

Shell Foundation



Applying Business Thinking to Global Development Challenges

Achieving SDG 7: The Need to Disrupt Off-Grid Electricity Financing in Africa

With the current pace of financing, SDG7 will be missed by more than 100 million households in sub-Saharan Africa.

Shell Foundation and Catalyst Off-grid Advisors have produced a report that puts the shortfall in sharp focus, and highlights the level and type of funding required to meet the UN goal.

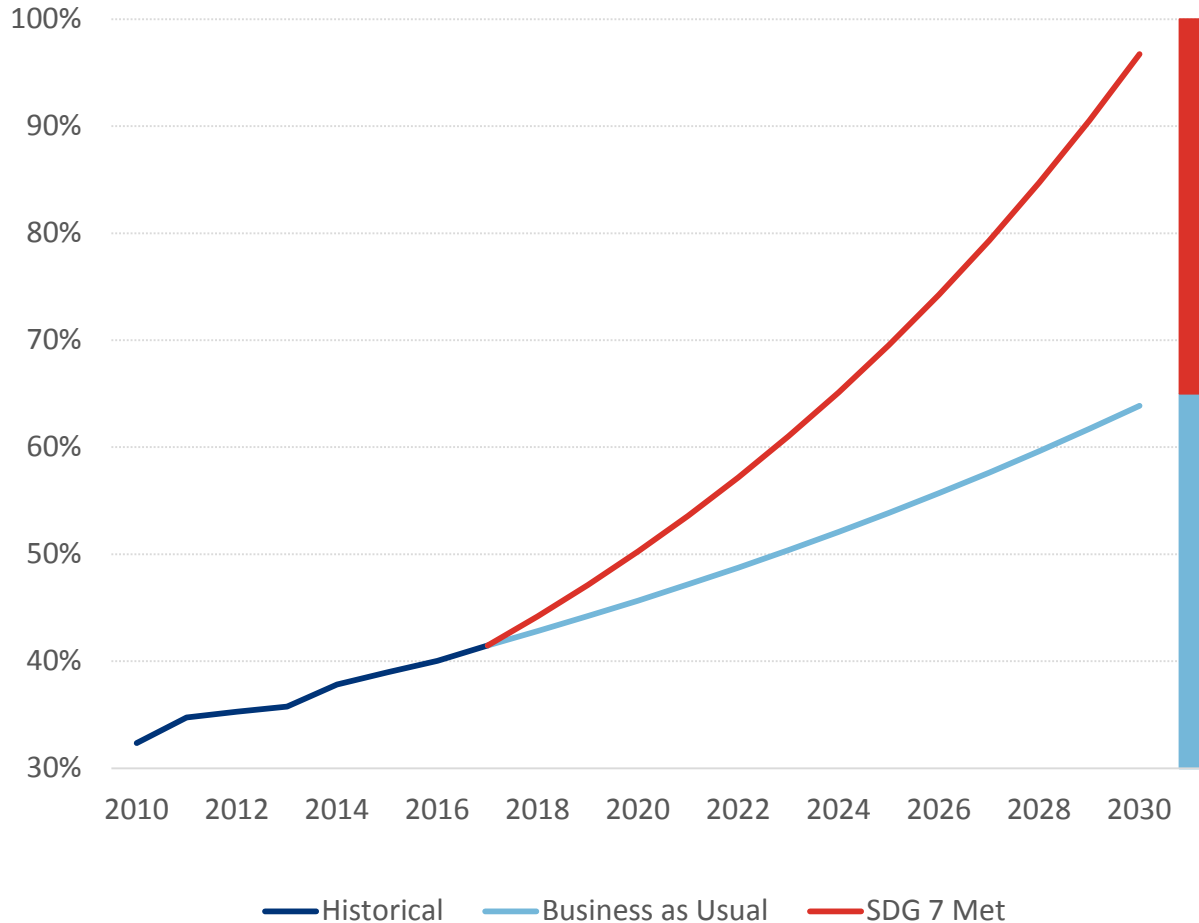


SDG 7 is a global imperative, yet we are falling far behind its achievement, especially in Africa



At the current pace, SDG 7 will be missed by more than 100 million households.....

Share of SSA Households with Electricity Access:
SDG7 vs. BAU



Continuing with Business as Usual :

65%

of HHs will have electricity access by 2030

104 million

HHs will remain without access (only 20M fewer than today).

\$11 billion

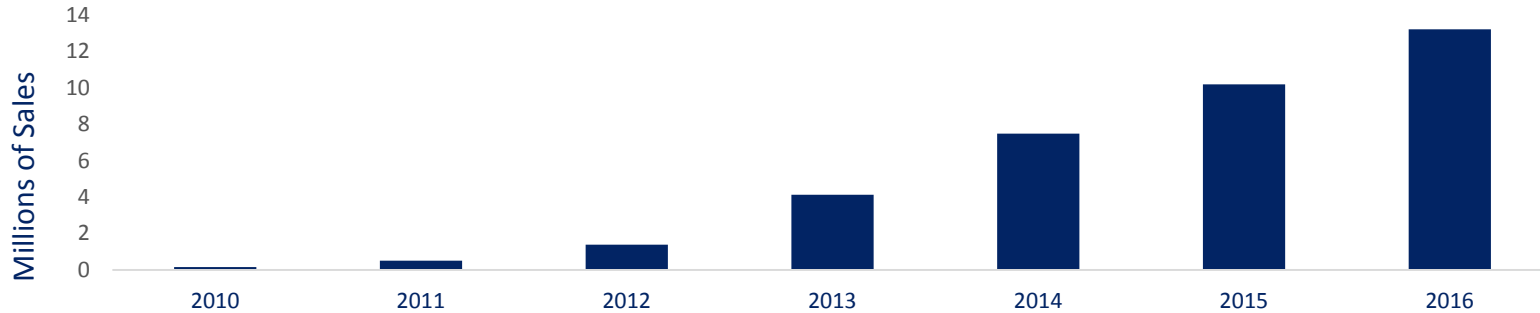
In capital required for mini-grid and SHS



.....and yet the progress to date on OGS has been remarkable, thanks to pioneering enterprises

SSA Cumulative Sales of Off-Grid Solar Products*

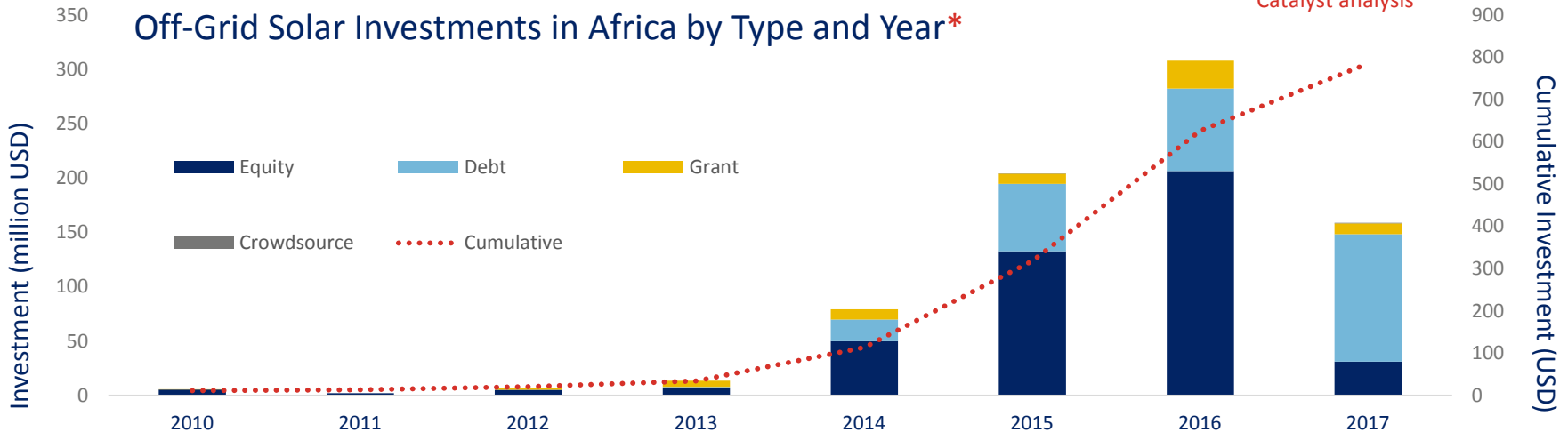
* Sales data of Lighting Global quality verified products (both lanterns and SHS)



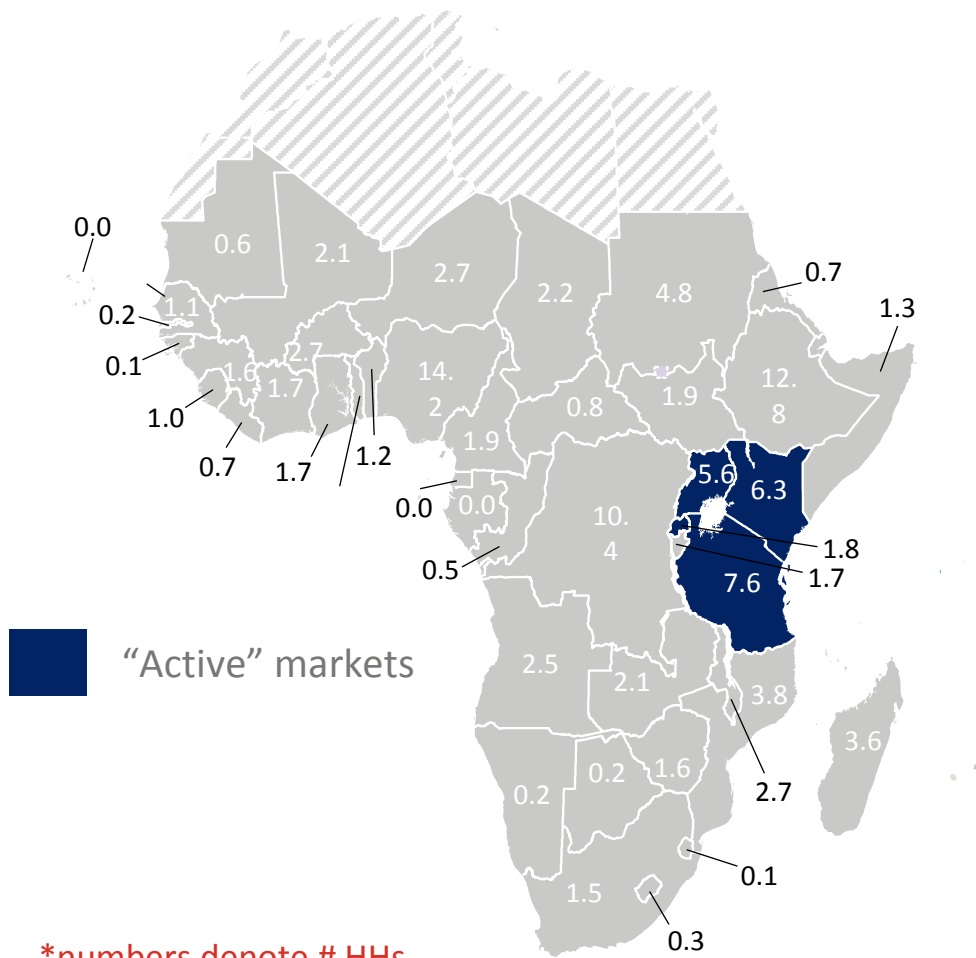
...and financial backers

Off-Grid Solar Investments in Africa by Type and Year*

* Catalyst analysis



The scope of the challenge, however, is daunting



*numbers denote # HHs without access to electricity

- Over **125M HHs** lack access to modern energy services.
- With current grid extension and population growth trends, a total of **210M off-grid HHs** will need to be connected by 2030.
- Only **4 of 48 markets** are **"Active" off-grid electricity markets**, where more than one company selling solar home systems at scale (>20,000 customers) in that market.

Our approach to analysing SDG 7 in Africa



We've focused on portions of SDG 7

SDG 7

Our Analysis

Global

● SSA only

Access to affordable, reliable, sustainable, and modern energy for all

● Clean Cookstoves

● Grid Extension

● Off-Grid Solutions (SHS and MG)

● Households

Increase Share of Renewables

● Outside of scope

2x rate of improvement in energy efficiency

● Outside of scope

Enhance international cooperation

● *Scaling Off-Grid Energy Platform*

LDCs, SIDs, Land-locked

● Yes – Universal Access

● Full alignment

● Partial fit

● Outside of our scope



We combined top-down and bottom-up analyses



- Where are we now vis-à-vis SDG7?
- Where are we headed?
- What is the gap between BAU and SDG 7?

- How much time and capital is required to build an off-grid enterprise?
- What pace of deployments are required?
- What does this mean for SDG 7?

- How many enterprise deployments, when?
- What markets?
- How much capital?
- What type of capital?
- What else?

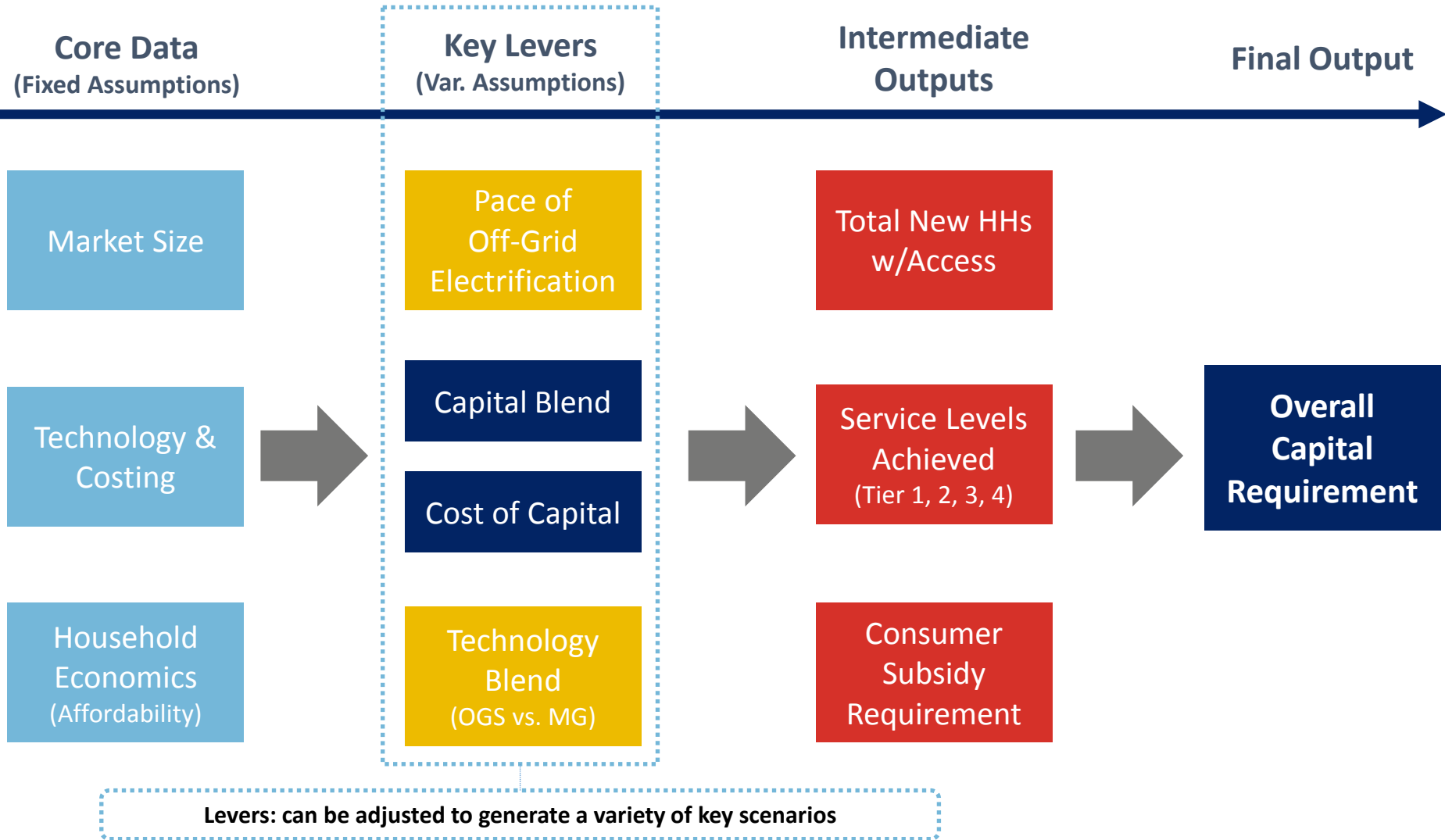


Top-down analysis: Overview and Approach

- **Unit of analysis:** Sub-Saharan Africa
- **Approach:** Modelled the continuum of capital required continent-wide to achieve universal electricity access
 - Includes breakdown of household service levels and direct subsidy requirements
- **Suitability of approach:**
 - OGS and mini-grid companies operate across borders;
 - Granular, country-level detail is not required; and
 - Working under a short timeline
- **Capital requirements** to be driven by key intermediate determinations, including:
 - The quantum of HHs in need of OGS or mini-grid solutions;
 - The all-in cost of delivering such systems; and
 - The technology blend of products delivered



Predictive Model: Architecture (Visualised)



Data sources for predictive model

Population: UN DESA

Grid connectivity: International Energy Agency – Africa Energy Outlook, World Bank data

Mini-grid connectivity: Various World Bank data sources (concessions study, project appraisal documents)

Off-grid solar sales: GOGLA off-grid market reports

SHS costing: Various industry sources

Mini-grid costing: Various industry sources

Affordability: World Bank PovCal data



Several assumptions underlie the model

Demographics

2017 Avg. Household Size	5 PAX/HH
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OGS Sales Data

Share of Active OGS Systems in SSA	50%
Hist. % of OGS Sales to HHs w/o Grid	80%
Hist. % of OGS Sales to HHs w/Grid	10%
Hist. % of OGS Sales to SMEs	10%

OGS Trends

WC Loan Interest Rate (US\$)	10%
Consumer Finance Interest Rate (US\$)	10%

Off-Grid Solar

Tier 1 SHS 2017 FOB Price	\$55
Tier 2 SHS 2017 FOB Price	\$130
Annual Change in SHS FOB Price	-5.0%
Annual OPEX as % of Total T1 SHS Cost	40%
Annual OPEX as % of Total T2 SHS Cost	30%
Tier 1 SHS Customer Pmt (for 18 mths)	\$6
Tier 2 SHS Customer Pmt (for 24 mths)	\$13
Non-Payment Rate	10%

Mini - Grids

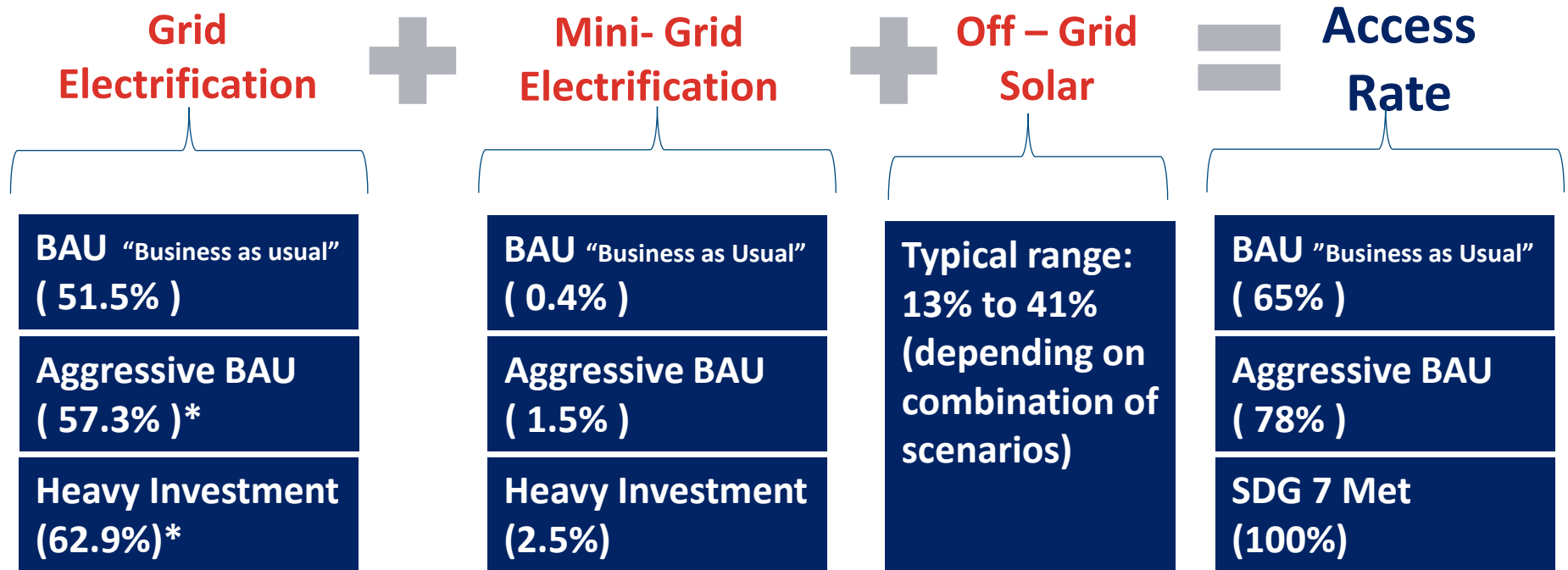
Mini-Grid Generation capacity per customer	250
Mini-Grid CAPEX Cost	\$2.5/W
Annual Change in CAPEX Cost	-3.0%
Upfront Soft Costs	\$1/W
Annual Change in Soft Costs	-3.0%
Mini-Grid All-In Investment Cost	3.5
2017 OPEX Cost as % of Total CAPEX	5%

Financing

SHS Lifetime (years)	4
Annual Change in Tier 1 % Sales	-1.0%



We modelled scenarios using the following inputs and variable assumptions



*NB: Even in the IEA's African Century Scenario, grid expansion rates are lower than these estimates.

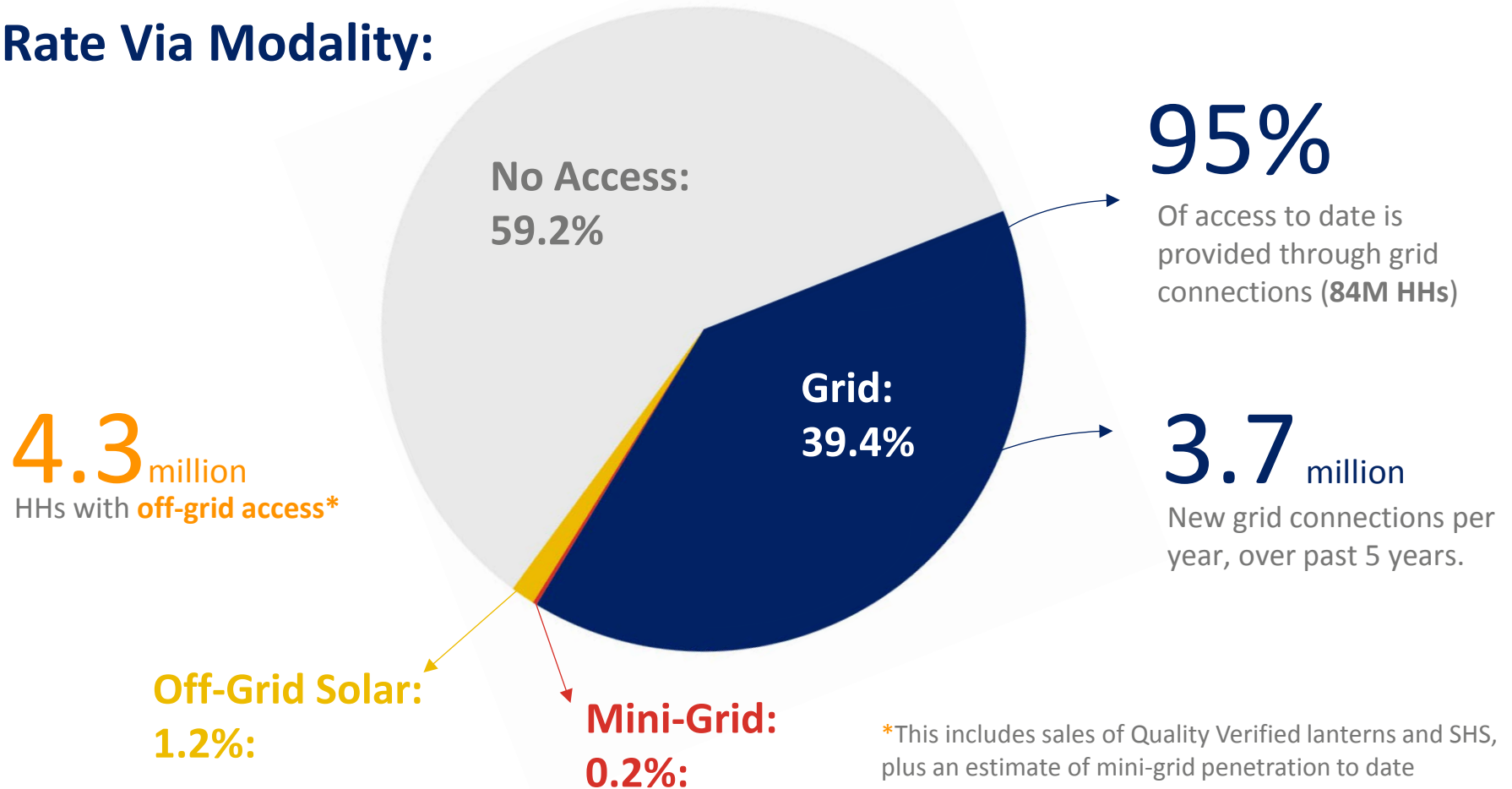


Framing the Continental Challenge



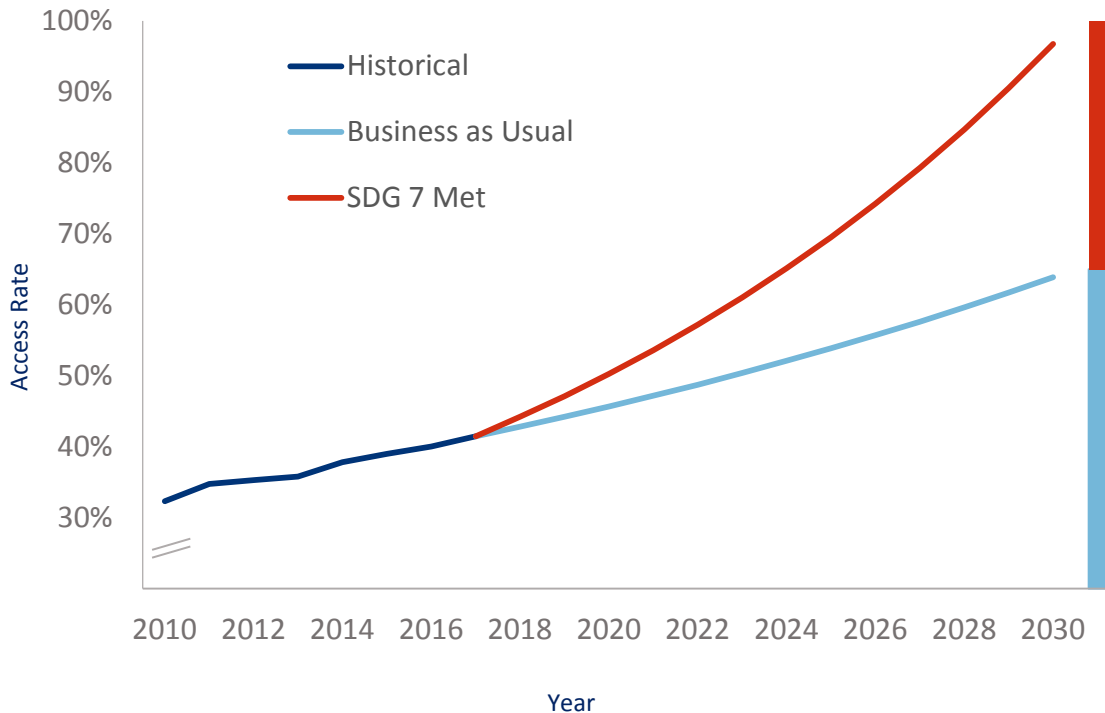
Not surprisingly, the grid still delivers the majority of energy services to households

2017 HH Access Rate Via Modality:



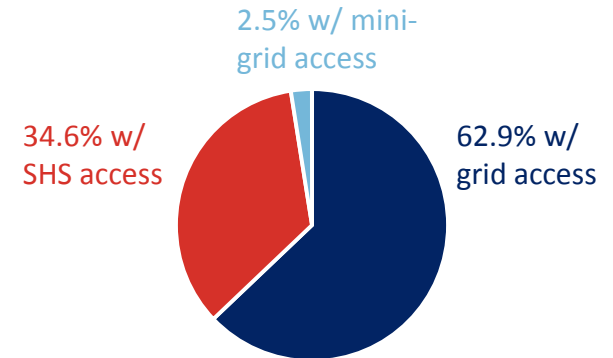
Even with heavy grid and mini-grid projections, SHS would still need to deliver 34.6% of access in order to achieve SDG 7

Share of SSA Households with Electricity Access:
SDG7 vs. BAU



298 million

HHs will have electricity access by 2030, with...



...and requiring

\$31 billion

for mini-grid and SHS



Consumer affordability will be a challenge: our simulation shows that US\$4 billion may be needed



37%

of SSA households may not be able to pay for off-grid solar products

\$4B

shortfall in the ability of households to pay

How this was derived:

- Used the World Bank PovCal tool to develop several “poverty lines” across SSA
- Attributed a resultant level of ability to pay shortfall
- And assumed:
 - A household would be willing to pay **5%** of its total income on electricity
 - The shortfall represents the remaining costs to provide a needed **\$6/month** on electricity.



For example:

HH with **an income of \$1.5/day** will have a **\$3.7/month shortfall**

HH with **an income of \$2.0/day** will have a **\$3.0/month shortfall**

HH with **an income of \$3.0/day** will have a **\$1.5/month shortfall**



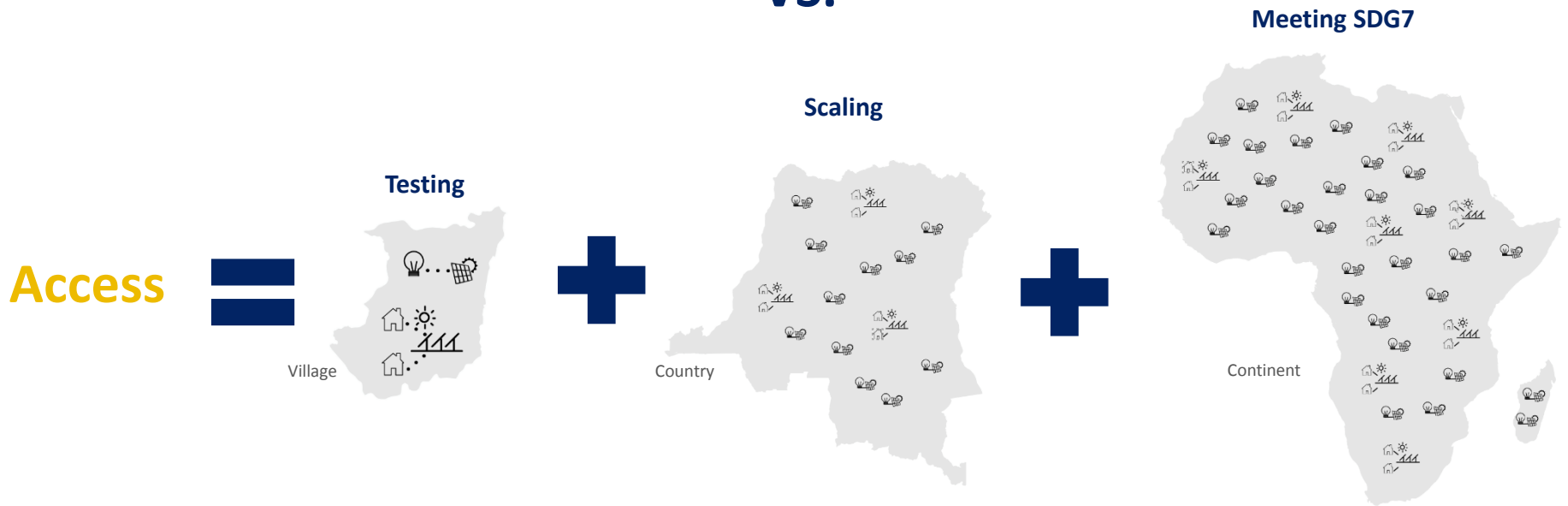
Enterprise-Level Perspectives



An Enterprise lens is critical: delivering off-grid access happens one SHS or mini-grid deployment at a time

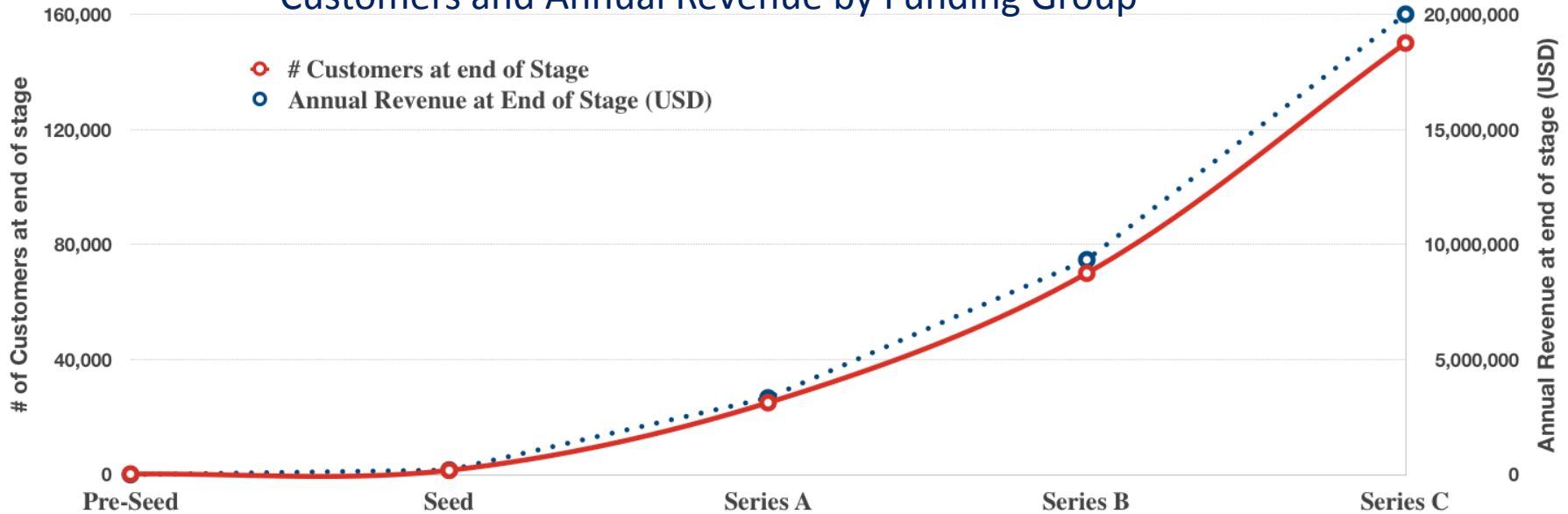
Grid Electrification + Mini-Grid Electrification + Off-Grid Solar = Access Rate

VS.



And it's hard work: establishing and scaling an SHS off-grid deployment in *one country* takes years and millions of dollars

Customers and Annual Revenue by Funding Group



	Pre-Seed	Seed	Series A	Series B	Series C
# customers at end of Stage	200	1,500	25,000	70,000	150,000
Debt (USD)		300,000*	1,000,000	3,750,000	9,500,000
Equity (USD)	50,000*		5,000,000	7,500,000	11,000,000
Grants (USD)	150,000	200,000	1,000,000	1,000,000	
Capital Sources	Founders, friends and family	Angels, foundations, family offices	Early stage impact funds, foundations	DFIs, specialised funds	Commercial sources, de-risking instruments

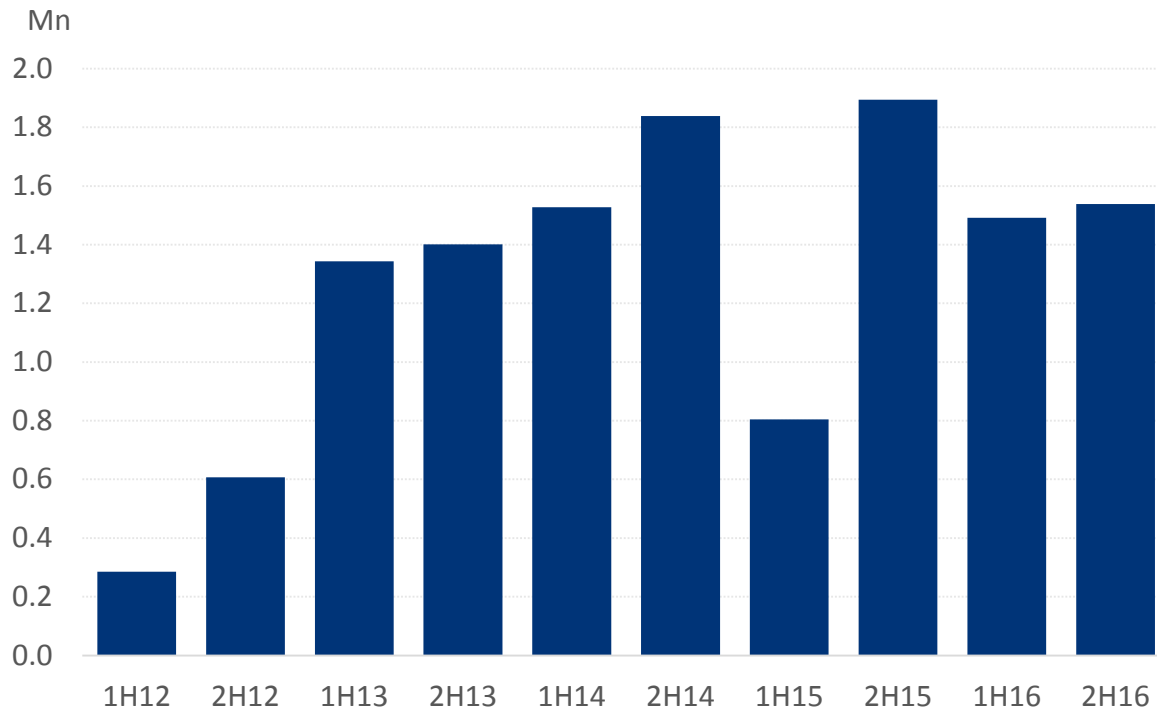
* Founders (Friends/Family) Equity

* Convertible Debt



Meanwhile, the industry's sales are flat. While there are explanations, this trend is worrisome.

SSA Annual Sales of Off-Grid Solar Products



Currency Devaluation

The industry's FX risk is considerable given that most enterprises are capitalised in hard currency and paid in local currency

Drought

The disposable income of many rural customers was heavily impacted by recent droughts

Import Tariffs

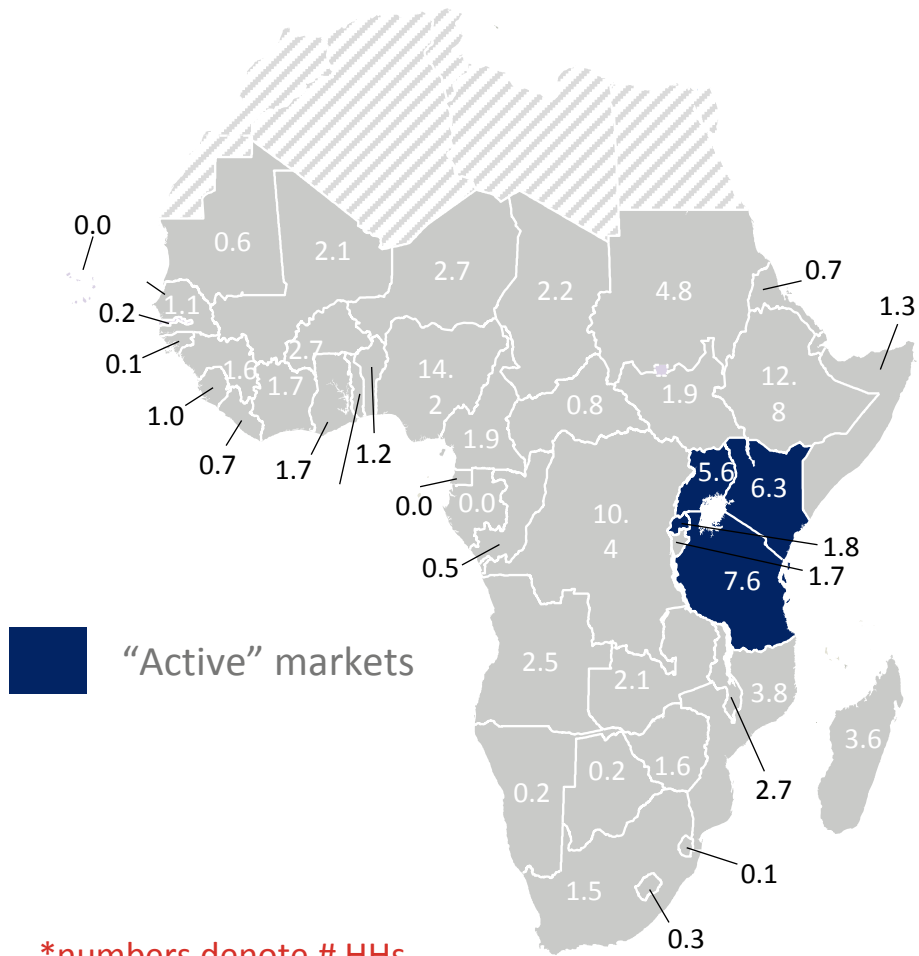
Policy changes within EAC countries has resulted in higher tariffs and affected solar product sales

Market Concentration

Figures are subject to the "lumpiness" of individual orders, particularly in four East African markets where the industry is concentrated



...particularly given that only 1% of off-grid households have been reached.



*numbers denote # HHs without access to electricity

Only **4 of 48** markets are **“Active” off-grid electricity markets** (more than one company selling solar home systems at scale [$>20,000$ customers]).

Concentration in “easy” markets:

- open markets, where private sector-led activities relatively easy
- Anglophone countries
- “Silicon Savannah” - Kenya as epicenter

Achieving SDG 7 in “active” markets alone is a daunting task, with greater scale and competition needed

1. Growth within each market*

For 1st Generation (scaling) OGS companies, financing to achieve:

- Scale
- Profitability
- Sustainability

Types of capital required:

- Growth stage equity
- Debt, mostly local currency

* Modelling Assumptions:
10 1st Generation company deployments capture 75% of market share in these markets.



2. Competition within markets**

Enable competitive, sustainable markets via new deployments (among 1st, 2nd and 3rd Gen OGS companies)

Early stage capital, to enable deployments to reach growth capital phase

Types of capital required:

- Grants
- Patient equity
- Early debt

** Modelling Assumptions:
remaining 25% market share captured by 2nd and 3rd generation company deployments, capped at 250,000 customers each



“Active” markets have 15 scaled deployments, with total market penetration of around 6%.

Uganda

6.2M HHs - Off Grid Market Size

250,000 HHs - Market Penetration to date

4 - Deployments currently at scale:

M-KOPA SOLAR

fenix intl

solar now

Village Power

Kenya

7.1M HHs - Off Grid Market Size

750,000 HHs - Market Penetration to date

4 - Deployments currently at scale:

d.light

Qazuri

BBOXX

M-KOPA SOLAR

Rwanda

1.7M HHs - Off Grid Market Size

100,000 HHs - Market Penetration to date

3 - Deployments currently at scale:

BBOXX

mobisol

IGNITE
Power for a Greener East

Tanzania

7.2M HHs - Off Grid Market Size

200,000 HHs - Market Penetration to date

4 - Deployments currently at scale:

mobisol

M-KOPA SOLAR

OFF-GRID ELECTRIC

GCS
TOGETHER WE CAN DO MORE



To achieve SDG7 in “active” markets, 43 new deployments and \$4.7 billion of capital (including \$137M of grants) are needed

Uganda

10 1st gen company deployments

serving **4.5M HHs** and requiring:

- \$24M Grant
- \$321M Equity
- \$657M Debt

7 2nd and 3rd gen company deployments

serving **1.5M HHs** and requiring:

- \$16M Grant
- \$178M Equity
- \$154M Debt

Rwanda

4 1st gen company deployments

serving **1.2M HHs** and requiring:

- \$9M Grant
- \$111M Equity
- \$124M Debt

2 2nd and 3rd gen company deployments

serving **0.4M HHs** and requiring:

- \$5M Grant
- \$50M Equity
- \$40M Debt

Kenya

10 1st gen company deployments

serving **5.1M HHs** and requiring:

- \$24M Grant
- \$337M Equity
- \$718M Debt

7 2nd and 3rd gen company deployments

serving **1.7M HHs** and requiring:

- \$16M Grant
- \$183M Equity
- \$175M Debt

Tanzania

10 1st gen company deployments

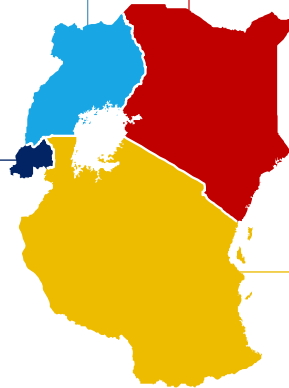
serving **5.4M HHs** and requiring:

- \$24M Grant
- \$345M Equity
- \$751M Debt

8 2nd and 3rd gen company deployments

serving **1.8M HHs** and requiring:

- \$19M Grant
- \$205M Equity
- \$184M Debt



And yet those are the “easy” countries. What about the rest of the continent, which is virtually untapped?

- “Latent” markets require substantial early-stage, risk tolerant capital in order to be unlocked
- New 2nd and 3rd generation OGS companies need to be seeded, while 1st generation OGS companies need support for international expansion
- Consolidation likely occur through M&A activities among the 1st, 2nd, 3rd generation companies



First, we have the “Big 3”: 46M off-grid HHs, requiring 142 new deployments and \$9.2 billion

Nigeria

7.8M

HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$411M Equity
- \$849M Debt

12M

HHs to be served by an estimated **47** 2nd and 3rd gen company deployments requiring:

- \$110M Grant
- \$1.2B Equity
- \$1.2B Debt

Ethiopia

5.8M

HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$356M Equity
- \$626M Debt

8.6M

HHs to be served by an estimated **35** 2nd and 3rd gen company deployments requiring:

- \$82M Grant
- \$920M Equity
- \$894M Debt

DRC

4.9M

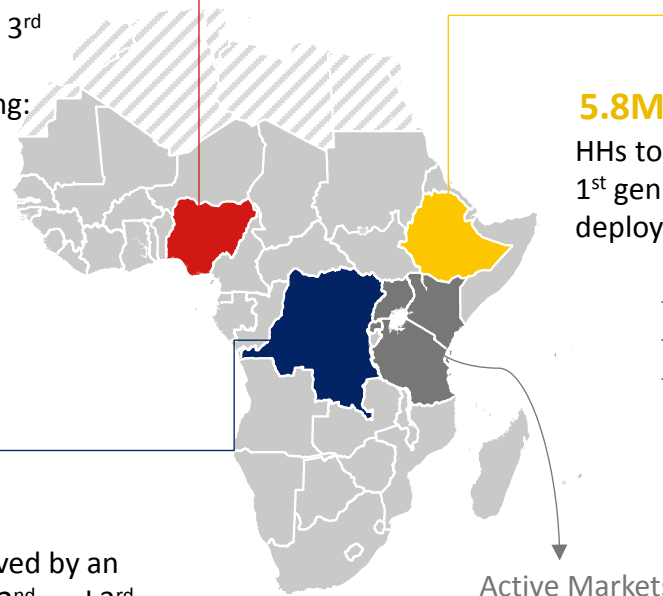
HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$331M Equity
- \$527M Debt

7.3M

HHs to be served by an estimated **30** 2nd and 3rd gen company deployments requiring:

- \$70M Grant
- \$786M Equity
- \$758M Debt



****Modelling Assumptions:**
40% market captured by 1st generation deployments, remainder captured by 2nd and 3rd generation deployments, capped at 250,000 customers each



West and Central Africa have 36M off-grid HHs, and need 117 new deployments and \$7.2B

West Africa 1

Cabo Verde, Gambia, Guinea, Guinea-Bissau, Mali Republic, Mauritania, Senegal Republic and Sierra Leone

3M

HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$278M Equity
- \$318M Debt

4.5M

HHs to be served by an estimated **19** 2nd and 3rd gen company deployments requiring:

- \$45M Grant
- \$495M Equity
- \$468M Debt

West Africa 2

Benin, Burkina Faso, Ghana, Liberia, Niger, Sao Tome and Principe, Togo and Ivory Coast

5M

HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$335M Equity
- \$544M Debt

7.6M

HHs to be served by an estimated **31** 2nd and 3rd gen company deployments requiring:

- \$73M Grant
- \$812M Equity
- \$781M Debt

Central Africa

Burundi, Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, Gabon, South Sudan and Sudan

6M

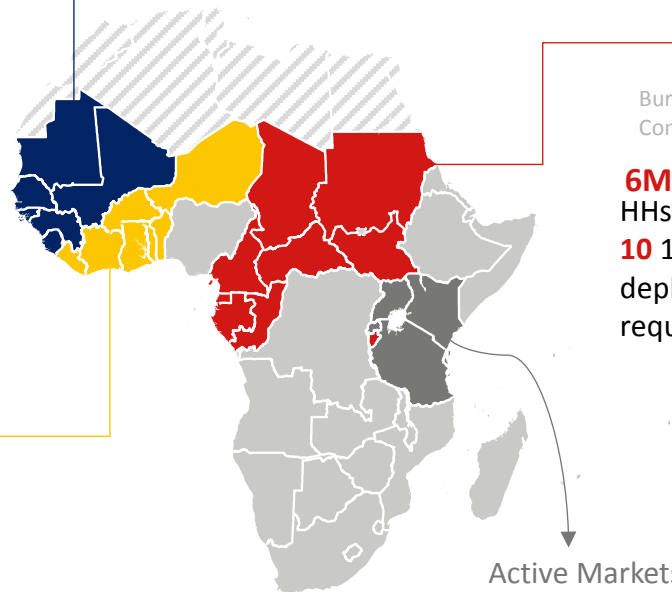
HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$361M Equity
- \$649M Debt

9M

HHs to be served by an estimated **37** 2nd and 3rd gen company deployments requiring:

- 86M Grant
- \$968M Equity
- \$925M Debt



****Modelling Assumptions:**
40% market captured by 1st generation deployments, remainder captured by 2nd and 3rd generation deployments, capped at 250,000 customers each



Southern Africa and the rest of east Africa have 22M off-grid HHs, require 85 new deployments, and \$4.8B

Southern Africa 1

Angola, Botswana, Lesotho, Namibia, South Africa and Swaziland

2M

HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$258M Equity
- \$234M Debt

3.4M

HHs to be served by an estimated **14** 2nd and 3rd gen company deployments requiring:

- \$32M Grant
- \$367M Equity
- \$353M Debt

Rest of East Africa

Comoros, Djibouti, Eritrea, Madagascar, Reunion, Seychelles and Somalia Republic

2.6M

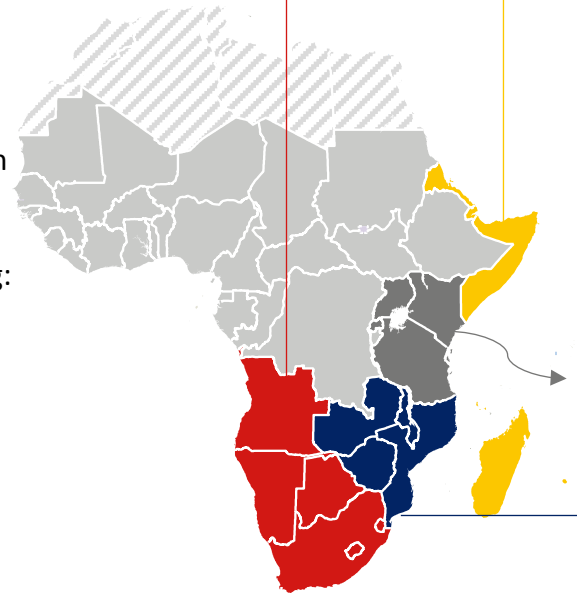
HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$268M Equity
- \$278M Debt

4M

HHs to be served by an estimated **17** 2nd and 3rd gen company deployments requiring:

- \$39M Grant
- \$441M Equity
- \$413M Debt



Active Markets

Southern Africa 2

Malawi, Mauritius, Mozambique, Zambia and Zimbabwe

3.9M

HHs to be served by **10** 1st gen company deployments requiring:

- \$24M Grant
- \$304M Equity
- \$421M Debt

5.9M

HHs to be served by an estimated **24** 2nd and 3rd gen company deployments requiring:

- \$56M Grant
- \$630M Equity
- \$611M Debt

**Modelling Assumptions:

40% market captured by 1st generation deployments, remainder captured by 2nd and 3rd generation deployments, capped at 250,000 customers each



SHS enterprise lens – what's needed to hit SDG 7: 298 deployments and \$26 billion, including \$943 million in catalytic grants

Latent Markets

104M HH Off-Grid Market Size

42M HHs to be served by 1st gen company deployments

62M HHs to be served by 2nd and 3rd gen company deployments

10 1st gen company deployments requiring:

211M In grant finance

2.9B In equity

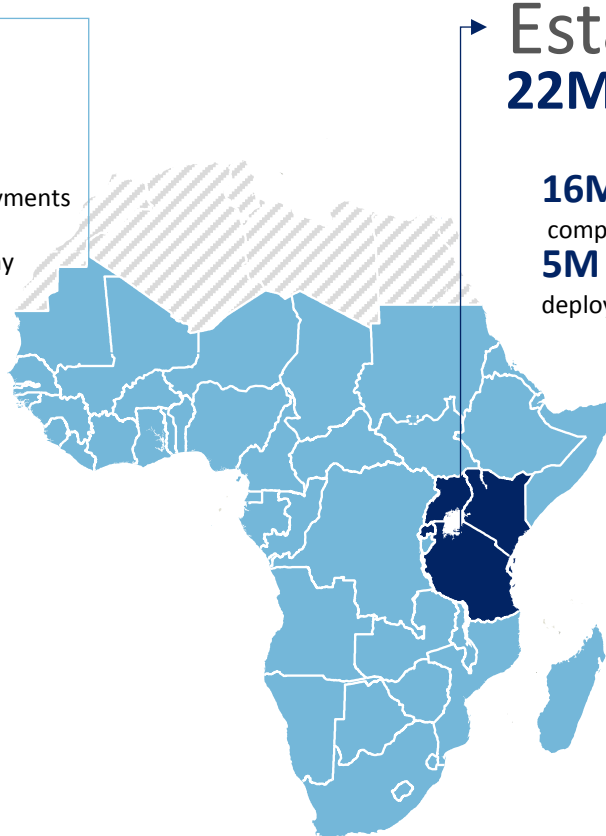
4.5B In debt

254 2nd and 3rd gen company deployments requiring:

596M In grants

6.7B In equity

6.4B In debt



Established Markets

22M HH Off-Grid Market Size

16M HHs to be served by 1st gen company deployments

5M HHs to be served by 2nd and 3rd gen company deployments

10 1st gen company deployments requiring:

80M In grants

1.1B In equity

2.3B In debt

24 2nd and 3rd gen company deployments requiring:

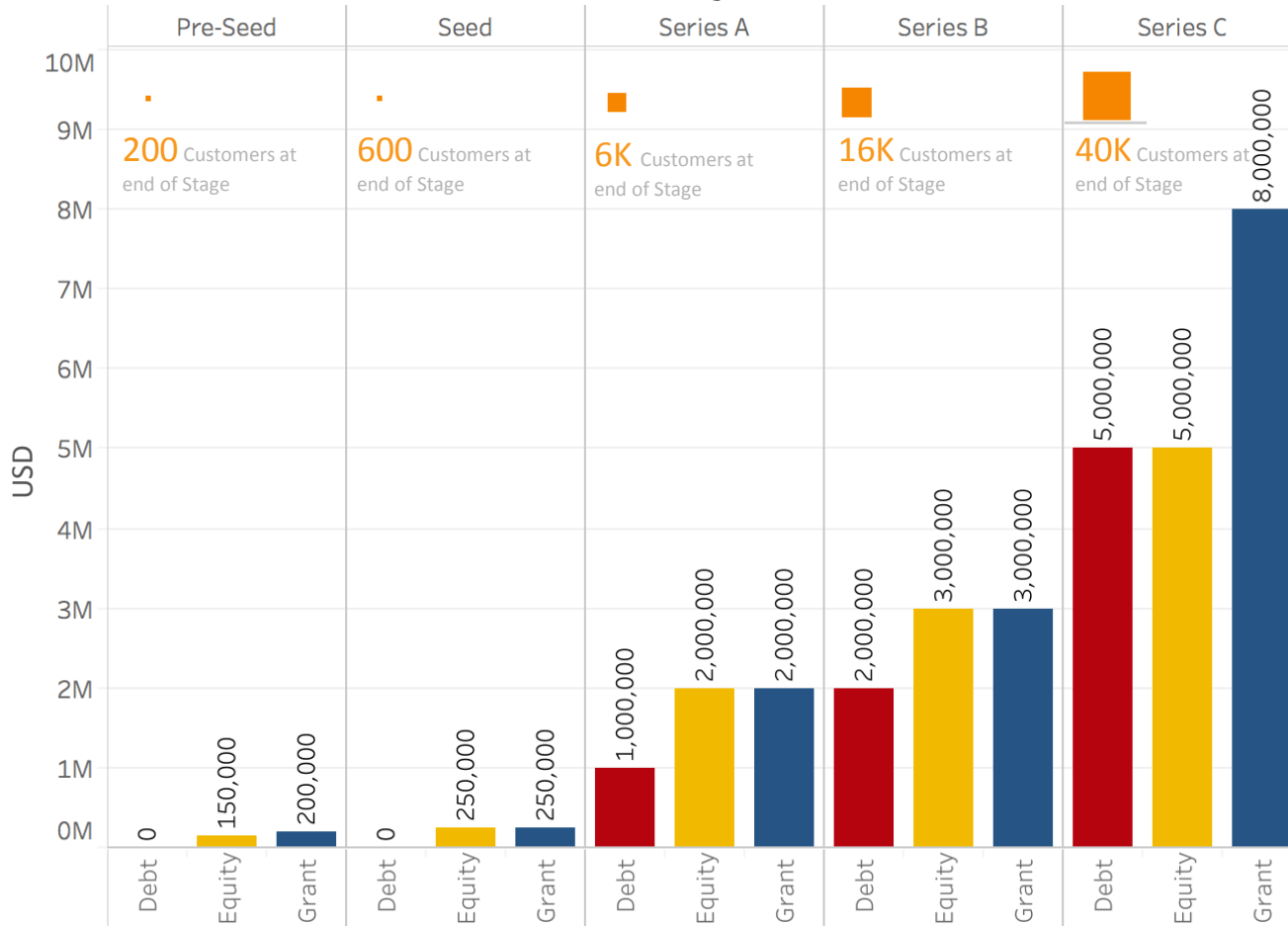
56M In grant finance

617M In equity

555M In debt



Mini-grids could catalyse rural SMEs and HH productive use; would require considerable grant capital given business model economics



31.8M In total
Capital Needs:

8M Debt

10.4 M Equity

13.4 M Grant

40,000
cumulative
customers by end of
series C



To serve 2.5% of SSA households via mini-grids in 2030 would require an additional 39,000 MG deployments and \$7.1B in capital

Today 2017

0.2%

Of households served by mini-grids

0.5M*

HHs with mini-grid connections

3,000

Total mini-grids

In 2030 Assuming 2.5%

2.5%

Of households served by mini-grids

7.5 M

HHs with mini-grid connections

42,000**

Total mini-grids

* Inferred from recent analysis of mini-grid concessions in Africa and authors' knowledge of market trends

** Assuming the following: 50kW installed capacity; 200 customers per site; \$2.5/W capex and \$1/W upfront soft costs

\$7.1 billion

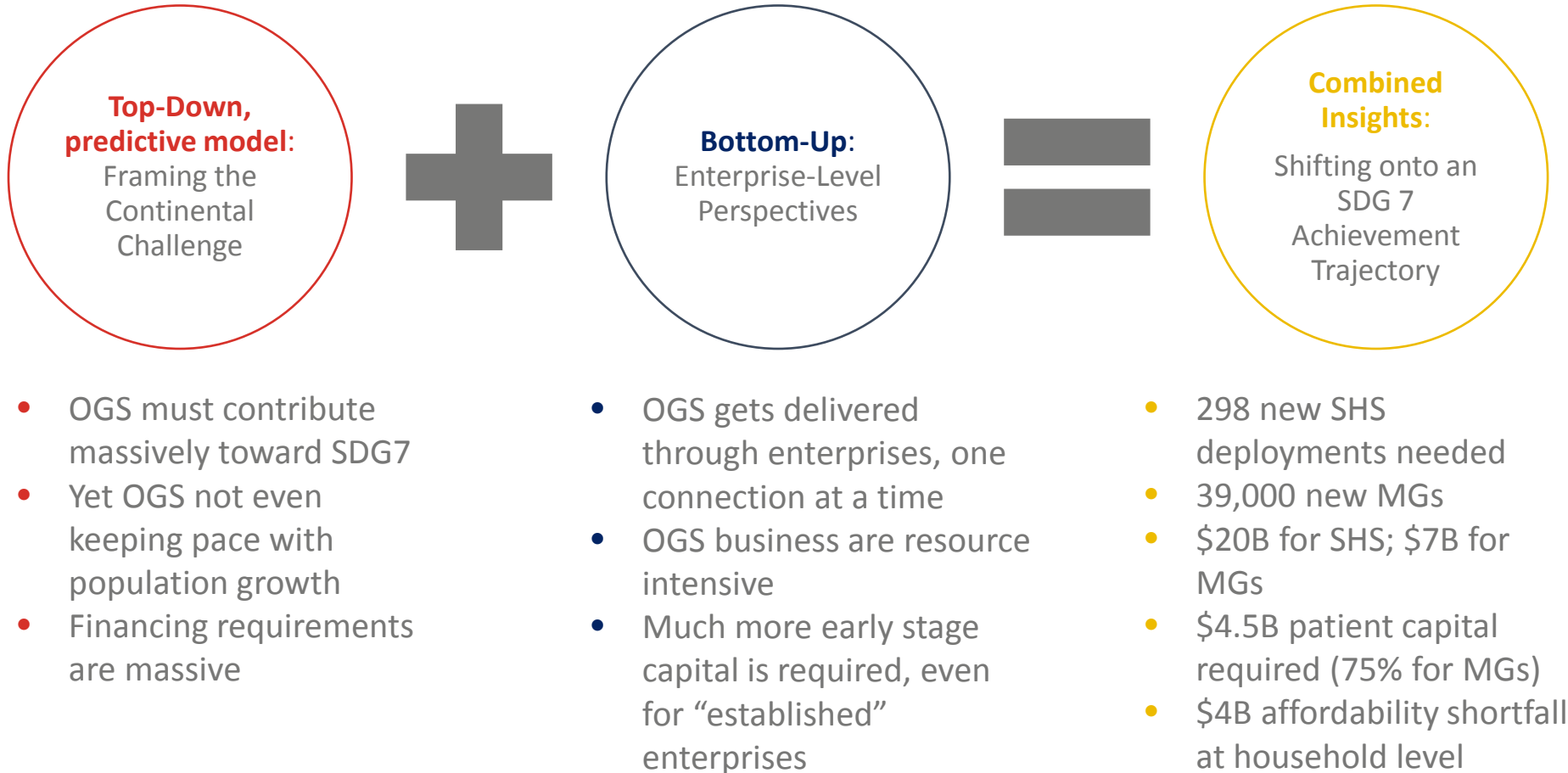
In total capital would be required to achieve this



Shifting onto an SDG 7 Achievement Trajectory



What the analysis tells us



Summary: Achieving SDG7 in each model

Top-Down

Predictive Model

\$31 billion

In mini-grid and OGS capital requirement

7.5 million

HHs with **Mini-Grid** connections by 2030

103 million

HHs with **SHS** connections by 2030

\$4 billion

SHS affordability shortfall

Achieving
SDG7

Bottom-Up

Enterprise Level Model*

\$33 billion

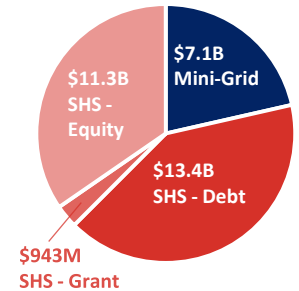
In mini-grid and OGS investment

7.5 million

HHs with **Mini-Grid** connections by 2030

126 million

HHs with **SHS** connections by 2030



* assuming 2.5% access via mini-grids and heavy grid investment

Notes: SHS connections differ due to each model's assumptions: the bottom-up model uses a static value for total # of HHs, while the top-down accounts for grid expansion and population growth. The financing figures being proximate are a coincidence, given the different inputs/assumptions used to derive them



CATALYST

OFF GRID ADVISORS

What this means for key stakeholders

OGS Entrepreneurs

What this means for established players:

- Growth in existing markets + massive expansion (and growth) in new markets.
- Need to figure out new ways to move into new markets
- Need to double down on grant capital to fuel expansion

What this means for 2nd and 3rd generation companies:

- Many, many more are needed.
- Space to enter established markets, but latent markets hold the real opportunity
- Differentiate approach to market entry

African Governments

- Create enabling conditions for industry takeoff.
- Fiscal incentives and predictable regulatory environments will be critical
- Consider the fiscal implications of off-grid vs grid, and public vs private sector led
- Infrastructure finance principles: just like the grid.

Mini-Grid Entrepreneurs

- Massive scale up required, comes down to capital raises and execution
- Productive use and SME growth keys to justifying higher Capex
- Focus on ring-fencing sites, raising capital around those
 - (including massive concessional financing)

Investors

- Industry demands much more patient capital
 - Still an infant industry that requires significant concessional financing
- Especially for equity investors, very few opportunities
 - And yet there needs to be massive amounts of equity going into the market
 - Signals that new ventures need to be seeded
- Fundamental change required in order to motivate expansion into new markets and mobilise early stage capital



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