The Lab

Global Innovation Lab for Climate Finance

GREEN AGGREGATION TECH ENTERPRISE (GATE)

INSTRUMENT ANALYSIS
SEPTEMBER 2018

Green Aggregation Tech Enterprise (GATE)

LAB INSTRUMENT ANALYSIS

September 2018

DESCRIPTION & GOAL —
A risk pooling and guarantee facility that addresses mini-grids revenue risk and increases clean energy access in Sub-Saharan Africa

SECTOR —
Electricity/power; Financial services

PRIVATE FINANCE TARGET —
Private investors in the insurance and guarantee sector in Sub-Saharan Africa

GEOGRAPHY —
For pilot phase: Nigeria, Kenya, Zambia and the DRC
In the future: Other Sub-Saharan African countries with mini-grid potentials

The Lab identifies, develops, and launches sustainable finance instruments that can drive billions to a low-carbon economy. It is comprised of three programs: the Global Innovation Lab for Climate Finance, the Brasil Innovation Lab for Climate Finance, and the India Innovation Lab for Green Finance.

AUTHORS AND ACKNOWLEDGEMENTS

The authors of this brief are Joseph Mabe and Xueying Wang.

The authors would like to acknowledge the following professionals for their cooperation and valued contributions including the proponents Ana Hajduka (Africa GreenCo), Felix Brand (Lions Head Global Partners) and Tinashe Makoni; and Working Group members Mahua Acharya (GGGI), Kome Ajegbo (Africa Finance Corporation), Claudio Allatorre Frenk (IDB), Steve Bailie (IFC), Steve Baker (UK Department of Business, Enterprise and Industrial Strategy), Thomas Belazis (Rockefeller Foundation), Kelly Carlin (Rocky Mountain Institute), Adam Connaker (Rockefeller Foundation), Jonathan First (Development Bank of Southern Africa), Abyd Karmali (Bank of America Merrill Lynch), Alexia Kelly (Microgrid Investment Accelerator), Susanne Kern (Deutsche Bank), Lori Kerr (Climate Finance Advisors), Ken Locklin (Impax Asset Management), Emily McAteer (Odyssey Energy Solutions), Emily Mills (UK Department of Business, Enterprise and Industrial Strategy), Seyni Nafo (Africa Renewable Energy Initiative), Juan Roberto (IDB), Ash Sharma (Frontera Consulting) and Eric Wanless (RMI).

The authors would also like to thank Barbara Buchner, Ben Broche, and Maggie Young for their continuous advice, support, comments, and internal review.

The Lab's programs have been funded by Bloomberg Philanthropies, the David and Lucile Packard Foundation, the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU), the Netherlands Ministry for Foreign Affairs, Oak Foundation, the Rockefeller Foundation, Shakti Sustainable Energy Foundation, the UK Department for Business, Energy & Industrial Strategy, and the U.S. Department of State. Climate Policy Initiative serves as Secretariat and analytical provider.

1. CONTEXT

Mini-grids have the potential to deliver around 40% of all new electricity connections in Sub-Saharan Africa by 2030. Uncertain and unpredictable cashflows are a key barrier to private investment in mini-grids and prevent the mini-grid sector from scaling up.

Africa faces the challenge of providing electricity to 600 million people. Most Sub-Saharan Africans without power live in remote areas. Mini-grids represent an opportunity to address energy access without the challenges of standard grid electrification. According to the IEA, about 40% of all new electricity connections until 2030 could be delivered economically through mini-grids - requiring installation of 4000 – 8000 mini-grids a year in 25 years.

However, the mini-grid market is failing to reach its potential with limited investment by private financiers. Mini-grid customer demand is difficult to predict, with little historic data from which to make forecasts. Rural residential and commercial customers often have non-existent or extremely limited credit histories. This makes it difficult to assess the revenue-generating potential of a mini-grid project – and therefore its bankability. As a result, mini-grids are overwhelmingly financed with grants and equity and some limited concessional debt.

The Green Aggregation Tech Enterprise (GATE) guarantees a baseline level of revenues to address revenue uncertainty barriers – demand risk and payment risk – in mini-grids. This guarantee transforms the credit quality of mini-grid projects to unlock private capital flows into the sector. GATE aims to show that mini-grids represent a bankable asset class for local and international investors and enable market forces to scale the mini-grid sector.

CONCEPT

2. INSTRUMENT MECHANICS

The Green Aggregation Tech Enterprise (GATE) is a new guarantee facility that addresses revenue risk in mini-grids. GATE guarantees a baseline level of revenues.

2.1 INSTRUMENT DESIGN

2.1.1 GATE GUARANTEES MINI-GRID REVENUES TO UNLOCK PRIVATE FINANCE

At present, demand risk – the risk that mini-grid customers will consume less electricity than expected, resulting in lower revenues than expected – creates revenue uncertainties that prevent private investment in mini-grids. As a result, mini-grids are overwhelmingly financed with grants, equity and some concessional debt.

In GATE's product offering, mini-grids pay a premium to gain a guaranteed minimum revenue stream:

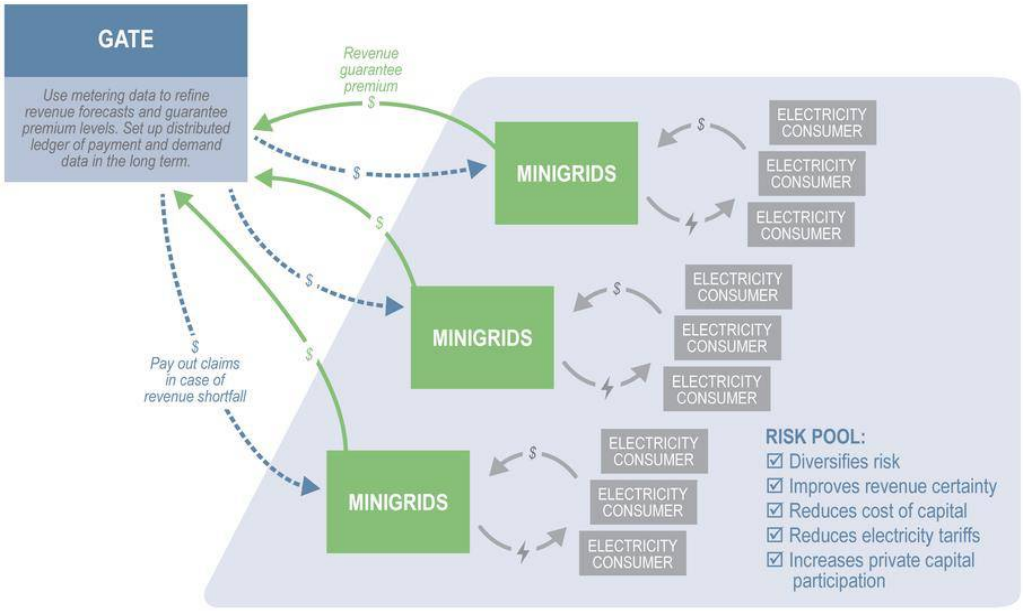
1. The mini-grid agrees a periodic revenue threshold with GATE, over a fixed time
2. Mini-grids pay a regular premium to GATE for each period covered
3. In the event that revenue falls below the threshold, GATE pays out the difference

GATE's guaranteed baseline revenue ensures that a mini-grid's debt obligations can be serviced in the event of demand shortfalls. This can transform the financing of mini-grids: from donor grants to debt finance.

2.1.2 GATE CREATES A GUARANTEE PLATFORM THAT EFFECTIVELY POOLS RISK

GATE is a platform that provides a guarantee product to a diverse portfolio of mini-grids, across different locations and customer bases to pool the risks that face individual mini-grids. This enables GATE to price these risks more effectively than individual investors. Figure 1 illustrates GATE's mechanics at the portfolio level.

Figure 1: GATE mechanics at the portfolio level



2.2 TARGET COUNTRIES

Based on an analysis of regulatory conditions, electrification rates and grid expansion plans and the state of the mini-grid market, Nigeria, Kenya, Zambia and the DRC are prioritized as the first countries in which to implement GATE.[1] After pilot implementation, GATE will look to expand to additional Sub-Saharan African countries. We identified Angola, Cote d'Ivoire, Democratic Republic of Congo, Ghana, Mozambique, Namibia, Rwanda, Senegal, Tanzania, Uganda and Zimbabwe as promising countries for further expansion.

2.3 TARGET INVESTORS

GATE's initial target investor base will include development finance institutions and philanthropic foundations. In time, GATE will look towards private investors familiar with the African renewable energy sector. Finally, as the mini-grid sector matures (in part due to GATE's leveraging of private finance), GATE will increasingly look towards financial institutions as well as conventional insurers and reinsurers.

[1] See Annex B, for more detail on the market assessment in these countries.

3. INNOVATION

GATE addresses a market gap: its guarantee instrument provides revenue certainty to mini-grids to enable private investment in the sector

3.1 COMPLEMENTING THE EXISTING ECOSYSTEM

GATE is an innovative solution that addresses demand and payment risk, key obstacles to private investment in and the subsequent scale-up of the mini-grid market. No other products in this market target these key barriers: GATE provides a unique added value.

Table 1 compares GATE to existing guarantee and insurance instruments in Sub Saharan Africa. These instruments provide risk mitigation to renewable energy generation but focus mainly on the on-grid energy market and exclusively on barriers such as trade partner payment risk, investment risk, and currency exchange risk.

Table 1: Comparable instruments to GATE

Organization	Overview of organization	Comparable instrument
African Trade Insurance Agency (ATI)	Supports renewable energy generation by providing trade credit insurance and covering political and investment risks	Trade credit insurance on payment faults[2]
African Guarantee Fund (AGF)	Supports financial institutions to increase finance to SMEs through guarantees and technical assistance	Partial risk guarantee for debt instruments[3]
GuarantCo	Supports infrastructure finance by providing credit guarantees to enable long-term local currency debt	Local currency partial risk guarantee[4]
Infracredit Nigeria	Infracredit guarantees institutional investment in the Clean Energy Infra Fund. The fund invests in debt notes of eligible off-grid clean energy projects	Guarantee[5]

These instruments do not target demand and customer payment risks in the mini-grid sector and GATE would therefore be additional and complementary to them. In addition, GATE could act as a catalyst for the deployment of mini-grid focused instruments from these and other organizations.

GATE will enter the market as a number of mini-grid focused debt facilities are in development and as impact-oriented investors turn towards the sector. GATE enables funding to flow from these entities without introducing market distortions. This minimizes the potential for unintended negative consequences.

[2] See http://www.ati-aca.org/our-solutions/our-products/trade-credit-insurance/ for more information
[3] See http://www.africanguaranteefund.com/en_new/products-ten for more information
[4] See https://www.guarantco.com/products-services for more information
[5] See http://infracredit.ng/portfolio-items/energising-a-sustainable-economy/ for more information

3.2 CHALLENGES TO INSTRUMENT SUCCESS

GATE faces two key challenges to success: 1) understanding pooled portfolio risk; and 2) building a sufficiently large and diversified portfolio.

3.2.1 CHALLENGE 1: UNDERSTANDING POOLED PORTFOLIO RISK

At present, data on – and understanding of – demand risk at the individual mini-grid level are limited. Understanding pooled demand risk (at the portfolio level) is an additional challenge. GATE's key cost item – payouts in the event of demand shortfalls – is determined by aggregate demand risk at the portfolio level: understanding this is key.

Work is required to develop data on and better understand key questions surrounding mini-grid demand prediction at the portfolio, such as:

- What is the correlation between different mini-grids?
- What are the key variables (macro and micro) that drive demand, and what data can be used to measure them?
- What constitutes a diversified portfolio? How can this be quantified?
- What is the best predictive model to assess portfolio-level demand?
- How can we assess the effectiveness of ancillary off-grid services as a tool for demand stimulation?

These key questions will be addressed in the Phases 1 and 2 of GATE's development, as described below in Section 4. Implementation Pathway and Beyond. Answering these questions will generate data that can be a valuable public good.

3.2.2 CHALLENGE 2: BUILDING A SUFFICIENTLY LARGE AND DIVERSIFIED PORTFOLIO

Guarantee businesses depend upon scale; GATE is no exception. The larger GATE's portfolio, the less volatile is its pooled risk and the better able GATE is to manage payouts.

GATE's business plan is to grow as quickly as possible while maintaining a robust and diversified portfolio. As GATE is likely to be lossmaking before it reaches scale there is a clear drive for fast growth: increasing the number of mini-grids in GATE's portfolio rapidly. On the other hand, due diligence processes before taking on mini-grids must be thorough, to establish a robust understanding of each mini-grid's key characteristics and ensure a diversified portfolio.

To overcome this challenge, GATE will:

- Leverage mini-grid trade networks, such as the Africa Mini-grid Developers Association (AMDA) to attract mini-grid customers
- Build relationships with developers
- Engage with government procurement programs and major energy access programs such as Kenya Off-grid Solar Access Project for Underserved Counties (KOSAP)[6], and the World Bank -supported mini-grid procurement program in Nigeria

[6] http://projects.worldbank.org/P160009?lang=en

MARKET TEST AND BEYOND

4. IMPLEMENTATION PATHWAY AND REPLICATION

GATE will launch pilots in 2018-2019, scale up the program in 2020-2022, attract private sector participation in 2023-2027, and reach potential commercialization in 2028-2030.

Table 2 shows the implementation pathway for GATE: the path from proof of concept to financial sustainability.

Table 2: GATE implementation pathway and timeline

Year	Implementation Pathway
2018 – 2019	Phase 1: Proof of concept • Secure working capital grant funding, seek partnerships, build out team and formalize operation processes • Secure concessional equity to back portfolio guarantee liabilities in Phase 1 • Launch pilots to prove the concept with a portfolio of 3 – 4 mini-grids totaling ca. 1 MW of generation capacity
2019 – 2022	Phase 2: Deployment • Obtain concessional funding to build a diversified portfolio and support early anticipated operating losses before scale is reached • Deploy the instrument in multiple sites in pilot countries (Nigeria, Kenya, Zambia and the DRC) • Refine pricing, corporate structure, and data collection technologies and applications • Streamline due diligence process to minimize transaction costs • Attract non-DFI capital
2023 – 2027	Phase 3: Scale-up • Expand product offering to additional countries • Lower operating costs through streamlined procedures • Deliver consistent returns through improved data monitoring, increased diversification and risk tranches • Attract further private capital involvement in lower risk tranches
2028 – 2030	Phase 4: Commercialization and replication • Build a 10-year track record and demonstrate instrument viability to mainstream private insurance and reinsurance market • Transition to fully commercial entity with a broader ecosystem of products

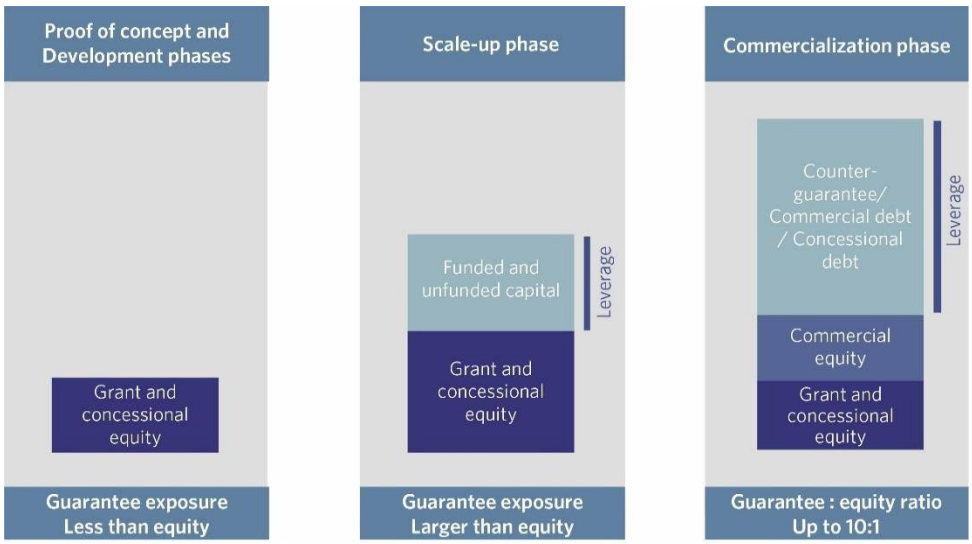
4.1 CAPITAL NEEDS

GATE has two types of capital requirements along its implementation pathway:

1. Funding to meet operating costs until the entity is profitable
2. Capital to cover guarantee exposure in a given period

Figure 2 illustrates a credible pathway for GATE's capital structure and 'leverage ratio' (defined as the ratio of capital held to exposure guaranteed). In Phase 1, GATE must hold as much capital as it is exposed to guarantee coverage (a leverage ratio of 100%). In Phase 4, the guarantee exposure can be up to 10 times as high as GATE's various forms of capital combined (a leverage ratio of 10%). Lowering this leverage ratio is key to increasing GATE's returns.[7]

Figure 2: Illustrative GATE capital structure and leverage in different phases



4.1.1 PHASE 1

In the Proof of Concept, GATE's portfolio of 4 mini-grids is too small to return positive earnings: GATE requires grant funding to meet operating costs. This is the riskiest stage of GATE's growth and guarantee exposure must be fully covered. Table 3 outlines estimated capital needs in Phase 1.

Table 3: Phase 1 Proof of concept capital requirement

Capital type	Capital use	Cost (US$)
Grant	Working capital *Operational funding until GATE generates revenues*	450,000
Equity / Grant	Capital required to back portfolio payout liabilities *100% of debt for four mini-grids*	5.57 million
TOTAL		6.02 million

4.1.2 PHASES 2-3

With negative earnings before interest, tax, depreciation and amortization (EBITDA) until year four, GATE requires working capital funding in the form of grants during these initial years.[8] As detailed in Annex C, working capital will cover additional research, concept development,

[7] See sensitivity analysis in Annex E for an analysis of the impact of varying leverage ratios
[8] See cashflow analysis in Annex E for more detail

and any eventual advisor costs as well as outreach (potentially requiring travel) to mini-grid developers, investors, and stakeholders. The funds will also be used to pay for costs incurred during the implementation of GATE in its pilot phase, including transaction costs (legal and financial advice), salaries of the initial GATE team, setting up GATE's management entity, negotiations with follow-on investors, and continued pipeline development in GATE's initial target markets.

To cover GATE's guarantee exposure, GATE initially requires concessional equity and grants from development finance institutions (DFIs). As GATE scales, its portfolio can be split into tranches with different risk-return profiles. This tranched structure will crowd private capital into lower risk tranches, as public and concessional capital take a first loss position. Based on discussions with commercial reinsures, GATE will also be attractive to actors in commercial reinsurance markets in its later phases of development. Conversations with insurers indicate an appetite for such risk – provided that GATE can demonstrate a reasonable low-loss track record and robust statistical predictability of cash flows.

4.1.3 PHASE 4

As GATE achieves commercial viability – with a 10-year track record and considerable data on product performance – public support can be phased out completely, replaced entirely by private capital.

4.2 CREDIT RATING

Once GATE's portfolio is sufficiently large and has sufficient track record, GATE aims to achieve a credit rating. This will assist GATE to attract additional commercial liabilities and increase the leverage ratio that GATE can achieve. GATE's unique structure means that current rating methods are unsuitable; preliminary conversations are ongoing with credit ratings agencies regarding suitable bespoke methods.

4.3 IMPLEMENTATION PARTNERS AND KEY STAKEHOLDERS

GATE was proposed to the Lab by Ana Hajduka, Felix Brand and Tinashe Makoni. Ana is the Founder and CEO of Africa GreenCo and is an energy and infrastructure professional with over 14 years' experience in emerging markets, in particular Africa. Africa GreenCo aims to bring about innovative models for power sector development in Africa and can act as the development vehicle for GATE's setup on the mini-grid side. Felix is an Associate at Lions Head Global Partners, a financial advisory and asset management firm focused on Africa. Felix specializes in renewable energy, both on- and off-grid, infrastructure and fund structuring. Tinashe is a banking and finance lawyer who specializes in energy projects in Africa. Tinashe is a Vice President at Barclays Bank Plc and a director of the International Lawyers for Africa, a multi-award winning international training program for African Lawyers.

The GATE team has engaged in discussions with a variety of key actors to identify partnerships required to support implementation.[9]

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[9] In particular, the GATE proposal has strong potential for synergies with EU initiatives in the energy access area, such as ElectriFI by making more projects bankable and facilitating deployment of capital to new off grid investments. This could also help deliver access to energy as an enabler for productive uses, job creation and inclusive sustainable development and economic growth. GATE also has synergies with the objectives of Green People´s Energy initiative.

Table 4: Partnerships in GATE implementation

Stakeholder type	Potential partners	Description of potential partnership
Trade bodies	Africa Mini-grid Developers Association (AMDA)[10]	Data, information, networking with potential customers, regulatory support
Concessional capital providers	A number of development finance institutions with strong indications of interest	Concessional equity and grant providers
Mini-grid developers	Multiple	Potential customers
Data solution providers	Odyssey	Provide trusted data to determine product payouts[11]
Debt providers	Please see Table 1 in Section 3.1 above	Please see table 1 in section 3.1 above

5. IMPACT

GATE has the potential to unlock private finance to deploy thousands of mini-grids. The potential market size for GATE is enormous: 27 million connections for households and businesses in Kenya, Nigeria and Zambia by 2023, with 11.71 million tons CO_2 abatement potential annually.

5.1 QUANTITATIVE MODELLING

We modelled both the impact of GATE upon a typical mini-grid and GATE's (portfolio level) finances. For more details on the modelling assumptions for mini-grid impact and GATE's finances, see Annexes D and E respectively.

5.1.1 GATE TRANSFORMS MINI-GRID FINANCES TO UNLOCK PRIVATE FINANCE FOR THE SECTOR

At present, demand risk and payment risk create revenue uncertainties that prevent access to private finance for mini-grids. With the GATE guarantee, mini-grid revenues become predictable and risk reduces for debt investors. The net effect is the lenders can relax their lending conditions.

[10] AMDA's objective is to see 100% electrification in Africa by 2030, in line with the global initiative for universal access to electricity by that year. Decentralised renewable power generation and distribution systems such as mini-grids are viewed as key to providing power to the roughly 600 million people in Africa that currently lack access to modern energy services

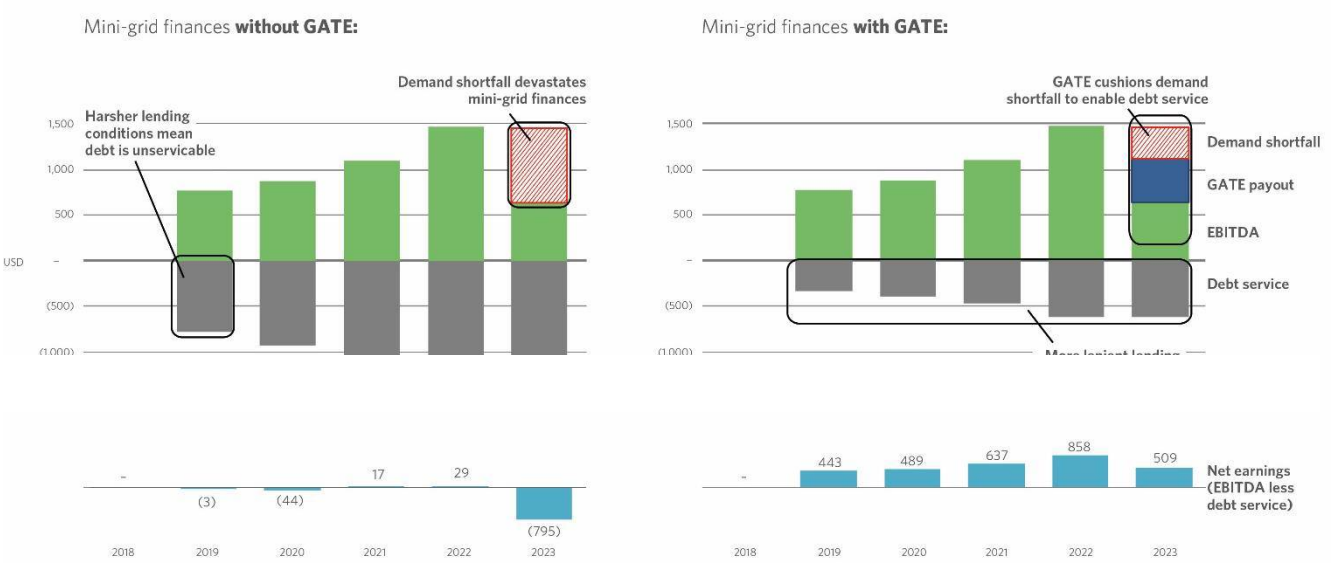
[11] Odyssey Energy Solutions, a software platform connecting developers and investors via end-to-end mini-grid data analytics and monitoring. It has amassed a pipeline of over 550 projects that seek an estimated investment of more than US$ 500 million. The separate projects require an investment of between US$ 40,000 and US$ 3 million.

We modelled the impact of GATE on a typical 0.76 MW project, where a demand shock reduces revenues by 50% in a given year of operations. The results show that GATE transforms mini-grid project economics through improved access to finance, coupled with recoupment in the event of revenue shortfalls.

Figure 3 illustrates how GATE transforms mini-grid finances and safeguards debt service in the event of revenue shortfalls for a commercially funded (30% equity, 70% debt) 0.76 MW mini-grid.

- Without GATE, stricter lending conditions mean the project is unviable: debt service cannot be met – this project would never be approved. In addition, the demand shortfall in the fifth year of operations devastates mini-grid finances.
- With GATE, looser lending conditions enable debt financing and GATE's guarantee safeguards debt service when demand falls in the fifth year of operations. GATE enables equity returns of 20%.

Figure 3: Mini-grid finances with and without GATE. Without GATE, the project is unviable: it would not be approved.



5.1.2 AT SCALE, RISK DIVERSIFICATION AND DATA MANAGEMENT ENABLE FINANCIAL SUSTAINABILITY

GATE's main revenue source is the premiums paid by mini-grids in its portfolio. GATE's key cost item is payouts to mini-grids in the event of revenue shortfall. At any given point, GATE must hold sufficient cash or near-cash instruments to cover a significant payout event. To maximize returns, GATE must optimize this balance sheet item.

To understand GATE's need for initial public support and its long-term financial sustainability, we modelled three growth pathways for GATE.[12] Note that – due to insufficient data on portfolio-level mini-grid performance – we model cases in which GATE makes no pay-outs:

[12] See Annex E for more detail on the growth pathways modelled for GATE

these are *best case scenarios*.[13] In Table 5 we see that GATE can be financially sustainable and deliver attractive returns once it operates at scale.

Table 5: Returns on equity and payback period for growth scenarios modelled

Growth Scenario	2030 portfolio size (MW)	Return on round 1 equity	Payback period
High	700	18.0%	12 years
Central	380	13.6%	14 years
Low	180	9.0%	17 years

5.1.3 GATE AIMS FOR FULL COMMERCIALIZATION BY 2028-2030

Public support is required in initial funding rounds to de-risk GATE. Our modelling suggests that, in a conservative scenario, public support for GATE can be phased out after 5 – 10 years, with GATE offering an attractive investment opportunity by year 5 - 7.

We analyzed public investors' exit scenarios – their ability to sell a stake once GATE is de-risked.[14] Sale of the donor's equity stake to a private investor in years 5, 7, or 10 would provide returns of 8.1%, 9.8%, and 10.4% respectively. Donor investment has the potential to make attractive returns and crowd in private capital simultaneously.

5.2 ENVIRONMENTAL AND SOCIAL IMPACT

GATE has significant potential to unlock private finance for mini-grids and scale up the market to deliver access to affordable, reliable, sustainable and modern energy for all (Sustainable Development Goal 7).[15] GATE's potential market size - and impact – is huge: 5.1 GW mini-grid capacity, driving increased levels of energy access for 27 million households and businesses (greater than the population of Australia) and 11.71 million tons of CO_2 abatement per year (equivalent to Ethiopia's annual emissions) in Kenya, Nigeria and Zambia by 2023.

In Phases 1 and 2, GATE builds a diversified portfolio – laying the foundations to scale up in Phases 3 and 4. GATE aims to enable 40 mini-grids (c. 12 MW) by 2023. This portfolio will deliver electricity connections to over 60,000 households and businesses.

For households, increased levels of energy access deliver socio-economic benefits:

- Improved gender equality (Ashden, 2017)
- Improved health outcomes, especially for women (Ashden, 2017) (IEA, 2017)
- Improved education: over 90 million primary school aged children in sub-Saharan Africa attend schools without electricity (IEA, 2017, p. 27)

For businesses, increased energy access can enable productivity enhancements, or new products, which contribute to economic development and job creation. (IEA, 2017, p. 29)

In the longer-term, GATE aims to develop a private sector market for mini-grids that delivers economies of scale to reduce tariff costs and increase mini-grid affordability.

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[13] See Annex E for a sensitivity analysis that tests the impact of pay-outs on GATE's performance

[14] In which donors sell their stake at the net present values of future cashflows, discounted at 12.4%. 10% is an acceptable return on equity for a financial services company in developed markets. A liquidity premium and an emerging market premium constitute the additional 4% premium.

[15] See https://sustainabledevelopment.un.org/sdg7

5.3 PRIVATE FINANCE MOBILIZATION AND REPLICATION POTENTIAL

GATE targets a potential annual mini-grid market size across Kenya, Nigeria and Zambia of US$ 5.7 billion by 2023.[16]

During deployment (Phase 2, 2019 – 2022), GATE will provide guarantees to a portfolio of around 40 mini-grids, or approximately 12 MW in generation capacity. These guarantees could catalyze US$ 61 million[17] of private investment in off-grid energy over Phases 1 and 2. In this scenario, donor funding in Phase 1 can crowd in private finance at a ratio of 10:1.

After Phase 2, GATE's aims to scale its portfolio rapidly – guaranteeing over 1000 mini-grids (~350 MW) and catalyzing a total of US$ 1.725 billion of private investment by 2030.

6. KEY TAKEAWAYS

Revenue uncertainty – demand risk and payment risk – create barriers to private investment in mini-grids. GATE addresses this barrier to enable the mini-grid sector to scale.

GATE meets the Lab criteria and has significant impact potential. GATE is:

- Innovative: GATE addresses a market gap: its guarantee instrument provides revenue certainty to mini-grids in Sub-Saharan Africa
- Financially sustainable: Risk diversification at scale and data management arrangements allow GATE to be financially sustainable. GATE aims to transition from public support to full commercialization by 2028 – 2030
- Catalytic: GATE has the potential to unlock private finance to deploy thousands of mini-grids a year in Sub-Saharan Africa in a non-distortive manner
- Actionable: With explicit interest and support from target country governments, mini-grids, industry associations, and data platforms, GATE expects to launch pilots in 2018 and to scale the program up in 2019

[16] Market size calculations are based upon market reports and government targets. See Annex F
[17] Assumes average mini-grid size of 300kW, at average cost of US$ 5 million per MW

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ANNEXES

A. KEY STAKEHOLDERS CONSULTED DURING RESEARCH

Table 6: Key stakeholders consulted during Lab research

Organization	Topic	Website
AMDA	Data sources, potential GATE customers, potential collaboration opportunities	http://africamda.org/
Camco Clean Energy	Barriers to mini-grid financing and product design; interaction with Renewable Performance Platform	http://www.camcocleanenergy.com/
DFID	Barriers in mini-grid market and how GATE can address these	https://www.gov.uk/government/organisations/department-for-international-development
Energy4Impact	Key risks for mini-grid developers; product design and rollout	https://www.energy4impact.org/
EU	Potential partnerships	
GuarantCo	GuarantCo partial guarantee product	https://www.guarantco.com/products-services
Infracredit Nigeria	Infracredit guarantee product	http://infracredit.ng/portfolio-items/energising-a-sustainable-economy/
Jay Taneja, UMassAmherst	Modelling customer demand profiles	https://ece.umass.edu/faculty/jay-taneja
Odyssey Energy Solutions	Mini-grid performance data and potential for collaboration	https://www.odysseyenergysolutions.com/
Partners Group Impact		https://www.partnersgroup.com/en/responsibility/we-are-responsible-citizens/pg-impact-investments/
PowerGen	Additionality and feasibility of GATE product	https://www.powergen-renewable-energy.com/
Rockefeller Foundation	Overcoming barriers to private investment in mini-grids	https://www.rockefellerfoundation.org/
Rocky Mountain Institute	Overcoming barriers to private investment in mini-grids	https://www.rmi.org/
sfr consulting	Products that address revenue risk	http://www.sfr-consulting.com/
Swiss Re	Feasibility and attractiveness of insurance and guarantee products in mini-grid sector	http://www.swissre.com/
Videre Global	Barriers to mini-grid financing and product design	http://videreglobal.com/
Z/Yen	Distributed ledger technology	http://www.zyen.com/

B. TARGET MARKET ASSESSMENT

To identify priority target markets for GATE, we assessed key variables such as regulatory conditions, electrification rates and grid expansion plans, and the state of the mini-grid market in Sub-Saharan African countries. From this, we identified Kenya, Nigeria and Zambia as key initial markets for GATE. We provide key details on the mini-grid landscape in each country below.

MINI-GRID LANDSCAPE IN KENYA

Electrification rates

The current electricity access rate in Kenya is between 50% and 75%, depending on the source (World Bank 2017b), (Kenya Power 2018). The Government of Kenya (GoK) aims for universal energy access by 2020. GoK aims to connect 90% of the population to the grid by 2020; the remaining population will be served via mini-grids and stand-alone systems (World Bank 2017). However, discussions with actors active in this space suggest that grid connections are frequently poor quality and unreliable, to the extent that grid-connected markets remain attractive market segments for mini-grid developers.

Regulatory landscape

A source of uncertainty in Kenya is that there are no regulations specific to mini-grids. Mini-grids are considered under the broader Energy (electricity licensing) regulations 2012, alongside larger energy generators.

Size of the mini-grid market

There are at least 21 companies operating in Kenya, serving between 1,000 to 2,5000 customers (World Bank 2017). We estimate (using conservative assumptions) that the size of the Kenyan mini-grid market will be 2,500 MW by 2023.

Key mini-grid programs

The Kenya Off-grid Solar Access Project (KOSAP), supported by the World Bank, will support the development of 120 mini-grids in 14 of Kenya's northern counties (World Bank 2017b).

MINI-GRID LANDSCAPE IN NIGERIA

Electrification rates

Nigeria has a 55% electrification rate nationwide. In rural areas, the electrification rate is 39% (World Bank 2017c). The Government of Nigeria (GoN) sees mini-grids as a key route to providing energy access, outlined in the Rural Electrification Strategy and Implementation Plan July 2016.

Regulatory landscape

The regulatory framework for mini-grids in Nigeria was issued in May 2016 by the Nigerian Energy Regulatory Commission (NERC) (NERC 2016). Mini-grids are categorized as smaller than 1 MW in size. Non-grid-connected mini-grids smaller than 100 kW are advised to register project and may choose to apply for a permit; those between 100 kW and 1 MW must apply for a permit (NERC 2016). Grid-connected mini-grids require a permit, regardless of size (NERC 2016). Multi-year Tariff Orders (which are based on cost recovery with reasonable returns) can be used to calculated tariffs (NERC 2016). Alternatively, an agreement can be reached with consumers representing at least 60% of electricity output. In the case of grid-

extension encroaching on the mini-grid's customers, the mini-grid developer (if the mini-grid is permitted) is entitled to compensation equal to the remaining depreciated value of its assets (NERC 2016). Permitted mini-grids must adhere to technical codes and standards (NERC 2016).

Size of the mini-grid market

At present, there are at least eight private sector companies operating in Nigeria (Heinrich Boll Stiftung Nigeria 2016). The Rural Electrification Agency (REA) forecasts the deployment of 3,000 MW of mini-grids by 2023 (REA 2017). We apply a conservative downgrade factor to estimate 2,250 MW of mini-grid capacity deployed by 2023.

Key mini-grid programs

The REA was created and authorized to establish a Rural Electrification Fund, for which the REA conducts mini-grid pre-feasibility evaluations. At present, all mini-grids receive some form of subsidy (World Bank 2017c).
The World Bank Nigeria Electrification Project[18] is in the pipeline. This US$ 350 million project, once approved and operational, is expected to develop 850 mini-grids.

MINI-GRID LANDSCAPE IN ZAMBIA

Electrification rates

The electrification rate in Zambia is 31.2% nationwide; in rural areas it is at only 4.4% (CIFs 2017). The rural population makes up 58% of the total population (CIFs 2017). Rural areas are poor and sparsely populated: 77% of the rural population lives below the poverty line and rural Zambia has one of the lowest population densities in Southern Africa (World Bank 2017b). Grid connections are unreliable: power shortages are frequent and 27% of firms own or share their own generator (World Bank 2017b).

Regulatory landscape

The regulatory landscape in Zambia is unclear (World Bank 2017b). The permit process is "cumbersome" and the licensing process unclear (World Bank 2017b). Tariffs are set by the Energy Regulatory Board – approved tariffs can vary from grid tariffs, based on the cost of supply for a specific project. Tariffs proposed to date have ranged from US$ 1.79 / kWh to US$ 2.35 / kWh (World Bank 2017b).

Size of the mini-grid market

At least 13 mini-grids are operational in Zambia (World Bank 2017b). Ten of these are owned by the national utility ZESCO, one is community owned and two are privately owned. Three new mini-grids are in development.

Key mini-grid programs

The World Bank Electricity Service Access Project has a US$ 5.9 million off-grid electricity access expansion component. This includes a smart subsidy program and an off-grid loan facility (World Bank 2017b).

[18] http://projects.worldbank.org/P161885?lang=en

OPPORTUNITY FOR GATE IN DRC

The DRC Government has launched a new initiative, which aims to tender greenfield concessions for the development, financing and operation of solar-based isolated grids in the Democratic Republic of Congo (DRC) in urban areas, starting with three pilot projects, whose total investments represent about USD85mn at inception.

This initiative is supported through a Technical Assistance by DFID from the Essor programme, whose objective is to assist the Congolese Government (GoDRC) in improving the level of electrification in the DRC. The envisaged procurement of the three pilot concessions is to be handled by a public agency within the Ministry of Energy, namely the "*Unité de Coordination et de Management*" (UCM).

The three pilot projects would initially encompass the towns of Bumba, Gemena, and Isiro. Together, they account for an estimated 460,000 inhabitants.

The overall number of connections (domestic and non-domestic) is expected to reach approximately 13,000 connections in Year 1 enabling to address energy needs totalling almost 13GWh for the three towns and 49,000 connections enabling to address energy needs totalling almost 69GWh in Year 20. The Request for Qualification (RfQ) is to be launched by the end of September 2018, followed by the Request for Proposals phase to be launched during Q1 2019.

C. GATE CAPITAL REQUIREMENTS – PHASE 1

We present a budget-line breakdown of Phase 1 Proof of Concept capital requirements as shown in Table 3 in the main report.

CAPITAL REQUIREMENTS TO COVER OPERATING COSTS IN PHASE 1

Grant funding will be required until GATE generates revenues for the items in Table 7:

Table 7: Detailed capital requirements to cover operating costs in Phase1: Proof of Concept

ITEM	COST
Salaries	US$ 280k
Chief Executive Officer	US$ 120k
Director	US$ 90k
Associate	US$ 70k
Transaction Costs (e.g. legal advice, due diligence costs)	US$ 50k/transaction
Overheads	US$ $150k
Office	US$ 50k
Travel	US$ 100k
Working Capital	US$ 50k
TOTAL	US$ 450k

This grant funding will cover additional research, concept development and any eventual advisor costs as well as outreach (potentially requiring travel) to mini-grid developers, investors, and stakeholders. The funds will also be used to pay for costs incurred as a result of the implementation of GATE in its pilot phase, including transaction costs (legal and financial advice), salaries of the initial GATE team, setting up GATE's management entity, negotiations with follow-on investors, and continued pipeline development in GATE's initial target markets.

CAPITAL REQUIREMENTS TO COVER GUARANTEE EXPOSURE IN PHASE 1

In Phase 1, GATE provides guarantee to 3-4 mini-grids. In this phase, investor confidence requires that GATE is capitalized sufficiently to cover these projects entirely. A combination of concessional equity or grants will be required for the items in table 8:

Table 8: Capital requirements to back guarantee exposure in Phase 1

ITEM	COST
Capital to back portfolio payout liabilities	US$ 5.57 million
TOTAL	US$ 5.57 million

D. MODELLING GATE IMPACT UPON MINI-GRID FINANCES

KEY ASSUMPTIONS TO MODEL IMPACT OF GATE UPON MINI-GRID FINANCES

We modelled the finances of a 0.76 MW mini-grid that suffers a 50% reduction in revenues in a given year – in this case the 5th year of operations. We modelled two key scenarios to demonstrate how GATE can transform mini-grid financing:

1. A "baseline" scenario: A commercially funded mini-grid (30% equity, 70% debt), with an average tariff of US$ 1/ kWh, without GATE
2. A "with GATE" scenario: A commercially funded mini-grid (30% equity, 70% debt), with an average tariff of US$ 1/ kWh, with GATE

Table 9 outlines key assumptions in the two scenarios

Table 9: Key assumptions in Baseline and With GATE scenarios

Assumptions	Baseline	With GATE
Product details		
Premium paid to GATE	0%	5%
First-loss threshold	N/A	20%
Revenue shortfall in given year	50%	50%
Tariff		
Average tariff	US$ 1 / kWh	US$ 1 / kWh
Lending conditions		
Debt service reserve account	3 months	3 months
Minimum DSCR	1.5	1.2
Interest rate	12%	7%
Debt tenor	5 years	10 years

With the GATE guarantee, mini-grid revenues become predictable and risk reduces for debt investors. The net effect is the lenders can relax their lending conditions. Based on conversations with relevant stakeholders, we assumed that the interest rate charged would reduce from 12% to 7% and that debt tenor would increase from five to ten years.

IMPACT OF GATE UPON MINI-GRID FINANCES

With GATE, a mini-grid project can deliver returns to equity of 20.1%, paying equity investors back after 9.5 years. GATE enables project leverage of up to 70%.

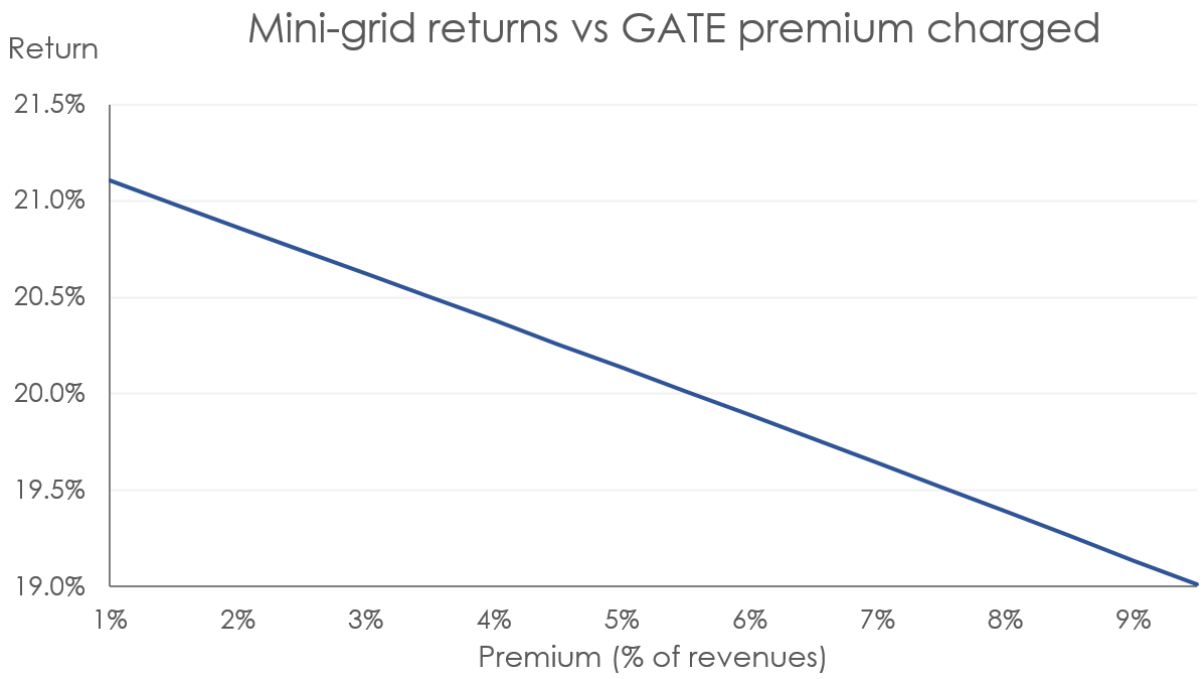
Without GATE, a mini-grid is not commercially viable, with negative returns to equity on the same tariff. The mini-grid is unable to meet its debt obligations, with a debt service cover ratio (DSCR) frequently below 1. As a result, *this project would never be approved*. This is as we would expect: at present, the overwhelming majority of mini-grids are currently funded through donor grants and equity, with a limited amount of concessional debt.

To provide a return over 20% without GATE, a project in GATE's target markets would require either a) grant funding worth over 65% of project value (US$ 3.68 million); or b) an average 29% increase in tariff levels (to US$ 1.29 / kWh).

Hence in this scenario analysis, per mini-grid GATE reduces the cost burden on donors by up to US$ 3.68 million or saves consumers up to US$ 11.65 million[19] in avoided energy costs, compared to baseline.

SENSITIVITY OF MINI-GRID RETURNS TO GATE PREMIUM

Figure 4: Sensitivity analysis - impact of GATE premium upon mini-grid returns



We conducted a sensitivity analysis to understand the impact of changing GATE's premium upon mini-grid returns. Figure 4 shows the impact of varying GATE's premium (as a percent of total mini-grid revenues) upon mini-grid returns to equity. In this analysis, other GATE product parameters (payment threshold, coverage period, etc.) are held constant.

We see that mini-grid returns are relatively inelastic to the premium charged – doubling premium payments charged by GATE from 4% to 8% of total mini-grid revenues causes only a 1% reduction in mini-grid returns to equity.

Mini-grid developers are likely to be willing to trade the prospect of marginally higher but much riskier returns (without GATE) for marginally lower but much less risky and more predictable returns (with GATE). GATE's value proposition for a mini-grid developer is strong.

[19] Lifetime undiscounted savings in reduced energy tariffs

DETAILED ASSUMPTIONS IN MINI-GRID PROJECT MODEL

The table below provides further detail on the assumptions made to model mini-grid finances.

Table 10: Detailed assumptions in mini-grid project model

PROJECT DETAILS	Units	Value
Plant size	MW	0.76
Number of Connections	#	1,453
Daily total (peak)	MWh	3.88
Average hourly generation (peak)	MWh	0.16
Implied capacity factor	%	21.4%
USES	**Units**	**Value**
Financing fees		
Upfront fee	%	2%
Commitment fee	%	2%
Development costs & admin	%	5%
Project cost		
Capex	US$ million	4.94
Project cost	US$ million	5.26
SOURCES	**Units**	**Value**
Overall Capital Structure		
Leverage	%	70.0%
Equity	%	30.0%
Principal repayment profile	switch	Sculpted
DSRA	months' revenue	3
Min DCSR	#	2.53
Debt interest	%	7.0%
Debt tenor	years (post COD)	10.00
Overall Cost		
Debt (capex)	US$ million	3.46
Equity (capex)	US$ million	1.48
Debt (total)	US$ million	3.69
Equity (total)	US$ million	1.58
OPERATIONS	**Units**	**Value**
Commission year	Year	01/01/2019
End of operations	Year	31/12/2043
O&M		
O&M cost Solar	000 US$/MW/year	20
O&M Diesel (fixed)	000 US$/MW/year	10
O&M Diesel (variable)	000 US$/hour	0.0003
Diesel Running/Day	hours	4
O&M Battery	000 US$/MW/year	20
Genset Operations		
Fuel Cost	US$/ltrs	0.75

Fuel Use	ltrs/MWh	210
PPA tenor/Project Lifetime	years	25
Degradation (solar)	%	0.50%
Tax	%	30%
Collections Rate	%	95%
ELECTRICITY SALES/REVENUE	Units	Value
Average starting tariff	US$/kWh	1.00
Indexation	%	2%
Portion indexed	%	10%
REVENUE SHORTFALL	Units	Value
Start year revenue shortfall	year	01/01/2023
Reduction in revenues	%	50%
Shortfall duration	years	1.00

E. **MODELLING GATE'S FIN**ANCES

KEY ASSUMPTIONS IN GATE CORPORATE MODEL

1. GUARANTEE PRODUCT

We assume the following for GATE's guarantee product:

Table 11: GATE guarantee product - key characteristics

Forward capital cover	3 years
Coverage period	8 years
Equity First-Loss/Deductible	20%
Fee	5% of topline revenue

Forward capital cover is the number of years' worth of capital coverage that GATE holds on balance sheet. So, if GATE has expected liabilities of US$ 10 million in a given year, it would need to hold US$ 30 million in cash and near-cash assets with forward capital cover of 3 years.

Coverage period is the contract period for GATE's guarantee product.

Equity First-Loss/Deductible is the level of revenue loss (beneath the pre-agreed threshold) for which participating mini-grids are liable. GATE is then liable for revenue losses after this deductible. For example, if revenues were 50% lower than the threshold value, the mini-grid would be liable for the first 20% loss and GATE liable for the next 30% loss.

Fee is the premium paid by the participating mini-grid to gain a guaranteed baseline revenue stream. Fees are as a % of topline revenue.

2. GATE GROWTH PATHWAYS

To model GATE's performance, it is necessary to assume a growth pathway for GATE. We modelled three growth scenarios: Low, Central and High scenarios.

Growth pathways are defined by two key drivers of GATE's performance:

1. *Scale*: The size of GATE's portfolio and the continued ability to originate projects
2. *Leverage ratio*[20]: Informally, this is GATE's ability to underwrite more value than it has capital cover for. This may require a local or international rating. Formally, this is the ratio of capital (cash or near-cash instruments) held to back guarantee exposure

Figure 5 shows the growth scenarios modelled for GATE. Unless otherwise mentioned we refer to the Central growth scenario.

The top chart shows the annual leverage ratio (mini-grid revenues guaranteed / cash and cash-like assets held to back guaranteed revenues) over time. In each scenario, the leverage ratio gradually decreases as the GATE portfolio increases in size and aggregate

[20] Note that where the paper refers to GATE's own leverage ratio, i.e. the amount of equity and grants invested in GATE as compared to debt and counter-guarantees, the paper uses the term 'equity ratio'

revenue shortfalls become more predictable and less volatile. In the bottom chart, we see the growth rate of GATE's portfolio: the annual rate at which mini-grids are added to GATE's portfolio.

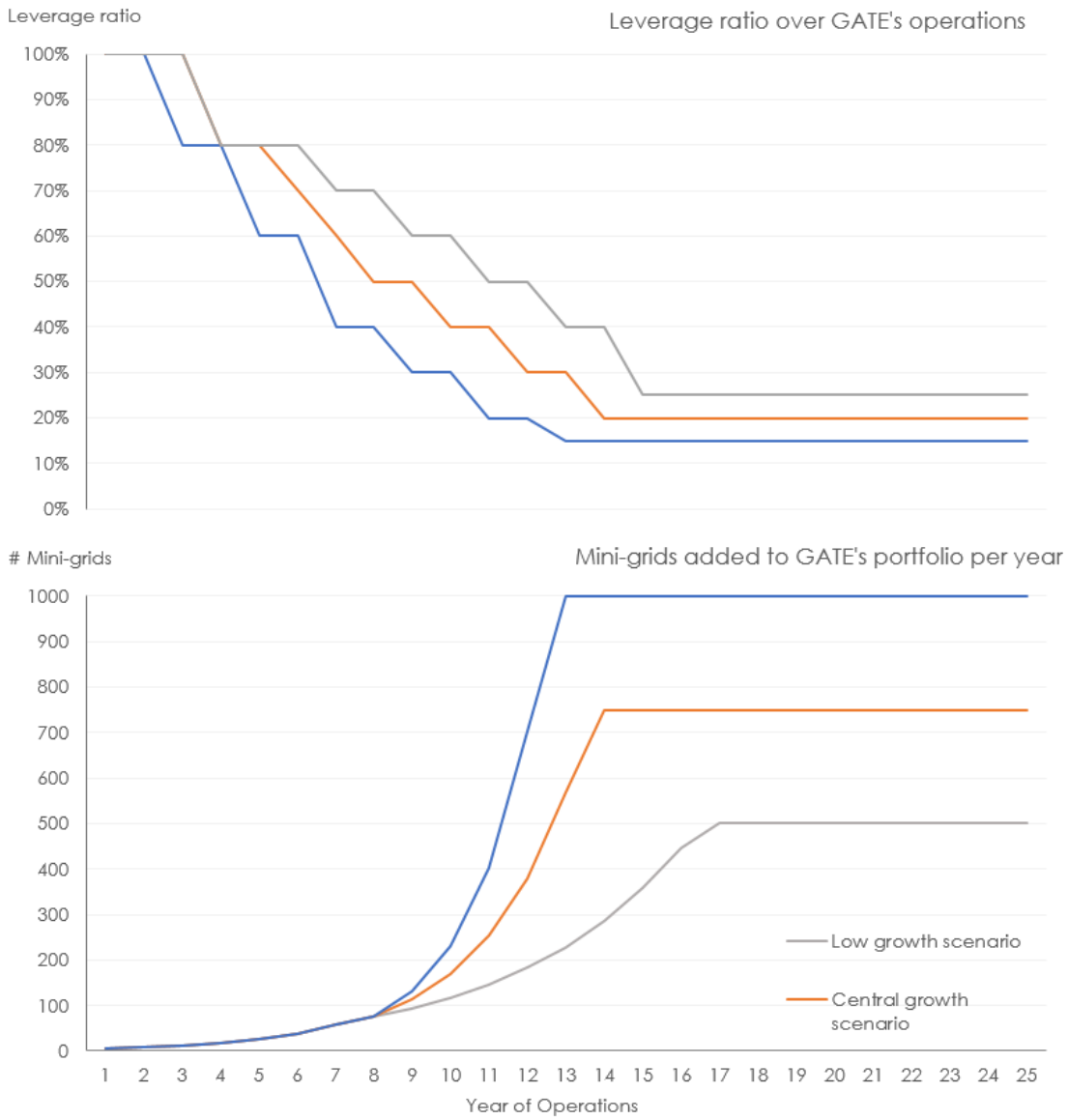


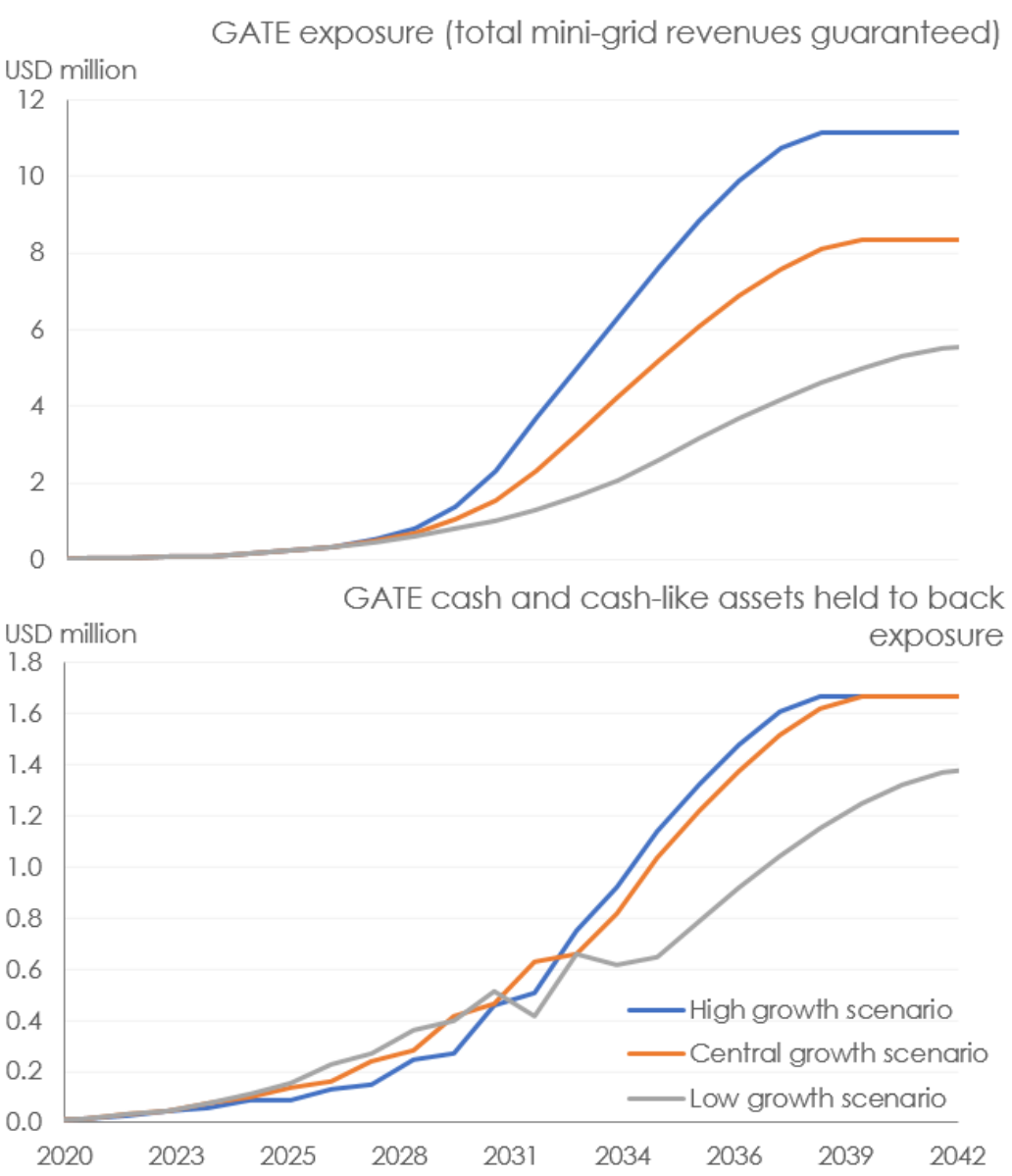
Figure 5: Growth scenarios modelled for GATE. Growth scenarios are determined by the rate of growth of GATE's portfolio (mini-grids added to the portfolio per year) and the leverage ratio (the ratio of cash-like capital held to revenues guaranteed across GATE's portfolio

Figure 6 shows GATE's exposure (aggregate mini-grid revenues guaranteed over the portfolio) and GATE's cash and cash-like assets held to back this exposure over time. Recall that

$$Leverage\ ratio = \frac{Cash\ and\ cash-like\ assets\ held\ to\ back\ total\ mini-grid\ revenues\ guaranteed}{Total\ mini-grid\ revenues\ guaranteed}$$

Thus Figure 6 provides further detail on the chart of leverage ratio over time in Figure 6.

Figure 6: GATE exposure and cash-like assets held to back exposure over time



GATE FINANCIAL PERFORMANCE ACROSS GROWTH PATHWAYS

Table 12 outlines how returns to equity and payback period vary in each pathway. We see that GATE can deliver strong returns for round one investors, but that payback periods are relatively long. The high-risk nature of investment at early funding rounds, combined with the relatively long payback period, shows the need for initial public funding.

Table 12: Return on equity and payback across Low, Central and High growth scenarios

Growth Scenario	Max Leverage ratio	Average annual growth rate	Max New Mini-Grids MW/year	IRR Round 1 Equity	Payback period
High	7.5:1	68%	300	18.0%	12 years
Central	5.0:1	50%	225	13.6%	14 years
Low	4.0:1	32%	150	9.0%	17 years

GATE FINANCIALS IN CENTRAL GROWTH PATHWAY

Table 13 shows the funding required by funding round, and the returns and payback period for each funding round in the Central growth pathway (unless otherwise specified from hereon we refer to the Central growth pathway). Again, we see that GATE can deliver attractive returns – returns that increase at later funding rounds as GATE reaches scale. GATE will be increasingly attractive to attract private investors as it scales up.

Table 13 – Equity Returns by Funding Round in Central Growth scenario

Funding round	Investment (US$ m)	Year	Return to equity	Payback period
Round 1	18.67	1	13.6%	14 years
Round 2	28.08	3	15.7%	12 years
Round 3	54.49	5	18.9%	10 years
Round 4	62.91	7	23.3%	8 years

Table 14 shows the capital structure assumed at each funding round.

Table 14: Capital structure by funding round in the Central growth pathway

	Round 1	Round 2	Round 3	Round 4
Investment in year	2019	2021	2023	2025
Equity	50%	100%	35%	5%
Grants	50%	0%	0%	0%
Counter-guarantees/unfunded products	0%	0%	65%	95%

GATE CASHFLOW ANALYSIS

In Section 4.1 Capital Needs of the main report, we noted that GATE has negative earnings until year four. GATE's revenues (composed of mini-grid premiums, treasury earnings and potential profit-sharing with mini-grids) are variable and proportional to portfolio size. GATE's costs have a fixed component (salaries and overheads) and a variable component (transaction costs and payouts). Until year four, fixed costs outweigh variable revenues. From year four onwards, variable revenues outweigh total costs as GATE reaches scale. Figure 7 shows GATE's net revenues, costs, and EBITDA over the lifetime of the business.

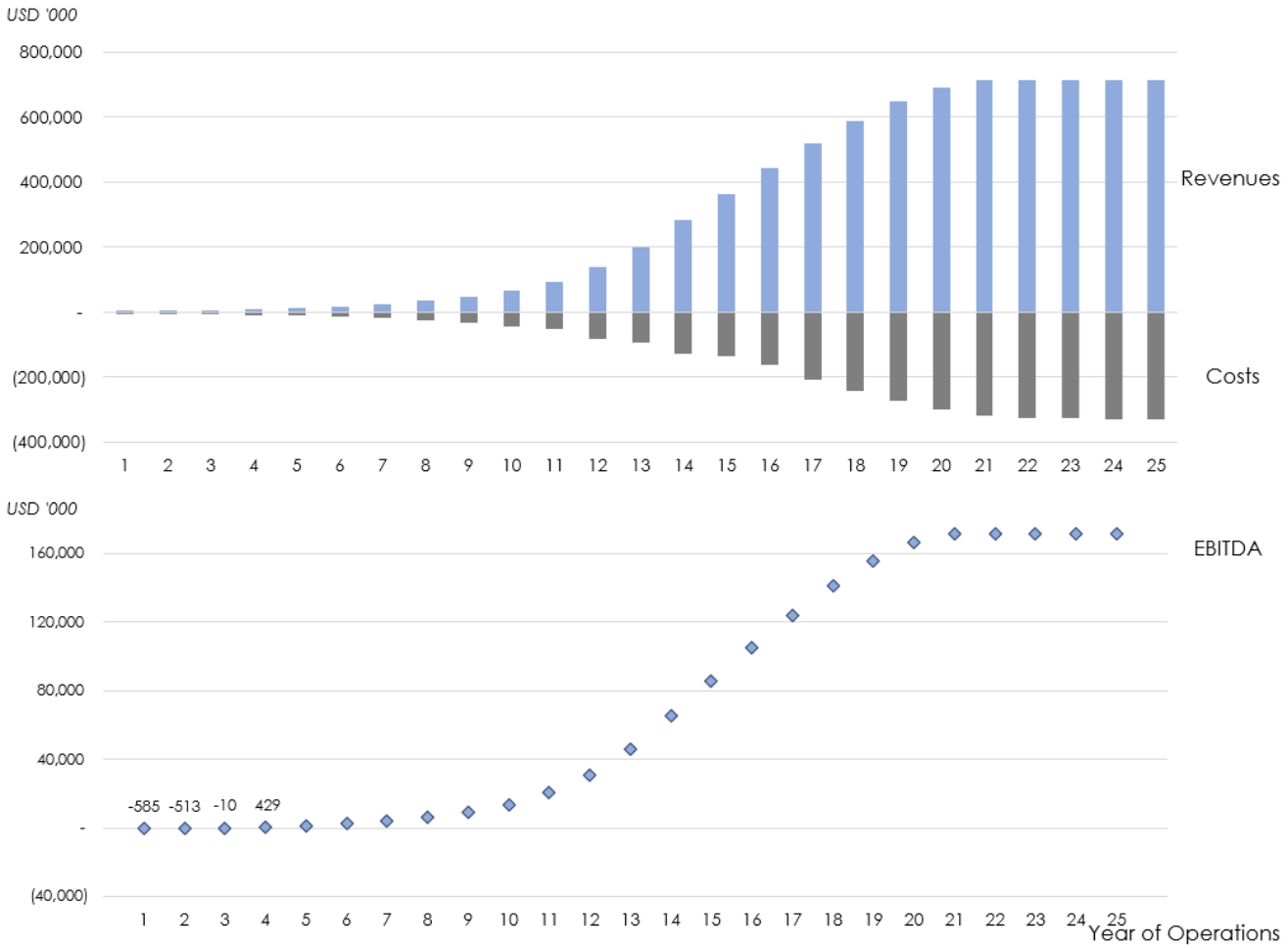


Figure 7: GATE cashflows: Revenues, costs and EBITDA over project lifetime. EBITDA is less than zero for the first three years. As scales up EBITDA rises.

Note again that this analysis – the Central Growth pathway – assumes that there are no payouts to mini-grids. This is a best-case scenario. See Figure 8 in the below section for an analysis of GATE's sensitivity to payouts.

GATE SENSITIVITY TO KEY VARIABLES

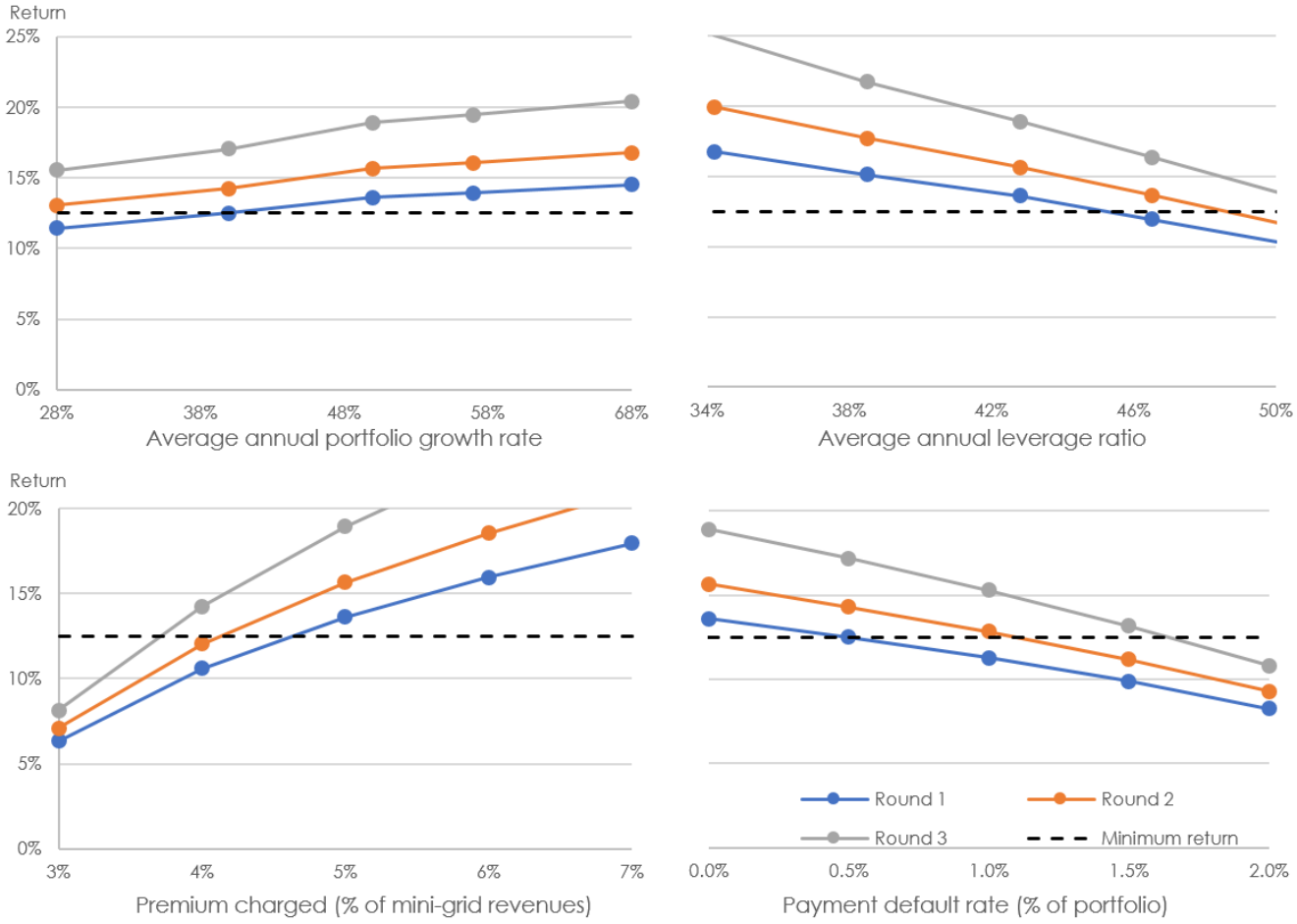
We conducted a sensitivity analysis to understand the impact of changing variables on the returns to equity from investment in GATE in funding rounds one to three. All other variables were held constant as each variable was varied. Our analysis identified the following variables as key drivers of GATE's performance: average annual portfolio growth rate, average annual leverage ratio, premium charged and payment default rate. Figure 8 shows how GATE's returns to equity vary for each key variable.

We briefly define each variable:

- Average annual portfolio growth rate: The % increase in portfolio size per year, on average over the project lifetime. Note that the portfolio growth rate is capped at a maximum, as detailed in Table 12 above.
- Average annual leverage ratio: The leverage ratio is defined above. In the growth pathways, GATE's leverage ratio changes over time. The average annual leverage ratio is the average leverage ratio across the lifetime of the project.
- Premium charged: The premium charged to mini-grid customers, as a percentage of mini-grid total revenues.
- Payment default rate: The average proportion of GATE's potential liability exposure that materializes per year. For example, if GATE guarantees USD 1 million worth of mini-grid revenues, with a 20% first loss deductible, then GATE is liable for a maximum of USD 800 thousand guarantee payments per year. In this scenario, a 2% default rate would mean GATE pays out USD 16 thousand.

Figure 8 underlines the importance of GATE's phased approach to implementation and commercialization. Data from Phases 1 and 2 will enable the GATE team to refine the pricing methodology for premiums.

Figure 8: Sensitivity of GATE equity returns to key variables. For assumptions see Modelling Assumptions



Growth is a key driver of returns – but low payment default rates and high leverage ratios (the two of which are closely linked: the lower and less volatile default rates are, the lower the leverage ratio can be). Measured growth in phase 2 will both enable a diversified portfolio that can have low leverage ratios and provide data on what constitutes a diversified portfolio. As well as providing these data, mini-grid performance data in Phases 1 and 2 will enable a detailed analysis of default rates and a predictive model on future payment defaults.

DETAILED ASSUMPTIONS IN GATE FINANCIAL MODEL

Table 15: Detailed assumptions in GATE financial model

PORTFOLIO	Unit	Value
Mini-grids		
Average Mini-grid Capacity	kW	300
Average Tariff	US$/kWh	1
Power Generation/Consumption	MWh/year	580
Assumed Revenue/kW installed	US$/kW	1933.3
Starting number of mini-grids	#	5
Growth Rate in first period	%	50%
Maximum MG/year in first period	#	75
Tariff	US$/MWh	100
Growth rate in second period	%	50%
Maximum MG/year in second period	#	750
Average Growth Rate	%	50%
Treasury		
Cash		1%
US$ T-Bills	%	2.0%
Country A Reference Rate	%	15%
Country B Reference Rate	%	13%
Country C Reference Rate	%	14%
Mid-term Instrument Yield	%	4%
Cash Management		
Cash	%	30%
Short-term Instruments: UST	%	30%
Short-term Instruments: LC	%	0%
Mid-term Instruments	%	40%
PRODUCT	**Unit**	**Value**
Coverage	%	80%
Deductible	%	20%
Coverage Period	years	8
Forward Capital Cover	years	3
Fee	%	5%
CAPITALIZATION	**Unit**	**Value**
Funding Round 1		
Total Capital		
Equity	%	50%
Grant	%	50%
Funding Round 2		
Total Capital		
Equity	%	100%
Funding Round 3		
Total Capital		
Equity	%	35%
Guarantee	%	65%
Funding Round 4		

Total Capital		
Equity	%	5%
Guarantee	%	95%
GUARANTEE TERMS	Unit	Value
Funding Round 3		
Fee	%	5%
Tenor	years	10.00
Grace	years	1.00
Upfront	%	0.20%
Funding Round 4		
Fee	%	5%
Tenor	years	6.00
Grace	years	1.00
Upfront	%	0.20%
OPERATIONS	Unit	Value
Staff		
CEO	US$ '000	120
Director	US$ '000	90
Associate	US$ '000	70
Number of new staff added every x years	#	2
New staff added every x years (input value = x)	years	2
Max staff	#	40
First staff increase	US$ '000	2
Working Capital		
Years of capital required	#	2
Working capital	US$ '000	50
Transaction Costs		
Initial Cost per Deal	US$ '000	50
Overheads		
Office	US$ '000	50
Travel	US$ '000	100
Overhead yearly increase	US$ '000	5%
TIMINGS	Unit	Value
Model Start	year	01/01/2019
Model Duration	years	25
Model End	year	31/12/2043
Funding Rounds		
Round 1	year	1
Round 2	year	3
Round 3	year	5
Round 4	year	7
Round 5	year	9
MACRO/GENERAL	Unit	Value
Inflation	%	2%
Tax	%	10%
PAY-OUTS AND PORTFOLIO UNDERPERFORMANCE	Unit	Value

% of portfolio revenues guaranteed that default per year[21]	%	0%

F. IMPACT ANALYSIS – ASSUMPTIONS

In this section we outline some of the key assumptions made to calculate GATE's potential catalytic, socio-economic and environmental impact.

MINI-GRID CAPACITY IN PHASE 2 TARGET COUNTRIES

Table 16: Key assumptions used to estimate mini-grid capacity in phase 2 target countries

Country	Year	Value	Source
Kenya	2023	2,500 MW	TFE Consulting 2017
Nigeria	2023	3,000 MW	REA 2017
Zambia	2023	340 MW	Based upon estimate of 5% of population addressed by mini-grids in 2030 (World Bank 2017b)

Socio-economic and environmental impact

Table 17: Key assumptions used to assess socio-economic and environmental impact

Variable	Units	Value	Source
Customers per 1MW mini-grid	# customers	5,270	Estimated by regressing mini-grid size vs customer numbers, using data from World Bank 2018b
Average mini-grid cost	US$ million	5	Conversations with subject-matter experts
Baseline emissions factor	tCO_2 / MWh	1.7	UNDP 2013

[21] As detailed below, we assume that GATE makes no pay-outs in the Low, Central and High growth scenarios. Data on mini-grid portfolio performance are insufficient to model portfolio performance accurately. Instead we choose to model a "best-case" scenario – which can be seen as an upper bound on performance.