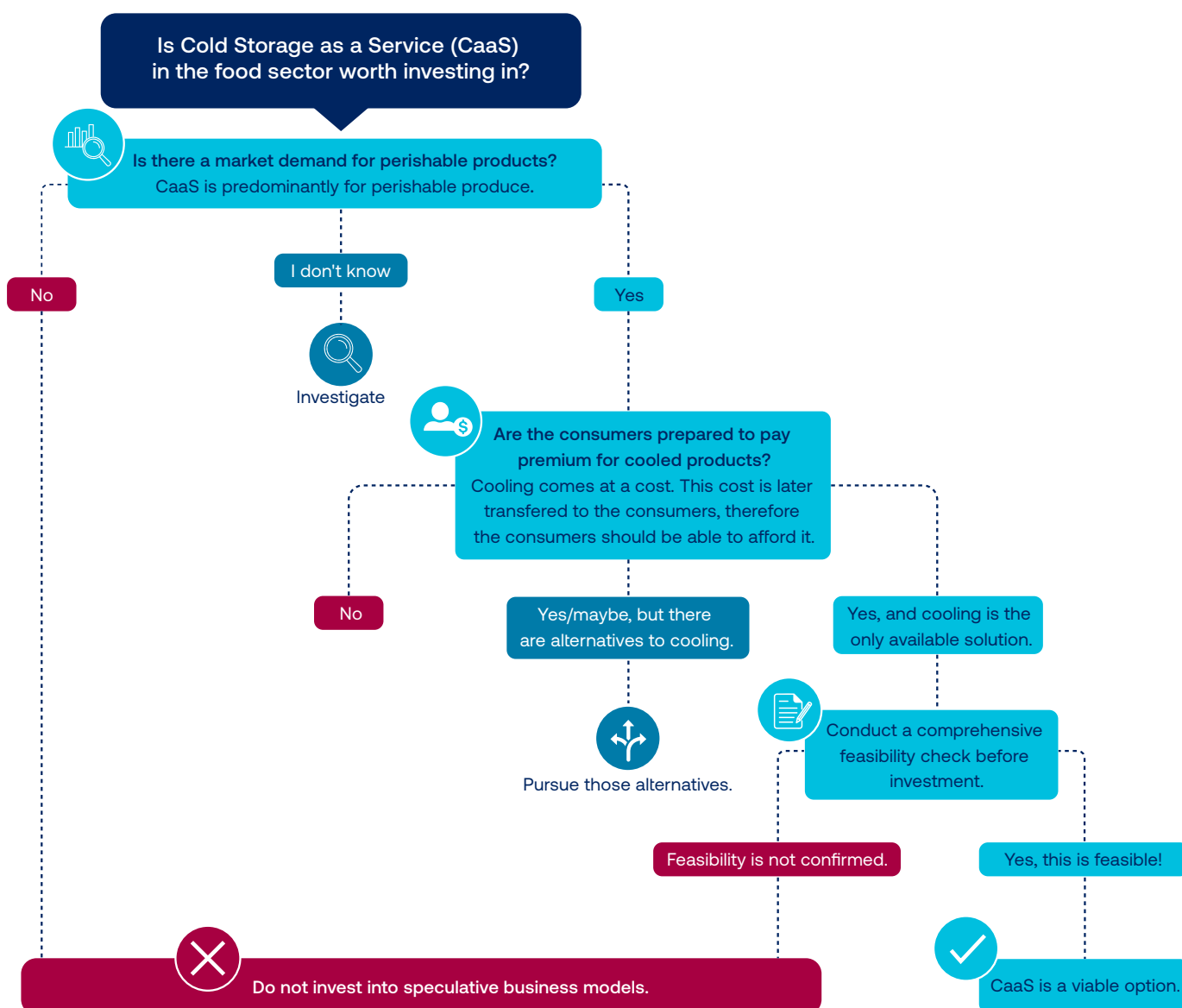
Cooling solutions must be demand-driven

The project demonstrated that cooling solutions should be designed around actual market demand rather than assumed or theoretical need. Although post-harvest losses are a recognised challenge in Rwanda's horticulture sector, not all market actors require cold storage in the same way.

Future interventions should therefore begin with a detailed analysis of value-chain dynamics, existing coping mechanisms, production volumes, transport conditions, market demand and users' willingness to pay. Tools such as post-harvest assessment methodologies can support this process and help determine whether cold-chain interventions are commercially and technically viable.

Infobox | When does CaaS create value?

Cooling as a Service is not a one-size-fits-all solution. Cold storage is most effective when it responds to a clear market need. The CaaS experience showed that technology alone does not guarantee adoption. Sustainable cooling depends on sufficient volumes, reliable markets, viable business models, and users who can translate improved quality preservation and reduced post-harvest losses into economic value.



This decision tree has been developed based on a technical exchange between EnDev and Bas Hetterscheid from Wageningen University & Research, Netherlands.

Market sellers may not provide a sufficient business case on their own

The initial focus on market sellers, wholesalers, and farmers proved too narrow. Many market sellers handled small quantities of produce, making paid storage difficult to justify.

In contrast, aggregators and exporters appeared to offer greater commercial potential due to larger volumes, stricter quality requirements, and more predictable demand. Future interventions should therefore consider rental and leasing models for users with higher and more predictable demand.

Cooling is a niche technology, not a universal solution

Cold storage is most effective where products have high market value, require quality preservation, or must comply with cooling standards, for example, berries, dairy, fish or meat, where cooling can directly support quality, safety, and market access.

For lower-value products or small quantities of unsold produce, the cost of cooling may outweigh the benefits. Successful cold storage systems, therefore, require sufficient produce volumes, predictable demand, purchase guarantees, and capable ownership structures.

Behaviour change requires more than awareness raising

Awareness campaigns improved understanding but did not significantly increase utilisation. Some sellers remained sceptical about cooling, while others lacked sufficient commercial incentives to change established practices.

Future programmes should combine awareness-raising with practical demonstrations and business models that clearly show how cooling improves incomes, reduces losses, or opens new market opportunities. Without this clear commercial link, awareness-raising alone is unlikely to drive sustained adoption.

Transport and handling losses must be addressed alongside cooling

Market sellers also faced deterioration of produce during transportation. Importers often used large

Infobox | A learning pilot with lasting value

The most important outcome was not the technology itself, but the evidence and learning it generated.

By testing the opportunities and limitations of Cooling as a Service in Rwanda, the pilot provided valuable evidence on what makes cold-chain investments viable and sustainable. These insights informed the design of the EnDev PURE.Ag Project and laid a stronger foundation for future productive energy and cold-chain interventions.

bags that damaged products at the bottom, resulting in losses shared between importers and market sellers. In such cases, cold storage at the market does not solve the full problem, because damage occurs before the produce reaches the cold room.

Future cold-chain interventions should therefore consider the entire post-harvest system, including harvesting, packaging, handling, transport, aggregation, and storage. Cooling can only deliver impact when it forms part of a wider solution to quality preservation.

Early-stage cold-chain models need subsidy support

The CaaS pilot showed that cold storage technologies remain costly for small-scale farmers and market sellers. Even where potential business cases were identified, investment costs were often too high to be fully recovered through cold room revenues alone.

Early-stage systems therefore require subsidies, grants or blended financing to offset high development and investment costs. Subsidies should be designed carefully to support market testing and business model development while avoiding long-term dependency.

Ownership and operational capacity are critical

Successful cold storage systems require capable ownership and strong operational management.

The low utilisation of the installed units highlighted the need for additional business development support for operators, alongside more targeted engagement with potential users.

Future interventions should assess not only the technology and users but also the operator's capacity to manage sales, customer relationships, maintenance, pricing, and business development.

Procurement and regulatory processes affect implementation

The project faced issues related to procurement, customs and local permits, which delayed implementation. These challenges affected project timelines and reinforced the need to account for import procedures, permitting requirements, and local regulatory processes during project design.

Government regulations on food safety and cooling are also important for the success of cold-chain investments. Clear standards and stronger enforcement can help create demand for appropriate cooling solutions, particularly in value chains where temperature control is linked to quality and safety.

Future interventions should therefore consider the enabling environment as carefully as the technology itself.

The CaaS Project highlighted that a careful assessment of market, technical and commercial risks should precede investments in cooling. The decision tree below provides a framework for evaluating the viability of cold-chain investments.



Reflection

Reflecting on the experience, Dr Georgia Badelt of GeoCode International GmbH, who supported the business development of the implementing company on behalf of EnDev, observes:

► 'The pilot showed that cold storage technology can only succeed when it is supported by trusted partnerships, reliable data, and business models that create value for farmers as well as market actors.'

The solar-powered cold room technology showed promise, and early financial analysis suggested strong business potential. However, as implementation progressed, gaps in baseline and monitoring data limited the ability to assess commercial viability and adapt business models based on evidence.

The project also revealed the importance of farmer-centred business models. Many farmers continued to sell to buyers offering immediate cash payments, while aggregators struggled to secure a stable supply of produce. Without tailored incentives, faster payment mechanisms, and stronger relationships with producers, utilisation of the cold rooms remained below expectations.

Although the pilot did not demonstrate a scalable business model under the conditions tested, it yielded important lessons. Successful cold-chain investments require more than technology. They depend on reliable data, strong incentives, trusted partnerships, and business models that respond to the realities of agricultural markets. These lessons now provide a stronger foundation for designing future cold storage initiatives that are both commercially viable and inclusive.

8 Productive Use of Renewable Energy in Agricultural Value Chain (PURE.Ag) Project

Empowering smallholder farmers to invest in renewable energy and sustainable agriculture



8.1 Strengthening agricultural resilience through renewable energy

Agriculture is the backbone of Rwanda's economy, employing around 40 per cent of the workforce and contributing roughly one quarter of the national gross domestic product.¹² The sector is dominated by smallholder farmers cultivating staple crops such as maize, beans, cassava, and potatoes.

However, most farming remains rainfed. In 2024, less than 6 per cent of cultivated land was estimated to be under irrigation, leaving farmers and agricultural production highly exposed to climate variability and erratic rainfall patterns. These conditions affect crop yields, household food security, and farmers' ability to generate reliable income from agriculture.

Smallholder farmers face multiple barriers to adopting irrigation. Many lack access to affordable mechanised irrigation technologies, suitable financing, and profitable markets. Limited knowledge of good agricultural practices, weak market linkages, and insufficient access to produce buyers further reduce the commercial value of irrigation investments. As a result, many smallholder farmers in rural Rwanda

continue to practice seasonal, small-scale subsistence farming with limited opportunities to increase production and income.

For cooperatives and larger farmers seeking more reliable irrigation, diesel pumps are often the first affordable option because of their relatively low upfront cost. However, they are expensive to operate due to recurrent fuel costs and also have adverse environmental impacts. These challenges underscore the need for more sustainable and cost-effective irrigation technologies.

Solar water pumps offer a more sustainable alternative. Once installed, they can reduce recurrent fuel expenditure, support production during dry seasons and strengthen farmers' resilience to changing rainfall patterns. However, their higher upfront cost continues to limit adoption, particularly among smallholder farmers.

The Government of Rwanda has prioritised irrigation as part of its efforts to increase agricultural productivity and rural incomes. Through programmes implemented by the Rwanda Agriculture and Animal Resources Development Board (RAB) with development partners, subsidies have helped

12. World Bank, *Rwanda Economic Update, April 2025: Modernizing Agriculture to Accelerate Structural Transformation*, ed. no. 24 (Washington, DC: World Bank, 2025), 4–5. ↗

farmers acquire irrigation equipment. Nevertheless, Rwanda's solar irrigation market remains at an early stage. Even with public subsidies, the share of the cost borne by farmers can remain unaffordable for lower-income producers.¹³

The market also faces supply-side constraints, particularly in developing business models suited to the needs and income patterns of smallholder farmers. Solar irrigation companies have limited experience with instalment-based payment models aligned with agricultural production cycles. At the same time, many suppliers are reluctant to extend credit directly to farmers because of concerns about repayment capacity, seasonal incomes, and the absence of conventional collateral. This limits their ability to address affordability through supplier-led financing. At the same time, financial institutions often lack sufficient knowledge of solar irrigation technologies and agricultural value chains to develop suitable loan products.

Beyond irrigation, renewable energy also creates post-harvest opportunities for smallholder farmers. Solar-powered threshers, hullers, and milling machines can enable farmer cooperatives to process crops locally, reduce post-harvest losses, and add value to their produce. For cooperatives, this creates opportunities to generate additional income while extending the productive use of renewable energy beyond agricultural production.

Against this backdrop, EnDev pioneered the Productive Use of Renewable Energy in Agricultural Value Chains (PURE.Ag) Project between September 2023 and June 2026. The project sought to strengthen Rwanda's solar irrigation market by addressing key barriers to the adoption of irrigation technologies, while expanding the productive use of renewable energy across agricultural value chains.

A central focus was improving access to sustainable financing that could enable smallholder farmers to invest in and adopt renewable energy-based irrigation technologies. PURE.Ag tested results-based financing (RBF) incentives to encourage solar water pump suppliers to introduce pay-as-you-go (PAYGo) and other instalment-based payment models. As implementation progressed, the project

Infobox | What is productive use of renewable energy?

Productive use of renewable energy refers to the application of renewable energy technologies in activities that generate income or improve productivity. In agriculture, this can include solar-powered irrigation, milling, threshing, cooling, drying and other forms of processing. The value of the technology lies not only in the energy it provides, but in whether it enables farmers and enterprises to increase production, reduce costs, add value or reach stronger markets.

adapted its approach and supported the development of a collateral-free digital group loan, with repayments aligned with agricultural harvest cycles. The project also addressed post-harvest processing by supporting the productive use of solar-powered equipment, including maize threshing, hulling and milling technologies. This component built on lessons from the EnDev Cooling as a Service (CaaS) Project, under which solar-powered cold-storage infrastructure had been installed but remained underutilised – a challenge shared by many cold-storage interventions across the country. PURE.Ag explored how the existing solar energy infrastructure owned by cooperatives could support additional productive uses alongside cold storage, improving asset utilisation, supporting local value addition, and creating new income opportunities for farmer cooperatives.



8.2 Combining market development, farmer support, and access to finance

The EnDev PURE.Ag Project was implemented through a partnership between GIZ, Mercy Corps through its Energy 4 Impact platform (MC-E4I), the European Cooperative for Rural Development (EUCORD), and, from September 2025, MoneyPhone Africa Ltd.

MC-E4I managed overall project implementation and worked with participating private-sector

13. Energy 4 Impact, 'PURE.Ag: Advancing Solar Irrigation in Rwanda', 24 March 2024, updated 28 March 2024. ↗

companies to strengthen their business models and market capacity. Drawing on its expertise in market-based programming, productive use of energy, agriculture, and financial inclusion, MC-E4I provided technical assistance to help companies improve their operations, customer engagement, and financing approaches.

EUCORD led farmer engagement, awareness-raising, agricultural training, and market linkages. Drawing on its expertise in agricultural value-chain development, EUCORD worked with farmers and cooperatives to strengthen agricultural practices, connect them with technology providers and financial institutions, and improve links to markets.

MoneyPhone joined PURE.Ag in September 2025 through a direct grant agreement with GIZ. The Dutch-Rwandan fintech brought expertise in digital, collateral-free micro-loans to smallholder farmers, enabling the project to test a new financing model for solar irrigation during its second phase.

The project also collaborated with private-sector actors, farmer cooperatives, financial institutions, district authorities and national government partners. This partnership-based approach strengthened technical rigour, promoted local ownership, and created enabling conditions for interventions to be scaled.

Phase I: testing RBF for solar irrigation

The first phase of PURE.Ag focused on developing and testing sustainable business models that could make solar water pumps more accessible to smallholder farmers.

The project introduced a supply-side RBF mechanism for participating solar water pump companies. Under this model, companies received payments only after agreed results had been achieved and verified. The incentives were intended to encourage suppliers to introduce instalment-based financing, including PAYGo and harvest-based repayment models, for low-income smallholder farmers and farmer groups. The intervention initially targeted six districts: Rwamagana, Bugesera, Kayanza, Gatsibo, Ngoma, and Nyagatare.

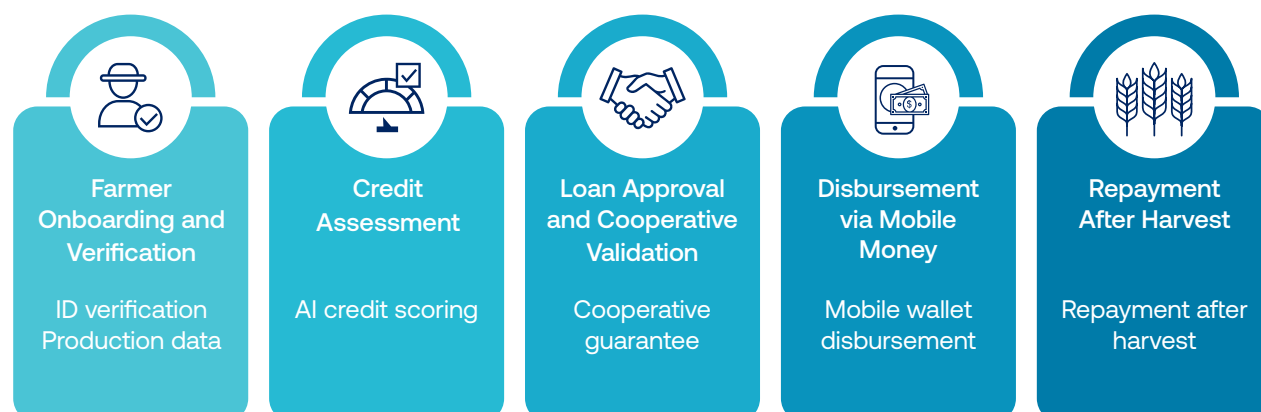
Rather than duplicating existing initiatives, PURE.Ag was designed to complement the government-led Sustainable Agriculture Intensification for Improved Livelihoods, Food Security and Nutrition Project (SAIP), funded by the World Bank and implemented by RAB. SAIP subsidised irrigation equipment, while PURE.Ag sought to address the share of the cost that farmers still had to finance. The intended model therefore combined government subsidies with instalment-based financing offered by solar water pump suppliers.

This arrangement aimed to make solar irrigation more affordable while encouraging private companies to

MONEYPHONE LENDING PROCESS

Digital lend tailored to smallholder farmers •

No collateral • Cooperative-based • Harvest aligned repayment



establish commercial relationships with smallholder farmers. It also tested whether RBF incentives could reduce the perceived risk of offering instalment-based financing in an emerging market.

PURE.Ag adopted a facilitative, private-sector-led approach. Solar water pump companies acted as the primary providers of technologies and related services, while the project supported market development by reducing risk, strengthening market capacity, and helping to develop viable financing models suited to smallholder farmers.

The model combined three main components:

1. RBF incentives to support the distribution of solar water pumps and the development of consumer-financing models – later replaced by a dedicated access-to-finance model;
2. targeted technical assistance for solar water pump companies and financial institutions; and
3. farmer training, demonstration workshops, and market linkages to strengthen farmers' knowledge and capacity to invest in and make productive use of solar irrigation.

Together, these components sought to address several interrelated market barriers:

- developing suitable business and financing models that address the affordability barriers faced by smallholder farmers due to the high upfront costs of solar water pumps;
- providing technical support to solar water pump specialist companies to strengthen awareness-raising and establish sustainable business models;
- supporting farmers with the knowledge and market connections needed to make productive investments in solar water pump systems to improve their livelihoods and strengthen their capacity to repay financing; and
- creating an enabling environment that supports partnerships with solar water pump specialists, facilitates effective customer-supplier relationships, and ensures reliable after-sales support.

Phase II: developing a digital financing model

Implementation of Phase I revealed limitations in the original financing model. The RBF model depended partly on the continued availability of the government subsidies through SAIP. When the SAIP programme was temporarily suspended, the intended

combination of public subsidy and supplier-led instalment financing could no longer operate as designed. At the same time, solar water pump companies remained reluctant to carry the full credit risk of lending directly to smallholder farmers, particularly without clarity on the future of the subsidy mechanism.

PURE.Ag therefore adapted its approach. The RBF model was discontinued, and the project shifted from a supplier-led PAYGo financing model to a financial institution-led approach. GIZ partnered with MoneyPhone to develop a dedicated digital loan product for smallholder farmers seeking to invest in solar irrigation, while solar water pump companies continued to supply equipment and after-sales services.

This revised model addressed a central constraint: how to finance solar irrigation without requiring technology suppliers themselves to act as lenders. MoneyPhone provided group-guaranteed, collateral-free loans to smallholder farmers through mobile technology. Operating through farmer cooperatives, the platform enabled digital loan applications, assessments, disbursements, and repayments, with the process completed within five days or less. The system also generated financial data and AI-based credit scores, helping previously underserved farmers begin to build formal credit profiles.

GIZ supported the development of the digital back-end for the solar irrigation loan product. At the same time, MoneyPhone led loan processing, disbursement, and repayment management, alongside farmer engagement and digital financial literacy support.

Under the revised model, farmers formed groups that jointly applied for loans and provided a collective repayment guarantee, removing the need for conventional physical collateral. Five farmers jointly accessed one loan to acquire and share a solar water pump. Participating farmers repaid the loan over six months, with repayments aligned with harvest periods and scheduled after the sale of agricultural produce. By matching repayments with seasonal income, the model reduced the risk of farmers having to repay loans before income was generated from irrigated production and created a more suitable financing solution for smallholder farmers.

MoneyPhone worked closely with the existing PURE. Ag partners throughout implementation. Farmer

mobilisation, financial literacy, and awareness campaigns were jointly delivered to ensure that potential borrowers understood both the solar irrigation technology and their loan obligations.

Piloting solar-powered maize processing

PURE.Ag also explored how renewable energy could support agricultural value addition beyond irrigation.

A rapid value-chain assessment was conducted across the six districts to identify productive-use opportunities that could strengthen the income-generating potential of smallholder farmer groups. The assessment identified maize as the dominant value chain and highlighted demand for local threshing, hulling, and milling services.

Based on these findings, the project piloted solar-powered maize-processing businesses with two farmer cooperatives in Rwamagana and Kayonza districts. Each cooperative received a set of maize threshing, hulling (de-husking), and milling equipment.

Rather than installing separate energy systems, the processing equipment was integrated into existing solar infrastructure originally installed to power cold-storage facilities. As the cold rooms were used mainly during specific production periods, excess solar generation and battery storage capacity remained available for much of the year. Connecting maize-processing equipment to this infrastructure allowed the cooperatives to make greater productive use of the existing renewable energy assets.

Cooperative members initially received technical training on machine operation and basic maintenance. Training covered power switching procedures, cleaning, dust removal, feeder-tray maintenance, basic troubleshooting, and early identification of faults.

This was followed by support in maize-processing business management and performance monitoring. Cooperative members received training in managing processing services, tracking revenues and costs, attracting customers, and maintaining the equipment as an income-generating cooperative asset.

The pilot sites were also intended to serve as learning and demonstration centres for neighbouring farmer groups interested in productive-use technologies and local agro-processing.



8.3 Results and impact of the PURE.Ag Project

Strengthening private-sector capacity

PURE.Ag strengthened the capacity of participating solar water pump companies to serve the agricultural market by improving their business models, internal systems, and customer engagement. Through targeted business development support, companies strengthened their approaches to product promotion, supply chain management, customer service, and strategic partnerships. The project also developed and integrated digital tools, including KoBoToolbox and Looker Studio, to strengthen customer data management and business monitoring. Participating companies rated the technical assistance 'very good' and reported that these tools could be readily integrated into their existing operations.



The support also helped identify constraints limiting companies' ability to expand the solar irrigation market, including limited access to PAYGo financing, fragmented customer records, and reactive after-sales services. In response, companies received support to expand farmer outreach, improve inventory planning, and explore partnerships with financial institutions to address affordability and extend their market reach.

Building awareness of solar irrigation

The project increased awareness of solar-powered irrigation among farmers, farmer cooperatives, and local agricultural stakeholders, laying the foundation for wider market adoption.

During the first phase, mobilisation workshops across the six target districts introduced off-grid rural farmers, district agronomists and cooperative leaders to solar water pumping and irrigation systems, other productive-use technologies, and available financing options. The engagement also created direct links between farmers and participating solar water pump companies.

During the second phase, PURE.Ag partners worked with participating companies and MoneyPhone to engage further farmer cooperatives in the Eastern Province. Cooperatives were identified through the existing networks of MoneyPhone and EUCORD, as well as through referrals from companies that had identified groups interested in acquiring solar irrigation systems.

The awareness-raising activities introduced farmers to the newly developed loan product and solar irrigation technology, while demonstrations allowed them to see the systems operating on their own fields. With a focus on gender inclusion, more than half of the farmers engaged were women.

Strengthening farmers' technical and business capacity

Beyond technology deployment, PURE.Ag strengthened farmers' ability to use renewable energy technologies productively and manage irrigation as an investment in their agricultural businesses. Training combined modern agricultural practices with the technical operations and maintenance

of solar water pumps and other productive-use equipment. Agribusiness and financial literacy support covered business operations, loan obligations, cash-flow management, and investment planning, while a training-of-trainers programme delivered through pre-existing Farmer Field Schools supported the wider transfer of modern agricultural practices.

Commercial linkage activities also connected farmers with solar water pump suppliers, financial institutions and produce aggregators. Together, these skills and connections enabled farmers to use the technology effectively, manage their investments, and access markets where increased production could generate returns.

Testing productive uses of renewable energy beyond irrigation

The solar-powered maize-processing pilot tested whether existing solar infrastructure could support additional productive uses beyond cold storage. By connecting maize threshing, hulling, and milling equipment to existing solar generation and battery capacity, two farmer cooperatives in Rwamagana and Kayonza districts were able to use the same renewable energy assets for different agricultural activities and generate income. However, revenues are not yet sufficient for the businesses to be fully profitable.

As the equipment only became operational in 2026, further analysis will be required to assess the business case and its potential for replication and scale. The pilot nevertheless showed that underused solar infrastructure can support additional productive activities, particularly when combined with the technical and business skills needed to operate the equipment effectively.

Expanding access to finance

One of PURE.Ag's most significant achievements was the testing of a new pathway through which small-holder farmers could finance and own solar irrigation systems without direct hardware subsidies, strengthening their agency as agricultural entrepreneurs.

Despite time limitations and implementation outside the main irrigation season, a small number of farmer groups acquired unsubsidised solar water pump systems through the cooperative-based

financing model using the digital loan product developed with MoneyPhone.

While ownership rests with the registered borrower groups, the pumps are shared among cooperative members and other farmers irrigating nearby land, extending the benefits well beyond the formal loan holders.

This marked an important shift from subsidy-dependent access towards farmer investment. The systems are likely among the first unsubsidised solar water pumps acquired by smallholder farmers in Rwanda through a dedicated digital financing product. The experience demonstrated the potential to expand access to climate-smart technologies without relying on direct hardware subsidies, while enabling farmers to invest in productive assets themselves. Early repayment performance was encouraging. Twelve per cent of the participating groups repaid their loans ahead of schedule, and no defaults were recorded during the implementation period. Stakeholder consultations consistently identified harvest-aligned repayment as one of the model's

greatest strengths. Instead of fixed monthly instalments, repayments were scheduled around periods when farmers generated income from crop sales, better matching debt obligations with seasonal cash flow.

Beyond financing these initial irrigation systems, the PURE.Ag Project established important building blocks for a scalable financing model. It developed a dedicated digital loan product, strengthened MoneyPhone's lending platform, engaged farmer cooperatives as financing partners, and generated practical evidence of cooperative-based digital finance for climate-smart agriculture. The learning generated through the model was also highly valued by other implementing partners and, importantly, by financial institutions engaged by PURE.Ag during implementation.

These foundations provide an important basis for expanding access to productive-use technologies and strengthening inclusive climate finance in Rwanda.



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Success story

Solar irrigation opens the door to export markets

In Urugero Village, Rwamagana District, the 26 members of Duhuzimbaraga Muhazi Cooperative share a common ambition: to improve their livelihoods through collective farming.

Established in 2018, the cooperative comprises 14 women and 12 men. The district administration allocated the group four hectares of land to cultivate jointly. During its early years, however, members practised mainly subsistence agriculture. Limited resources and exposure to commercial farming and agribusiness slowed their progress towards generating reliable income.

The cooperative cultivated tomatoes, green peppers, carrots, French beans, and cucumbers in open fields and in a 35-by-35 metre greenhouse. Yet, unreliable access to irrigation constrained production, particularly during dry periods. Without a dependable water supply, the farmers could not

fully use their land, plan production with confidence or pursue higher-value markets.

Reliable irrigation creates new opportunities

Through the PURE.Ag Project, the cooperative was connected with ECOLINK, a Korean agricultural company interested in purchasing chillies through a contract-farming arrangement.

The opportunity came with one important condition: the cooperative needed a reliable solar-powered irrigation system that could support consistent production and meet the buyer's quality requirements.

PURE.Ag therefore linked the cooperative with MoneyPhone to access financing for solar irrigation. Through this arrangement, the cooperative purchased three mobile solar water pumps to irrigate its greenhouse and four hectares of chilli fields.

Reliable irrigation has transformed the way the cooperative farms. Members no longer depend on unpredictable rainfall and can better plan production throughout the growing season. The solar-powered system also reduced irrigation costs while strengthening the cooperative's resilience to increasingly variable weather conditions.

With the irrigation system in place, the cooperative met ECOLINK's production requirement and secured a formal market for its chillies. Under the contract-farming arrangement, ECOLINK committed to purchasing the cooperative's harvest. The company also provided high-quality seeds, fertilisers, and pesticides, reducing some of the production risks faced by the farmers and supporting crop quality.

All four hectares were subsequently planted with chillies, producing a reported annual harvest of more than 10 tonnes.

The secured market has also changed the cooperative's approach to farming. Rather than producing primarily for local markets without confirmed buyers, members can now plan production around a formal commercial agreement.

For Jean Marie Nyamurasa, President of the Duhuzimbaraga Muhazi Cooperative, the benefits extend beyond irrigation.

► 'The solar water pumps helped us save money. With these savings, we were able to expand our farming land, which will allow us to repay the loan comfortably. Loans from MoneyPhone are easy to access. In the past, we tried to get loans from banks and SACCOs, but they required a lot of paperwork, charged several fees, and the process took a very long time. With MoneyPhone, the entire process took less than a week and no land titles were needed. Because the pump is portable and easy to move, we can also irrigate our newly expanded land.'

Building the skills to manage growth

Technology and market access were accompanied by practical training. PURE.Ag supported cooperative members with training in financial literacy, compost production and Good Agricultural Practices.

Financial literacy training strengthened members' understanding of loan management, saving and reinvestment. Compost-making skills supported more sustainable soil fertility management, while training in Good Agricultural Practices helped farmers meet the quality requirements of structured markets.

More than an irrigation system

Duhuzimbaraga Muhazi Cooperative's experience shows how finance, renewable energy, agricultural knowledge, and market linkages can work together.

The solar pumps did more than provide water. They enabled the cooperative to meet the production conditions of a formal buyer, make greater use of its land, and begin moving from subsistence-oriented farming towards commercial production.

With reliable irrigation, improved technical skills and a secured market, the cooperative has established a stronger foundation for future growth. Its experience demonstrates that smallholder farmers are better positioned to enter higher-value markets when technology is combined with suitable finance, practical training, and dependable buyers. ■



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8.4 Lessons for scaling productive use of renewable energy in agriculture

Productive energy requires an ecosystem approach

One of the strongest lessons from PURE.Ag is that productive use of renewable energy depends on an enabling ecosystem rather than on technology alone.

Farmers require access to reliable equipment, appropriate financing, technical knowledge, and markets so that productivity gains can translate into income. Technology suppliers require sustainable business models and after-sales capacity, while financial institutions need confidence in both the technology and the wider agricultural value chain.

These elements are interdependent. Lasting market development therefore depends on strengthening them together so that productive-use technologies can contribute to higher productivity, increased incomes, and more resilient agricultural value chains.

Affordability is also shaped by access to finance

Although smallholder farmers demonstrated a strong willingness to invest in solar irrigation, high upfront costs remain a major barrier to adoption. PURE.Ag showed that the challenge is not affordability alone but also access to financing products that reflect the realities of agricultural production.

The group loan model demonstrated that harvest-aligned repayment schedules can improve access to solar irrigation by allowing farmers to repay loans when income is generated from crop sales. However, access to finance alone is insufficient. Sustainable adoption also depends on market access, business support, and reliable after-sales services. This provides an important lesson for future projects, as the development sector increasingly seeks to blend public and private investment.

Smallholder farmers require integrated support beyond technology

The project demonstrated that access to renewable energy technologies alone is not sufficient to increase agricultural productivity or income. Smallholder farmers require complementary support in agribusiness, entrepreneurship, climate-smart

Infobox | Productive energy requires an ecosystem approach

PURE.Ag demonstrated that the productive use of renewable energy succeeds when access to finance, reliable technology suppliers, quality after-sales services, and market access work together. Financial institutions need confidence that private-sector partners can deliver quality equipment and reliable services, while farmers need access to markets to convert productivity gains into increased profits.

agriculture, financial literacy, and market access to strengthen their ability to invest in and sustainably use productive energy technologies.

The experience also showed that working through farmer groups and cooperatives can be more effective than engaging farmers individually. Cooperatives provide a practical platform for mobilisation, training, technology sharing, and access to finance, while strengthening local ownership and collective responsibility.

Different financing models are needed for different farmer groups

The project demonstrated that financing approaches should reflect the differing needs and capacities of Rwanda's farming sector. Larger farmers are generally better positioned to access PAYGo or other instalment-based payment models independently. In contrast, smallholder farmers require financing mechanisms that reduce risk through collective guarantees and dedicated financial-service providers.

The experience also showed that supplier-led PAYGo models remain challenging for smallholder farmers, as many technology providers are reluctant to assume credit risk for this target group. Separating lending from technology provision can therefore offer a more suitable model: financial institutions manage credit and repayments, while technology suppliers focus on equipment provision and after-sales services.

Private-sector capacity remains critical for market growth

Although interest in solar irrigation continues to grow, many technology suppliers still have limited experience in reaching and serving smallholder farmers.

The project highlighted the importance of continued technical assistance to strengthen business models, digital systems, customer management, awareness-raising, and PAYGo-specific operational practices. Capacity-building and appropriate de-risking mechanisms will remain important for encouraging private companies to expand access to productive-use technologies, particularly among market segments they have traditionally found difficult to serve.

Subsidies can stimulate markets but should not replace sustainable financing

Subsidy programmes have played an important role in promoting solar irrigation and reducing the initial cost of investment. However, the PURE Ag experience suggests that subsidies are most effective when they help stimulate market development rather than becoming the primary mechanism through which farmers access technology. Future interventions should therefore combine public support with sustainable financing solutions

that continue to function beyond the lifespan of subsidy programmes. This is particularly important where the objective is to build commercially viable markets rather than temporary access to subsidised equipment.

Productive-use technology should respond to viable business opportunities

The project reinforced that productive-use technologies generate the greatest value when they respond to clear market demand and viable business opportunities.

The maize-processing pilot demonstrated how existing renewable energy infrastructure can support additional productive activities beyond its original purpose. Integrating maize threshing, hulling, and milling equipment with underutilised solar-powered cold-storage infrastructure improved the use of installed energy assets.

However, the pilot also showed that technical utilisation alone does not establish a viable business case. With operations beginning only in 2026 and revenues still limited, further testing is needed to determine whether the model can generate additional income for farmer cooperatives through agro-processing services, and whether it can be replicated elsewhere.





Reflection

Breaking silos: Building partnerships for productive use of renewable energy in agriculture

Delivering productive use of renewable energy in agriculture requires expertise that extends well beyond energy technologies alone. Farmers need access to finance, agricultural knowledge, reliable technology, functioning markets, and capable private-sector partners.

Traditionally, renewable energy, agriculture, finance and market development have been implemented through separate interventions. The PURE.Ag Project set out to break these silos by bringing together organisations with complementary expertise to address the interconnected barriers facing smallholder farmers and work towards a shared goal: developing sustainable business models that could strengthen Rwanda's solar irrigation market beyond the lifetime of the project. This collaboration became a cornerstone of the project, not only supporting implementation but also laying important groundwork for the expansion of Rwanda's solar irrigation market.

To reflect on this collaborative journey, EnDev sat down with Pancras Odhiambo from Energy 4 Impact and Niels Hanssens from EUCORD to discuss how the partnership evolved, the challenges they encountered, the breakthrough moments that shaped the project, and the lessons they believe can inform future cross-sector initiatives. Looking back, both agree that PURE.Ag's greatest strength lay not only in what it delivered, but in how it was delivered: through equal partnership, continuous communication and complementary expertise that enabled the project to adapt as new opportunities and challenges emerged.

Bringing different expertise together

Although both organisations shared a common objective, each brought complementary expertise to the partnership.

For Energy 4 Impact, the focus was on developing sustainable market systems for renewable energy technologies. EUCORD complemented this with expertise in agriculture, farmer organisations and value-chain development, ensuring that technology was embedded within broader agricultural and commercial systems rather than introduced as a stand-alone solution.

Reflecting on this collaboration, Pancras Odhiambo from Energy 4 Impact explains:

► 'Our energy access programming is geared towards enabling the ecosystem—what we traditionally call market systems development. We often work directly with private sector entities. The winning equation here was onboarding an entity that is actually an expert on farmers and agriculture and therefore understands the needs and dynamics of farmers with respect to productivity and value chains. Then we came on board with the technology from the energy access side. That collaboration proved more impactful than scenarios where you have a technology you want to bring to a market segment without understanding its dynamics.'

For EUCORD, the partnership addressed a challenge the organisation had already encountered through earlier irrigation programmes.

As Niels Hanssens from EUCORD recalls:

- ▶ ‘We had just started introducing solar pumps through a grant we received from Rwanda Green Fund (FONERWA). It was part of our bigger project, where we were looking for financial solutions for irrigation. When we got the funding, we started introducing solar pumps but immediately realised what we were doing was not sustainable. We were handing out these pumps basically free of charge to demonstrate them. At the end of the day, you want to make sure that farmers can pay for the pumps themselves. Because of that, I was very happy with the opportunity to collaborate on PURE.Ag to find more sustainable ways of funding solar irrigation.’

Niels adds:

- ▶ ‘We are more focused on the value chain agriculture angle, so we brought that expertise—linking cooperatives and farmers to guaranteed markets. Because if farmers don’t generate income, how will they pay for this equipment? That’s a missing aspect we brought to the table.’

Adapting to changing realities

One of the defining features of PURE.Ag was its ability to adapt as market conditions evolved. The project was initially designed to complement the government-led SAIP Project, with the aim to combine public subsidies with supplier-led instalment financing. However, when implementation conditions changed, the partnership responded by developing an alternative financing model centred on digital, cooperative-based loans through MoneyPhone. For the partners, this flexibility became one of the project’s strengths.

Niels reflects:

- ▶ ‘I’m very happy that we onboarded MoneyPhone and rolled out an alternative model focusing on smaller irrigation systems financed through MoneyPhone loans. This is a really viable model that could be scaled up.’

Pancras also notes that introducing new financing approaches required changing attitudes across the market.

- ▶ ‘The challenge remains: bringing alternative business models into the market to trigger uptake of these technologies. But you need buy-in not only from the end user but also from



Pancras Odhiambo



Niels Hanssens

the service provider, who needs to adopt this new business model they haven’t had before. So first, getting them to appreciate the value in that model, but also getting them to see how that alternative opens up the market for them.’

Breakthrough moments

Although PURE.Ag reached a relatively modest number of direct beneficiaries, both Niels and Pancras believe its greatest achievements lie in the foundations it laid for future market development.

For Niels, one breakthrough stood out.

- ▶ ‘What’s freshest in my memory is the MoneyPhone experience. The fact that this was the first time farmers were taking subsidy-free pumps is indeed a breakthrough. All the other pumps provided through the project were partly subsidised.’

Pancras points to two additional milestones that demonstrated the project’s wider influence.

- ▶ ‘Two moments. First, when we were able to get PURE.Ag embedded into the ministerial document for irrigation systems from the very beginning—that was the political buy-in we were looking for. Second, one cooperative and one individual farmer were able to get into contract farming agreements with exporters on the basis of the work we had done and the equipment we enabled them to access. They now have access to the technology and a way to offload their produce. Those were clear breakthroughs.’

Beyond these milestones, both partners observed broader changes in the market. Farmers increasingly viewed agriculture as a business opportunity, while private-sector suppliers began recognising instalment-based financing as a commercially viable alternative to traditional cash sales.

As Pancras explains:

- ▶ ‘PURE.Ag was not just about bringing technology to the market. There was groundwork done in sensitising farmers—not only on the accessibility and availability of these technologies, but also in how they can run agriculture as a business for income generation. What excites me about PURE.Ag is that this groundwork has driven up the appetite for productive-use equipment, primarily solar irrigation.’

Pancras adds:

- ▶ ‘The partner companies we worked with are starting to appreciate instalment-based sales agreements as an alternative to cash sales. The fact that PURE.Ag brought this alternative model, which is getting acceptance and buy-in, is something to be proud of.’

What made the partnership work?

Both Pancras and Niels agree that the project’s success depended as much on the way the partners worked together as on the technical solutions they introduced.

Regular communication, trust between partners, complementary expertise and a willingness to remain actively engaged throughout the implementation created an environment in which challenges could be addressed collectively, and ideas could be developed and tested quickly.

Reflecting on the partnership, Pancras observes:

- ▶ ‘If an outsider had observed us, even for a minute, they might not have known who the donor was, who was the project manager, or who was implementing. It was a joint effort. Partnership is one thing, but being hands-on, being present, always giving ideas and sharing insights from other things you come across—that model is really valuable if partnerships are to make sense.’

Niels similarly highlights the importance of flexibility and communication.

- ▶ ‘The fact that [EnDev] was relatively flexible, willing to make changes along the line of the project, was very helpful. Adding MoneyPhone later down the line, adding a component on solar milling—those were very good ideas. It’s very difficult to design a project that’s going to last two or three years and know exactly what

you are going to do in a year, two and three. So, a certain level of flexibility from donors is always much appreciated.’

Niels also credits the project’s weekly coordination meetings with helping to maintain strong collaboration throughout implementation.

Looking ahead

Asked what recommendations they would offer future cross-sector programmes, both emphasise that successful productive-use interventions require more than technology deployment. A sustainable market depends on combining renewable energy with finance, agriculture, market development and institutional collaboration.

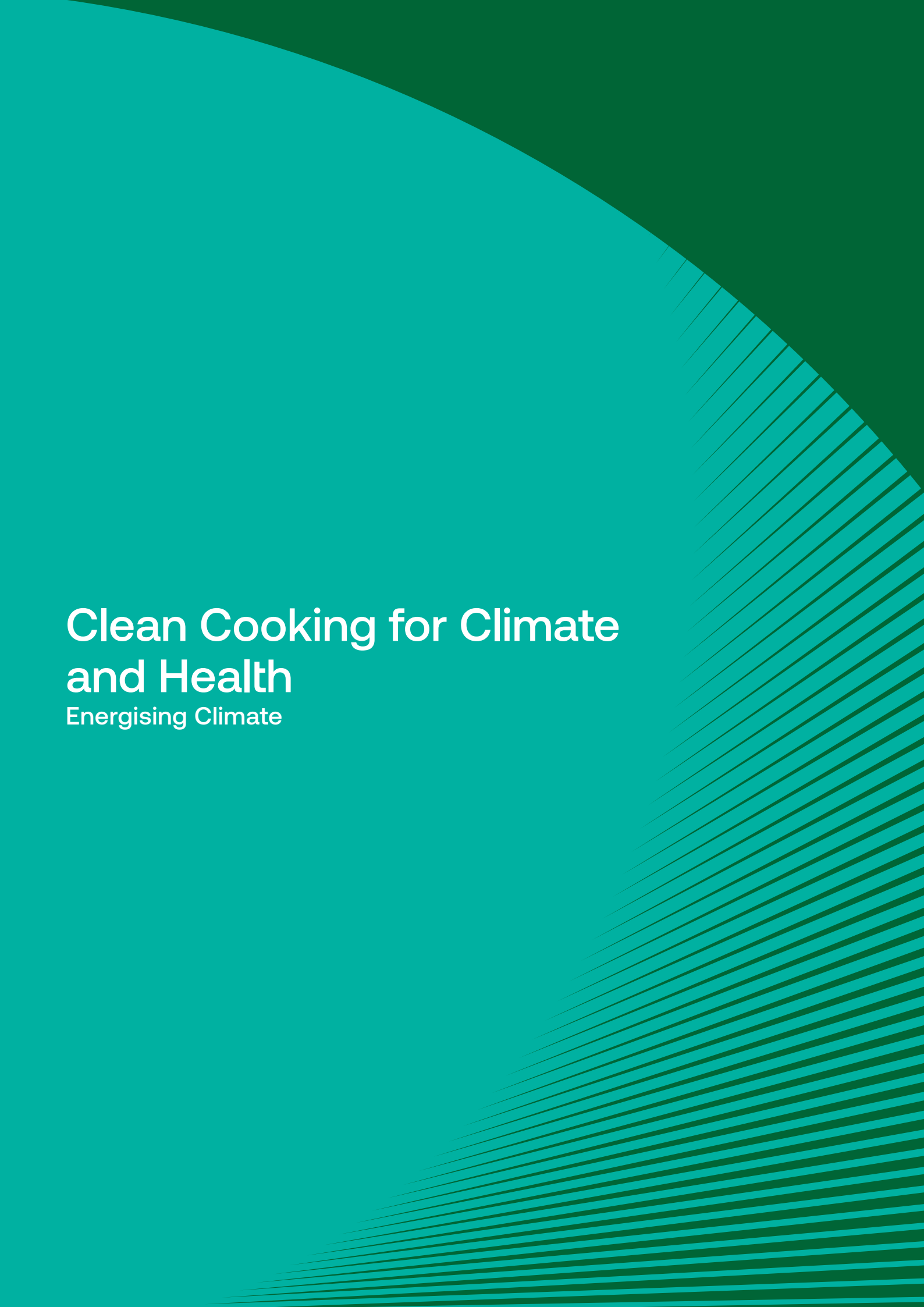
Pancras believes subsidy programmes should stimulate markets rather than replace them, and that projects should invest equally in building the capacity of both end-users and service providers.

- ▶ ‘Subsidies—whether from government or otherwise—should be just parts of a system. Subsidies are not the sustainable way to drive a market so that it can self-sustain and self-grow. Secondly, there’s always some level of groundwork that needs to be done—capacity building for both the end user and the service provider. Those have to be integrated into the project intervention design.’

For Niels, successful projects also require a holistic understanding of agriculture, strong market linkages and the flexibility to adapt as implementation progresses.

- ▶ ‘It’s not just focusing on irrigation. It’s also supporting cooperative development, doing value chain analysis to make sure you work on the right crops, making the linkage with markets between producers and buyers. All rooted in a good understanding of the local context.’

Together, these reflections reinforce one of PURE.Ag’s most important lessons: lasting market transformations depend not only on introducing innovative technologies, but on building partnerships that combine complementary expertise, adapt to changing circumstances and place farmers at the centre of sustainable market development. ■



Clean Cooking for Climate and Health

Energising Climate



9 Support to the National Domestic Biogas Programme

Testing the conditions for a viable domestic biogas market



9.1 Reducing dependence on traditional biomass

At the start of the EnDev programme, Rwanda depended heavily on biomass fuels for cooking. According to the 2002 Population and Housing Census, firewood met 90.4 per cent of cooking energy demand in rural households, while charcoal accounted for 7.4 per cent. Agricultural residues supplied most of the remaining 2.2 per cent. In urban households, firewood and charcoal supplied 52 per cent and 39.5 per cent of cooking energy demand respectively, with liquefied petroleum gas (LPG) and kerosene providing the remaining share.

Demand for wood fuel was estimated at 1.93 kg per person per day in 2005, considerably exceeding the estimated production of 0.46 kg (MININFRA, 2005). This imbalance placed continued pressure on Rwanda's biomass resources and strengthened the case for alternative cooking solutions.

The Government of Rwanda identified domestic biogas as one possible response. By converting organic material into a renewable cooking fuel, biodigesters could reduce dependence on firewood and charcoal while treating animal waste in a closed system. This offered the potential to lower greenhouse gas emissions and reduce household exposure to cooking smoke.

When operating as intended, a biodigester can also produce bioslurry for use as an organic fertiliser. For households, these combined benefits can reduce expenditure on cooking fuel and the time spent collecting firewood and cleaning smoke-blackened utensils. Women and girls, who commonly bear responsibility for these activities, can benefit particularly from these changes.

However, domestic biodigesters require considerable initial investment as well as a reliable supply of manure and water. Their viability therefore depends on more than the technical performance of the digester itself. Household resources, access to finance, construction quality, and long-term maintenance all influence whether a system remains operational.

Against this backdrop, planning for Rwanda's National Domestic Biogas Programme (NDBP) began in 2005 through cooperation between the Ministry of Infrastructure (MININFRA) and the SNV Netherlands Development Organisation, and became operational in 2007. EnDev began supporting the NDBP in 2009 and provided technical and financial assistance until 2011. Its support aimed to establish domestic biogas as a cleaner alternative to traditional biomass while developing the skills and enterprises required for a market-oriented sector.

Infobox | Biogas technology

Biogas is a renewable, combustible gas produced when organic materials—such as animal manure, food waste, and agricultural residues—decompose in an oxygen-free environment. During this natural process, known as anaerobic digestion, microorganisms break down the organic matter and release biogas.

Biogas can be used directly for cooking and heating or to generate electricity. When upgraded to biomethane, it can also be used as a transport fuel. Anaerobic digestion produces bioslurry, a nutrient-rich by-product that can be used as an organic fertiliser when properly managed.

materials, which were the predominant technology available at the time. These systems used cow dung to produce biogas for clean cooking. Depending on the size of the digester and the availability of feedstock, a household system was designed to provide approximately six hours of cooking energy per day.

A fixed-dome system comprises a sealed digester with a fixed gas-storage space and a compensating tank. Biogas collects in the upper part of the digester. As gas production increases, the resulting pressure pushes the slurry into the compensating tank. When gas is extracted, a corresponding amount of slurry flows back into the digester.

The technology was selected because trained local masons could construct the digesters and adapt them to Rwanda's climatic and soil conditions. They were expected to be durable, reliable, and easy to maintain, with an anticipated operating life of more than 20 years.



9.2 Laying the foundations for domestic biogas adoption

Developing a market-oriented biogas sector

Rather than treating biodigesters solely as household infrastructure, EnDev supported the government-led programme in establishing the foundations of a commercially viable and environmentally sustainable domestic biogas sector. The approach sought to reduce pressure on biomass resources while improving cooking conditions and supporting the agricultural use of bioslurry.

EnDev supported capacity development, training for technicians and entrepreneurs, quality assurance, and awareness-raising. Technical training institutions trained and certified masons and supervisors to construct and maintain domestic biodigesters.

The programme also worked with local companies involved in constructing and servicing the systems. Together, these interventions were intended to create a sustainable base of skilled providers and enable households to obtain technical support beyond the initial installation. EnDev also supported a feasibility study on biogas in Rwanda to inform programme design and the development of 'Made in Rwanda' clean cooking energy alternatives.

Promoting locally constructible systems

The programme focused on relatively small, fixed-dome digesters constructed from locally available

Design considerations included:

- the availability of suitable construction materials and skilled local labour;
- adaptation to local soil, climate, and feedstock conditions;
- reliability and ease of use;
- limited maintenance requirements; and
- the lowest achievable construction cost without compromising durability.

Rwanda had also pioneered larger biodigester systems through the Kigali Institute of Science and Technology (KIST), independent of EnDev's support. Installed at prisons in seven locations, these systems converted organic waste into energy and demonstrated the technology's potential at an institutional scale.

As the programme progressed, EnDev tested lower-cost alternatives, including plastic tubular digesters, to address the high initial investment required for masonry systems. However, the experience showed that reducing technology costs alone could not overcome broader financing, operational, and household-readiness constraints.

Targeting households with sufficient resources

The programme primarily targeted farming households able to supply at least 20 kg of animal waste

each day. This was approximately equivalent to the daily manure produced by two average stall-fed cattle or four adult pigs. Households also needed sufficient water and labour to feed and manage the digester consistently.

These requirements considerably narrowed the potential market. Interest in biogas did not necessarily mean that a household was ready to adopt the technology. Without sufficient livestock, water, capital, labour, and access to reliable technical support, a household was unlikely to sustain a biodigester over time.



9.3 Results and strategic insights from the NDBP

Building initial technical and private-sector capacity

EnDev's support helped develop technical capacity during the programme's early phase. By 2011, more than 200 masons had been trained, and approximately 40 companies were involved in constructing biodigesters. Awareness activities also introduced domestic biogas to farming households as an alternative to firewood and charcoal.

This capacity development established an initial base of local skills and demonstrated that domestic biodigesters could be constructed using locally available materials. However, the existence of trained masons and construction companies did not generate sufficient demand to establish the commercially viable market originally envisaged.

Benefits for households with functioning systems

According to EnDev's 2012 progress report, a study of biogas in Rwanda found that households with functioning digesters reduced their energy expenditure and reliance on firewood and charcoal.¹⁴ Digester-owning households spent approximately 30 per cent less on energy than households in the comparison group. This represented an estimated annual saving of up to RWF 58,000, driven largely by a reduction of approximately 5 kg in daily firewood consumption and lower charcoal use.

For these households, biogas also offered cleaner cooking conditions and reduced exposure to smoke. Where bioslurry was properly managed, the technology provided an additional agricultural input. These findings confirmed the potential value of biogas at household level, but the benefits depended on the system remaining functional and receiving sufficient feedstock.

Falling short of the programme's ambition

The programme's initial target was 15,000 digesters. However, in 2010, the target was revised to 3,000 digesters. During EnDev's engagement, the programme achieved about 90 per cent of the revised target by 2012, supported by a favourable policy environment and the benefits experienced by some participating households. Although this represented considerable progress towards the revised target, it remained substantially below the programme's original ambition. The considerable reduction in the target reflected the substantial difference between the programme's initial feasibility assumptions and the conditions that households and suppliers encountered during implementation.

An assessment of Rwanda's NDBP by researchers from the Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI) and the International Institute of Social Studies at Erasmus University Rotterdam found that the cost of some technologies was too high to support widespread adoption under local conditions. Affordability emerged as the most immediate constraint.

Because domestic biogas was a new sector in Rwanda, the feasibility studies relied on limited local market experience and underestimated the cost of constructing the systems. The feasibility studies had estimated that a commonly promoted 6 m³ digester would cost approximately RWF 260,000. During implementation, however, the actual cost reached around RWF 800,000 – almost three times the original estimate. Even with a subsidy of RWF 300,000, the estimated payback period was around nine years; without the subsidy, it extended to approximately 14 years.¹⁵

14. Energising Development (EnDev), *Progress Report 2012* (2012).

15. Arjun S. Bedi, Lorenzo Pellegrini and Luca Tasciotti, 'The Effects of Rwanda's Biogas Program on Energy Expenditure and Fuel Use', *World Development* 67 (2015): 461–74.

Infobox | Biodigesters today

Biodigester technology has evolved considerably since the National Domestic Biogas Programme was introduced. Earlier programmes largely promoted fixed-dome masonry digesters constructed on-site. Today, development partners and private companies are testing more diverse solutions, including compact, prefabricated, and transportable anaerobic digestion units.

Current UNDP-supported initiatives, for example, include biodigesters and clean cooking stoves provided through a partnership with HomeBiogas. Some systems form part of an integrated agricultural model combining livestock, biogas, and hydroponically grown fodder. Cow manure feeds the biodigester, while the biogas supports clean cooking and the resulting bioslurry can be used to enhance fodder production. By generating value across several agricultural activities, this integrated approach may strengthen viability at the cooperative level and contribute to increased milk production.

Work to develop Rwanda's biogas sector also includes efforts to prepare bankable proposals for national expansion and assess sustainable financing mechanisms, including carbon finance. These initiatives show that biogas remains relevant, but future expansion will depend on appropriate technology, viable financing, effective maintenance, and stronger integration with agricultural systems.

For many rural households, the potential long-term savings could not justify or finance such a high initial investment. Delays in introducing suitable loan products further limited adoption and weakened the programme's intended transition towards a market-oriented delivery model.

Long-term functionality remained a major concern

The programme's experience also showed that installation figures provide an incomplete measure of energy access. A 2022 inspection of 10,647 biodigesters installed through the wider NDBP found that 84.9 per cent were no longer operational.¹⁶ Reported causes included technical defects, inadequate maintenance, insufficient manure, incorrect feeding, limited access to water, and household relocation.

Although this inspection took place more than a decade after EnDev's support ended and covered the wider national stock of biodigesters, its findings underline the long-term sustainability challenges facing the sector. Construction capacity and subsidies could increase the number of installations, but they could not ensure that households would

operate the systems correctly or continue to have the resources needed to maintain them.

The programme ultimately produced mixed results. Functioning digesters delivered tangible benefits for some households, while the programme established an initial base of technical and private-sector capacity. However, high investment costs, limited access to finance, and persistent operational challenges constrained adoption and long-term use. The programme fell considerably short of its ambition, but its experience generated important lessons about affordability, household readiness, and the support systems needed to sustain biodigester technologies.



9.4 Lessons from the programme

Base programme design on verified household economics

The substantial difference between the projected and actual cost of a digester fundamentally affected the programme's viability. The feasibility assessments did not sufficiently reflect realistic construction costs, household cash flow, expected fuel

16. Energy Development Corporation Limited, *Report on Installed Biogas Plants Countrywide* (May 2022).

savings, or the full cost of maintenance. As a result, the installation targets and market projections did not hold under local market conditions.

Accordingly, in later projects, such as the Pro-Poor RFB Project, affordability was assessed thoroughly before large-scale implementation, using costs verified under local market conditions rather than technical estimates alone.

Establish financing before promoting widespread adoption

High upfront costs deterred adoption, while delays in launching biogas loan products left households without an appropriate financing option. Subsidies reduced the purchase price but did not make the remaining contribution affordable for much of the target group.

This limited the programme's intended transition towards a market-oriented delivery model. Suitable credit or payment mechanisms could have facilitated expansion. To be effective, however, financing terms would have needed to reflect household income patterns, and the time required for energy savings to offset the investment. The programme's experience demonstrated that technical suitability alone was insufficient to create a viable market if prospective users could not finance it.

Integrate biogas with farming systems and household capacity

Livestock ownership alone proved to be an inadequate eligibility criterion. Households also needed reliable water, sufficient labour, suitable space, and the capacity to manage daily feeding and routine maintenance. Changes in livestock ownership or household location can quickly render a digester unusable.

At the same time, domestic biogas is most viable when it forms part of a functioning livestock and agricultural system. Manure supplies the digester,

while bioslurry can support crop or fodder production. This relationship can increase the value of the technology beyond cooking energy.

However, integration should not be assumed. Farmers require practical guidance on managing manure, operating the digester, and using bioslurry safely and effectively. Cooperation between the energy, livestock, agriculture, and finance sectors is therefore essential.

Measure functionality and build a service market

Training masons and supporting construction companies were necessary steps, but the market also required reliable maintenance, quality control, and access to replacement components. The high proportion of non-operational systems demonstrates the limitations of measuring progress through installations alone.

Modern remote monitoring devices, which were not available during the programme's implementation, now make it possible to track whether digesters continue to produce usable gas and identify potential performance problems. They can also support the timely provision of maintenance and help programmes investigate why systems cease to operate. Long-term functionality can and should be incorporated into programme targets, supplier responsibilities, and verification systems.

Service providers also need sufficient and predictable demand to remain commercially active, particularly in remote areas. Rather than treating installation, quality assurance, and after-sales service as separate activities, these functions need to be connected through a coherent delivery and accountability system.



All photos © GIZ/Alice Kayibanda



Reflection

A lasting change: Jean's reflections on biogas

In 2026, more than a decade after EnDev's support ended, Jean Mwumvaneza reflects on how the biogas assistance he received during the programme's early implementation changed daily life for his household.

Jean is a farmer in Rwagihura Cell, Nyankenke Sector, in Gicumbi District, where he lives with his wife and seven children. Before the programme reached his area, the family used candles and kerosene lamps for lighting and depended on firewood for cooking, as charcoal was not readily available locally.

Cooking was particularly difficult during the rainy season. Freshly cut or damp wood produced heavy smoke and took longer to burn, delaying meal preparation and filling the kitchen with smoke.

When Jean first heard about domestic biogas, he wanted to see the technology in operation before investing. He therefore made the one-and-a-half-hour journey to Kigogo Village to visit a household with an operational biodigester.

► 'I liked what I saw and contacted the construction company.'

The company's standard 4 m³ digester cost RWF 400,000. However, Jean needed a larger system to meet the cooking needs of his family and the workers on his farm. He therefore invested in an 8 m³ digester costing RWF 800,000, including an NDBP subsidy of RWF 300,000.

Once the system became operational, biogas replaced firewood as the household's principal cooking fuel. The improvement was particularly noticeable during the following rainy season: the kitchen was no longer filled with smoke from burning damp wood, and meals could be prepared more efficiently.

The change also allowed Jean to retain the trees on his land instead of cutting them for cooking fuel. According to Jean, harvesting and selling these trees later generated approximately RWF 2 million per harvest, providing an additional source of income.

► 'My daily life changed because I no longer needed firewood for cooking. The trees we saved became a source of income, and during the rainy season there was no longer smoke in the kitchen.'

Over the years, Jean continued to strengthen his household's economic position. He bought a motor-cycle during the programme's early implementation period, followed by a car in 2017. He subsequently constructed two commercial properties in Gicumbi town – one in 2018 and another in 2025. Jean considers the biodigester – which enabled his transition to biogas – and the income generated by preserving his trees to have contributed to his household's broader economic progress.

His experience also encouraged change beyond his household. After seeing Jean's system in use, his immediate neighbour installed an 8 m³ digester of the same size.

Jean's experience demonstrates the long-term benefits that a functioning and appropriately sized biodigester can provide under favourable conditions. It also reflects the resources required to sustain such a system: sufficient livestock and feed-stock, the capacity to make a considerable financial contribution, and the ability to operate and maintain the digester over time. These conditions enabled biogas to work well for Jean's household, although they were not available to every family targeted by the programme.



10 Results-Based Financing for Refugees (RBF4R) Project

Expanding clean cooking access and productive energy use in Rwanda's refugee camps



10.1 Expanding access to clean cooking in refugee settings

Refugee camps in Rwanda continue to rely heavily on traditional biomass fuels, including firewood, charcoal, and agricultural residues, for household cooking, due to limited access to affordable and reliable cooking energy solutions. Refugee households, representing more than 137,000 individuals,¹⁷ often depend on limited fuel distributions or collect firewood from surrounding areas. In some camps, households also harvest wetland plants, such as papyrus, for use as cooking fuel. Most fuels are burned using open fires or inefficient traditional stoves.

These practices impose significant social, environmental and health costs. The continued reliance on biomass contributes to environmental degradation and deforestation while exposing refugees, particularly women and girls, to protection risks during fuel collection, including harassment and gender-based violence. Traditional cooking methods also generate high levels of indoor air pollution, creating additional health and safety concerns within households.

Although some refugee households have access to free liquefied petroleum gas (LPG) through

United Nations High Commissioner for Refugees (UNHCR) support, supplies are often insufficient to meet cooking needs between refills. As a result, many households continue to rely on secondary cooking solutions that are unsafe, inefficient, and highly polluting.

The Rwanda Ministry in charge of Emergency Management (MINEMA) and UNHCR have continued to highlight the growing need for clean and efficient cooking solutions in refugee settings. However, reductions in humanitarian assistance, including cash-based energy assistance following aid suspensions, have further constrained refugee households' ability to access clean cooking technologies and fuels. Affordability, therefore, remains one of the most significant barriers to adoption, particularly in the absence of long-term subsidy schemes or access-to-finance mechanisms that would enable beneficiaries to pay for cookstoves in instalments.

Moreover, the challenge extends beyond affordability. Implementing a market-based approach in refugee settings requires sustained awareness-raising and community engagement to strengthen adoption among the most vulnerable households. However, the potential benefits are

17. United Nations High Commissioner for Refugees, Rwanda Registration Team, ProGres database, data as of 31 December 2025.

significant. Reduced fuel consumption and shorter cooking times can lower household expenditure while freeing time for education, childcare, and livelihood activities.

As Practical Action expanded its work on refugee energy access, the Government of Rwanda simultaneously scaled up a national clean cooking programme for Rwandan citizens, building on the Results-Based Financing (RBF) mechanisms originally derived from EnDev's Pro-Poor RBF approach. Refugee households, however, remained excluded from these subsidy programmes.

Against this backdrop, and guided by EnDev's Leave No One Behind (LNOB) principle, GIZ and Practical Action began exploring whether RBF approaches could be adapted effectively to refugee settings. The focus shifted from inclusion in principle to operational feasibility: how market-based energy delivery models could function sustainably and equitably in a humanitarian context.

At the same time, early implementation reinforced a broader insight: clean cooking interventions alone would not fully address the energy needs of refugee

Infobox | Why clean cooking matters in refugee settings

More than 137,000 refugees in Rwanda continue to rely heavily on biomass fuels such as firewood, charcoal, and agricultural residues, either on a daily basis or as a complementary solution when free LPG is unavailable. Limited access to affordable and reliable clean cooking solutions contributes to protection risks, environmental degradation, household air pollution, and growing pressure on vulnerable households already facing reduced humanitarian assistance.

communities. If households were to be supported through improved cooking solutions, there was also a clear opportunity to consider how energy access could contribute to wider economic activities within the camps. From the outset, the intervention therefore also considered the role of energy in supporting camp-based economies. When designed around real business needs, productive use of energy technologies can enable small and medium-sized enterprises to expand operations,



increase income, and create employment opportunities within refugee communities.

This dual perspective – addressing refugee household energy needs while enabling productive use – shaped the integrated design of the EnDev Results-Based Financing for Refugees (RBF4R) intervention. The project therefore sought not only to improve access to cleaner cooking solutions but also to test how market-based energy interventions could strengthen self-reliance and contribute to more resilient refugee communities.

Refugees (RE4R II) Project, which was funded by Sweden and implemented by Practical Action.

Through a grant agreement with Practical Action, GIZ financed the RBF4R Project while Practical Action led implementation across Rwanda's five refugee camps: Mahama, Nyabiheke, Mugombwa, Kigeme and Kiziba.

RBF4R sought to test whether the RBF mechanism, which had already demonstrated success in Rwanda's national clean cooking sector, could improve access to higher-tier clean cooking technologies in refugee settings. The intervention aimed to reduce the cost of clean cooking stoves and improve affordability for vulnerable refugee households while maintaining a market-based delivery model. Through a demand-side subsidy mechanism directly built on the RE4R II Project, the intervention increased access to improved cookstoves among households with limited ability to pay.

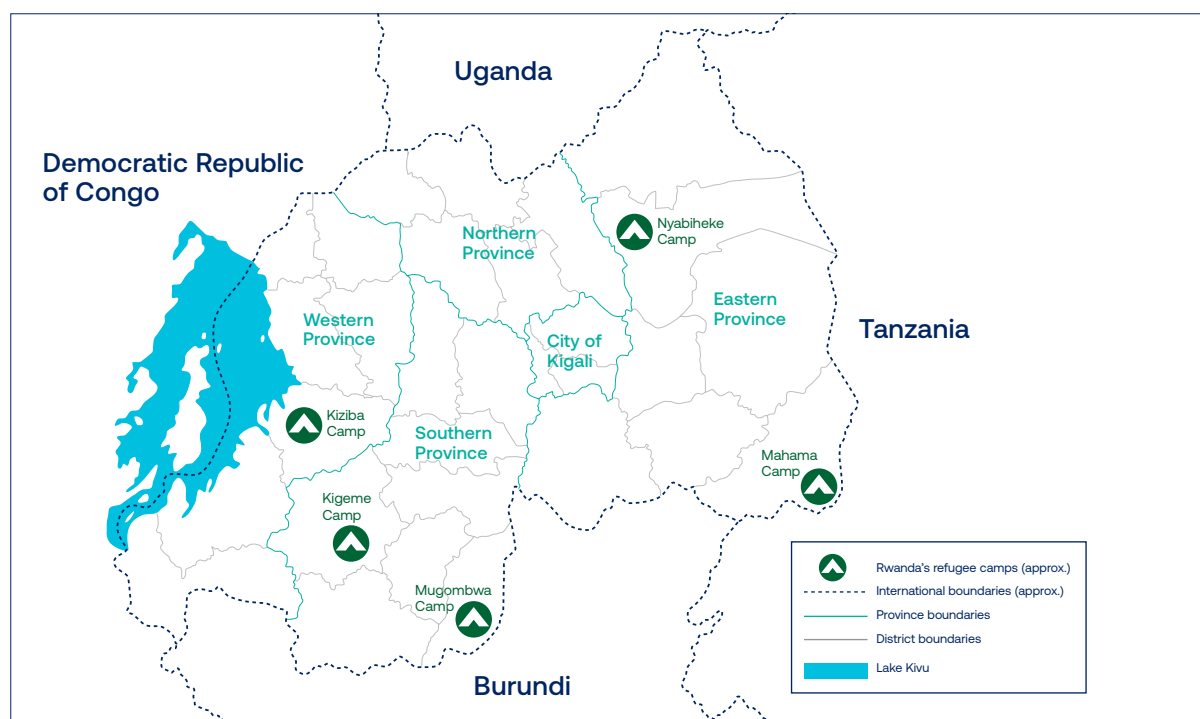
A key driver behind the project intervention was the exclusion of refugee households from existing national clean cooking subsidy schemes. While Rwandan nationals benefit from clean cooking RBF programmes administered by the World Bank, the

10.2 Combining targeted subsidies, market delivery, and productive use of energy

Targeted market-based approaches to reach vulnerable households

Despite ongoing clean cooking interventions in Rwanda's refugee camps, affordability remains a significant barrier, particularly for the most vulnerable households. To address this challenge, the EnDev RBF4R Project was implemented between July 2023 and December 2025 as a complementary intervention to Phase II of the Renewable Energy for

Refugee camps across Rwanda



Infobox | Targeting the most vulnerable households

RBF4R used refugee data, stakeholder consultations and community validation to identify households facing the greatest barriers to clean cooking access. The eligibility process combined information from the UNHCR ProGres database with inputs from refugee representatives, village leaders, and implementing partners. To avoid excluding highly vulnerable households not captured through the standard data-driven process, the project also created a contingency allocation outside the main eligibility category.

Energy Development Corporation Limited (EDCL), and the Development Bank of Rwanda (BRD), refugee households are not eligible for these mechanisms. In response, the RBF4R Project introduced targeted subsidies designed specifically for the most vulnerable refugee households, aligned with the national subsidy levels at the time to improve access while minimising market distortion.

The project formed part of EnDev's broader LNOB financing window, under which refugees were identified as a priority target group. Given that available resources could not support all refugee households, the project applied an intersectional targeting approach to identify the most vulnerable beneficiaries facing the greatest barriers to access. Consultations were conducted with refugee representatives, NGOs, UNHCR, MINEMA and other relevant stakeholders, resulting in the development of an intersectionality framework based on data from the UNHCR ProGres database. This approach responded directly to refugees' concerns regarding beneficiary selection and refugee categorisation.

To operationalise the process, RBF4R developed an eligibility tool that enabled stove suppliers to verify household eligibility and register sales. The approach was subsequently validated through stakeholder consultations across the refugee camps before implementation.

In line with the 2022 Rwandan Ministerial Guidelines on Clean Cooking Technologies and EnDev's

ambition to promote higher-tier cooking, only Tier 3 and Tier 4 clean cooking stoves qualified for support. These comprised natural-draft and forced-draft models. Subsidies covered 90 per cent of the market price, aligned with national subsidy levels at the time of project design. Based on the RBF mechanism, stove suppliers received subsidy payments only after the achieved results had been independently verified, ensuring accountability while maintaining incentives for market delivery.

Under the initial project design, subsidies were available exclusively to the most vulnerable refugee households identified through the intersectionality framework. However, uptake within this target group remained lower than anticipated. In response, the project adapted its approach by expanding eligibility to include all households classified under Category 1 of the World Food Programme (WFP) food assistance framework. These are households that receive full assistance from UNHCR and WFP. Different amounts of cash assistance are provided to different refugee groups, with higher levels of support directed to the most vulnerable families. Category 1 refers to the most vulnerable. At the same time, subsidies for natural-draft stoves increased from 90 to 95 per cent to further stimulate uptake, while subsidies for forced-draft stoves remained unchanged at 90 per cent.

The adaptation highlighted an important operational lesson: vulnerability frameworks must balance data-driven targeting and local realities. Stakeholder consultations had raised concerns about categorisation and potential exclusion, noting that highly vulnerable households could be excluded through a purely data-driven selection process. To address these concerns, the project reserved 10 per cent of the stoves it supported for vulnerable households outside Category 1. Beneficiaries under this contingency allocation were jointly identified by village leaders, camp refugee executive committees, and Practical Action, then manually integrated into the eligibility tool.

Linking energy access to livelihood opportunities

While clean cooking formed the core of the intervention, the project also recognised that energy access could contribute to broader economic opportunities within refugee communities.

The project therefore complemented its clean cooking intervention with targeted support for women-led enterprises within the camps to access productive use of energy (PUE) technologies. Under this arrangement, the project subsidised 80 per cent of appliance costs, while beneficiaries contributed the remaining 20 per cent.

Women entrepreneurs were first mapped and surveyed to assess their interest and business needs. Appropriate PUE technologies were then selected jointly with the beneficiaries. In addition to access to technology, participating women received business development support to strengthen the productive use of the technologies and improve the sustainability of their enterprises.

Infobox | Productive use of energy in refugee economies

For RBF4R, productive use of energy meant connecting women-led enterprises with energy technologies that could immediately improve business operations. Refrigeration, lighting, communication devices, and small solar-powered equipment were selected based on existing business activities in the camps, rather than promoted as standalone technologies. This helped ensure that energy access translated into income, service reliability, and business growth.

10.3 Results and impact of the RBF4R Project

Energy access and economic opportunities for refugee entrepreneurs

The project initially aimed to support the distribution of 6,700 higher-tier cookstoves across the five refugee camps in Rwanda on a first-come, first-served basis. However, implementation challenges, including lower-than-expected sales volumes, supply-chain challenges, and the limited project implementation timeline, necessitated revising the target to 2,250 higher-tier cookstoves, a more realistic and achievable figure. In parallel, the project aimed to support 50 refugee women entrepreneurs through access to PUE technologies and business development support.

Clean Cooking

During implementation, the project reached 62 per cent of the revised target and 21 per cent of the original target.

While uptake remained below expectations, the intervention demonstrated that targeted subsidies can expand access to higher-tier technologies among refugee households that would otherwise remain excluded from the clean cooking market. The project also provided practical insights into how affordability, fuel availability, humanitarian assistance, and consumer awareness influence adoption decisions in refugee settings.

Beyond households, the intervention also helped strengthen market development within refugee camps. Three participating suppliers upgraded from Tier 2 stove production to Tier 3 and Tier 4 solar-powered stove technologies, contributing to improved product quality and greater technology diversification within the refugee cooking energy market.

All participating suppliers established sales points across the five refugee camps and conducted awareness campaigns between March and mid-April 2025. However, sales performance varied significantly across locations due to differences in fuel availability, energy access conditions and operational capacity.

The Mahama Refugee Camp recorded the highest sales volumes. This was largely driven by the camp's larger population and limited access to alternative cooking fuels. Unlike in other camps, nearby forests are inaccessible for firewood collection, forcing many households to harvest papyrus from the Akagera River as an alternative fuel source. Uptake in Mahama also increased following reductions in free LPG distribution and cuts in UNHCR energy cash assistance, which intensified demand for alternative cooking solutions.

In contrast, the Nyabiheke Refugee Camp recorded comparatively lower sales volumes. One of the main constraints was the absence of a permanent UNHCR office within the camp. Operational limitations affecting token distribution to eligible refugee

households delayed implementation and contributed to slower uptake.

Productive Use of Energy

The PUE component exceeded expectations, demonstrating strong demand for energy-enabled livelihood solutions among women entrepreneurs in refugee camps. By directly linking energy access to business needs, the intervention strengthened income generation, improved household welfare, and enhanced economic resilience among refugee households.

The project supported more than 90 women-led enterprises, nearly double the original target. Supported businesses included grocery shops, canteens, bars, and alimentation businesses. The project supported solar refrigerators and solar home systems, enabling access to televisions, radios, and solar-powered shaving machines.

Participating entrepreneurs strengthened their businesses through extended operating hours, improved refrigeration capacity, and expanded customer reach. Beneficiaries also received business development support, including training in record-keeping and business linkages, as well as access to finance. These measures further strengthened their enterprises.

The intervention generated measurable economic outcomes among supported businesses and households. Average business income increased from RWF 45,300 at baseline to RWF 76,420 following project support, representing an increase of 69 per cent. The number of jobs created increased from 41 to 70, representing growth of 71 per cent.

Access to informal financing mechanisms also improved significantly. While no beneficiaries had previous experience with any access to finance mechanisms prior to the intervention, 25



entrepreneurs had joined informal savings and lending groups following the intervention.

Beyond income generation, beneficiaries reported greater ability to pay for healthcare, cover school fees, and purchase more nutritious food for their families. The intervention therefore contributed not only to business growth, but also to reduced dependence on humanitarian assistance and strengthened household dignity and self-reliance.

The strong performance of the PUE component demonstrates that energy access interventions can directly strengthen refugee livelihoods when technologies respond to clearly identified business models. While the clean cooking component highlighted the challenges of affordability and adoption, the PUE intervention illustrated how energy access can also contribute directly to livelihoods, economic participation, and pathways towards greater self-reliance.



10.4 Lessons for market-based energy access in refugee settings

Although the project did not achieve its envisaged clean cooking targets, RBF4R generated important operational and strategic lessons for future refugee energy programmes.

As Rwanda's first RBF intervention implemented within a humanitarian setting, the project provided valuable evidence on both the opportunities and limitations of applying market-based clean cooking approaches within refugee camps. The key findings and lessons have subsequently informed stakeholder discussions and contributed to the design of future refugee energy initiatives, including collaboration with the WFP and the UN Joint Programme on Clean Cooking.

Accelerating Climate Action and Clean Cooking for Inclusive Mitigation and Adaptation in Rwanda (ACACIA) is a new five-year UN Joint Programme co-led by WFP and the UN Environment Programme (UNEP) and co-designed with the Government of Rwanda to support a coordinated national clean cooking transition. ACACIA brings together seven participating UN agencies under a common programme framework, with the aim of improving coordination, aligning technical assistance, and mobilising pooled or complementary financing



'The RBF4R has made an important contribution to Rwanda's clean cooking transition by showing that market-based approaches can be designed to reach refugee and vulnerable households. Its support to higher-tier cooking solutions and women-led energy use in refugee settings has generated practical lessons on affordability, verification, supplier engagement and demand creation.'

The UN, through the new Joint Programme "Accelerating Climate Action and Clean Cooking for Inclusive Mitigation and Adaptation in Rwanda" (ACACIA) will build on this experience by ensuring that RBF is embedded as part of a broader finance architecture that can support and scale sustained access to clean cooking across vulnerable communities.'

– Rebeca Solis del Campo
Energy Advisor–Social Protection, School Feeding, Disaster Risk Management, World Food Programme

around Rwanda's clean cooking priorities. The programme targets rural households, schools, refugees and host communities.

Key positive outcomes

Targeted subsidies can expand access to underserved markets

The intervention demonstrated that targeted subsidies can help bridge affordability gaps and enable vulnerable refugee households to access higher-tier cookstoves that would otherwise remain unaffordable under normal market conditions. By reducing upfront investment costs while maintaining a market-based delivery model, the project expanded the addressable market for participating companies and created opportunities to reach customer segments often excluded from commercial energy markets.



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At the same time, the experience showed that subsidies alone are insufficient to drive large-scale uptake. Even at high subsidy levels, additional investment in awareness-raising, consumer engagement, and last-mile distribution remains necessary to stimulate demand.

RBF can work in humanitarian settings

The project successfully tested RBF tools, including eligibility systems and independent verification mechanisms, within a complex humanitarian environment. Despite operational challenges, the intervention yielded verified, credible results.

As the first RBF-supported market intervention implemented in refugee camps in Rwanda, the project demonstrated that performance-based

financing approaches can be adapted to humanitarian settings while maintaining accountability and transparency. The experience provides a practical foundation that can inform future humanitarian energy programmes.

User satisfaction supports long-term transition potential

Households that adopted higher-tier cookstoves consistently reported positive user experiences and strong appreciation for the technologies and their benefits. Beneficiaries highlighted reduced smoke exposure, improved cooking performance, shorter cooking times, and lower fuel consumption as key advantages. Many users expressed a strong preference for pellet stoves, particularly models using forced-air draft technology.

A business-driven PUE approach strengthens livelihoods

The PUE component achieved particularly strong results because support responded directly to identified business needs, rather than promoting predefined technologies.

By aligning technologies with viable business opportunities, the intervention contributed directly to increased income generation, business growth, and household resilience. The experience demonstrated that energy access can act as a direct enabler of business growth and economic resilience among women-led enterprises in refugee camps.

Infobox | Why the PUE component succeeded

The PUE component achieved strong uptake because the technologies responded directly to the identified business needs of women entrepreneurs. Rather than promoting predefined appliances, the intervention worked with beneficiaries to identify technologies aligned with existing livelihood activities, while also providing business mentoring. This business-driven approach strengthened income generation, increased enterprise resilience, and improved household welfare.



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Key challenges and lessons learned

Awareness raising and behavioural change

- **Sustained behaviour change requires continuous community engagement**

The project demonstrated that awareness-raising is not a one-time activity but a continuous process. Sales increased most effectively when awareness-raising activities were conducted consistently and directly within communities, for example, through weekly cooking demonstrations with local women's groups at the village level in the camps. This highlighted the importance of frequent, localised engagement to build trust, address performance-related concerns, and sustain interest in clean cooking technologies.

The intervention also underscored the importance of demonstrating practical benefits. Both households and businesses often require visible evidence before adopting unfamiliar technologies. Demonstration activities, therefore,

played a critical role in overcoming preferences for traditional fuels and establishing clean cooking practices.

- **Humanitarian contexts require tailored approaches to market development**

Many refugee households have spent years receiving humanitarian assistance through direct distribution mechanisms. As a result, market-based approaches require additional investment in communication, trust-building, and consumer education. The project demonstrated that transitioning from aid-based delivery models to market-based systems is not simply a financial challenge. It also involves behavioural change and requires households to perceive energy technologies as investments towards self-sufficiency, rather than assistance.

The experience further showed that suppliers often need targeted incentives and technical support to reach last-mile customers in humanitarian settings. Future interventions should therefore consider key market barriers such as transportation costs, distribution risks, and customer acquisition challenges when designing subsidy mechanisms.

Supply-side capacity constraints

- **Private sector capacity remains critical for market growth**

Although consumer interest in higher-tier cookstoves increased, participating companies frequently experienced stock shortages and supply chain disruptions. Dependence on imported spare parts, combined with limited access to finance, constrained suppliers' ability to respond consistently to market demand.

Moreover, many companies still lack the financial capacity to sustainably reduce stove prices without continued subsidy support. The intervention, therefore, highlighted the delicate balance between subsidies acting as market catalysts and subsidies creating long-term dependency within the private sector. In-depth technical assistance provided by the EnDev ReCIC Project, co-funded by the European Union, and the EnDev Global Energy Enterprise Coach instrument benefited some of the companies under RBF4R and emphasised the importance of such support for future interventions.

- **Enabling environment requires strengthening**

The project also highlighted the importance of strengthening the broader enabling environment. Adjustments required to comply with the Ministerial Guidelines on Clean Cooking Technologies for Tier 3 and higher cookstoves often necessitated multiple rounds of testing. At the same time, long waiting periods for stove testing delayed market entry for improved technologies. While these challenges reflected a transitional phase in the sector, they reinforced the importance of accessible testing infrastructure and technical support for stove manufacturers. Testing capacities have since increased

through support provided by the EnDev ReCIC Project, which strengthened the Rwanda Standards Board (RSB) stove testing laboratory. [\(Read more about the ReCIC Project in the following chapter\).](#)

Ability and willingness to pay

- **Affordability remains an important determinant of adoption**

One of the most significant lessons from the intervention was that affordability continues to shape both the adoption and the sustained use of clean cooking technologies.

Most eligible refugee households have limited, often unstable income-generating opportunities, constraining their purchasing power even when high subsidy levels are provided. This challenge was compounded by reductions in cash assistance programmes and the discontinuation of the cash-for-energy initiative, which further weakened households' ability to contribute financially to clean cooking technologies. At the same time, continued access to free LPG for many households reduced incentives to transition towards alternative cooking solutions.

The intervention also confirmed that refugee households that adopted clean cooking strongly prefer high-quality cooking technologies. However, the most preferred technologies often remain financially inaccessible within the current market system.

The project therefore demonstrated that clean cooking transitions in refugee settings cannot be separated from broader questions of household income, financing mechanisms, and social protection systems.

- **Adoption does not necessarily lead to exclusive use**

Monitoring data showed that 75.6 per cent of supported households continued to use secondary or tertiary cooking technologies alongside their improved cookstoves. This practice, commonly referred to as fuel stacking, was primarily driven by constraints on fuel

affordability and availability. The findings underline the importance of understanding household cooking behaviour and the factors that influence technology adoption and sustained use.

RBF design, administration and data management

- **Humanitarian subsidy systems require trust, simplicity, and strong communication**

Implementing a market-based subsidy mechanism in a refugee setting requires considerably more than technical system design. Throughout implementation, data protection remained a central priority, reflecting the sensitive nature of refugee data and the complexity of the broader humanitarian context in which the intervention operated.

The project also demonstrated that administering a dedicated digital RBF system for a relatively small target group required significant coordination and resources. Compared with national RBF programmes, beneficiary verification, data management and stakeholder engagement were considerably more complex and costly. This suggests that, where feasible, integrating refugees into existing national subsidy frameworks may offer a more cost-efficient and sustainable long-term solution. Future subsidy schemes should also be designed with clearly defined targeting mechanisms, appropriate subsidy levels and exit strategies to ensure the effective use of limited resources.

The intervention further highlighted the importance of trust and communication in humanitarian markets. Some beneficiaries expressed concerns that participation in the programme could affect their eligibility for other forms of humanitarian assistance. These perceptions occasionally reduced willingness to engage with the subsidy mechanism, despite the intervention's potential benefits.

At the same time, communication channels did not always reach all intended beneficiaries. Reliance on SMS-based communication created challenges and raised concerns related to

Infobox | What RBF4R showed

RBF4R demonstrated that market-based energy access can work in refugee settings, but not through subsidies alone. Future programmes will need to combine targeted and temporary subsidies with stronger community mobilisation, institutional access to finance for refugees, and technical assistance for suppliers to deliver more affordable, high-quality stoves aligned with refugee preferences.

data accuracy, communication effectiveness, and inclusivity. The experience demonstrated that future programmes should combine digital systems with trusted community-based communication channels to strengthen transparency, improve beneficiary understanding and increase participation.

The project showed both the potential and the complexity of applying market-based RBF approaches in refugee camps. Finding the right balance between targeted and temporary subsidisation, institutionalising access to finance for refugees, and supporting the private sector in developing more affordable, high-quality stoves will remain a central challenge for future programmes. Refugee energy access requires more than technology delivery. It requires trust, affordability, business viability, and sustained engagement with the realities of humanitarian markets.



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Success story

Cooking with greater safety, dignity, and choice

Across Rwanda's refugee camps, improved cookstoves supported through the RBF4R Project are helping vulnerable households cook more safely, affordably and reliably. For many families, rising charcoal prices, inconsistent LPG supplies, and reduced humanitarian assistance have made daily cooking increasingly uncertain. The introduction of pellet-based cooking solutions is helping some households reduce fuel costs, improve safety, and regain greater control over daily life.

When cooking fuel runs out

In Mahama Refugee Camp, Therese Baransaniye knows how quickly daily life can become difficult when cooking fuel is unavailable. Having arrived in the camp in 2015 as one of its first residents, she has witnessed the growing challenges households face in accessing reliable cooking energy.

► 'Before the introduction of improved cookstoves, households in the camp relied primarily on LPG for cooking,' she explains. 'However, the supply was often insufficient. When the gas ran out, we were left without any alternative cooking means, which made daily life extremely difficult.'

Like many refugee households across Rwanda's camps, families in Mahama face increasing pressure from rising charcoal prices, limited access to firewood, and reductions in humanitarian energy assistance. In some locations, women and girls continue to walk long distances to collect firewood, exposing themselves to protection risks and physical danger.

In Kiziba Refugee Camp, Speciose Kaneza, a mother of two, describes the consequences these pressures can have on vulnerable households.

- ▶ ‘Families were often forced to walk long distances in search of firewood, exposing themselves to serious risks such as falls, injuries and, in some cases, attacks in the forest,’ she says. ‘At the same time, energy cash assistance in the camp has been reduced for some households and completely suspended for others. As a result, many families struggle to afford cooking fuel, making daily meal preparation uncertain and stressful.’

A more affordable way to cook

For many households, improved cookstoves are reducing dependence on charcoal and firewood while significantly lowering cooking costs. Across the camps, beneficiaries consistently describe pellet fuel as a more affordable alternative to traditional cooking fuels.

- ▶ ‘In the past, people had to go to the forest to collect firewood, but now, since I got this stove, I buy pellets and cook easily,’ says Gloria Uwimpuhwe from Mugombwa Refugee Camp.

For Speciose, the financial savings have brought greater stability within her household.

- ▶ ‘While a sack of charcoal costs between RWF 16,000 and 17,000, I now spend only about RWF 5,000 per month on pellets,’ she explains. ‘On average, my daily cooking fuel cost is now between RWF 200 and 400, which is significantly lower than the cost of cooking with charcoal. This difference has significantly eased the financial pressure on my family.’

According to her, the monthly savings of approximately RWF 12,000 now help cover household expenses and support her children’s needs at a time when humanitarian assistance is becoming increasingly constrained.

- ▶ ‘If a household can save the RWF 12,000 each month and set it aside over several months, it can serve as start-up capital for a small, practical business,’ she adds. ‘That can help families move toward greater self-reliance.’

Faster cooking, more time for other activities
Beyond affordability, households also report significant improvements in cooking efficiency and time management. Meals can be prepared more quickly and with less fuel, freeing time for childcare, casual work, and other livelihood activities.

- ▶ ‘In approximately three hours, I can prepare three pots of food, including cassava flour or rice with sauce,’ Speciose explains. ‘With just one cup of pellets, which is about 800 grams, I can cook a full meal, reheat beans or heat water for bathing my children.’

The time savings have enabled her to organise household responsibilities more efficiently and participate in small income-generating activities.

- ▶ ‘When my children return home, they often find meals already prepared,’ she adds.

More than a stove

For Therese, the benefits extend beyond cooking. She particularly values the stove’s ability to charge mobile phones, helping her reduce everyday household expenses.

- ▶ ‘Its battery stores electricity efficiently,’ she explains. ‘When fully charged, it allows me to cook and still have enough power to charge mobile phones. This has reduced our household expenses, as I no longer need to pay for phone-charging services.’

Across the camps, beneficiaries consistently highlight improvements in safety, cleanliness, and household well-being. Compared with traditional charcoal stoves, the improved cookstoves produce less smoke and can be used safely indoors.

- ▶ ‘The stove is safe, hygienic and smoke-free, allowing me to cook inside the house without health concerns,’ says Speciose.

Several households also appreciate the flexible payment arrangements introduced through the RBF4R Project, which allow families to pay gradually according to their financial capacity.

As Gloria explains:

- ▶ ‘One good thing about this stove is that you are not forced to pay money you do not have. You pay according to your ability. That is the advantage of the stove.’

Challenges remain

Despite these improvements, challenges remain. While higher-tier cookstoves have expanded access to cleaner cooking solutions, pellet affordability continues to affect sustained use, particularly among households that have lost energy cash assistance or face unstable incomes.

- ▶ ‘What we now need is continued assistance to access affordable cooking fuel, such as pellets, so that families can fully benefit from this solution,’ explains Therese.

Gloria similarly believes that smaller, more flexible pellet-purchasing options could help lower-income households continue using the technology.

- ▶ ‘Someone who does not have enough money to buy a kilogram of pellets cannot cook,’ she says. ‘But if someone can buy pellets in small amounts and pay gradually, that would be very helpful.’

Nevertheless, beneficiaries consistently describe the cookstoves as a meaningful improvement in their daily lives.

- ▶ ‘This initiative has improved safety, reduced costs and restored dignity to how families like mine prepare food each day,’ says Speciose. ■





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Success story

A Refrigerator opens new opportunities

In Mahama Refugee Camp, cold drinks are more than a convenience during the dry season – they are a business opportunity.

For Solange Utamuliza, a mother of two, access to solar-powered refrigeration through the RBF4R Project transformed a small business idea into a growing source of household income.

Before receiving support, Solange had long planned to open a small alimentation business selling drinks and basic goods. However, purchasing a refrigerator remained beyond her financial reach.

▶ 'I had some starting capital,' she explains, 'but it was not enough to buy a refrigerator.'

Turning demand into opportunity

Without refrigeration, business growth remained limited despite strong customer demand for cold drinks within the camp.

▶ 'Considering the heat in Mahama, everyone wants a cold drink to refresh their body and quench their thirst,' she says.

Through the RBF4R Project, Solange obtained a refrigerator, which immediately expanded her business opportunities. In Mahama's hot climate, refrigerated drinks quickly attracted new customers and increased daily sales.

▶ 'Compared to the clients I had before buying the fridge, they have now increased because many come specifically for cold drinks,' she explains. 'I have really progressed.'

Before receiving the refrigerator, Solange sold goods worth approximately RWF 10,000 per day. Today, her daily sales range between RWF 50,000 and RWF 70,000. This increase in income also enabled her to complete her financial contribution towards the appliance within a relatively short period.

>>>

- ▶ ‘If I had not received the support, I would not have been able to pay the full cost of the refrigerator,’ she adds.

Strengthening household resilience

The growth in Solange’s business has directly strengthened her household finances. Previously, her husband was the family’s sole income earner, while day-to-day expenses immediately absorbed her own earnings.

- ▶ ‘Now, I also run a business that helps support our family, and we are even able to save money,’ she explains.

One factor behind her success has been her decision not to increase prices despite introducing refrigerated products. By maintaining affordable prices, she attracted more customers and strengthened her competitiveness within the camp market.

The refrigerator has also opened opportunities for future business expansion. Solange now plans to stock milk and other refrigerated products that remain difficult to access within the camp.

- ▶ ‘People who travel far to buy milk from places with refrigerators could instead come here,’ she explains. ‘This would reduce their travel time.’

Powering refugee livelihoods

Solange’s experience illustrates how PUE technologies can strengthen refugee livelihoods when support responds directly to identified business opportunities.

Beyond increasing income, access to refrigeration has helped improve household resilience, expand economic participation, and strengthen pathways towards greater self-reliance within the refugee community.

For Solange, the refrigerator is more than a business asset. It has created new opportunities to grow her enterprise, contribute to her household income and build greater financial security for her family. ■

11 Reducing the Climate Impact of Cooking in Rwanda (ReCIC) Project

Strengthening cooking energy systems for Rwanda's clean cooking transition



11.1 Laying the groundwork for a stronger cooking energy market

Rwanda's high population density and limited land availability make the country particularly vulnerable to deforestation and environmental degradation. At the same time, most households continue to rely on solid biomass for cooking and often use inefficient technologies that contribute to greenhouse gas emissions, accelerate forest degradation, and affect public health.

Recognising these challenges, the Government of Rwanda (GoR) identified clean cooking as a national priority. Through its Biomass Energy Strategy (BEST), the government set an ambitious target to reduce the share of households using inefficient cooking solutions from 83.3 per cent in 2014 to 42 per cent by 2024. Progress, however, remained slower than anticipated. According to a government survey¹⁸ conducted in 2020, more than 76.1 per cent of Rwandan households still relied on artisanal cookstoves and three-stone fires for cooking.

This slow transition reflected the wider state of Rwanda's cooking energy market, which was still in its early stages of development. Although a small number of local producers had emerged, production capacity and product quality remained low, and improved cookstoves had not yet reached households at scale.

Several structural barriers continued to constrain market development. Producers and distributors had limited access to finance, while fragmented distribution networks made it difficult to reach consumers, particularly in rural areas. Household awareness of and exposure to more efficient, reliable, and higher-performing cooking technologies also remained limited, and markets for alternative fuels were still underdeveloped. As a result, the growing policy commitment to clean cooking had not yet translated into a strong, self-sustaining market.

Quality assurance was another critical gap. As Rwanda's cooking energy market evolved, the need for stronger quality assurance and regulatory systems became increasingly apparent. However,

18. Ministry of Infrastructure, *National Survey on Cooking Fuel Energy and Technologies in Households, Commercial and Public Institutions in Rwanda* (Kigali: Ministry of Infrastructure, 2021).

limited capacity to test products, verify performance, and support the effective implementation of standards constrained market development.

Institutional cooking and productive-use applications were also largely underserved. Most sector interventions focused on household cooking solutions, with limited attention given to schools, public institutions, and other high-consumption users such as restaurants, where inefficient biomass use remained significant. These settings represented an important opportunity to reduce fuel consumption, expand the range of cooking technologies available in Rwanda, and demonstrate cleaner cooking solutions at scale.

Against this backdrop, the EnDev Reducing the Climate Impact of Cooking in Rwanda through Improved Cooking Energy Systems (ReCIC) Project was jointly implemented by GIZ and SNV between November 2020 and October 2025. Co-funded by the European Union under the Global Climate Change Alliance Plus (GCCA+) initiative and the German Federal Ministry for Economic Cooperation and Development (BMZ), the project was designed to address key barriers across the cooking energy value chain and support Rwanda's broader transition towards a more efficient, reliable, and quality-driven cooking energy market.

ReCIC aimed to develop a viable market for improved biomass cookstoves (ICS), increase production capacity, expand household access, and reduce emissions through the sustained adoption of cleaner technologies. To achieve this, the project worked across interconnected intervention areas: strengthening local ICS production capacity and enterprise development, increasing consumer awareness and adoption, and advancing institutional cooking solutions.

Alongside market development activities, the project worked closely with the GoR to strengthen regulatory frameworks, improve stove testing and quality assurance systems, and enhance coordination among sector stakeholders. Together, these efforts aimed to build a more coordinated, reliable, and market-oriented cooking energy market capable of supporting long-term development.

Infobox | Improved biomass cookstoves (ICS)

ICS are designed to use biomass fuels such as charcoal, firewood or pellets more efficiently than conventional three-stone fires or basic stoves. By improving combustion and heat transfer, they reduce fuel consumption, lower smoke emissions, and provide a safer and more convenient cooking experience. Improved cookstoves are available in different designs and capacities, ranging from household stoves to larger models used in institutions such as schools.



11.2 Strengthening Rwanda's local production and market capacity for improved cooking technologies

A central constraint to the growth of Rwanda's cooking energy market was the limited capacity of local enterprises to produce, market, and distribute improved cookstoves at scale. As Rwanda's regulatory environment evolved, strengthening local enterprises became critical to building a competitive and sustainable market for more efficient cooking technologies.

To address this challenge, ReCIC established the Cooking Energy Business Growth Fund (CEBGF), a competitive private-sector support mechanism that combined investment grants with tailored technical and business development support. Rather than providing stand-alone financing, the fund linked grant disbursements to clearly defined milestones, strengthening accountability while helping enterprises overcome key operational and investment barriers.

The CEBGF targeted high-potential micro, small and medium-sized enterprises (MSMEs) contributing to Rwanda's broader clean cooking transition through the production of ICS and alternative cooking fuels. During the early stages of implementation, the fund focused on enterprises producing Tier 2-compliant technologies, reflecting prevailing market conditions. As Rwanda strengthened its

regulatory framework through the introduction of the Ministerial Guidelines for Clean Cooking Technologies in 2022, ReCIC progressively shifted its support towards helping enterprises upgrade to Tier 3 and higher-performing technologies. This enabled businesses to improve product quality, comply with emerging standards, and strengthen their market competitiveness.

Fourteen MSMEs were initially selected and signed grant agreements. While one company voluntarily withdrew and another was disqualified, the remaining 12 enterprises completed the programme. These included 10 biomass cookstove companies and two alternative fuel enterprises. Supported businesses reported improvements in production efficiency, customer reach, product quality, and business management. Three enterprises that initially operated as cooperatives evolved into more structured and commercially competitive businesses.

Recognising the important role of smaller and less formalised actors in Rwanda's biomass cooking value chain, and in line with EnDev's Leave No One Behind principle, ReCIC complemented the fund by supporting five pottery cooperatives producing clay cookstoves. Through targeted training, in-kind assistance, and market linkages with larger companies, the project helped these cooperatives improve production quality and strengthen their integration into formal supply chains.

Across the supported enterprises, investments in equipment and machinery, technical upgrading, and business development services increased production capacity and improved product performance. Most participating companies transitioned towards Tier 3+ technologies, contributing to the wider availability of higher-performing, locally manufactured 'Made in Rwanda' cookstoves.

Beyond technology improvements, the intervention also strengthened the business foundations of participating enterprises. Companies introduced stronger financial management systems, improved marketing and customer engagement approaches, and adopted more structured internal controls. A number of enterprises became better positioned to engage with commercial financiers and investors, improving their prospects for future growth.

The intervention demonstrated that local manufacturers can compete successfully in an increasingly

Infobox | The Cooking Energy Business Growth Fund (CEBGF)

The CEBGF was a competitive business challenge fund designed to help local enterprises strengthen and scale their cooking energy businesses. Selected ICS and alternative fuel producers, companies and cooperatives received investment grants alongside tailored business development support.

Enterprises took ownership of implementing their approved investment plans, including procuring equipment and upgrading production facilities. Grant funds were disbursed in tranches as agreed milestones were completed, combining enterprise ownership with accountability and targeted support for business growth.

Infobox | Understanding the tier framework

Cookstove performance is commonly assessed using the ISO tier framework, which classifies technologies from Tier 0 to Tier 5 based on indicators such as thermal efficiency, emissions, safety, and durability. Tier 0 represents performance comparable to traditional cooking methods, while Tier 5 reflects best-in-class technologies. In Rwanda, Ministerial Guidelines introduced in 2022 established a transition towards higher-performing cookstoves, requiring newly disseminated biomass stoves to meet at least Tier 3 standards.

quality-driven market when they receive the right combination of financial, technical, and business support. More importantly, it showed that enterprise development can serve as a catalyst for wider market transformation by improving product quality, strengthening the biomass cooking value chain, and increasing consumer confidence in locally manufactured technologies.

At the same time, the intervention highlighted persistent structural challenges. Consumer affordability remains a significant constraint, particularly for higher-performing technologies, while weak last-mile distribution networks continue to limit market penetration. Most enterprises also remain



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Testimonial

Where enterprise growth meets care

‘When I founded Inganzo Pottery Company Ltd in 2018, we were only five workers producing around 20 cookstoves per day under very challenging conditions. During the rainy seasons, production would sometimes stop completely because we lacked adequate workspace and storage facilities. With support from the ReCIC Project, including business development assistance and the construction of a production shed, we were able to expand our operations and increase production.

Today, we employ 50 skilled casual workers, 30 of whom are women, alongside six permanent staff members. Our production capacity has increased significantly, and we can now produce around 500 cookstoves within two or three days. Most importantly, many of our workers – especially women and young mothers – have improved their livelihoods. Several employees have been able to build houses,

start small businesses, and provide more stable support for their families.

One of the most meaningful changes I am proud of is how the company has been able to support women working at our production site. As the business expanded, many mothers began bringing their children to work because they had no safe place to leave them during the day. We decided to establish a small pre-nursery at the workplace so that children could play, eat, rest, and remain safe while their parents worked nearby. This initiative has improved productivity, reduced safety risks, and given parents peace of mind, knowing their children are being cared for close to them.’

– Delphine Uwajeneza,
Founder and Managing Director,
Inganzo Pottery Company Ltd,
Kayonza District

dependent on subsidy-supported market demand. Meanwhile, Rwanda's growing policy emphasis on LPG and electric cooking is reshaping the sector, requiring producers to continuously adapt, innovate, and diversify their business models. These dynamics underline the importance of maintaining a flexible and market-responsive private sector capable of contributing to Rwanda's evolving clean cooking transition.

of coordinated interventions across the sector. By strengthening the capacity of local manufacturers to develop and produce Tier 3+ technologies, ReCIC complemented the World Bank's Energy Access Quality Improvement Programme (EAQIP), which stimulated consumer demand through demand-side subsidies. The close collaboration between ReCIC and EAQIP created favourable conditions for accelerating the transition towards higher-performing cooking technologies.



Lessons from the intervention

Enterprise development requires integrated support

Access to finance remains a critical constraint, but financing alone is insufficient to drive market transformation. ReCIC demonstrated that enterprise development is most effective when financial support is combined with technical upgrading, business development services, and stronger market linkages. The project also highlighted the value

Adaptive project design is essential in evolving markets

Cooking energy markets evolve rapidly in response to changing policies, technologies, and consumer preferences. During implementation, ReCIC continuously adapted its interventions to Rwanda's transition towards Tier 3+ technologies and the evolving regulatory framework. The experience showed that projects benefit from implementation flexibility to adjust support measures, technical assistance, monitoring frameworks, and capacity-building activities as market conditions evolve, while maintaining their overall objectives.

Market growth depends on stronger enabling systems

Strengthening enterprises is only one part of successful market development. ReCIC showed that investments in manufacturers alone are insufficient when key market functions, such as testing and certification systems, distribution networks, retail structures, and fuel supply chains, remain underdeveloped. Building a supportive enabling environment proved equally important in creating the conditions in which enterprises could grow, compete and reach consumers.

Production capacity does not automatically translate into market uptake

One of ReCIC's key lessons was that increasing production capacity does not automatically translate into higher sales or wider adoption. While many supported enterprises significantly expanded their manufacturing capacity, production often remained demand-driven rather than capacity-constrained. Consumer affordability, limited access to financing, and weak last-mile distribution continued to constrain market uptake, highlighting the importance of addressing supply and demand-side barriers in parallel.



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Success story

From workshop floor to industry growth: how Eco Green is building Rwanda's clean cooking future

The workshop at Eco Green Solutions Ltd, located on the north-eastern outskirts of Kigali, is loud and busy. Hammers strike metal in a steady rhythm while workers move between stacks of steel liners and half-assembled pellet stoves.

Near the entrance, Jean Damascene Murwanashyaka stands beside the company's plasma cutting machine, guiding a large metal sheet onto the machine's flat cutting table. Above the sheet, the cutter moves back and forth with mechanical precision, cutting one perfect steel circle after another. In just a few minutes, 18 circles emerge from a single sheet – components that will later become part of Eco Green's pellet stoves.

Across the workshop floor, Seif Hamoud, Eco Green's Director of Business Development, watches the activity unfold. Five years ago, the company did not have a plasma cutter – or anyone trained to operate one.

Founded in 2018 and officially registered in 2020, Eco Green began as a small clean energy company producing improved cookstoves and sustainable biomass pellets with rented equipment and limited factory space. At the time, workers manually cut metal sheets one by one using angle cutters. Production was slow, material waste was high, and the company struggled to produce stoves to meet growing demand.

As Rwanda's cooking energy market began to evolve, companies like Eco Green faced a common challenge: how to increase production, improve product quality, and remain competitive in an increasingly quality-driven market.

That challenge began to change when Eco Green received support through the ReCIC Project's Cooking Energy Business Growth Fund. In 2022, the company invested approximately EUR 40,000 through

the grant in a range of new production equipment and machinery. Among the investments was a plasma cutter imported from China and valued at approximately RWF 7.5 million (around EUR 4,800). It took four months for the machine to arrive in Rwanda.

The investment marked a turning point. Before acquiring the new machinery, workers manually cut around 810 stove tops per day. Today, the plasma cutter enables Eco Green to produce up to 2,700 stove tops daily while significantly reducing raw material waste.

Yet for Seif, the investment was never solely about increasing production speed.

► ‘It’s a balancing act,’ he explains. ‘We want to increase efficiency, but we also want to create jobs.’

That balance is visible throughout the workshop. Around 45 workers hammer and shape metal components, while others assemble electrical fan systems, manage pellet production, or prepare materials for stove assembly. During large production orders, Eco Green employs up to 100 casual workers in addition to its permanent staff.

The company itself has expanded considerably. Before receiving the support through ReCIC, Eco Green employed eight people — three permanent staff and five casual workers. Today, it employs 23 permanent staff alongside a growing network of temporary workers engaged during peak production periods.

Building skills for a growing industry

The arrival of modern production machinery also created an entirely new challenge: finding people with the technical skills to operate and maintain it.

► ‘When the machine arrived, it was very difficult to find qualified operators,’ Seif recalls. ‘These jobs did not really exist before.’

Eco Green eventually engaged an external expert to train two employees to operate the machine. One of them was Jean Damascene Murwanashyaka.

Now 32 years old, Jean Damascene first joined Eco Green in 2019 as an intern while studying mechanical engineering and manufacturing technology. After graduating and briefly working for another

manufacturing company, he returned to Eco Green in 2022 as an operator and maintenance engineer.

Today, he programs and operates the plasma cutting machine, maintains production equipment, supervises pellet production systems, and trains other staff in machine operation and workplace safety.

► ‘During my internship, I understood the theory,’ Jean Damascene says. ‘But at Eco Green I learned how production really works.’

Through additional training and workshops supported by the ReCIC Project, Jean Damascene further developed his technical and management skills in biomass cookstove production and fuel processing. Over time, he has become one of the company’s key machine operators in a role that barely existed within Rwanda’s cooking energy market a few years ago.

The job has also transformed his personal life. Jean Damascene explains that his income has enabled him to support his extended family, invest in land and housing, and improve his family’s living conditions. At home, he now cooks using one of Eco Green’s pellet stoves.

More than one machine

For Eco Green, the transformation extends beyond a single company or a single piece of equipment. Investment in machinery, technical skills, and local manufacturing capacity has helped the company scale production of higher-performing cookstoves while strengthening its position within Rwanda’s evolving cooking energy market. It has also contributed to the development of new industrial and technical skills that are increasingly needed as the market evolves and quality standards continue to rise.

Inside the workshop, another metal sheet slides onto the cutting table as workers continue hammering stove components nearby. The machine may have increased production speed, but the workshop around it reflects something equally important: the growth of a local industry creating new skills, new jobs, and new opportunities.

As Rwanda continues its transition towards cleaner cooking solutions, companies like Eco Green demonstrate how investment in local manufacturing can strengthen domestic value chains and help build a more competitive and resilient cooking energy market — one stove, one skill, and one opportunity at a time. ■



11.3 Driving consumer awareness and adoption

Strengthening local production capacity alone was not sufficient to transform Rwanda's cooking energy market. As ReCIC's enterprise development activities progressed, it became increasingly clear that market growth also depended on whether households understood, trusted, and valued improved cooking technologies. Building consumer demand, therefore, became a critical complement to strengthening supply.

At the start of the project, awareness of improved biomass cooking technologies remained limited among many households. Concerns about product reliability, unfamiliarity with new technologies, limited understanding of their long-term benefits, and limited information to help consumers distinguish between higher- and lower-performing products continued to slow adoption. As a result, a significant gap persisted between the growing availability of improved cookstoves and effective consumer demand.

To address this challenge, the ReCIC Project placed consumer awareness and behaviour change at the centre of its market development approach. Rather than simply promoting improved cooking technologies, the project sought to strengthen consumer confidence, encourage informed purchasing decisions, and stimulate demand.

The project implemented a multi-channel awareness and marketing approach under the NOZA IMITEKERE campaign, which means 'clean cooking' in Kinyarwanda. Combining national media outreach with direct community engagement, the campaign sought to translate awareness into practical understanding and purchasing interest.

A nationwide media campaign formed the backbone of the intervention. Activities included 24 televised advertisements and television talk shows, 420 radio spots and live talk shows, and social media and online communication via the EnDev website. Printed materials and branded communication products were used during community mobilisation activities, cooking demonstrations, and other local outreach events to reinforce the campaign messages and support direct engagement with households.

Infobox | NOZA IMITEKERE – Building demand for clean cooking

The NOZA IMITEKERE campaign served as ReCIC's primary consumer engagement platform. Through television, radio, social media, printed materials, roadshows, live cooking demonstrations, and community mobilisation activities, the campaign reached households across Rwanda with messages on fuel savings, health benefits, safety, environmental protection, and the benefits of improved cooking technologies. As Rwanda's policy and regulatory framework evolved, campaign messaging also evolved to promote higher-performing Tier 3+ cooking technologies, helping consumers make more informed purchasing decisions.

Campaign messaging was developed in close coordination with the Ministry of Infrastructure (MININFRA), the Ministry of Environment (MoE), and other government stakeholders. This ensured consistency with national priorities and strengthened the credibility of messages promoting improved cooking technologies across the cooking energy sector.

While national media outreach helped raise awareness, community-level engagement played a critical role in building trust and influencing consumer behaviour. ReCIC implemented community mobilisation activities across 12 districts, including 195 cooking demonstrations, four roadshows, and engagement through platforms such as Umuganda and Joint Action Development Forums. These events often attracted between 400 and more than 1,000 participants per session, creating opportunities for direct interaction between households, producers, and local stakeholders.

Cooking demonstrations and live events proved particularly effective because they allowed households to observe stove performance first-hand, compare technologies, ask practical questions, and better understand fuel efficiency and day-to-day use. This practical experience helped translate awareness into confidence and provided consumers with a stronger basis for informed purchasing decisions.

The demonstrations also created valuable marketing opportunities for local producers. Many enterprises had limited capacity to promote their products or engage directly with potential customers. By bringing producers and consumers together, ReCIC strengthened product promotion, improved customer engagement, and created stronger market linkages.

Even where households expressed a willingness to purchase improved cooking technologies, adoption remained constrained by multiple barriers. While affordability and limited access to consumer finance reduced purchasing power, weak distribution networks, limited product availability, and unclear purchasing pathways often prevented interested households from accessing products. Demand creation is therefore most effective when economic and market access barriers are addressed alongside consumer awareness.



Results and remaining constraints

Monitoring data and stakeholder feedback indicated that the campaign contributed to increased awareness, interest, and acceptance of improved cookstoves and alternative cooking fuels. Households demonstrated a stronger understanding of key benefits, including reduced fuel consumption, lower household expenditure on cooking fuels, improved health and safety, environmental protection, and greater cooking convenience. In many cases, participation in awareness activities directly influenced purchasing decisions, either immediately or over time. The campaign also increased the visibility of locally manufactured ICS in the market.

However, awareness alone did not guarantee sustained adoption. Household purchasing power remained a significant constraint, particularly for higher-performing technologies. Inconsistent product availability, weak last-mile distribution systems, limited after-sales support, and unclear information about where products could be purchased reduced the conversion of interest into long-term use.

These challenges reinforced an important lesson from the broader ReCIC intervention: demand creation and supply-side development must advance together. Behaviour change can stimulate demand, but lasting market transformation depends on households being able to access affordable, reliable, and higher-performing cooking technologies when they are ready to purchase them.

Experiential engagement builds trust more effectively than one-way messaging

One of ReCIC's key lessons was that households were more likely to trust and adopt improved cooking technologies after experiencing them first-hand. Cooking demonstrations and direct interaction with producers enabled consumers to better understand stove performance, fuel savings, and ease of use than one-way communication alone. Practical experience proved to be one of the strongest drivers of consumer confidence and informed purchasing decisions.

Communication strategies should reflect consumer behaviour

Selecting communication channels based on how target audiences access information can significantly improve the effectiveness and efficiency of awareness campaigns. ReCIC found that cost-effective channels such as radio and community-based WhatsApp groups often generated greater outreach and engagement than more resource-intensive television campaigns. Consistent messaging across government institutions, enterprises, and project partners further strengthened public confidence during Rwanda's transition towards higher-performing cooking technologies.

Demand stimulation must align with market readiness and enterprise engagement

Awareness campaigns were most effective when producers and distributors actively participated in community outreach, and consumers could readily access products. Direct interactions with enterprises shortened the pathway from interest to purchase. ReCIC demonstrated that generating demand alone was insufficient if enterprises



Lessons from the intervention

Consumer interest only translates into adoption when barriers to purchase are addressed

ReCIC demonstrated that creating consumer interest is only the first step towards market uptake.

and wider market systems were not equipped to respond. Coordinating demand-side activities with enterprise capacity, distribution systems, and retail networks proved essential for converting consumer interest into sustained market uptake.

11.4 Strengthening the enabling environment and quality assurance systems

As the cooking energy market evolved, the need for a credible quality assurance system became increasingly important. While enterprise development and consumer awareness were essential to market growth, neither could deliver lasting results without reliable mechanisms to verify product performance and support the implementation of standards.

In Rwanda, the Rwanda Standards Board (RSB) is mandated to develop and maintain standards for improved cooking technologies, undertake product testing and certification, and support the dissemination and implementation of quality requirements

Infobox | Why Testing Matters

Quality assurance systems help ensure that cookstoves perform as claimed and meet recognised standards for efficiency, emissions, durability, and safety. Reliable testing protects consumers from poor-quality products, enables producers to demonstrate compliance, and provides regulators with the evidence needed to enforce standards. In growing clean cooking markets, testing and certification play a critical role in building trust and supporting the transition towards higher-performing technologies.

within the sector. Although national standards (RS 290) and international standards (ISO 19867) were already in place for certifying cookstoves, the country's stove testing laboratory remained in its early stages of development. Limited equipment, constrained technical capacity, and insufficient staffing reduced its ability to provide timely and consistent testing services.



At the same time, Rwanda's policy shift towards higher-performing Tier 3+ cookstoves increased the need to strengthen product performance verification and support the effective implementation of national performance standards.

To address these challenges, ReCIC supported the strengthening of RSB's stove testing laboratory through a combination of infrastructure investment, technical capacity building, and institutional development. Working closely with RSB, the project strengthened the technical capacity of laboratory staff through structured training programmes aligned with international testing protocols. This improved compliance with ISO standards and enhanced the consistency, reliability, and credibility of testing procedures.

A comprehensive capacity assessment identified key operational gaps in laboratory infrastructure and equipment. Based on these findings, ReCIC supported the procurement of essential laboratory equipment, including a climate chamber and complementary testing instruments. The climate

chamber was particularly important, as it enabled standardised fuel conditioning, helping to ensure more accurate and comparable performance results across stove models.

Additional investments in spare parts and supporting equipment improved operational continuity and reduced downtime. Together with strengthened technical capacity and permanent staffing, these improvements reduced testing turnaround times from approximately six months to around three to four weeks. Over the course of the project, the laboratory evolved from a nascent facility into a credible and fully functioning national testing centre.

The strengthened laboratory generated benefits well beyond the testing facility itself. It enabled Rwanda to verify cookstove performance independently, support the implementation of national performance standards more effectively, and provide manufacturers with access to reliable in-country testing.



By 2025, the laboratory had gained increasing national, regional and international recognition. Positive feedback during ISO-related conferences and growing demand from neighbouring countries demonstrated confidence in the facility's capabilities, with producers from Burundi, the Democratic Republic of the Congo, Uganda, and Tanzania submitting their products for testing in Rwanda.

At the same time, growing demand for testing services highlighted a new challenge. As more producers sought product testing and certification, pressure on laboratory resources increased. Rising workloads, longer waiting times, and emerging capacity constraints underscored the need for continued investment in human resources, infrastructure expansion, and workflow optimisation to ensure testing capacity keeps pace with market demand.

Beyond strengthening the laboratory, ReCIC also contributed to broader institutional development within Rwanda's clean cooking sector. This included providing technical support for the development of Rwanda's Clean Cooking Compact in 2021, and placing an international expert within the Energy Development Corporation Limited (EDCL) to strengthen coordination, stakeholder engagement, and sector governance.

Together, these interventions demonstrated that market transformation depends not only on stronger enterprises and informed consumers, but also on capable institutions that provide credible testing systems, maintain standards, and support their implementation. By strengthening both the technical and institutional foundations, ReCIC helped establish key building blocks for Rwanda's long-term clean cooking transition.



Lessons from the intervention

Quality assurance combines laboratory testing with real-world evidence

Laboratory testing provides the foundation for assessing stove performance and verifying compliance with established standards. However, ReCIC demonstrated that laboratory results alone cannot fully capture how technologies perform under real operating conditions. Field experience highlighted that factors such as fuel quality, fuel moisture, and user practices can significantly influence stove

performance. Combining laboratory testing with field evidence therefore provides a more comprehensive understanding of technology performance and can better inform product development and consumer guidance.

Building quality assurance systems requires sustained institutional investment

Establishing a credible quality assurance system extends far beyond procuring laboratory equipment. ReCIC demonstrated that long-term functionality depends on continuous investment in skilled personnel, equipment maintenance, replacement parts, operational budgets, and internationally recognised accreditation processes. Sustainable financing and institutional commitment are therefore essential to ensure that testing and certification systems remain reliable as the market continues to develop.

Quality assurance systems must evolve alongside the market

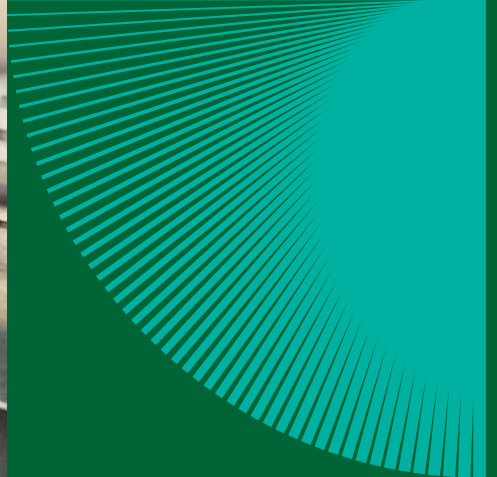
As technologies improve and markets mature, quality assurance systems must evolve with them. ReCIC highlighted the importance of regularly reviewing testing procedures, certification processes, and institutional capacities to ensure they remain responsive to changing market needs. Experience from Rwanda, complemented by exchanges with other countries in the region, further showed that complementary testing approaches, such as voluntary pre-testing facilities, could support product innovation while reducing pressure on national testing laboratories.

Quality standards create greater market impact when quality is visible to consumers

The introduction of performance standards encouraged manufacturers to improve product quality and invest in higher-performing technologies. However, ReCIC also demonstrated that standards alone are insufficient if consumers cannot readily distinguish higher-tier products from lower-quality alternatives at the point of sale. Making product quality visible through certification labels or other market transparency mechanisms can strengthen consumer confidence while creating stronger incentives for manufacturers to invest in quality.



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Success story

From test lab to the kitchen: how Rwanda is raising the bar for cookstoves

At the Rwanda Standards Board (RSB), people like Valentine Mukakamana play a critical role in building that trust. She helps test and evaluate cleaner, more efficient cooking technologies against recognised performance standards before they reach households across the country.

The water is boiling, and steam rises from the pot placed on a cookstove. With a concentrated look, Valentine watches the measuring device display, carefully weighs the filter papers and records the figures. Fine particulate matter below 218 milligrams per megajoule delivered and carbon monoxide below 7.2 grams per megajoule delivered – good values.

Valentine works as a technician in the cookstove testing laboratory of RSB, a government institution responsible for providing standards-based solutions for trade promotion and consumer protection. Today, she is testing the stove's fuel efficiency and

emissions performance. Before beginning the Water Boiling Test, Valentine conditions the fuel using the laboratory's fuel conditioning climate chamber. The chamber ensures that the fuel is maintained at the required moisture level – neither too wet nor too dry – which is important for the testing of particulate matter. By the end of the testing process, which takes approximately one week, she will have gathered enough data to answer a crucial question: Does the model meet the efficiency, emission reduction, safety and durability standards that the Government of Rwanda has set for all cookstoves?

These tests form an essential part of Rwanda's efforts to build a stronger and more performance-driven cooking energy market, ensuring that consumers, producers, and policymakers can have confidence in the technologies entering the market. The Government of Rwanda has committed to accelerating the transition towards

higher-performing cooking technologies. Under the Ministerial Guidelines for Clean Cooking Technologies, minimum performance requirements have progressively increased, with an emphasis on allowing only stoves with a minimum performance level of Tier 3 from January 2024 onwards. This means that the stoves must meet recognised standards and criteria with regard to efficiency, emissions, safety, and durability. At the same time, through the 'Made in Rwanda' initiative, the government continues to promote local production of cookstoves to create jobs and reduce dependency on imports.

The ReCIC Project supported Rwanda in this endeavour by working closely with the government and the RSB to lay the groundwork necessary for people and businesses to have long-term access to improved cooking technologies. Standards and certifications help build consumer trust, improve product quality, create opportunities for clean cooking businesses to access finance, and provide manufacturers with clear guidelines. Together, these systems create conditions for a more transparent, competitive, and quality-driven clean cooking sector.

Inefficient stoves not only consume more fuel and waste heat but also produce harmful smoke that poses health risks to cooks – predominantly women in Rwanda – and to children who spend time around cooking areas. Setting performance standards and strengthening testing capacity help ensure that only high-quality products enter the market. The RSB testing laboratory plays a key role in this process: it provides evidence that cookstoves produced in Rwanda meet these requirements.

Local test capacities for faster market entry

Valentine and her colleagues have now tested hundreds of different stove models. Testing a batch of six to 10 stove samples now takes about three to four weeks, compared with around six months before the laboratory was strengthened through ReCIC support. The project provided modern testing equipment, including precision scales, a climate chamber, and specialised measuring devices. It also supported the recruitment of permanent staff and strengthened technical capacity through training aligned with international testing standards.

► 'Before, we could hardly keep up; we had neither the right equipment nor enough staff to test all the stoves,' recalls Bernard Kabera, Director of the Material Testing Laboratories Unit at RSB.

Prior to the laboratory upgrade, manufacturers often had to send their stoves to Uganda for testing, resulting in high costs and lengthy waiting periods. With the modernisation of the laboratory, Rwanda now offers its own product testing and certification services. This has reduced barriers for local producers and improved access to testing and certification services, supporting the development and market entry of more efficient cookstoves.

The testing laboratory represents a crucial step forward in strengthening sustainable cooking solutions in Rwanda. Looking ahead, RSB aims to obtain accreditation under the International Organization for Standardization (ISO/IEC 17025), becoming the second accredited cookstove testing laboratory in the region after Uganda. Through policy support and close collaboration with RSB, ReCIC helped strengthen Rwanda's institutional capacity to implement national performance standards.

Today, the strengthened laboratory is increasingly recognised across the region, attracting testing requests from neighbouring countries and positioning Rwanda as an emerging centre for cookstove testing. More importantly, its impact extends far beyond the laboratory itself. Faster, more reliable testing helps local manufacturers develop improved products and comply with evolving standards, while providing institutions and policymakers stronger evidence to support standard implementation and sector development.

By strengthening Rwanda's national testing capacity, ReCIC helped establish one of the key institutional foundations needed to support the country's long-term clean cooking transition, while also ensuring that an increasing number of Rwandan households can switch to safe, more efficient, improved cookstoves. ■



11.5 Advancing institutional cooking solutions

While household cooking remains the primary focus of many clean cooking interventions, institutional cooking represents a significant yet often overlooked component of Rwanda's energy demand. Schools, hospitals, prisons, and other public institutions consume large volumes of biomass, resulting in high fuel costs, inefficient energy use, and challenging working conditions for kitchen staff. Addressing these high-consumption users is essential to achieving broader environmental, economic, and social benefits.

Institutional kitchens require specialised solutions that differ fundamentally from those used in households. Large cooking volumes, diverse meal preparation requirements, and complex kitchen layouts mean that standard household technologies cannot simply be scaled up for institutional use. Effective institutional cooking systems must be designed to operate safely, efficiently, and reliably under demanding conditions while meeting the practical needs of kitchen operators.

Recognising this opportunity, ReCIC adopted a practical, pilot-driven, iterative approach to designing, testing, and refining improved biomass cookstove systems under real operating conditions.

The pilot was implemented in collaboration with the Jumelage Rhineland-Palatinate Partnership at Groupe Scolaire Kabuga Catholique (GS Kabuga), a school serving 2,800 students daily. The site provided a realistic testing environment that reflected actual cooking practices, infrastructure constraints, and daily operational pressures. A new ventilated kitchen was constructed, and initial institutional stove models were installed for testing. Early results revealed significant technical and operational challenges. These included inconsistent fuel efficiency, overheating and equipment damage, uneven heat distribution, and high levels of smoke exposure in cooking areas. Rather than viewing these challenges as project setbacks, the pilot provided valuable evidence that informed the next stage of technology development.

Infobox | Why Institutional Cooking Matters

A single school, hospital, or prison can consume significantly more biomass than hundreds of households combined. Improving cooking efficiency in these institutions can therefore generate substantial fuel savings, reduce pressure on forest resources, improve working conditions for kitchen staff, and lower operating costs. Institutional cooking also provides an important opportunity to demonstrate clean cooking technologies at scale and generate lessons that can inform national policy and future investments.

ReCIC responded through an iterative design process. Stove designs were progressively modified based on user feedback and field performance. Local masons were trained to construct and adapt improved systems on site, while adjustments to combustion chamber design, construction materials, and ventilation systems – including the installation of chimneys – improved both performance and safety.

The upgraded 'Kabuga' stove models demonstrated substantial improvements compared with the baseline system, the Muvero stove. Fuel consumption declined, smoke emissions were reduced, and working conditions for kitchen staff improved.

Formal testing by the RSB classified the improved stove models as Tier 5 for carbon monoxide emissions and Tier 3–4 for thermal efficiency. These results demonstrated that well-designed biomass-based institutional stoves can achieve strong emissions performance while delivering measurable operational benefits under real operating conditions.

Beyond the technical performance of the stoves, the pilot generated important lessons for institutional cooking more broadly. It demonstrated the value of iterative technology development, user-centred design, and practical field testing in developing solutions that respond to operational realities rather than theoretical assumptions.



All photos © RVO/Makmende Media



Success story

A model for change: pioneering smoke-free kitchens for schools across Rwanda

How Kabuga Catholic School's shift to cleaner cooking is protecting health, cutting emissions, and setting a powerful example for schools nationwide.

In the kitchen where cook Onesphore and his colleagues prepare lunch for the 2,800 pupils of Kabuga Catholic School, the headteacher of a neighbouring school examines the large 500-litre pots filled with rice, beans and maize. What strikes him immediately is the air. It is clear. There is no thick smoke, no coughing, no stinging eyes, and no danger from glowing-hot stoves. The kitchen feels safe, efficient – almost peaceful.

This visit is not unusual. Principals from surrounding schools regularly come to Kabuga to see the 'smoke-free kitchen' and witness what the benefits of cleaner cooking can mean for their own schools.

The growing interest reflects a wider challenge. While household cooking often receives most attention within clean cooking initiatives, public

institutions, such as schools, consume large quantities of biomass every day. Improving cooking efficiency in these settings presents an important opportunity to reduce fuel consumption, improve working conditions, and lower emissions at scale.

Transforming the kitchen: less smoke, faster meals, and lower costs

Today, Kabuga's kitchen is safer, cleaner, and more energy-efficient than it was just a few years ago. Testing under both controlled and real institutional cooking conditions demonstrated significant reductions in fuel consumption compared to the previously used Muvero stove. Cooking times have reduced considerably, with Onesphore reporting a reduction of approximately 40 minutes in boiling time.

Most notably, the air quality in the kitchen has improved dramatically.

► ‘The smoke has reduced significantly, and we haven’t had any burn incidents since the new stoves were installed. We also use much less firewood now,’ says cook Onesphore proudly. Another cook adds, ‘These stoves cook well. They don’t burn food, the meals stay warm after cooking, and there’s no smoky taste.’

It was not always like this. Before 2021, the kitchen at Kabuga Catholic School was a scene of constant smoke and intense heat. The school relied on large and bulky Muvero stoves and open fires for cooking. Cook Onesphore recalls the thick smoke that filled the kitchen, leaving staff with watery eyes, persistent coughs, and painful burns from the hot metal surface of the Muvero stove or the open flames of the fires. The kitchen consumed about 4 m³ of firewood daily, costing the school more than USD 1,200 per month – a significant strain on its budget.

Change began when the ReCIC Project selected the school as a demonstration and learning site for institutional cooking. The goal was to reduce biomass consumption and harmful emissions while improving institutional cooking efficiency.

Challenges and lessons: from Kabuga 1.0 to 2.0

The first step of the intervention involved constructing a new, well-ventilated kitchen and installing two institutional stoves – one with a capacity of 500 litres and another with a capacity of 1,000 litres, known as Kabuga 1.0. Developed through a collaboration between the ReCIC Project and the Jumelage Rhineland-Palatinate Partnership, the stoves were designed to reduce firewood consumption, improve cooking efficiency, and lower smoke emissions.

However, early testing revealed several challenges. Excessive heat caused cracks in the cooking pots, melted the metal grates, and heat loss around the pots reduced cooking efficiency.

Based on the operational experience and feedback from kitchen staff, the system was progressively improved and re-engineered into what became known as Kabuga 2.0. The original 1,000-litre stove was replaced with two new, improved 500-litre models, giving the school three stoves in total. Internal vanes were added to improve heat

distribution, while in the absence of pumice stones local volcanic rocks were used in the combustion chamber because they are easier to maintain and replace if damaged. Kitchen staff also received training on stove operation and maintenance, and the school acquired a scale to monitor fuel consumption more accurately.

This iterative process of testing, learning, and redesign ultimately resulted in a more efficient, practical, and user-friendly cooking system.

Kabuga: a model for schools across Rwanda

The transformation is already delivering benefits for GS Kabuga Catholique. Savings from reduced fuel consumption are helping the school invest in better meal provision, while also easing financial pressure on parents, who previously had to contribute to firewood costs. Working conditions for kitchen staff have improved considerably, and the school has demonstrated that cleaner and more efficient cooking can be achieved without compromising the scale and reliability required for institutional meal preparation.

But the story does not end here. Kabuga demonstrates what more efficient institutional cooking can look like in Rwanda. Improved biomass systems can provide an effective transitional solution where infrastructure, energy supply, and affordability limit rapid fuel switching. The pilot shows how immediate gains in efficiency, emissions reduction, and working conditions can support institutions while contributing to the country’s longer-term clean cooking ambitions.

Most importantly, the experience shows that successful institutional cooking depends on dedicated solutions, continuous learning, and close engagement with users. By combining innovation with practical testing, Kabuga has become more than a successful school kitchen. It has become a model for how cleaner cooking solutions can improve health, protect the environment, strengthen livelihoods, and create a better learning environment for students — proving that small changes can spark lasting impact far beyond a single school. Above all, it demonstrates a scalable model that can be adapted and replicated in schools across Rwanda and beyond.



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Muvero Stove

Design: Bulky metal stove with a low fire chamber, limiting efficient heat distribution.

Fuel use and efficiency: The metal grate that holds the firewood burns out quickly and is rarely replaced, so wood is often burned with poor airflow, wasting fuel. The stove's design also prevents complete combustion, resulting in smoke and low efficiency.

Health risks and safety hazards: Thick smoke causes coughing, watery eyes, and respiratory problems, while hot metal surfaces and open flames lead to frequent burns.

Cost impact: High firewood consumption made school kitchens expensive to run.

Kabuga Stove

Design: Fixed, locally constructed stove made from local materials including fire bricks, cement, and volcanic rocks, with a chimney and stainless steel pot.

Fuel use and efficiency: Improved airflow, durable grates, and controlled heat flow across the pot bottom enable more complete combustion and efficient heat transfer. As a result, the Kabuga stove uses less fuel and cooks more efficiently (45 per cent thermal efficiency; Tier 4).

Health risks and safety hazards: Smoke exposure is minimal due to good ventilation and a chimney, improving air quality and reducing respiratory irritation, while fully enclosed combustion and cool outer surfaces help lower burn risks.

Cost impact: Testing data show that the Kabuga stove uses 19% less fuel per student than the Muvero stove. In addition, critical parts are either long-lasting or easy to replace, reducing maintenance costs.



Lessons from the intervention

Real-world testing is essential for technology development

Laboratory testing provides valuable performance data and remains essential for technology assessment. However, ReCIC demonstrated that piloting technologies under real operating conditions generates additional evidence that laboratory testing alone cannot provide. Observing stove performance over time in an institutional setting provides valuable insights into actual fuel consumption, operational challenges, and user practices, helping to refine the technology and build a more realistic understanding of its performance in practice.

Iterative and user-centred development leads to more effective solutions

One of ReCIC's key lessons was that institutional cooking technologies are unlikely to succeed through a single design cycle. Repeated testing, user feedback, and technical refinements proved essential for improving performance, durability, and usability. The project also demonstrated that technical performance alone is insufficient: technologies must fit kitchen infrastructure, cooking practices, maintenance requirements, and user needs. Engaging cooks and institutions throughout the development process enabled the project to identify practical challenges, adapt the technology, and improve its suitability for long-term use.

Scaling requires both local technical capacity and sustainable service models

Training local masons and technicians strengthened local ownership and reduced dependence on external expertise for construction, maintenance, and repairs. ReCIC also demonstrated that wider replication requires viable financing and maintenance models that enable institutions to invest, operate, maintain, and eventually replace technologies over time.

Across its interventions, ReCIC demonstrated that transforming Rwanda's cooking energy market requires more than improved technologies alone. Lasting market development depends on strengthening enterprises, stimulating consumer demand, building credible quality assurance systems, and supporting capable institutions through a coordinated market development approach.

While important challenges remain – including affordability, consumer financing options, fuel availability, and last-mile distribution – ReCIC established stronger foundations for future investment and market development. Continued collaboration between government, the private sector and development partners will be essential as Rwanda advances its broader clean cooking transition.



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Reflection

From connection to collaboration: building a financing model that could grow

Making improved cooking technologies available does not necessarily make them accessible. For many low-income households, upfront costs remain a significant barrier, while local companies often lack the capital and systems needed to offer and manage consumer financing themselves.

To test an innovative approach to this challenge, ReCIC facilitated a partnership between Safer 1 Ltd, a producer and distributor of improved cookstoves, and MoneyPhone, a Dutch–Rwandan fintech company licensed by the National Bank of Rwanda (BNR) that provides digital finance to smallholder farmers and rural entrepreneurs. By combining Safer 1's technology and distribution expertise with MoneyPhone's digital financing model and rural customer network, the partnership explored how higher-tier cooking technologies could be made more accessible and affordable to low-income households in rural areas.

Beyond facilitating stove purchases, the collaboration generated valuable insights into consumer financing, customer outreach, and repayment mechanisms. EnDev spoke with Marthe Paauwee, CEO of MoneyPhone, and Christine Muhongerwa, CEO of Safer 1 Ltd, about how the partnership evolved, the challenges it addressed, and the lessons it generated for longer-term market-based approaches with the potential for broader replication and scale.

From shared challenge to complementary strengths

Before ReCIC brought the two companies together, Safer 1 and MoneyPhone had never worked together. Yet each was addressing a different part of a closely connected challenge.

Safer 1 develops improved cookstoves for low-income households but faced challenges related to affordability and last-mile access. Offering customers instalment payments required capital that the company did not have, while managing repayments placed an additional burden on its operations.

Christine Muhongerwa from Safer 1 Ltd recalls:

► 'We explored financing options, such as instalment payments, but providing credit requires significant capital, which we did not have at the time. In addition, following up with customers on repayments was very resource intensive.'

MoneyPhone, meanwhile, was already providing digital agricultural loans to underserved rural customers and wanted to broaden its financing offering to include technologies that could improve their livelihoods.

Marthe Paauwee from MoneyPhone reflects:

► 'For us, integrating green solutions had been a goal for a long time. Our clients are highly vulnerable to climate shocks, so we wanted to

support not only their farming activities but also their daily lives, while promoting solutions that are better for the environment. The partnership with Safer 1 aligned very well with this objective.’

ReCIC provided the connection between the two companies and helped establish the trust needed to explore a joint approach. The partnership also enabled them to define clear and complementary roles.

As Marthe explains:

- ▶ ‘A key factor is that we each focus on our core strengths: MoneyPhone on financing and Safer 1 on technology and distribution.’

The innovation: making finance work for both sides

Drawing on this new partnership, MoneyPhone integrated stove financing into its existing loan structures. Customers could repay the cost over time, while Safer 1 received payment upfront.

For Safer 1, this removed one of its biggest constraints: the company no longer needed to finance customers from its own working capital or manage repayment collection itself.

Christine reflects:

- ▶ ‘MoneyPhone pays us upfront, which improves our cash flow and allows us to scale. Customers repay over time, so the model works for both sides.’

The collaboration extended beyond financing. MoneyPhone worked through selected cooperatives, providing financial literacy training and helping members navigate the digital loan process, while Safer 1 simultaneously conducted cooking demonstrations. Combining finance with practical product engagement helped households better understand both the technology and how they could pay for it.

The partners also observed an unexpected social dimension that brought men and women into the same sessions. Women were often drawn to discussions around cooking technologies, while men engaged more strongly with financial literacy. Bringing both into the same sessions created opportunities for shared learning and more balanced household decision-making.



Christine Muhongerwa



Marthe Pauwee

For the two companies, the experience reinforced a simple but important principle: financing works more effectively when it is connected to trusted customer networks, practical product experience, and partners with clearly defined roles.

From collaboration to market opportunity

The partnership generated benefits for both businesses. Safer 1 expanded its customer base, improved its cash flow and reached low-income households that had previously been difficult to serve. MoneyPhone broadened its product offering and strengthened its relationships with rural clients.

Customers, meanwhile, gained an alternative to paying the full cost of a stove upfront. The partners reported reductions in fuel use and household expenditure, alongside time savings and reduced exposure to smoke.

However, the collaboration also revealed the limits of what a partnership alone can solve. Access to affordable capital remains a major constraint on scaling consumer finance.

Marthe reflects:

- ▶ ‘Access to affordable capital remains critical for scaling. It is also important to find reliable private-sector partners who share the same target group and values.’

For Christine, finance and last-mile access remain closely connected:

- ▶ ‘Access to finance is key for local companies. Affordable loans and strong last-mile distribution are essential to reach low-income households.’

The experience therefore showed that a viable partnership model can address important barriers, but wider scale still depends on financing conditions

and market systems that allow businesses to serve lower-income customers sustainably.

As Marthe explains:

- ‘It is important to integrate solutions into existing financial products. Combining cost-saving technologies with income-generating loans creates a very strong and sustainable model.’

Looking ahead

Perhaps the strongest indication of the partnership’s value is that it continued beyond the intervention that brought the two companies together.

For Christine, the goal is to reach more households and continue scaling the distribution of clean cooking solutions, particularly among low-income communities. She explains:

- ‘The model has proven to be very successful, and we are already seeing growing interest from other partners. We are currently in discussions with other organisations to explore how we can replicate and expand this approach.’

Building on lessons from ReCIC and with further support through EnDev, MoneyPhone began developing a similar financing approach for other green technologies, starting with solar-powered irrigation systems under EnDev’s PURE.Ag Project. (Read more about the PURE.Ag Project, page XX).

For Marthe, the key was not to begin with scale, but first to test whether the model worked:

- ‘What is important for us is that we always start small, test the model, and build a strong proof of concept. Now that we have demonstrated that the model works – both from an impact and a business perspective – we are in a good position to scale and attract further partners and investment.’

What began as an introduction through ReCIC therefore evolved into something broader: a practical model for connecting technology providers, financing partners, and underserved customers. Its longer-term value lies not only in facilitating access to improved cookstoves, but also in the lessons generated on how partnerships can test, adapt, and transfer financing approaches across different technologies and markets. ■

Safer 1 Ltd

Safer 1 Ltd develops and distributes improved cooking solutions for low-income households. Its solution combines an energy-efficient cookstove with a heat-retention thermo box, reducing fuel consumption and the need for constant supervision during cooking.

The technology helps households reduce firewood expenditure, save time, and limit exposure to smoke and open-fire risks. By reducing the time spent collecting fuel and monitoring cooking, it can also free up time for other household and income-generating activities.

Key offering: Improved cookstoves | Heat-retention cooking | Last-mile distribution

MoneyPhone

MoneyPhone is a Dutch–Rwandan fintech company providing digital finance to smallholder farmers and rural MSMEs. Its fully digital platform uses customer data and AI-based credit scoring to assess borrowers and provide collateral-free loans through mobile technology, with approval and disbursement typically completed within three to five days.

Working through farmer cooperatives, MoneyPhone combines digital lending with financial literacy support and repayment schedules aligned with agricultural cycles. Its model can integrate productive investments, such as agricultural inputs, with technologies that reduce household costs or strengthen livelihoods.

12 Sustainable eCooking Access to Leverage Electricity Uptake in Rwanda (SCALE.up) Project

Building the evidence and market for electric cooking in Rwanda



12.1 Turning electricity access into cleaner cooking

Rwanda has made substantial progress in expanding electricity access, reaching 88.4 per cent as of July 2026. However, average household electricity consumption remains low, at approximately 17 kWh per month – only slightly above the heavily subsidised lifeline tariff threshold. This low consumption affects the financial sustainability of electricity provision and limits the wider socio-economic benefits that electrification can deliver. Household demand also varies considerably throughout the day, remaining relatively low during daytime hours before rising intermittently to peak levels in the evening.

At the same time, 76.1 per cent of households continue to rely on traditional biomass – charcoal and firewood – for cooking.¹⁹ In urban areas, the Fifth Rwanda Population and Housing Census found that 50 per cent of households relied on charcoal and 34 per cent on firewood. The effects extend beyond household expenditure. Smoke from traditional cooking fuels contributes to indoor air pollution and associated health risks, particularly for women

and children, while continued demand for biomass places pressure on forest resources.

Electric cooking – or eCooking – offers an opportunity to address these challenges while increasing the use of Rwanda’s electricity infrastructure. In urban and peri-urban areas, it has the potential to provide a cleaner, safer and more convenient alternative to charcoal and liquefied petroleum gas (LPG). By increasing household consumption, eCooking can also strengthen the customer base of the Rwanda Energy Group (REG), thereby supporting utility revenues. Moreover, switching from biomass to electricity can reduce household exposure to cooking-related smoke, ease pressure on forest resources, and support Rwanda’s wider clean-cooking and climate ambitions, including those advanced through the Global eCooking Coalition (GeCCo).

Yet, eCooking remains at an early stage of market development, with only around 1 per cent of Rwandan households using electricity as a cooking fuel. Upfront appliance costs, limited financing, concerns about electricity prices, and low consumer awareness have constrained uptake.

19. Ministry of Infrastructure, *Energy Sector Strategic Plan 2024–2029* (Kigali: Government of Rwanda, 2024). ↗

Distributors also face restricted access to working capital, limited appliance availability, and gaps in after-sales support.

A further constraint was the lack of comprehensive evidence from real-world market conditions. Previous research had largely relied on small-scale trials involving selected groups of households or hypothetical scenarios. While these studies provided important baseline information, policymakers, utilities and investors had limited evidence about actual consumption, fuel substitution, household purchasing decisions, and the effectiveness of different incentives under market conditions. This evidence was essential for designing scalable interventions.

The EnDev Sustainable eCooking Access to Leverage Electricity Uptake in Rwanda (SCALE.up) Project was designed to address this evidence gap. It tested market-based approaches to accelerating eCooking adoption and reducing fuel stacking while generating comprehensive, real-world data on consumption, household behaviour and cost dynamics under market conditions. The project also examined how financial incentives, consumer awareness, and policy engagement could support wider adoption.



12.2 Testing eCooking under real-world market conditions

The SCALE.up Project was funded through the final Netherlands Enterprise Agency (RVO) Innovation Window for EnDev and was implemented by GIZ between September 2024 and June 2026. The project was designed as a holistic, market-based pilot to test and validate the feasibility of expanding eCooking under real-world market conditions.

The project targeted urban and peri-urban households in 11 districts selected for their high use of, and expenditure on, charcoal and relatively stable grid access: Gasabo, Kicukiro, Nyarugenge, Kamonyi, Muhanga, Ruhango, Bugesera, Rwamagana, Kayonza, Musanze and Rubavu.

SCALE.up was implemented in close partnership with the Ministry of Infrastructure (MININFRA), the Rwanda Energy Group (REG), the Rwanda Utilities Regulatory Authority (RURA), the Kigali Collaborative

Infobox | Why eCooking matters

eCooking connects two national priorities: expanding access to clean cooking and making greater use of Rwanda's electricity infrastructure. It reduces household exposure to cooking smoke, saves time, eases pressure on biomass resources, and increases electricity consumption.

Realising these benefits, however, depends on affordable appliances, reliable electricity, informed consumers, and a supply chain capable of meeting demand.

Research Centre (KCRC), district authorities, and private-sector actors. Solektra Rwanda Ltd and Sun Alliance Ltd participated as appliance distributors. This collaboration connected household-level implementation with market development and national policy discussions.

The project combined three mutually reinforcing components: results-based financing (RBF) for metered appliances, gender-responsive consumer awareness activities, and policy-oriented research. Together, these components allowed SCALE.up to test household demand for eCooking and assess the market and institutional conditions required for wider adoption.

Lowering the entry barrier through RBF

RBF formed the core of the intervention. Households could purchase an induction stove or electric pressure cooker at a subsidised price. Solektra also offered payment by instalment (PAYGo), further reducing the entry barrier for interested households. Importantly, the intervention retained a market-based approach: households selected their appliances, made their own purchasing decisions, and contributed towards the cost of appliances. This approach strengthened ownership while making the appliances more accessible.

A performance-based rebate was implemented to encourage households to adopt eCooking appliances. Under the scheme, households received

a rebate of RWF 105 (around EUR 0.07) for each kilowatt-hour (kWh) of electricity consumed by the eCooking appliance during cooking. The rebate was disbursed over a period of up to six months and calculated from metered usage. Its value was equivalent to the prevailing lifeline tariff for the first 15 kWh consumed each month. Participating companies transferred the rebate to households through reductions in PAYGo payments or direct cash transfers.

The primary purpose of the rebate was to stimulate behavioural change by addressing perceived operating-cost barriers and encouraging the adoption of eCooking as a viable and economical alternative. Participating distributors received a modest supply-side incentive to offset the technology and administrative costs associated with metered appliances and usage verification.

Using metering to understand household behaviour

The electricity consumed by eCooking appliances was monitored through embedded or tamper-resistant external meters. This enabled the project to calculate usage-based rebates accurately while generating real-time data on cooking-related electricity consumption.

The limited availability of metered appliances in the Rwandan market initially delayed implementation. In response, Sun Alliance Ltd developed a locally produced external metering solution, which was subsequently validated by the Rwanda Standards Board (RSB). This expanded the range of appliances that could participate in the pilot and generated practical experience in adapting monitoring systems to the Rwandan market.

Building confidence through practical demonstrations

Financial incentives alone could not address the widespread perceptions that cooking with electricity was expensive, unsuitable for Rwandan food or intended principally for women. SCALE.up therefore combined the intervention with gender-responsive awareness campaigns and live cooking demonstrations in the target districts.



All photos © GIZ

The demonstrations allowed households to compare cooking times, energy use and costs while seeing familiar dishes prepared using electric appliances. Particular attention was given to foods requiring two to five hours of cooking, such as beans and isombe (ground cassava leaves), which many consumers believed could not be prepared effectively with electricity. Electric pressure cookers proved especially relevant for these longer-cooking foods. However, the maximum six-litre capacity of available cooking pots was identified as a constraint for some Rwandan households, whose average size is approximately four people.

Campaign messages were carefully designed to be gender-responsive, targeting both women and men

as household decision-makers. Male allies and role models participated in cooking demonstrations to challenge established gender norms, encourage men's participation in household cooking, and present eCooking as a practical household technology rather than one intended only for women. District, sector and cell authorities, women's councils, and private-sector entities supported mobilisation and helped the project reach potential consumers through trusted local structures.

Generating evidence for policy and market development

SCALE.up developed a comprehensive eCooking study to assess electricity consumption, fuel substitution, affordability, and the implications of different electricity tariff options. REG's Research and Development Department led the study with technical support from KCRC, strengthening institutional ownership of the research process and its findings.

The analysis drew on a survey of 724 eCooking and non-eCooking households, device-level metering, and electricity meter prepayment data. It examined the effect of the usage-based rebate, changes in biomass consumption, and the technical implications of scaling eCooking within the existing electricity system.

Rather than prescribing a single tariff model, the study assessed several options and their respective trade-offs. Its findings provided MININFRA, REG, and RURA with real-world market evidence to inform future deliberations on electricity pricing, consumer support, and grid readiness.

Translating evidence into consumer communication

The project used the research findings to develop a Consumer Information Campaign Strategy built around three core message pillars.

- What is the real cost? This pillar addresses misconceptions about the cost of eCooking through messages such as 'Cooking with electricity likely costs less than you think.'
- What can you eCook? This pillar demonstrates the versatility of eCooking appliances for Rwandan meals, including longer-cooking staples, and addresses concerns that electric

Infobox | How the eCooking RBF worked

Upfront incentive: Reduced the purchase price of an induction stove or electric pressure cooker.

Household contribution: Maintained consumer choice and ownership of the appliance.

Usage-based rebate: Rewarded verified electricity consumption over a period of up to six months.

Supply-side support: Helped distributors meet the additional costs of metering, administration, and reporting.

- appliances cannot prepare traditional dishes.
- How can you obtain a device? This pillar explains available purchasing and financing options that can help households overcome upfront cost barriers.

The strategy proposed visual campaigns through posters and billboards, conversational approaches through radio infomercials and roadshows, and partnership campaigns integrating public- and private-sector promotion at points of sale. By grounding its messages on real-world market data, this strategy is being shared among key government and implementing partners. As EnDev's support drew to a close, SCALE.up handed the strategy over to its partners for continued use.

Learning through regional exchange

SCALE.up also facilitated an exchange between Rwandan stakeholders and counterparts from Kenya, Uganda, and Ethiopia. A study visit to Kenya provided an opportunity to compare approaches to appliance markets, awareness-raising, tariff design, and policy development. This exchange offered a valuable regional perspective and was particularly relevant given the growth of eCooking across the region: although the participating countries operate under different market conditions, their experiences can inform one another's strategies and approaches for advancing the eCooking sector.



12.3 Results and evidence for wider adoption

SCALE.up generated tangible results and important insights across household behaviour, market, data, institutional and policy dimensions, validating its role as an important contributor to Rwanda's eCooking transition.

Evidence of household demand and changing cooking practices

The project generated evidence of substantial latent demand for eCooking. Among non-participating households surveyed as part of the eCooking study, approximately 54 per cent expressed interest in adopting the technology. This indicated that the main barriers to adoption were economic and informational rather than rooted in fundamental resistance to the technology. Misconceptions about cost were particularly significant, accounting for more than 60 per cent of the concerns raised about eCooking.

Convenience, speed, and safety were the principal reasons households gave for adopting an eCooking appliance. Both participating and non-participating households generally perceived eCooking as safer than charcoal or LPG. Women also identified time savings as an important benefit.

The study findings challenged previous assumptions about the persistence of fuel stacking. Among adopters, 42 per cent – principally users of induction stoves – reported fully transitioning to electricity for cooking while retaining other fuels only as a backup during power interruptions. This was particularly remarkable because earlier studies conducted under non-market conditions had found that households generally continued to stack fuels, shifting only about one-third of cooking events to electricity.

The project also demonstrated the suitability of electric appliances for preparing Rwandan staple foods. Electric pressure cookers successfully prepared longer-cooking staples such as beans and isombe, addressing an important concern among potential consumers and supporting greater fuel substitution.



The project also observed changes in household gender dynamics. Men’s participation in cooking increased among some adopting households, while women consistently highlighted convenience, safety, and time savings. Although these observations were anecdotal, they indicate that eCooking has the potential to influence how cooking responsibilities are shared within households.

These findings were also shared with stakeholders from Kenya, Uganda, and Ethiopia through the project’s regional learning activities, positioning Rwanda as a leader in eCooking evidence generation.

Stronger evidence for public-sector decision-making

SCALE.up generated Rwanda’s first comprehensive market-based dataset on eCooking behaviour, electricity consumption, fuel-substitution rates, and household cost considerations. Before the electricity tariff adjustment introduced in October 2025, average monthly appliance consumption ranged from approximately 31 to 41 kWh for induction stoves and from 33 to 55 kWh for electric pressure cookers. Following the tariff adjustment, consumption declined among users affected by higher tariffs and had not stabilised by February 2026. The available data therefore indicated possible price sensitivity, although longer-term analysis would be required to determine whether the decline was temporary or sustained.

MININFRA and REG recognised the KCRC tariff study as an important contribution to ongoing policy deliberations. By moving beyond a narrowly defined tariff roadmap to include actionable consumer messages and stakeholder communication channels, the study supported ongoing policy dialogue and provided REG with evidence-based materials to promote eCooking adoption.

The study also identified characteristics of the early-adopter market. Demographic analysis showed that early adopters were generally between 35 and 44 years old, while more than 60 per cent had attained tertiary education. These findings point to the need for future interventions to reach younger and lower-income households more deliberately.

Infobox | What the eCooking tariff study found

- Consumer interest in eCooking existed, but appliance prices and electricity costs remained central concerns.
- Households valued the convenience, speed, and safety of eCooking.
- Forty-two per cent of adopters reported transitioning fully to electricity for cooking.
- No single tariff option addressed every policy objective without trade-offs.
- Appliance financing and reliable consumer information are at least as important as tariff support.

Strengthened distributor experience

The project strengthened the practical experience of participating distributors in appliance sales, consumer engagement, and usage monitoring. Sun Alliance developed a locally produced external meter that was validated by RSB and expanded its presence in the emerging eCooking market. Solektra benefited from the consumer demand and market insights generated by the project, which could inform future initiatives, including Rwanda’s first large-scale eCooking carbon project under Article 6 of the Paris Agreement.

Tariff changes reinforced the importance of affordability

In October 2025, the Government of Rwanda introduced an electricity tariff adjustment that was independent of SCALE.up and not specifically focused on eCooking. Yet, it indirectly made eCooking more attractive for low-consumption households by increasing tariffs for medium- and high-consumption users while raising the lifeline consumption threshold.

This change demonstrated the sensitivity of eCooking adoption to electricity prices. It also showed that tariff measures can be considered as an instrument alongside appliance financing, energy-efficient cooking practices, consumer information, and broader grid-planning requirements.



12.4 Lessons for scaling eCooking interventions

Market-based purchasing supported sustained use

The project's per-kWh rebate had little discernible effect on household behaviour. Substantial reductions in fuel stacking among households appeared instead to be attributable to the fact that they independently selected and contributed towards the cost of their appliances. Forty-two per cent of participating households reported fully transitioning to eCooking.

This experience suggests that market-based promotion of eCooking may be the key driver for large-scale behavioural change. Households' purchasing decisions and their own payments consistently fostered ownership, underscoring the importance of sensible subsidy designs that avoid over-subsidising. When households contributed to appliance costs, they demonstrated better care for the devices and more consistent usage.

Demand creation must be matched by a functioning supply chain

Awareness activities generated consumer interest, but working capital emerged as a critical bottleneck. Solektra's limited access to inventory financing prevented it from importing additional appliances and contributed to stock shortages. As a result, demand could not always be converted into sales, leaving some interested households unable to purchase appliances, creating frustration and lost opportunities. This demonstrated that consumer interest alone cannot expand the market unless distributors can finance and maintain readily-available stocks.

Rwanda's location and relatively small domestic market compounded this challenge. Long import routes increased lead times and transport costs, while purchasing appliances in foreign currency and earning revenue in Rwandan francs exposed distributors to exchange-rate risks.

Future projects should therefore assess distributor stocks, import schedules, and financing needs before launching large consumer campaigns. Blended-finance mechanisms, such as revolving funds or partnerships with financial institutions, could help distributors manage import cycles and foreign-currency exposure, while expanding their distribution networks.



'I think that, in the next five to ten years, we will see many more people using eCooking technology. But successful adoption is not only about the technology itself. It is also about understanding consumers' needs and behaviours, managing expectations, and staying close to customers at every step of the journey.'

– Alain Harelimana
Solektra Ltd

Metering should serve a clearly defined purpose

Metering generated valuable data and enabled usage-based rebates, but it also increased appliance costs and delayed implementation because suitable metering technologies were not readily available. Sun Alliance's development of a locally validated solution eventually helped address this constraint, but the experience highlighted the need to balance the value of detailed consumption data against the cost and complexity of collecting it.

This assessment may change with further market developments, as remote monitoring technologies become more widely available and affordable. Until then, metering should be used where it answers a specific programme or policy question – not as a default requirement for every eCooking intervention.

Consumer communication must begin with cost and cooking experience

Concerns about electricity costs accounted for more than 60 per cent of the issues raised by surveyed households, despite evidence that eCooking could be cost-competitive. Awareness campaigns

should therefore lead with clear and credible cost comparisons. Practical tools, such as cost calculators used during roadshows or radio programmes, can make these differences easier for consumers to understand.

Live demonstrations are equally important and are most effective when they feature longer-cooking foods. Many households continued to stack fuels when preparing food such as beans and isombe, because they doubted whether electric appliances could cook them effectively. Prioritising electric pressure cooker demonstrations for such meals and directly addressing fuel-specific misconceptions became crucial for driving full substitution and addressing concerns about whether eCooking can replace biomass fuels. Solektra is also exploring the introduction of an induction-compatible pressure cooker to address this constraint for induction-stove users.

Gender-responsive outreach can broaden household ownership

Gender-responsive campaigns demonstrated the value of engaging women and men through targeted approaches, as introducing eCooking into households can challenge established gender norms. Anecdotal evidence indicated that men participated more in cooking after eCooking was introduced, while women consistently identified time savings as a key benefit. These findings support parallel campaigns for women and men, using male allies and role models to normalise men's involvement in cooking.

Group structures also provided effective entry points. Women's councils and savings groups showed particularly strong interest in eCooking. Partnering with these organisations through group-guarantee arrangements can help reduce affordability barriers while strengthening women's roles as decision-makers in the adoption process.



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Tariffs and non-tariff measures both influence adoption

Tariff sensitivity emerged as a major consideration. Following the October 2025 tariff increase for medium- and high-consumption users, eCooking consumption declined and had not stabilised by February 2026. Further analysis would be required to determine whether this was a temporary or sustained effect. This demonstrates the importance of factoring price elasticity into tariff design. Options could include time-of-use tariffs or off-peak discounts for eCooking, although research suggests that cooking demand may be difficult to shift to different times of day.

The eCooking study found that each of the four tariff models evaluated carried significant trade-offs. Untargeted consumption blocks could benefit households that did not use electricity for cooking; appliance-metered rebates required smart or separately metered devices; and separate metering increased costs. No single tariff mechanism could simultaneously guarantee affordability, accurate targeting, and administrative simplicity.

Still, non-tariff interventions proved equally, if not more, important than tariff changes. Appliance financing and consumer information campaigns can play a critical role in driving adoption. The upfront cost of appliances, combined with misconceptions about the operating costs of eCooking, remains a key barrier to wide-scale adoption.

Scaling requires attention to grid readiness

As eCooking expands alongside other electricity uses, including e-mobility and productive-use appliances, questions about grid capacity and reliability are becoming increasingly important. Targeted grid assessments and demand-management measures will be essential to identify potential pressure points and prevent supply constraints from undermining consumer confidence and adoption.

Public-private coordination strengthens implementation

Collaboration among government institutions, district authorities, researchers, and private companies connected policy analysis with practical market experience. Local government involvement also strengthened community mobilisation and gave awareness campaigns greater credibility.

Infobox | The Global eCooking Coalition (GeCCo)

GeCCo was founded by the anchor partners EnDev, Modern Energy Cooking Services (MECS), Sustainable Energy for All (SEforAll) and the Global Energy Alliance for People and Planet (GEAPP) to support a large-scale transition to eCooking. EnDev and

SEforAll facilitated the Government of Rwanda's engagement with GeCCo and worked closely with key partners in the Coalition. SCALE.up was Rwanda's first project funded and implemented explicitly as a contribution to GeCCo.



‘GeCCo Secretariat greatly values the leadership and collaboration of the EnDev Rwanda team, whose close engagement with the Government of Rwanda was instrumental in supporting Rwanda’s letter of intent to join GeCCo.

Rwanda’s strong electricity access, commitment to quality standards, and growing awareness of e-waste management together create an enabling environment for the transition to eCooking. These foundations position Rwanda as an ideal country to help demonstrate how clean electric cooking can be scaled sustainably and effectively.’

– Alicia Butterfield
Global Manager, GeCCo Secretariat,
Modern Energy Cooking Services (MECS),
Loughborough University

Institutionalising these partnerships could support sustained outreach and community mobilisation, allowing future programmes to combine national policy direction with local outreach, private-sector delivery, and continuous learning from household data. Complementary initiatives can also reinforce one another by expanding the appliance market, increasing consumer familiarity, and reducing the risks associated with introducing a new technology.



12.5 The SCALE.up Legacy: Why This Project Matters

SCALE.up was not simply another pilot. It was Rwanda's first comprehensive, market-based test of eCooking at scale, generating unprecedented evidence to inform policy, market development, and investment decisions. Its distinct contribution rests on three pillars.

First, SCALE.up generated data for evidence-based decision-making on a scale not previously achieved in Rwanda. For the first time, the country has real-world data on eCooking consumption, fuel-substitution rates, and cost dynamics under market conditions. The findings challenge the persistent perception that eCooking is unaffordable and establish a robust baseline for future interventions. In particular, the eCooking study provides MININFRA, REG, and RURA with practical evidence to inform the development of scalable and financially sustainable eCooking policies suited to Rwanda's context.

Second, the project catalysed market development with the potential for lasting impact. By revealing latent demand – with 54 per cent of non-participants expressing interest in acquiring an eCooking appliance – SCALE.up demonstrated that consumer interest exists and can be activated through the right combination of measures.

Third, the study provides an important reference point for future policy decisions. REG and KCRC now have the evidence and analytical tools to advocate more effectively for the inclusion of eCooking in national energy-planning processes, supporting its validation and integration into the National Integrated Clean Cooking Plan and Tool.



‘Working alongside EnDev Rwanda through the Global Electric Cooking Coalition (GeCCo) has been a valued partnership and learning experience for the Solar-Electric Cooking Partnership (SOLCO) Rwanda.

As the host of GeCCo in Rwanda, EnDev has created an important space for coordination, evidence sharing, and practical reflection on how electric cooking can become accessible, affordable, reliable, and scalable for households.

EnDev's experience in advancing clean cooking access, including results-based financing approaches in refugee settings, has also provided valuable lessons for designing inclusive and scalable clean cooking models.

For SOLCO Partnership Rwanda, this collaboration has been highly complementary, helping bridge national eCooking learning with practical implementation pathways for refugee-hosting districts and last-mile communities. Beyond convening partners, EnDev has helped strengthen sector collaboration, build confidence in eCooking solutions, and shape a clearer pathway toward sustainable clean cooking adoption and scale in Rwanda.'

– Pauline Cyiza
SOLCO Partnership Rwanda Lead and Climate Action Partnership Manager, Last Mile Climate



Success stories

When the kitchen changes, family life changes

Six households are finding more time, better health, greater peace of mind and a fairer sharing of responsibilities through eCooking

In six Rwandan households, a quiet change is taking place around the daily preparation of meals. Electric pressure cookers and induction stoves are replacing much of the charcoal, firewood and LPG that families once depended on. Kitchens are becoming cleaner and safer, household expenses are falling, and meals are taking less time to prepare.

But the change is not only about the technology. Liberate is finding renewed energy for her business. Joselyne is becoming more involved in activities beyond her home. Esperance and Gaston are enjoying a more comfortable retirement. Joseph is encouraging everyone around him to cook. Daphrose is feeling more at ease about her

children's safety, while Jerome is discovering that he genuinely enjoys preparing meals.

Their circumstances are different, but each family is finding that a change in the kitchen can gradually change life throughout the household.

Liberate is finding time to dream again

In Kicukiro District, Liberate Nyirahabineza and her husband, Emanuel Kamere, are both in their 40s. Liberate runs a small informal business distributing charcoal stoves, while Emanuel works as a carpenter. They are raising their family in a home where cooking with firewood and charcoal previously filled the kitchen with smoke and left soot on the walls.

The smoke was affecting the family's health, particularly that of the children, who were experiencing persistent coughs. Cooking was also taking much of Liberate's time and energy, leaving her tired and with little time for her children or other business activities.

When a sales agent first introduced electric cooking, Liberate was sceptical. She wondered whether it would work well and whether the family could afford it. Since acquiring an electric pressure cooker and an induction stove through SCALE.up, however, the family's experience has changed her mind.

The smoke-related coughing has subsided and Liberate estimates that the household is now spending around half as much money on cooking fuel as it did before. She has also gained nearly ten additional hours each week—time she now devotes to her family and her business.

► 'Before, I was always tired,' she reflects. 'Now, I have time to dream and work towards a better future for my family.'

Today, Liberate is no longer simply trying a new appliance. She is an advocate for eCooking – a new way of cooking that has given her back some of the time, health, and energy she felt she had lost.

Joselyne is making room for life beyond the kitchen

Joselyne Uwase is a 28-year-old mother living with her husband, Jean Pierre, and their young child in a peri-urban neighbourhood of Gasabo District. Jean Pierre works in retail in the motorcycle sector, while Joselyne is balancing the demands of caring for their home and child.

Before adopting eCooking, the family relied on charcoal and LPG. Smoke and dust were part of cooking, as was the risk of burns from an open flame. Preparing the family's meals consumed much of Joselyne's time and left her with little energy for other activities.

► 'It was exhausting,' she recalls, 'and it limited my productivity every day.'

At first, Joselyne doubted that an induction cooker could prepare everything the family normally ate. As she continued using it to prepare breakfast, lunch,

and dinner, those doubts gradually disappeared. Jean Pierre is also helping with the cooking at weekends, making meal preparation a more shared part of family life.

With less time tied to the kitchen, Joselyne is exploring income-generating activities and participating in a women's savings group in her village. The change is giving her greater room to engage with opportunities outside her home. However, she notes that some neighbours remain unconvinced that electricity can cook food as effectively as charcoal or firewood. Because cooking practices are deeply shaped by cultural norms, Joselyne believes that further awareness-raising is needed to challenge these perceptions.

► 'We as husband and wife took the decision together, and now, eCooking has changed my life for the better.'

Esperance and Gaston are enjoying a gentler retirement

In Muhanga District, Esperance and Gaston Mudakengerwa are a retired couple in their 60s. Cooking with charcoal and LPG was costing them around RWF 30,000 each month and becoming increasingly physically demanding. Established household roles also meant that Esperance carried most of the responsibility for cooking, while Gaston rarely entered the kitchen.

The couple first heard about electric pressure cookers at one of the roadshows organised by local authorities as part of the SCALE.up intervention. The subsidised price caught their attention, but the appliance's simplicity was equally important: cooking in the traditional way was becoming more tiring as they grew older.

Since beginning to use the electric pressure cooker, their cooking expenses have fallen by around half. Preparing meals requires less physical effort, and the couple is finding more time and energy to care for their grandchildren and enjoy their retirement together.

One of the more unexpected changes is who is now cooking. Because the appliance is easy to operate, Gaston and the boys are helping in the kitchen, a space that they seldom entered before. Although

the family keeps a small amount of charcoal as a backup during power interruptions, electricity has become its principal means of cooking. Looking ahead, the couple sees solar energy as a potential solution to ensure uninterrupted eCooking.

As Esperance reflects:

- ▶ ‘eCooking is a healthier system that changes lives. Without it, we would miss out on the development and comfort it brings to our household.’

For Esperance and Gaston, that comfort is being felt in practical, everyday ways: lower expenses, less strenuous work, and more family members willing to prepare a meal.

Joseph is making cooking everybody’s business

Elsewhere in Muhanga District, Joseph Kabundi is a 60-year-old private consultant and business trainer living in a household of seven. Before the family adopted eCooking, the household was spending between RWF 25,000 and RWF 45,000 each month on charcoal and LPG. Those costs affected the money available for other priorities, including education, healthcare and insurance.

Joseph first encountered an electric pressure cooker when an electrician demonstrated how it worked. Intrigued, he began researching the technology and later learned about the subsidised appliances offered through SCALE.up and Sun Alliance.

The family now prepares meals more quickly and without smoke. The household’s cooking expenses have fallen substantially, and the cooker’s automated operation is making it easier for different household members to use the appliance.

For Joseph, however, the most meaningful change is not simply financial. He is preparing meals himself and encouraging women, men, children and even visitors to learn how to operate the appliance. Cooking is gradually becoming a household responsibility rather than work assigned principally to women.

As he states:

- ▶ ‘Cooking is no longer just a woman’s duty; it’s a family effort.’

Daphrose is cooking with greater peace of mind. In Kamonyi District, 43-year-old photographer Daphrose Nyiraminani lives with her husband, André Misago, a pastor, and their children. The family previously cooked with both charcoal and LPG. LPG was fast but expensive, difficult to obtain in their peri-urban neighbourhood and a source of concern in a home with children. Charcoal took longer and left the kitchen dusty and uncomfortably hot.

- ▶ ‘Cooking used to be stressful, costly, and unsafe for our children,’ recalls Daphrose.

Since the family began cooking with electricity, they prepare meals indoors without smoke, an open flame, or excessive heat. Cooking has become faster and less costly, but the biggest change for Daphrose is the reassurance it brings.

The appliance is also simple enough for other family members to use. As more of them get involved in preparing meals, Daphrose no longer carries the entire responsibility herself. The family is gaining time and comfort, while she is gaining something harder to measure: greater peace of mind.

Jerome is discovering the pleasure of cooking

For 52-year-old public servant Jerome Gasore, eCooking is changing a long-established household habit. He lives with his wife and their three children in Gasabo District, where the family previously depended on charcoal. It had seemed more affordable and safer than LPG in a home with young children, but preparing breakfast before work and school was slow and frustrating.

After hearing about eCooking from friends, Jerome and his family decided to try it. He had previously shown little interest in preparing meals, but the appliance’s speed and simplicity have changed his relationship with cooking.

► ‘Since we switched to electric cooking, we have been impressed by how fast, convenient, safe, and clean it is—and now even I enjoy cooking.’

Jerome is now becoming an enthusiastic participant in a task he once regarded as somebody else’s responsibility. For his family, the new appliance is not simply making cooking faster; it is helping turn meal preparation into something more family members can share—and even enjoy.

Six households, many forms of progress

The changes unfolding in these six homes are not identical. Yet, together, their experiences show how an everyday technology can touch different parts of family life. As the households continue using eCooking, they are spending less time around smoke and open flames, saving money, pursuing work and community activities and reconsidering who prepares the family’s meals.

The change is beginning in the kitchen, but it is not staying there. ■



CONCLUSION

Impact Continues

As EnDev concludes its engagement in Rwanda, one message stands out: impact continues. Operational activities may be drawing to a close, but the knowledge, partnerships, institutions, and market structures developed over the years will remain part of Rwanda's energy-access landscape. Government institutions, private-sector actors, development partners, and other programmes will continue to build on the approaches tested and the lessons learnt.

Looking ahead, the foundations are in place for further progress: financing models, stronger quality standards, improved institutional capacities, and more robust market mechanisms. This publication recognises the invaluable contributions of the many partners involved and documents the experience that can support future policy, programming, and investment. EnDev's lasting value lies not only in the projects implemented, but also in the vital knowledge generated, the systems strengthened and the approaches that others can continue to adapt and scale.

Aligned with Rwanda's priorities

Since its early engagement in 2006 and the official launch of its country portfolio in 2009, EnDev has supported Rwanda's efforts to expand reliable and sustainable energy access through market-based

and inclusive approaches. Its work remained closely aligned with national energy-sector priorities and adapted as Rwanda's policies, institutions, and markets evolved.

This included responding to the ministerial guidelines for solar and clean cooking technologies, while also contributing practical evidence to their development – most notably by promoting the adoption of VeraSol and Lighting Global standards for off grid solar products and quality driven approaches in clean cooking. EnDev's relevance to Rwanda's broader development and climate agenda is reflected in its contributions to achieving the Energy Sector Strategic Plan (ESSP), and the National Strategies for Transformation (NSTs), as well as in its support for Rwanda's nationally determined contributions (NDCs) through emission-reducing cooking solutions and renewable-based electrification.

Coherence with other programmes and sector actors remained central throughout implementation. EnDev's results-based financing (RBF) mechanisms and market-building approaches were pioneering in Rwanda and informed national scale-up. The Pro Poor RBF model was subsequently adopted and expanded by the World Bank, the Development Bank of Rwanda (BRD), and the Energy Development Corporation Limited (EDCL) as part of a nationwide framework. Similar approaches

were later extended to clean cooking and productive uses of energy (PUE).

EnDev also coordinated with complementary initiatives to avoid duplication and strengthen collective results. Through the EU co-financed ReCIC Project, for example, EnDev worked alongside the national clean cooking RBF programme to strengthen stove quality. The RBF4R Project, meanwhile, complemented the Sweden funded Renewable Energy for Refugees Phase II (RE4R II) initiative in displacement settings.

From market growth to deeper inclusion

Rwanda's energy access landscape evolved rapidly during EnDev's implementation period, particularly in the electricity sector. EnDev contributed to this national trajectory by stimulating early market growth through large scale, quality assured RBF mechanisms, and by demonstrating scalable delivery models that could be adopted or replicated by other actors.

As national electrification programmes expanded and access rates increased, EnDev's final implementation cycle shifted from volume towards depth. Greater priority was given to last-mile households, underserved market segments, and structural barriers, including limited access to finance and the difficulty of delivering services in harder-to-reach areas. Although this strategic shift resulted in lower headline numbers than in earlier implementation periods, it produced important institutionalisation and market-level effects.

The programme generated robust evidence on the performance of RBF mechanisms in humanitarian and displacement settings and established viable financial models for solar irrigation that provide a foundation for further implementation beyond the project period. In the clean cooking sector, EnDev supported the transition from artisanal towards more professional and semi industrial production. Building on earlier work by partners such as SNV and the AVSI Foundation, the ReCIC Project strengthened the technical and managerial capacities of stove producers, improved product quality, and supported nationwide distribution.

In electrification, technical standards introduced through EnDev-supported RBF mechanisms were taken up by government institutions, anchoring product quality and consumer protection to this day. Grid densification pilots implemented jointly with Rwanda Energy Group (REG) placed particular emphasis on last mile customers – predominantly poor and marginalised households, including many women headed households. These interventions combined physical connections with awareness, targeting and affordability support, providing a practical model for advancing universal electrification in an inclusive way.

Delivering value through practical systems

Rwanda's relatively small market and landlocked geography limited economies of scale, resulting in implementation costs slightly above the wider EnDev benchmark. At the same time, strong public-sector engagement supported timely, well-governed delivery and enabled close coordination with national systems.

EnDev employed a combination of lower cost interventions, including solar home systems and improved cookstoves, and more capital-intensive measures, such as mini grid development support and targeted grid densification. In the latter case, the programme designed an RBF mechanism based on standardised cost proxies for clusters of households located just beyond the national 37 metre connection subsidy radius. This created a relatively simple, administratively light, and cost effective instrument for extending connections and facilitating energy access for underserved households.

The programme also developed tools that continue to generate efficiency gains beyond individual projects. These include the RBF Eligibility Tool and the Off grid Monitoring Information System, both of which draw information from, and feed information into, national databases. The tools were handed over to government counterparts and remain in use years after their development. By supporting more efficient targeting, verification and reporting, they have reduced administrative costs while strengthening the quality and consistency of programme data.

Strengthening markets, livelihoods, and evidence

EnDev's market building interventions contributed to employment and income generation across energy supply chains and among end users. Jobs were created in stove production and distribution, solar-product retail and other energy-related services. Productive-use interventions also helped enterprises convert energy access into economic activity. These ranged from AVSI Foundation's support to entrepreneurs in mini grid locations to women led microbusinesses in displacement settings, including kiosks and barbershops.

Awareness campaigns on clean cooking, quality-assured solar products, and solar irrigation helped households and enterprises make informed purchasing and investment decisions. They also contributed to greater willingness to pay for reliable, efficient, and higher-quality technologies.

EnDev strengthened the wider enabling environment as well. Through ReCIC, support to the Rwanda Standards Board (RSB) expanded national testing capacity and reinforced the development of a quality oriented cooking-energy market. Technical verification and systematic data collection across projects also produced evidence that could inform the sector beyond EnDev's own implementation.

This was particularly significant in the field of eCooking. An in-depth study of household eCooking behaviour and electricity consumption produced Rwanda's first market based estimate of the total addressable eCooking market. Partners recognised this evidence as an important input for future planning, policy discussions, and investment decisions.

As with many RBF programmes, the availability of incentives sometimes attracted opportunistic grant seeking behaviour. EnDev addressed this risk through clear standards, independent verification, and requirements for quality after-sales services. These measures supported the emergence of a broader and more competitive supplier base while reinforcing accountability to consumers.

Anchoring capacity for the future

Follow-up visits to selected EnDev supported sites indicate that many supported enterprises remain operational and that some have expanded. This points to effects that extend beyond the period of direct programme support.

A central element of EnDev's approach was to anchor knowledge and capacity within the public institutions and private actors responsible for continuing the work. This included transferring stove designs and quality-control protocols, strengthening grid densification targeting methods, and building the operational capacity required to administer RBF mechanisms. Institutional capacity was strengthened within partners such as EDCL and RSB, while private sector firms developed stronger technical, managerial, and commercial capabilities.

Long-term financial sustainability nevertheless remains a challenge in parts of the energy-access ecosystem. Affordability constraints continue to affect both businesses and end users, particularly where technologies require relatively high upfront investment. EnDev therefore tested innovative financing approaches intended to broaden access, including the MoneyPhone digital loan model. The model is expected to be extended to additional user groups, increasing access to finance for energy-related purchases.

Recognising that knowledge can easily be lost during programme phase out, EnDev placed particular emphasis throughout its implementation on embedding tools, processes, and responsibilities within organisations that will remain active in the sector. The programme also engaged with emerging and continuing platforms, including the developing United Nations joint programme on clean cooking, to encourage the integration of EnDev's standards, evidence, and lessons into successor activities.

The combination of institutionalisation, private sector capacity development, and targeted financial innovation provides a sound basis for continued progress. It also highlights areas in which further public- and private-sector engagement will be required for the full long-term impacts of energy access to be realised.

Priorities for the road ahead

Sustaining and deepening the gains achieved will require continued attention to private sector development and inclusive delivery models. The approaches may differ by technology and market segment, but the underlying priorities remain closely connected: stronger businesses, better access to finance, informed consumers, reliable infrastructure, and services that reach those most at risk of being left behind.

For eCooking, local suppliers will require targeted business-development support and improved access to finance. Consumers will also need appropriate financing options, continued awareness-raising and behaviour-change efforts, and practical information that addresses concerns about appliance costs, electricity consumption, and cooking practices. These efforts must be accompanied by infrastructure readiness so that emerging electric cooking solutions can be adopted reliably and at greater scale.

In the higher tier cooking market, demand creation and behavioural change must progress alongside improvements in production. Manufacturers and distributors need the capacity to increase quality, expand availability, and reduce costs in ways that better reflect households' ability to pay. Quality assurance will remain essential to protect consumers and sustain confidence in the market.

For micro, small and medium-sized enterprises transitioning towards productive uses of energy, further development of innovative financing mechanisms will be critical. Farmers, barbers, kiosk owners, and other entrepreneurs often recognise the economic value of energy technologies but remain constrained by upfront costs and a lack of suitable lending conditions. Financing designed around enterprise cash flow and production cycles can turn energy access into a stronger engine of local economic growth.

Within the grid-electrification sector, inclusive project design should continue to distinguish between the availability of a connection and households' ability to access and use it. Last mile

and vulnerable households will require targeted measures that address affordability, internal wiring, awareness, and other barriers on the path towards universal electrification.

Off-grid and mini-grid markets will also require continued private-sector support. Improving the financial sustainability of mini-grids remains important, particularly in smaller or remote markets where operating costs are high, and demand may develop slowly. More reliable after sales service networks are equally necessary to ensure that households with off grid systems remain connected and continue to receive the full benefits of modern energy services.

A foundation for continued progress

Together with Rwanda's public and private partners, EnDev leaves behind stronger markets, more capable institutions, practical evidence and lasting opportunities. These results demonstrate that inclusive, quality driven energy access can power development long after a project has ended.

The next phase of Rwanda's energy transition will not depend on technology alone. It will require continued investment in institutions and businesses, sustained attention to affordability, behavioural change, stronger gender responsiveness, and delivery models that ensure that all Rwandans can benefit, particularly those from vulnerable and underserved populations. The systems and partnerships built over the past two decades provide a foundation for that work – and for Rwanda's continued progress towards universal access to sustainable energy solutions.

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