The Lab
Global Innovation Lab for Climate Finance

Solar Securitization for Rwanda

LAB INSTRUMENT ANALYSIS
September 2019

DESCRIPTION & GOAL

A tradable asset-backed security that helps solar developers de-leverage their balance sheets, supporting the expanded installation of solar home systems, increasing energy access.

SECTOR

Sustainable energy access

PRIVATE FINANCE TARGET

Local institutional investors and foreign investment funds in the initial phase. Subsequently, crowdfunding with retail investors through mobile banking.

GEOGRAPHY

For pilot phase: Rwanda
In the future: Other East African countries

The Lab identifies, develops, and launches sustainable finance instruments that can drive billions to a low-carbon economy. The 2019 Global Lab cycle targets four specific sectors across mitigation and adaptation: blue carbon in marine & coastal ecosystems; sustainable agriculture for smallholders in West and Central Africa; sustainable energy access; and sustainable cities.

AUTHORS AND ACKNOWLEDGEMENTS

The authors of this brief are Felipe Borschiver and Amanda Lonsdale.

The authors would like to acknowledge the following professionals for their cooperation and valued contributions including the proponents: Winnie Mutesi and Ivan Asiimwe (The Development Bank of Rwanda), Benjamin Nykariega (independent consultant), Adam Connaker and Clare Boland Ross (The Rockefeller Foundation), Abyd Karmali (BoAML), Kiyoshi Okumura (IFC), Andreas Arvanitakis and Alfred Helm (UK BEIS), Andreas Lunding (GCF), Jonathan First (DBSA), JP Moscarella (Climate Finance Advisors), Kome Ajeba (IFC), Hubert Ruzibiza and Teddy Mugabo (FONERWA), Charlotte von Moellendorff (BMU).

The authors would also like to thank Ben Broche, Barbara Buchner, Elysha Davila, Valerio Micale, Angela Woodall, and Maggie Young for their continuous advice, support, comments, design, and internal review.

The Lab's 2019 programs have been funded by the Australian, Dutch, German, and UK governments, as well as Bloomberg Philanthropies, GIZ, the International Fund for Agricultural Development (IFAD), the Rockefeller Foundation, and the Shakti Sustainable Energy Foundation. Climate Policy Initiative serves as Secretariat and analytical provider.

1. CONTEXT

Solar home systems are a reliable and economical off-grid solution for East Africans without energy access. A securitization instrument has the potential to rapidly increase market penetration of these systems.

Currently 185 million people in East Africa do not have access to electricity, relying on high-cost and carbon intensive diesel generators or hazardous kerosene lamps. Considering current grid extension and population growth trends, this number will reach 286 million by 2030. In 2017, energy access rates in the region ranged from only 9% in Burundi, to 64% in Kenya, with an average of 60% (World Bank, 2019).

Increasing clean energy access can not only decrease harmful emissions, but also improve health, employment, economic development, gender equality, safety, and education. Off-grid solutions like solar home systems offer a clean, reliable, and affordable energy solution for homes in East Africa. However, while substantial resources have been deployed in the region, it is estimated that around US$ 11 billion of mini-grid and solar home system investments would still be required to provide energy access for all (Shell Foundation, 2018).

About 80% of off-grid solar investments in East Africa have been made by grant or concessional sources (Shell Foundation, 2018). Subsidized capital is often needed to kick-start "inactive markets" (markets with no presence of solar developer, for example). On the other hand, "active markets", such as Rwanda, Tanzania, Kenya and Uganda require a more market-oriented approach. However, in most of these countries, grant and concessional capital have likely been crowding-out private investments, preventing further market growth. This underscores the need for financially sustainable instruments, which may include some early stage form of credit enhancement, but that present a concrete pathway to commercial viability.

In addition, although sales of off-grid solar products have been increasing significantly, they are still constrained by the customers' inability to make upfront payments. Therefore, to unlock energy access in East Africa, developers must be able to provide financing alternatives for solar home systems. This financing is, in turn, dependent on the developers' access to debt capital, which is limited by collateral requirements from banks and other funders. A securitization, which allows developers' loan portfolios to be used as collateral instead of cash, would fulfill these requirements, allowing solar developers to obtain capital to expand their sales, meeting the clean energy access needs of African households.

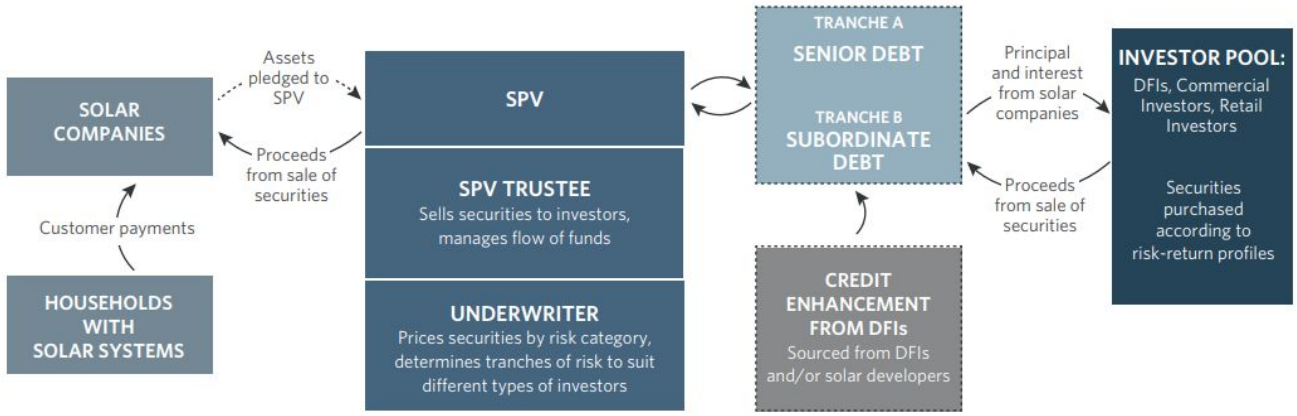
CONCEPT

2. INSTRUMENT MECHANICS

Solar Securitization for Rwanda is an initiative that pools loans from multiple solar developers into a tradable, asset-backed security, freeing up capital for expanding the solar home system market.

Solar Securitization for Rwanda utilizes securitization approaches that have been successfully applied in the solar sector in the United States and East Africa to a multi-originator platform. It aims to deepen the pool of available investment for solar developers, and accelerate the cash flow from their loans, enabling solar home systems to reach new homes more rapidly. The following diagram shows an overview of the process.

Figure 1: Instrument mechanics



The key steps and actors involved in the instrument include:

Step 1: Eligible loans from the solar home companies are pooled into a special purpose vehicle (SPV).

- ✓ Solar developers: the developers pledge some or all of their assets to a Special Purpose Vehicle (SPV)
- ✓ SPV Trustee: The trustee oversees the establishment of the SPV and the process for pledging the loans to the vehicle
- ✓ Legal counsel: Counsel will design and develop the documentation to establish the structure, work to identify and mitigate any legal or regulatory issues, and ensure that the structure is legal and has a clear process for investment and repayment, determining the waterfall of payments, etc.

Step 2: Loans are underwritten, priced, and divided into tranches. In the initial design, the instrument will be split into two tranches, with Tranche 1 being sold to investors, and Tranche 2 serving as a subordinated, first loss facility to provide downside protection to the senior tranche.

- ✓ Underwriter: Once the loans are pledged to the SPV, the underwriter performs due diligence, assesses risk, determines eligible loans, identifies and prices debt tranches. The underwriter also advises on the size and terms of the credit enhancement (subordinate tranche) based on historic and projected default rates.
- ✓ Ratings agency: If deemed necessary, a ratings agency will provide a credit rating for the instrument to be used in pricing and sales.

Step 3: The tranches are marketing and sold to investors.

- ✓ SPV Trustee: The Trustee will manage the process of marketing and selling the tranches
- ✓ Legal counsel: counsel will oversee the documentation of investments
- ✓ Development Finance Institutions (DFIs): DFIs will be needed to provide the first loss credit enhancement (subordinate tranche)

- ✓ Other investors: Commercial investors and DFIs will be the most likely buyers of the senior tranche

Step 4: Repayment and servicing.

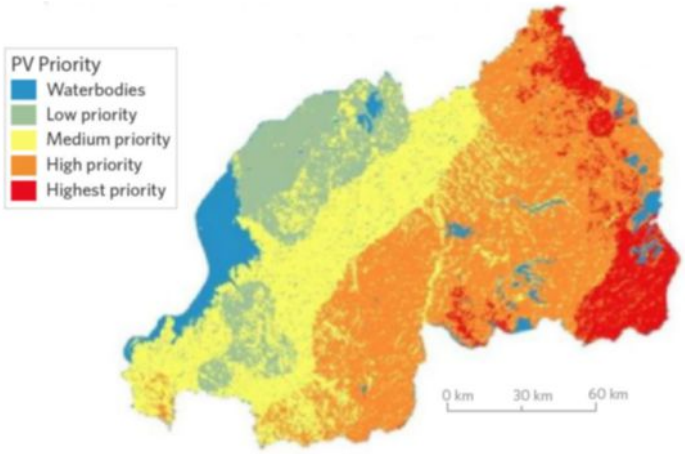
- ✓ SPV Trustee: The Trustee will oversee the flow of funds from the sale of the security to the solar developers, as well as the funds from repayment of the solar loans to the investors.

2.1 TARGET GEOGRAPHY: RWANDA

Only 34% of Rwanda's population of nearly 13 million have access to the national energy grid (and only 12% of the rural population). The remaining 66% are either cut off from energy access entirely or make use of expensive and carbon intensive diesel generators or kerosene lamps. To address this situation, the Rwandan government has laid out a national target of 100% energy access by 2024. Since developing a country-wide energy distribution network would not be feasible or cost-effective, this is being addressed mainly through off-grid solutions such as micro hydropower, solar, and methane generation.

With very high solar irradiance levels (over 2400 kWh/m2), Rwanda has favorable climate conditions for solar energy generation and a largely rural population (single-family units with high availability of area for solar). Rwanda is also one of the top East African countries in the "Doing Business" ranking by the World Bank Group (ranked 41 compared to a 114 East Africa average). The Solar Securitization instrument was proposed by the Development Bank of Rwanda (BRD), a government institution with a strong national and regional presence.

Figure 2: Priority solar areas in Rwanda



Source: NASA, 'Rwanda Agriculture & Energy'. (2013)

3. INNOVATION

Solar Securitization for Rwanda will be the first solar securitization initiative in East Africa to pool loans from multiple solar companies. It will enable solar developers to leverage their balance sheets and expand installations of solar home systems.

3.1 BARRIERS ADDRESSED: ATTRACTING PRIVATE CAPITAL AND INCREASING SOLAR DEVELOPERS' ABILITY TO LEVERAGE THEIR BALANCE SHEETS

Solar Securitization for Rwanda is an instrument designed to attract private capital to the solar home system market in Rwanda, with potential for scale-up in East Africa. It overcomes persistent financing barriers in the solar home system market, particularly solar developers' limited access to capital for market expansion, and high interest rates on solar home system loans.

Barrier Addressed	Description	Strategy
High collateral requirements from existing solar funders	Existing credit lines require up to 1.25x cash collateral for lending, while solar companies are often undercapitalized	Securitization alleviates the need for cash collateral
Solar companies carry their loan portfolios in their balance-sheets	Customer loans are paid over 2-5 years, with the outstanding balances being carried as assets in the solar companies balance sheets	Securitization provides off-balance sheet debt, increasing the companies ability to leverage
Access to credit is limited to local markets	Solar companies are funded by local credit lines and funds	Securitization enables solar companies to tap more liquid capital markets
High interest rates on loans (18-20%)	A non-standardized and illiquid market leads to high interest rates on solar loans	Once the initial set-up costs are paid for, subsequent issuance tend to carry cost-competitive interest rates

3.2 INNOVATION: FIRST SECURITIZATION IN EAST AFRICA TO ADDRESS MULTIPLE SOLAR DEVELOPERS

Currently, the major financing options for solar developers in Africa are either bank loans or through a non-bank entity focused on providing capital for renewable energy companies. Each of these instruments are included in Table 1 below.

There is another solar securitization initiative in East Africa: the BBOXX Distributed Energy Asset Receivables (DEARs) instrument in Kenya. However, in addition to being a small issuance, it was limited to the loan portfolio and product offerings of the company. Solar Securitization for Rwanda is the first solar securitization initiative in East Africa to pool loans from multiple solar companies.

Table 1: Instrument comparisons

Similar Instruments	Description	Differentiation
I&M Bank and BPR (Atlas Mara)	18-20% interest rate p.a. with 24 months maturity, and high cash collateral requirement	High collateral requirement and interest rates
SunFunder	Debt financing for residential, C&I off-grid solar ($250K-$5M directly to solar companies)	Loans sizes may be too large for Rwanda market high collateral requirement

Similar Instruments	Description	Differentiation
BBOXX DEARs	Similar securitization initiative based on BBOXX loan portfolio. Size was KES 52M (~$500K). Class A Notes yield 4.18%, Class B 5.58%	Focused on Kenya and limited to BBOXX's portfolio/products

3.3 CHALLENGES TO INSTRUMENT SUCCESS

Two main challenges need to be mitigated to ensure instrument success.

Complexity. An asset-backed security that pools the loan portfolios of multiple companies will be more complex than standard securitization initiatives and may present a challenge to underwriting and structuring.

However, the instrument mechanics include standardizing contracts and product warranties, as well as providing a credit enhancement mechanism on the initial offerings, which will help mitigate the risk associated with this complexity. As loans become more standardized and a loan performance track-record is obtained, the underwriting complexity, pricing, and need for credit enhancement should all decrease. The Lab has had discussions with a number of experts familiar with the solar home system space in East Africa and sub-Saharan Africa, which indicate that products and contract terms across solar developers are already quite similar, so may not require significant changes.

Market size. Another potential challenge is that the Rwandan market is still small - approximately US$ 18 million in total loans at present, and the costs associated with a securitization structure can be substantial. This implies that without significant blended capital, the initial offerings may be too small to be economical.

However, after its initial phase, the instrument could serve as a template to grow the market in Rwanda well beyond its current size. At Rwanda's current level of electrification (34%), if solar home systems are able to reach just 25% of those currently off the grid (~8.5 million people) with a system financed through a US$ 50 loan, this represents a market size of around US$ 100 million.

This "template" instrument also has the potential to be replicated throughout East Africa, where a number of the largest solar developers in Rwanda already have significant presence. Future instruments will be able to take advantage of the best practices, intellectual property and funding sources previously developed, with appropriate strategies for foreign exchange management.

MARKET TEST AND BEYOND

4. IMPLEMENTATION PATHWAY AND REPLICATION

The pilot offering will be around US$ 9 million, targeting the largest solar home companies in Rwanda, providing a template for replication across East Africa

The initial offering of Solar Securitization for Rwanda will be approximately US$ 9 million, targeting the largest solar home companies in Rwanda, and will be led by the Development Bank of Rwanda.

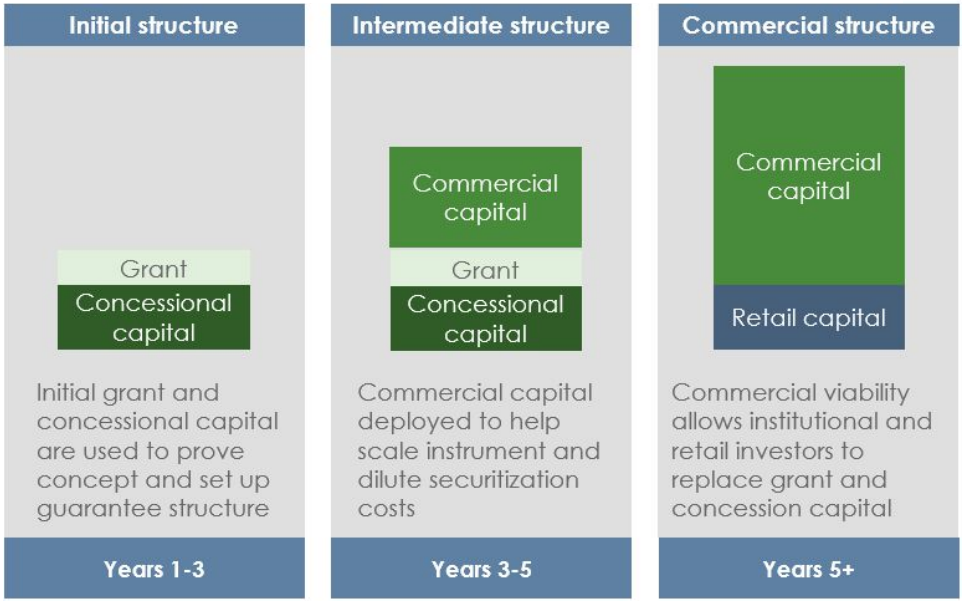
The instrument involves a number of actors and processes to convene the team, establish the initial structure, value the portfolio, and secure the credit enhancement. The implementation pathway of the instrument is as follows:

- **Design:** The design of the legal structure is expected to take 6 months and involve a legal counselor and a trustee.
- **Creation of SPV:** Once the structure is set up, an SPV will be established to manage the security.
- **Underwriting:** Next, an underwriter will begin an evaluation of the existing portfolio of solar home system loans, according to the pre-determined underwriting standards and risk-allocation methods. This should take another 3 months and will result in the pricing and trenching of the offering.
- **Rating:** Next, a ratings agency will likely provide individual ratings for the senior tranche, a process that will take 1 month.
- **Issuance and distribution:** Finally, the distribution efforts for the asset-backed security should take up to 6 months.

Section 4.1 below provides additional information on the progress to-date in convening the team to implement the securitization.

The capital base of the instrument will evolve with subsequent issuances, with concessional capital and grants providing a basis for the initial implementation and credit enhancement structure. Once a proof of concept has been established, commercial capital will be included to help scale the instrument and spread securitization costs across a larger capital base. Finally, grant and concessional capital will be phased out and retail investors will be brought in to diversify the investor base. Retail

Figure 3: Implementation pathway and timeline



investors will be using a mobile platform to buy and sell the securities. The administration costs of subsequent offering will be incremental.

4.1 IMPLEMENTATION PARTNERS

Key implementers for a standard securitization include a trustee, a ratings agency, legal counsel, and a donor or DFI to provide the credit enhancement. The Lab has identified several implementers to be a part of the team to structure, sell, and manage the securitization:

- **Oversight and sales:** The Development Bank of Rwanda (BRD) is the proponent of the instrument and will convene the partners, work with the underwriters, counsel, and trustee, and help to market the instrument to investors. BRD is a 50-year old institution with an extensive track record in energy finance.
- **Legal counsel:** Hogan Lovells LLP has agreed to provide pro bono legal services to structure the instrument
- **Trustee:** MTC Trust & Corporate Services Limited (MTC) from Kenya has been contacted and discussions are in progress to be the Trustee of the instrument
- **Ratings agency:** Global Credit Ratings Co. (GCR), an African ratings agency has been contacted and discussions are in progress to do the rating of the instrument and tranches
- **Credit enhancement:** The Development Bank of Southern Africa (DBSA) and the International Finance Corporation (IFC) have been contacted about providing a credit enhancement. Further discussions with these entities and others are required.

4.2 PILOT IMPLEMENTATION CHALLENGES

Key challenges to implementing the pilot are outlined in the table below.

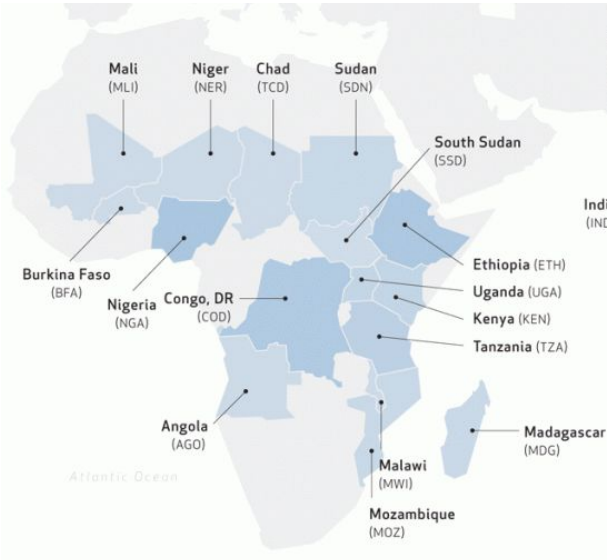
Challenge	Description	Solutions
Lack of standardization across developers	A lack of standardization across solar companies for contract terms, product offerings, maintenance, and warranties add complexity to the underwriting process.	• The underwriter and proponent will work with developers to develop more standardized offerings. • The credit enhancement facility will provide protection against unforeseen risks resulting from this challenge. • Future issuances will apply learnings from the pilot.

Challenge	Description	Solutions
Foreign exchange	The underlying assets of the securitization will be denominated in RWF, so a hedging facility is required to mitigate currency fluctuations in USD or EUR denominated issuances. Costs for such a facility may be too high for a small pilot issuance.	• The Lab has contacted the Multilateral Investment Guarantee Agency (MIGA) and the Currency Exchange Fund (TCX), both of which provide FX hedging services for emerging market currencies. • DFIs or other emerging market investors will likely have their own internal hedging facilities. • As the instrument grows, the cost of these FX hedging services will be reasonable compared to the instrument size.
Obtaining loan data	The Lab has been encountering challenges in obtaining essential information on loans and portfolio performance from solar companies, mainly due to their confidentiality concerns.	• The Lab has obtained data from the largest company in the sector (representing 36% of the market) has already provided the basis for our quantitative analysis. • The Lab is validating its assumptions with market experts (donors, solar associations, investors, etc.).
Funding implementation costs	Identifying funders to support the implementation costs, such as legal and registry fees, and trustee and ratings agency retainers, might be a challenge considering the innovative nature of the instrument.	• The Lab has secured pro bono counsel for the instrument. • The potential Trustee has been providing considerable pro bono advice in advance of a paid engagement. • Other donors will be needed to fund remaining costs for implementation and startup.

4.3 REPLICATION AND SCALE-UP

After its initial phase, the instrument has the potential of being replicated across the East African region, where energy access rates still average 60% in countries with healthy 5-6% per capita GDP growth rates. The large majority of East African countries are included in the Sustainable Energy for All (SEforALL) Heat Map (see Figure 4) that highlights the countries with most pressing needs in terms of electrification. Moreover, many other sub-Saharan countries have the same needs and could be targeted in the later phases of the instrument, which are expected to take place in 3-5 years.
The main barriers for replication outside of Rwanda are the specific regulatory and taxation frameworks of East African

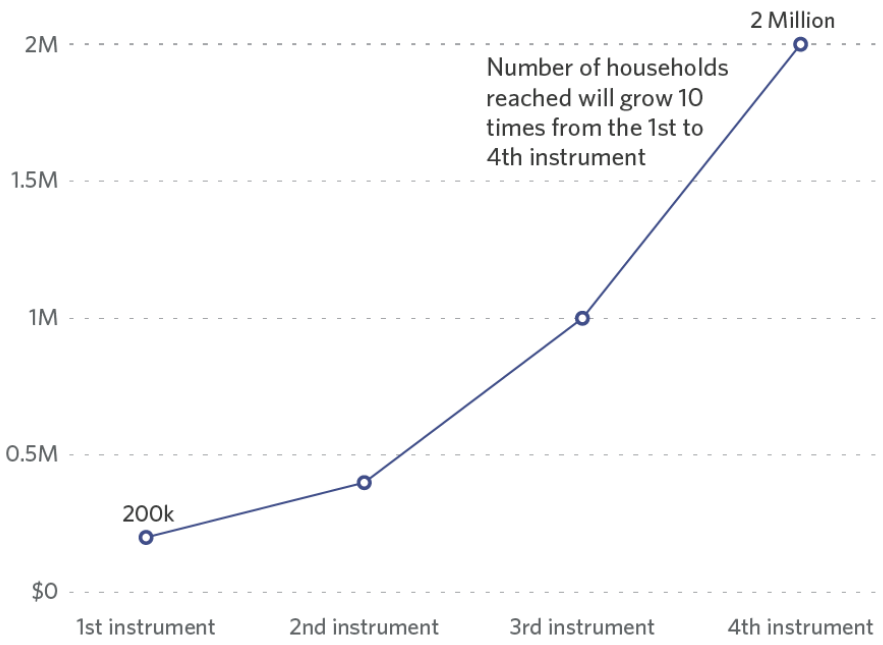
Figure 4: Heat map of energy access gap in sub-Saharan Africa (Source: SEforAll)



countries, along with lack of a common currency, all of which may limit the implementation of complex financial structures and/or overburden their economics. However, these can be overcome with the adherence of local governments. The Development Bank of Rwanda (BRD) is part of the Association of African Development Finance Institutions (AADFI), which will foster this adherence and help replicate the instrument to other African countries.

Starting from a customer base of 175,000 households, the instrument can be scaled-up to reach most households that lack energy access in Rwanda and, subsequentially, in neighboring countries. Based on the assumption that every US$ 10 million in securitization value can reach 200,000 households (US$ 50 loan x 200,000 = US$ 10 million), a US$ 100 million instrument could reach 2 million households, or 4% of the East Africa population without access to energy. The Lab estimates that the securitization can reach this size after 4 issuances, starting with the pilot at US$ 9 million, more than doubling to US$ 20 million to reach 400,000 households in Rwanda, then expanding to East Africa in 3rd and 4th issuances of US$ 50 million and US$ 100 million respectively. By developing a scalable template to securitize solar home system loans, this instrument has the potential to facilitate increased energy access across the continent.

Figure 5: Households reached in subsequent issuances



The Shell Foundation estimates that financing for financing mechanisms such as securitizations have the potential to increase energy access three times as quickly over a 15-year period compared to the current business as usual scenario. In Rwanda alone, this equates to an additional 4.8 million people with access to energy. In East Africa, this figure grows to over 120 million additional citizens.

5. IMPACT

A successful pilot has the potential to abate nearly 46,000 tons of CO2, save Rwandan families US$ 12.2 million per year, increase study time by over 1 billion hours, and reduce respiratory illnesses through the replacement of kerosene.

5.1 QUANTITATIVE MODELLING

In order to model the financial benefits of the pilot offering, the Lab used information on the amounts, sizes and non-payment history of solar home system loans, provided by the largest company in the Rwandan solar home system sector, with a 36% market-share.

Rwanda's off-grid solar sector has a high degree of concentration, as shown in the table below:

Table 2: Concentration of leading Rwandan off-grid solar companies

Company	Market Share
Company A	36%
Company B	22%
Company C	9%
Others	33%
Total	**100%**

The exact value of the offering will depend on the size of the loan portfolios, the size of the credit enhancement, and the residual equity (% of the loan portfolio) the solar companies will retain. The base case in the model assumes an initial portfolio of 175,000 solar home system loans of US$ 50 each, totaling approximately US$ 9 million. It assumes that 80% of the portfolio will be sold to investors (Tranche 1), with the remaining 20% to be purchased by a DFI as a first loss debt tranche (Tranche 2) subordinate to Tranche 1. Both tranches will target the same yield of 10%, but Tranche 2 will be granted an additional risk premium to make up for its subordinate status (reflected in the different coupon rates below).

As noted above, Tranche 1 investors for the first issuance are expected to be grant and concessional capital providers at first and subsequently, institutional and retail investors. Tranche 2 investors are expected to be DFIs and/or solar companies themselves. As a first loss, subordinated tranche, Tranche 2 is intended to serve as a loss cushion to protect the returns of the senior tranche. Portfolio allocation and pricing between tranches will be determined in cooperation with the underwriters and ratings agency.

The main assumptions for the model are described in the table below. Within this scenario, the instrument can meet a target return of 10% to Tranche 1 investors, in line with comparable securities, while providing significant capital to the solar companies for expansion. To receive a similar amount of capital (US $9 million) through other available financial instruments (as described in Section 3.2), solar companies would have to provide 1.25x in cash collateral, or US$ 11.25 million. By pledging their debt portfolio as collateral, the solar companies can immediately unlock the cash tied up in their existing loans and expand sales more rapidly.

Table 3: Expected returns for different tranches of investors

Item	Assumption	
	Tranche 1 Investors	**Tranche 2 Investors**
Coupon Rate	10%	13%
Expected Repayment Rate	88.9%	88.9%
Security Term	3.5 years	3.5 years

The repayment waterfall is modelled with fees (i.e., operating costs) being paid before any investor and Tranche 1 as senior to Tranche 2. In the case of a non-payment by customers in any given month, Tranche 2 investors will take the loss up to the point at which their 20% share of the portfolio is reached.

5.2 ENVIRONMENTAL AND SOCIAL IMPACT

The instrument has the potential to address significant climate and social issues in Rwanda and throughout East Africa. From an environmental perspective, each solar home system replaces at least one kerosene lamp, abating 0.08 tCO2 per year per lamp.[1] In terms of social impacts, with each solar home system installed, study time increases by an average of 3 hours per child per day, and the likelihood of respiratory illnesses also decreases due to the replacement of kerosene lamps. Moreover, once the solar home systems are paid for, families will save US$ 70 per year (approximately 10% of Rwanda's annual per capita GDP).

For a pilot that supports 175,000 solar home systems, with an average system life of 3.5 years, and 2 children per family this amounts to:

- **13,000 tCO2** abated in one year, or **46,000 tCO2** over 3.5 years
- **US$ 12.2 million in savings** annually, once the systems are paid for
- **383 million hours of extra study time** per year, or **1.3 billion hours** over 3.5 years

As outlined in Section 4.3, this instrument is intended to serve as a template for future securitizations and is fully scalable. The Lab estimates the 2nd instrument will reach US$ 20 million or 400,000 households, abating approximately 30,000 tCO2e per year. An expansion within Rwanda and to other East African countries in subsequent issuances can reach US$ 100 million (2 million households) in its 4th iteration and abate almost 150,000 tCO2e per year.

5.3 PRIVATE FINANCE MOBILIZATION AND REPLICATION POTENTIAL

For the pilot, the most likely sources of capital are DFIs, due to the high costs to set up the initial structure and the high level of residual risk that will require a credit enhancement facility.

As explained on Section 4 of this report, the Lab anticipates a phased approach whereby concessional and grant capital is replaced by private institutional and retail investors, while subsequent tranches would have decreasing credit enhancement based on a successful track record of repayment, increasing standardization across companies and product

1 Assumptions: consumption of 30 liters/lamp and emission factor of 75 kgCO2e per liter

maintenance, and economies of scale. Over the next five years, as the instrument is proven commercially viable, it could scale to US$ 20 million in Rwanda alone, assuming a doubling of the current loan portfolio size, providing energy access to around 10% of the population.

Subsequently, it will serve as a template for other countries in sub-Saharan Africa, where 125 million people still live without energy access, a gap that will require an estimated US$ 11 billion to be fulfilled.

6. KEY LAB TAKEAWAYS

6.1 2019 LAB FOCUS SECTOR: SUSTAINABLE ENERGY ACCESS

Solar Securitization for Rwanda addresses the goals of the Lab's Sustainable Energy Access stream. It accelerates the sales and deployment of solar home systems throughout Rwanda, where 66% of the population is without access to the energy grid. By increasing the capital available to solar companies and focusing on households that are currently reliant on expensive and carbon-emitting kerosene lamps, it enables rapid expansion of solar home systems in the country, and potentially in other East African countries, promoting sustainable energy access.

Due to its social and environmental aspects the instrument addressed Sustainable Development Goals (SDGs) such as Quality Education (#4), Affordable and Clean Energy (#7) and Climate Action (#13).

6.2 LAB ENDORSEMENT CRITERIA

Solar Securitization for Rwanda meets the Lab's four key criteria for endorsement in the following ways:

Innovation: This instrument will be the first of its kind in Africa to pool assets from multiple solar companies into a single structure, creating economies of scale and benefiting the maximum number of companies and their customers.

Financial sustainability: While initially requiring substantial blended capital and technical assistance, once the initial instrument is structured, the cost of future offerings will be incremental, and the need for credit enhancement should decrease as the risk profile is better understood through the track record.

Catalytic potential: The instrument has the potential to unlock much needed capital to be redeployed to expand sales and installation of solar home systems throughout Rwanda and countries in East Africa. While the pilot is expected to abate nearly 50,000 tonnes of CO_2 emissions over 3.5 years, an expansion to other East African countries in subsequent issuances can reach US$ 100 million and 2 million households and abate almost 150,000 tonnes of CO_2 emissions per year.

Actionability: An initial pilot offering will take place in Rwanda, sized at US$ 9 million and supporting 175,000 solar home systems. With the key actors in place, the pilot should take approximately 16 months to structure and launch. Pro-bono legal counsel has already been secured, while trustee and ratings partners have been identified.

7. REFERENCES

Energy Access and Security in East Africa, United Nations Economic Commission for Africa, website: https://www.uneca.org/sites/default/files/PublicationFiles/energy_access_and_security_in_ea_eng_fin_lowres_27dec2013.pdf

East Africa Economic Outlook 2018, African Development Bank Group, website: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/2018AEO/African-Economic-Outlook-2018-East-Africa.pdf

SEforALL Heat Maps, United Nations, address: https://www.seforall.org/heatmaps

Doing Business, The World Bank, address: https://www.doingbusiness.org/en/reports/global-reports/doing-business-2019

Black Carbon Emissions from Kerosene Lamps, Ecologic Institute, address: https://www.ccacoalition.org/sites/default/files/resources/black-carbon-and-kerosene-lamps-study.pdf

Market for Solar Home Systems (SHS) in East Africa*, Energypedia, address:* https://energypedia.info/wiki/Market_for_Solar_Home_Systems_(SHS)_in_East_Africa

Living Wage Series - Rwanda - January 2018, Wageindicator.org, address: https://wageindicator.org/salary/living-wage/rwanda-living-wage-series-january-2018

Achieving SDG 7: The Need to Disrupt Off-Grid Electricity Financing in Africa, Shell Foundation, address: https://shellfoundation.org/app/uploads/2018/10/Achieving-SDG-7-The-Need-to-Disrupt-Off-Grid-Electricity-Financing-in-Africa.pdf

Sunny Money website, address: http://www.sunnymoney.org/index.php/about/kerosene-vs-solar

World Bank Databank: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZG

8. ANNEX

8.1 OTHER COMPARABLE ENERGY SECURITIZATION INSTRUMENTS

Table A1: Other comparable energy securitization instruments

Instrument	Description	Country	Size	Expected Returns (per year)	Other Partners
SCTY (Solar City Group Distributed Solar Securitization)	Securitization of distributed solar assets and cash-flows from these assets	USA	USD 49,600,000	6,25%	Goldman Sachs, Credit Suisse (structuring agents) and Kroll (ratings agency)
HASI SYBs (Hannon Armstrong asset-backed Sustainable Yield Bonds)	Securitization of 100 individual on-balance sheet wind, solar, and energy efficiency assets	USA	USD 100,000,000	2,79%	Credit Suisse (leads the deal) and Kroll (ratings agency)
Tesla Solar Securitization	PPAs for solar rooftop leases	USA	USD 340,000,000	-	-
AES DE (AES Distributed Energy)	Securitization of distributed solar energy	USA		-	-
Green Bond South Africa Solar Project	Amortizing bond with a 15 year maturity and an 11% coupon	South Africa	ZAR 1 billion	11%	-

8.2 SENSITIVITIES

The base case assumptions for the securitization are as follows:

Table A2: Base case assumptions

Item	Unit	Amount
Total Loan Portfolio	USD	8,813,518
Tranche 1 Portfolio allocation	%	80%
Tranche 1 target return	%	10%
Tranche 1 tenor	Years	3.5
Tranche 2 Portfolio allocation	%	20%
Tranche 2 target return	%	13%
Tranche 2 tenor	Years	3.5
Estimated default rate (entire portfolio)	%	11.1%

These assumptions yield the following returns:

Table A3: Base case returns

Item	Unit	Amount
Tranche 1 IRR	%	10.5%
Tranche 1 NPV	USD	50,955
Tranche 2 IRR	%	-4.8%
Tranche 2 NPV	USD	-471,381

The assumptions that have the greatest impact on returns are the default rate and debt tenor. The base case assumes a constant default rate of 11.1%. In reality, it is more likely that the default rate will vary throughout the repayment period. The following sensitivities analyze the impact of a short term, extremely high default rate, which is intended to approximate an event such as a weather or economic catastrophe that would cause temporarily high default rates. The following tables show the returns to Tranches 1 and 2 from a 40% default rate lasting 3 months in years 1, 2, and 3 (sequentially). For the rest of the term, the default rate is 2%.

Returns to Tranche 1 decrease because the 40% default rate exceeds the 20% protection provided by Tranche 2. Returns for Tranche 2 increase because of the lower overall default rates, and the shorter-term high default rate. Finally, returns for the scenarios with the default occurring in years 2 and 3 are higher than for a high default in year 1, due to the time value of money.

Table A4: 2% throughout, with 40% default for 3 months in year 1 (real pre-tax)

Item	Unit	Amount
Tranche 1 IRR	%	9.4%
Tranche 1 NPV	USD	-66,988
Tranche 2 IRR	%	8.5%
Tranche 2 NPV	USD	-121,310

Table A5: 2% throughout, with 40% default for 3 months in year 2 (real pre-tax)

Item	Unit	Amount
Tranche 1 IRR	%	9.5%
Tranche 1 NPV	USD	-50,786
Tranche 2 IRR	%	8.9%
Tranche 2 NPV	USD	-104,959

Table A6: 2% throughout, with 40% default for 3 months in year 3 (real pre-tax)

Item	Unit	Amount
Tranche 1 IRR	%	9.7%
Tranche 1 NPV	USD	-36,001
Tranche 2 IRR	%	9.4%
Tranche 2 NPV	USD	-90,489

In each case, returns to Tranche 2, are below the target return and risk premium (10% and 3% respectively, 13% combined). The Lab team has considered an option whereby the tenor of Tranche 2 is 4 years (48 months), so 6 months longer than Tranche 1. In this case, once Tranche 1 has been repaid, Tranche 2 receives payments to recover the cash flow shortage from the earlier defaults, plus the payments owed for the remaining 6 months. Returns under this scenario are considerably higher for Tranche 2, while preserving returns to Tranche 1. Returns could be further improved by implementing some form of catch up payment to Tranche 2 to account for the time value of money.

Table A7: Base case default rates, 4-year tenor for Tranche 2, with capital return provision after Tranche 1 repaid (real pre-tax)

Item	Unit	Amount
Tranche 1 IRR	%	10.5%
Tranche 1 NPV	USD	50,955
Tranche 2 IRR	%	11.6%
Tranche 2 NPV	USD	-48,937