

# 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.

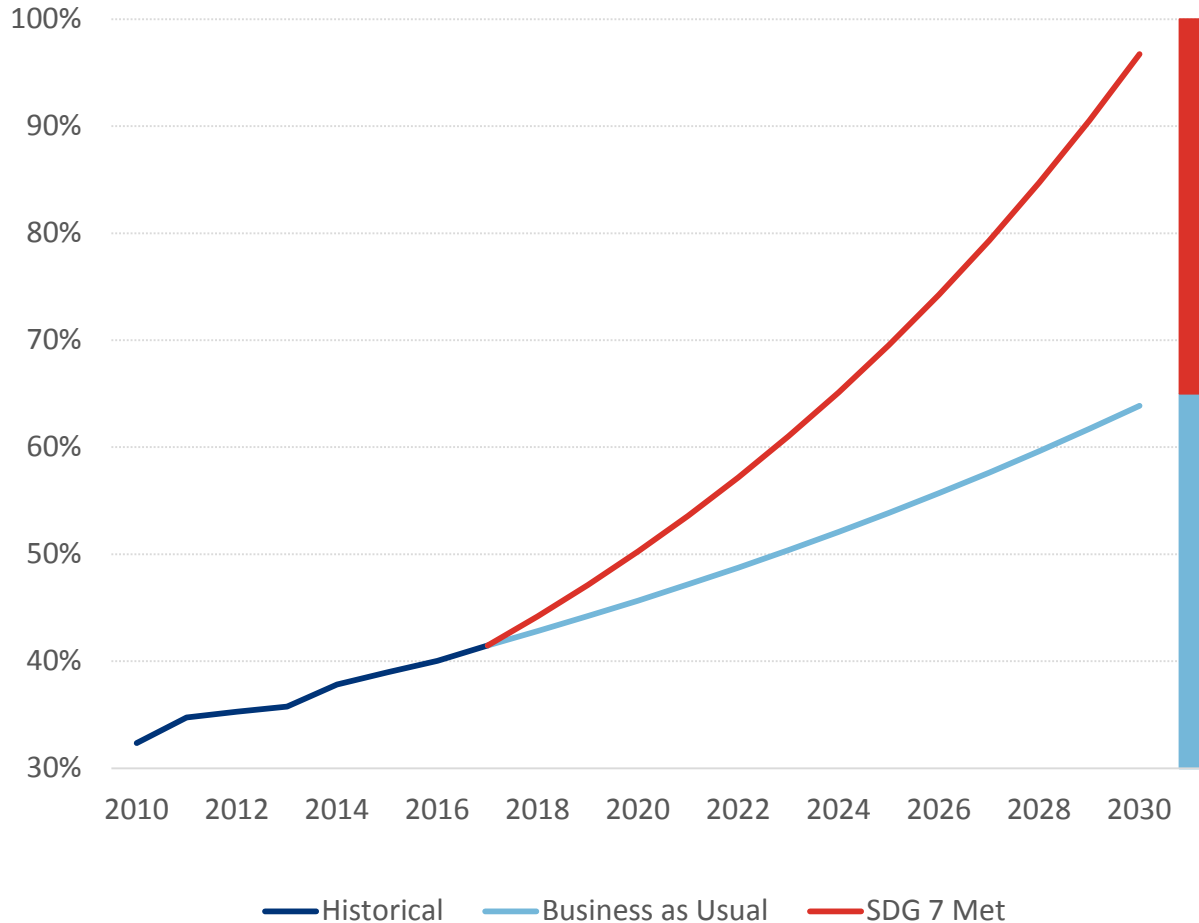


SDG 7 is a global imperative, yet we are falling far behind its achievement, especially in Africa



# 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**

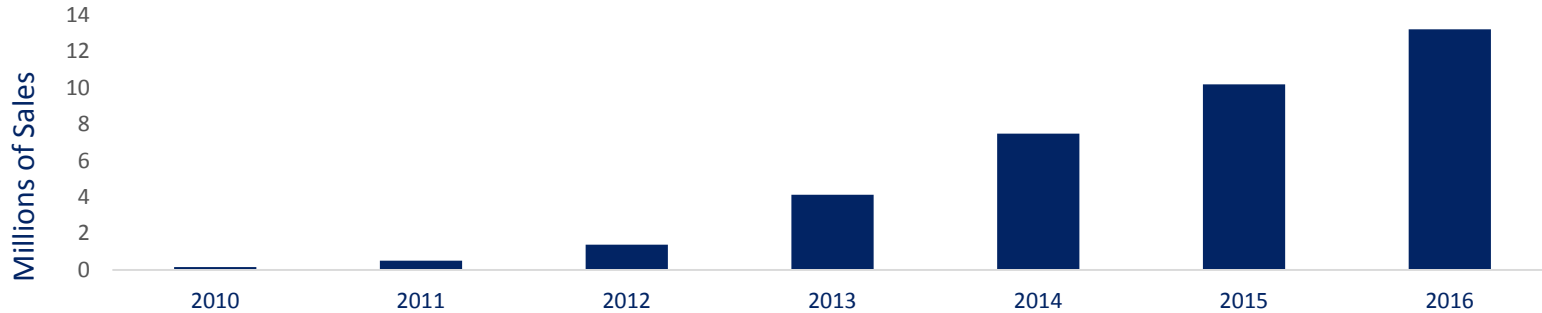
In capital required for mini-grid and SHS



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

SSA Cumulative Sales of Off-Grid Solar Products\*

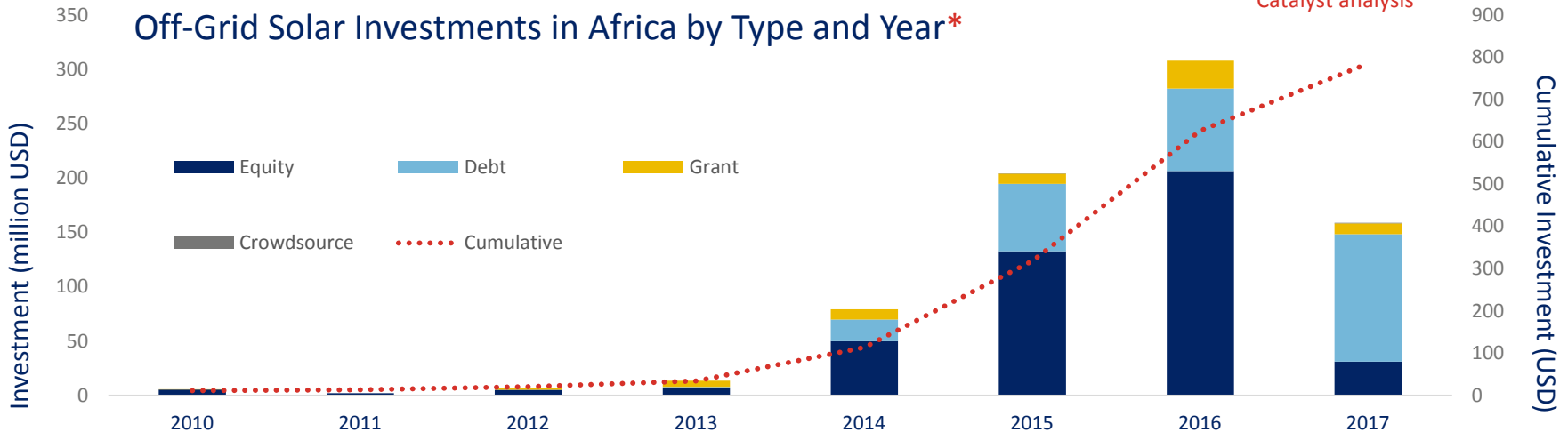
\* Sales data of Lighting Global quality verified products ( both lanterns and SHS)



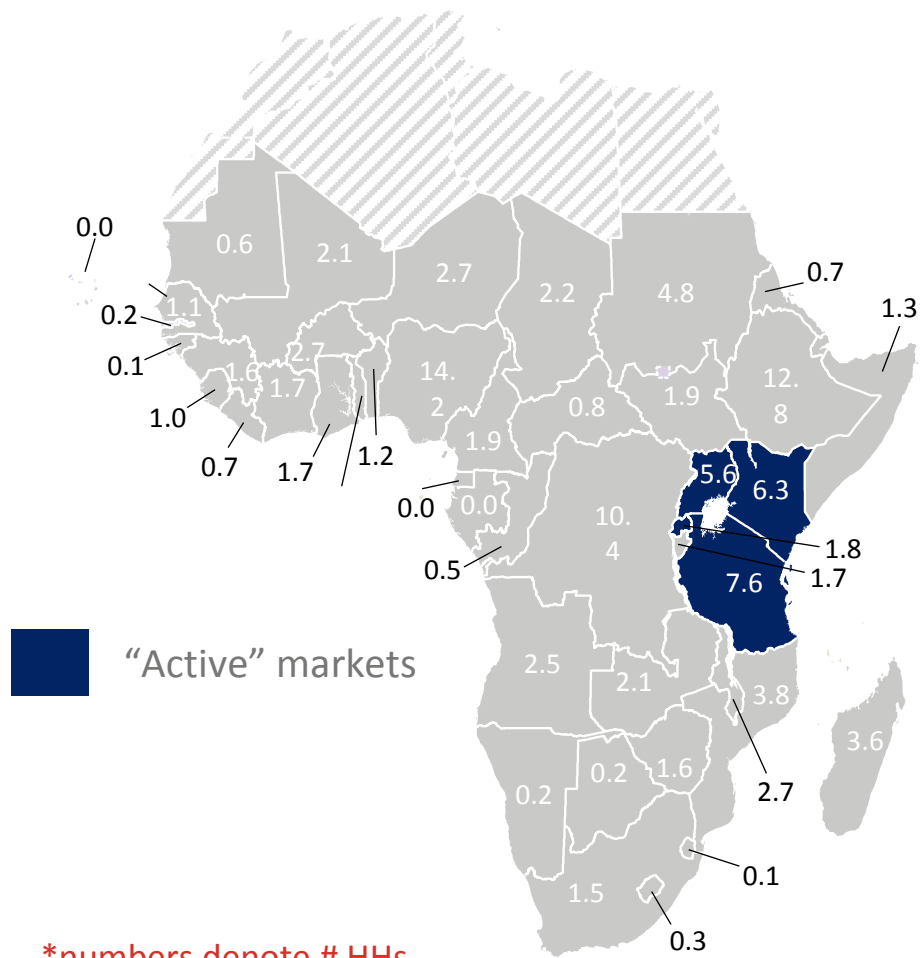
## ...and financial backers

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?



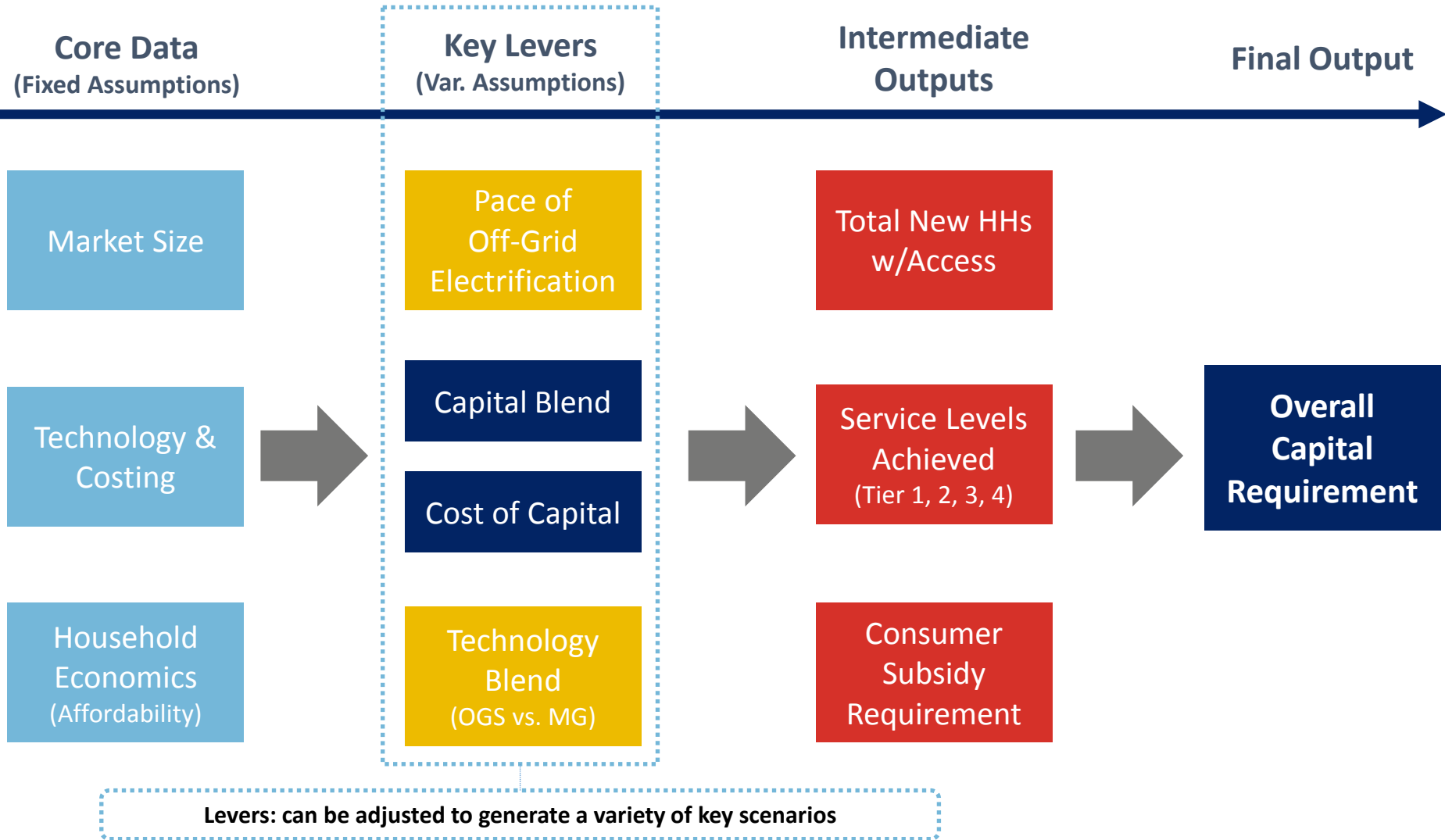


# Top-down analysis: Overview and Approach

- **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	<b>5 PAX/HH</b>
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## OGS Sales Data

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

## OGS Trends

WC Loan Interest Rate (US\$)	<b>10%</b>
Consumer Finance Interest Rate (US\$)	<b>10%</b>

## Off-Grid Solar

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

## Mini - Grids

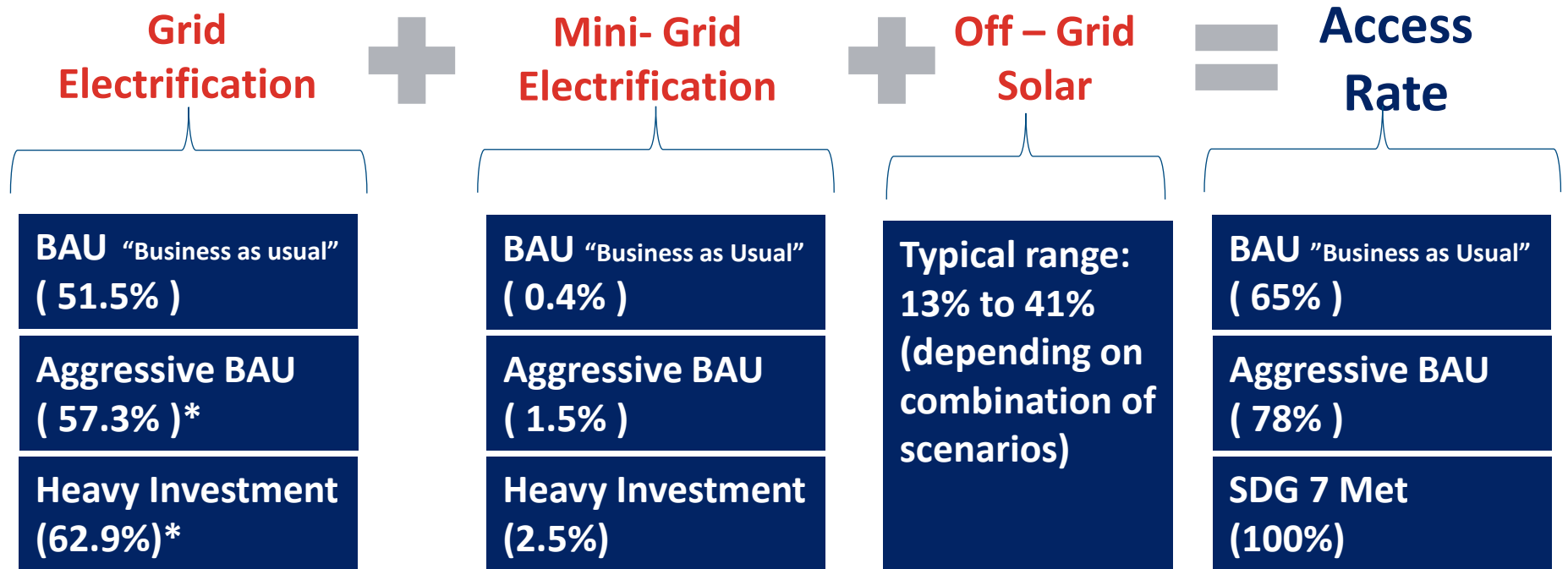
Mini-Grid Generation capacity per customer	<b>250</b>
Mini-Grid CAPEX Cost	<b>\$2.5/W</b>
Annual Change in CAPEX Cost	<b>-3.0%</b>
Upfront Soft Costs	<b>\$1/W</b>
Annual Change in Soft Costs	<b>-3.0%</b>
Mini-Grid All-In Investment Cost	<b>3.5</b>
2017 OPEX Cost as % of Total CAPEX	<b>5%</b>

## Financing

SHS Lifetime (years)	<b>4</b>
Annual Change in Tier 1 % Sales	<b>-1.0%</b>



# 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.

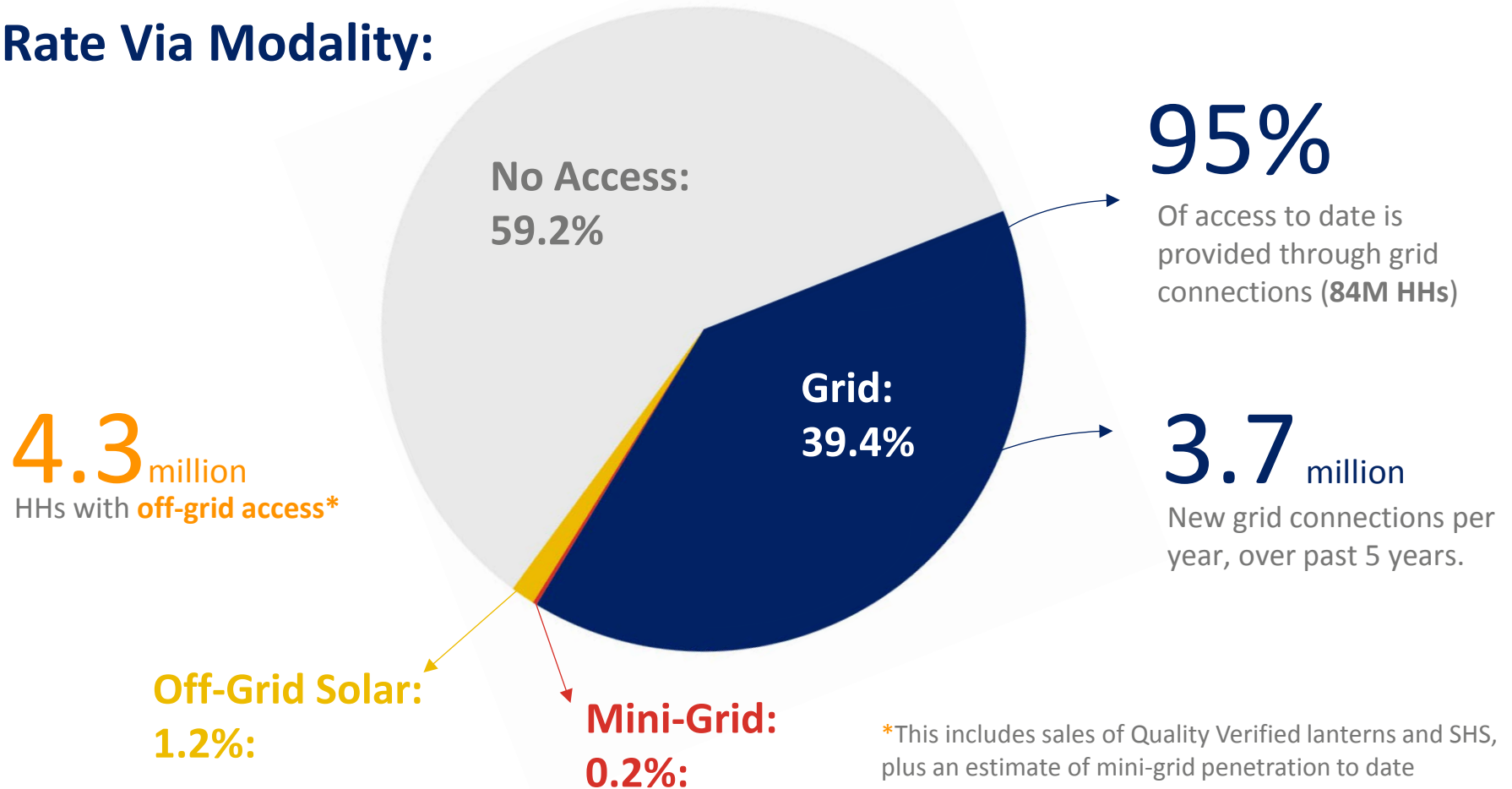


# Framing the Continental Challenge



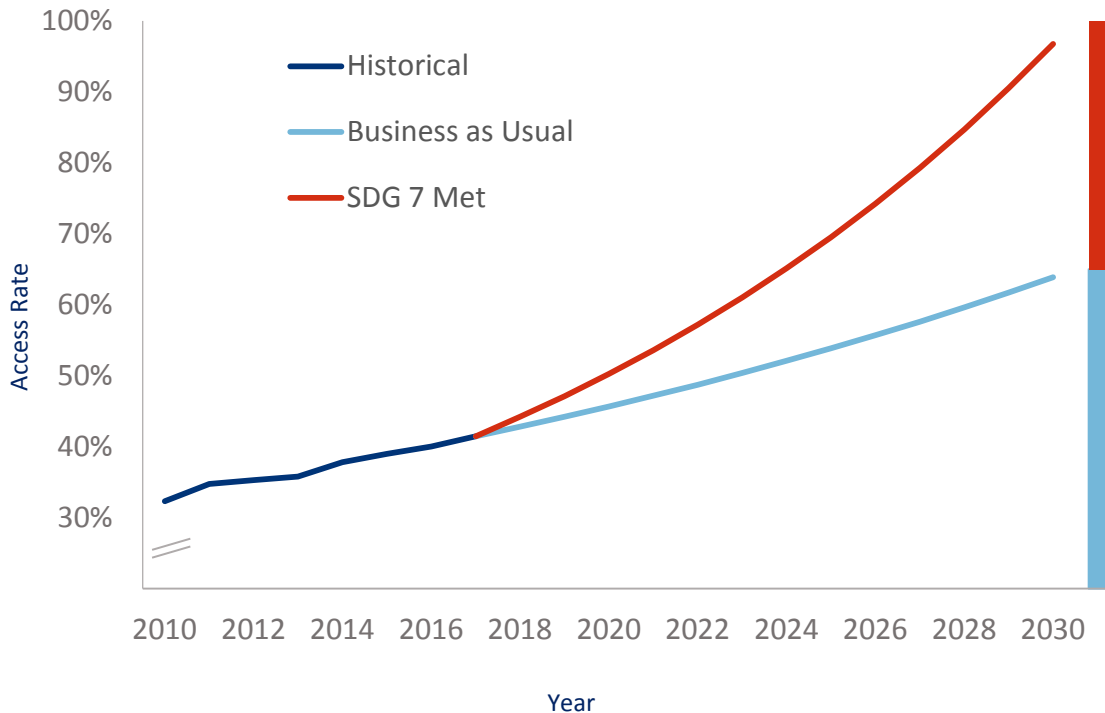
# Not surprisingly, the grid still delivers the majority of energy services to households

## 2017 HH Access Rate Via Modality:



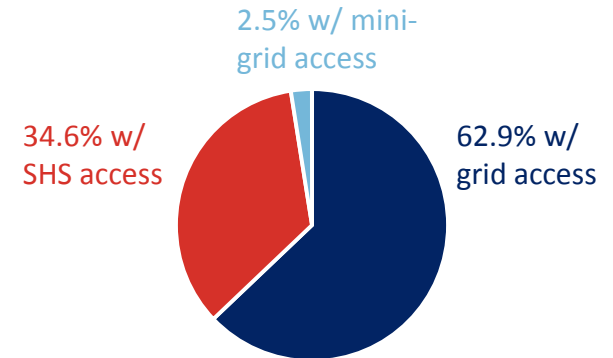
# Even with heavy grid and mini-grid projections, SHS would still need to deliver 34.6% of access in order to achieve SDG 7

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**



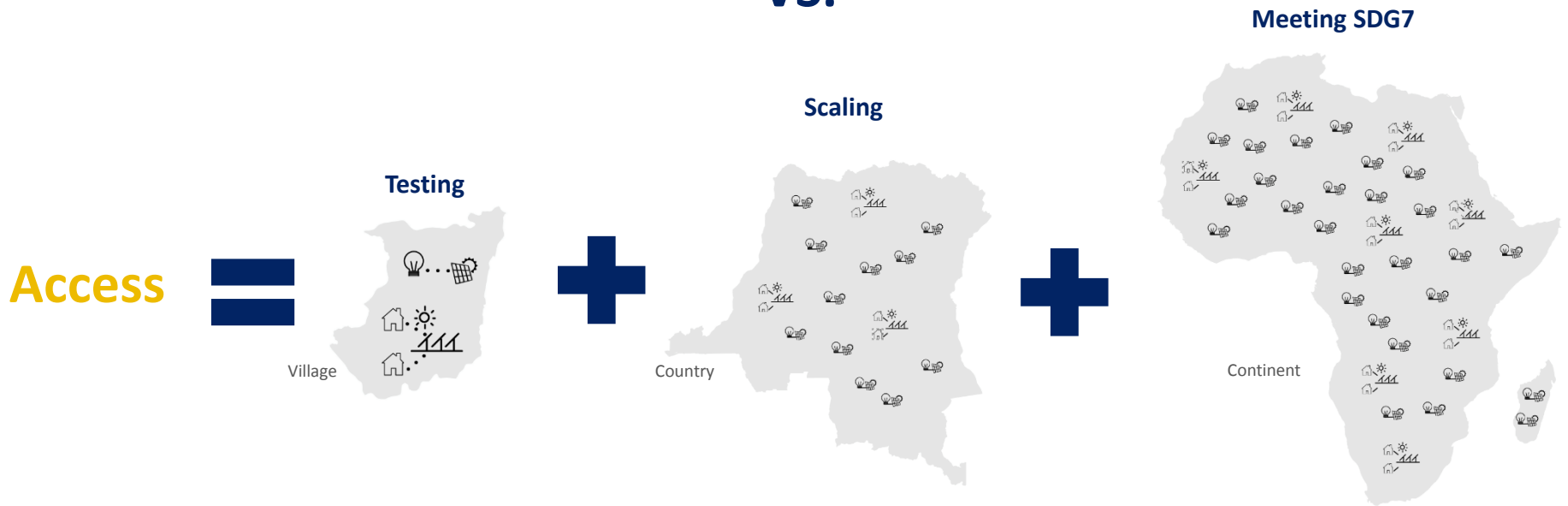
# Enterprise-Level Perspectives



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

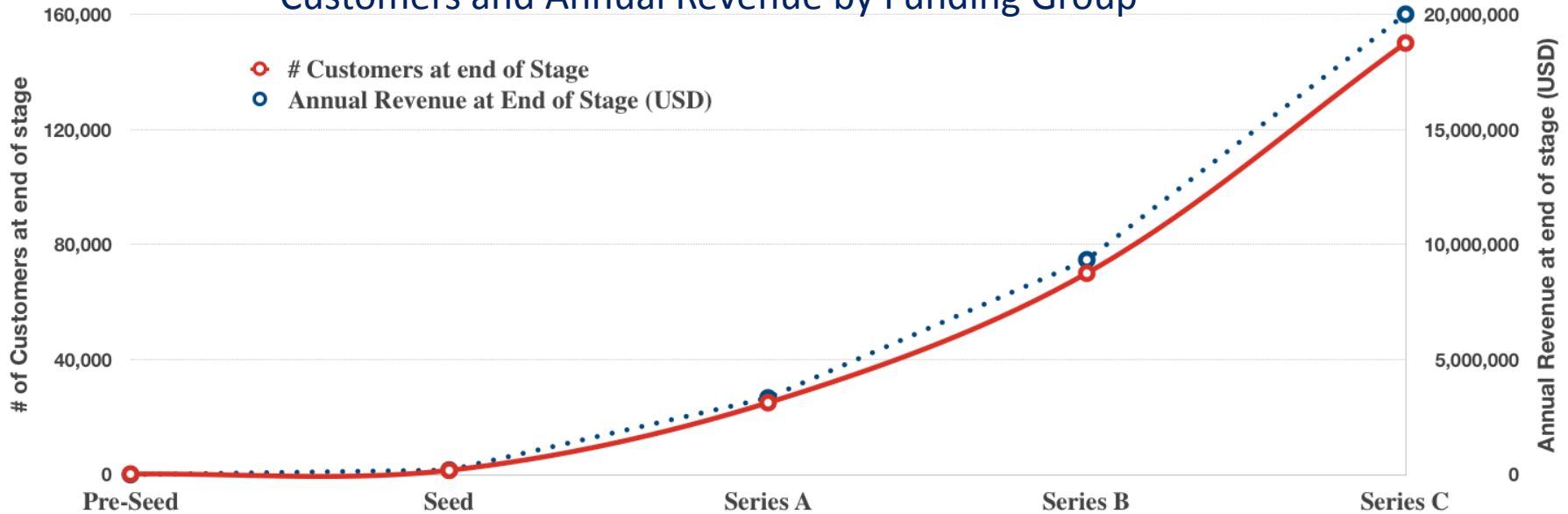
Grid Electrification + Mini-Grid Electrification + Off-Grid Solar = Access Rate

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

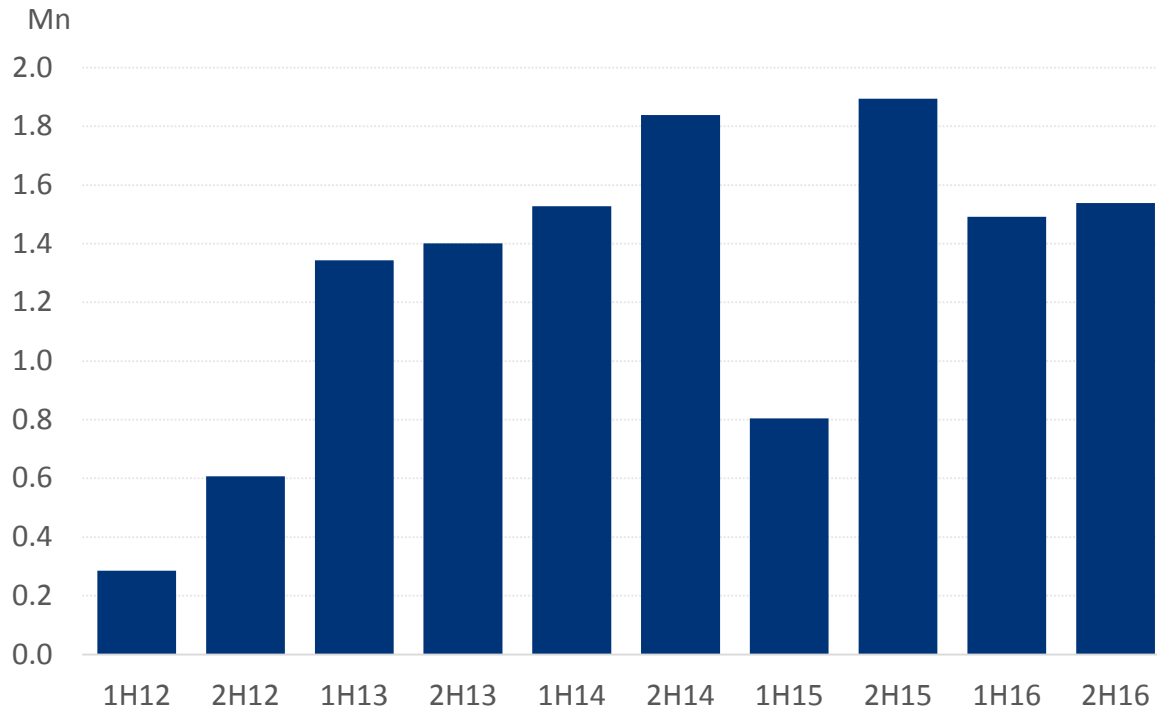
\* Founders ( Friends/Family) Equity

\* 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

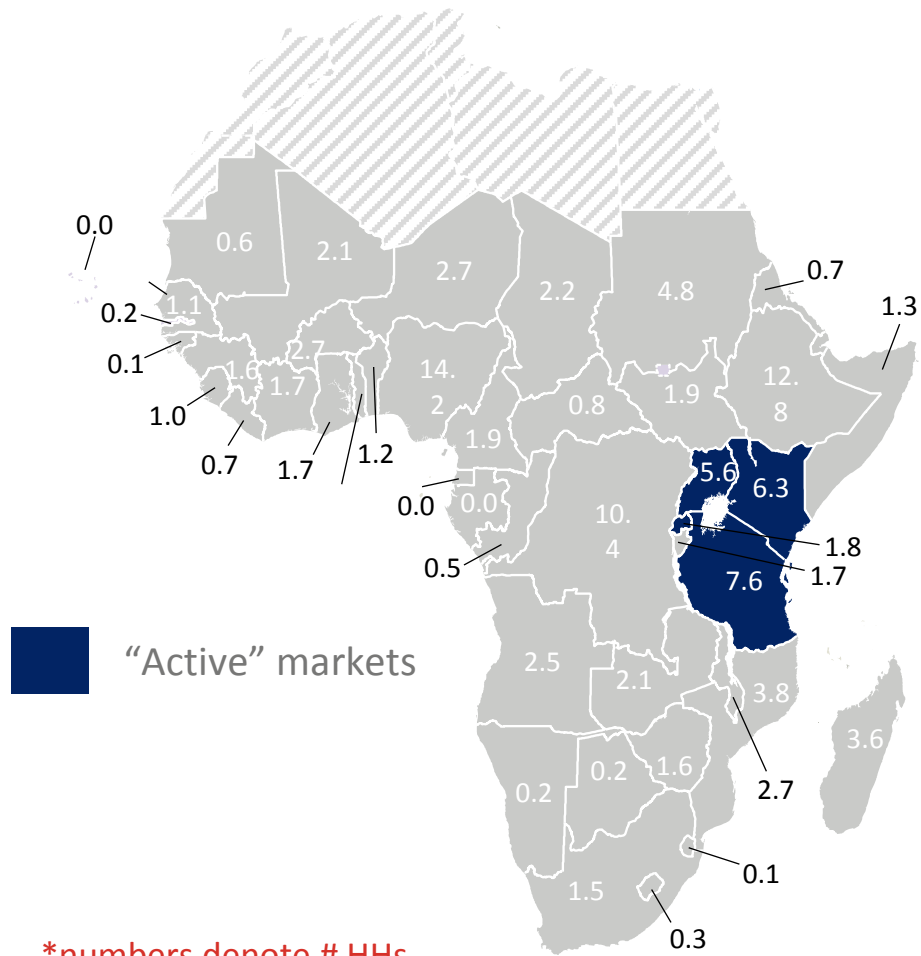
Policy changes within EAC countries has resulted in higher tariffs and affected solar product sales

## 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.



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

\*numbers denote # HHs without access to electricity

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

## 1. Growth within each market\*

For 1<sup>st</sup> Generation (scaling) OGS companies, financing to achieve:

- Scale
- Profitability
- Sustainability

Types of capital required:

- Growth stage equity
- Debt, mostly local currency

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



## 2. Competition within markets\*\*

Enable competitive, sustainable markets via new deployments (among 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> 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 2<sup>nd</sup> and 3<sup>rd</sup> 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:



## Kenya

**7.1M HHs** - Off Grid Market Size  
**750,000 HHs** - Market Penetration to date  
**4** - Deployments currently at scale:



## Rwanda

**1.7M HHs** - Off Grid Market Size  
**100,000 HHs** - Market Penetration to date  
**3** - Deployments currently at scale:



## Tanzania

**7.2M HHs** - Off Grid Market Size  
**200,000 HHs** - Market Penetration to date  
**4** - Deployments currently at scale:





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

## Uganda

**10** 1<sup>st</sup> gen company deployments

serving **4.5M HHs** and requiring:

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

**7** 2<sup>nd</sup> and 3<sup>rd</sup> gen company deployments

serving **1.5M HHs** and requiring:

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

## Rwanda

**4** 1<sup>st</sup> gen company deployments

serving **1.2M HHs** and requiring:

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

**2** 2<sup>nd</sup> and 3<sup>rd</sup> gen company deployments

serving **0.4M HHs** and requiring:

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

## Kenya

**10** 1<sup>st</sup> gen company deployments

serving **5.1M HHs** and requiring:

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

**7** 2<sup>nd</sup> and 3<sup>rd</sup> gen company deployments

serving **1.7M HHs** and requiring:

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

## Tanzania

**10** 1<sup>st</sup> gen company deployments

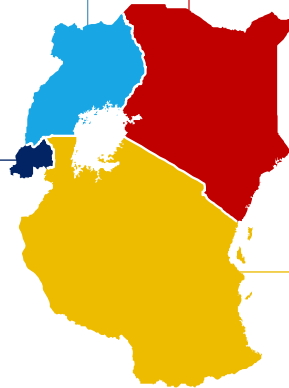
serving **5.4M HHs** and requiring:

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

**8** 2<sup>nd</sup> and 3<sup>rd</sup> 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 2<sup>nd</sup> and 3<sup>rd</sup> generation OGS companies need to be seeded, while 1<sup>st</sup> generation OGS companies need support for international expansion
- Consolidation likely occur through M&A activities among the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> 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** 1<sup>st</sup> gen company deployments requiring:

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

**12M**

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

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

## Ethiopia

**5.8M**

HHs to be served by **10** 1<sup>st</sup> gen company deployments requiring:

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

**8.6M**

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

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

## DRC

**4.9M**

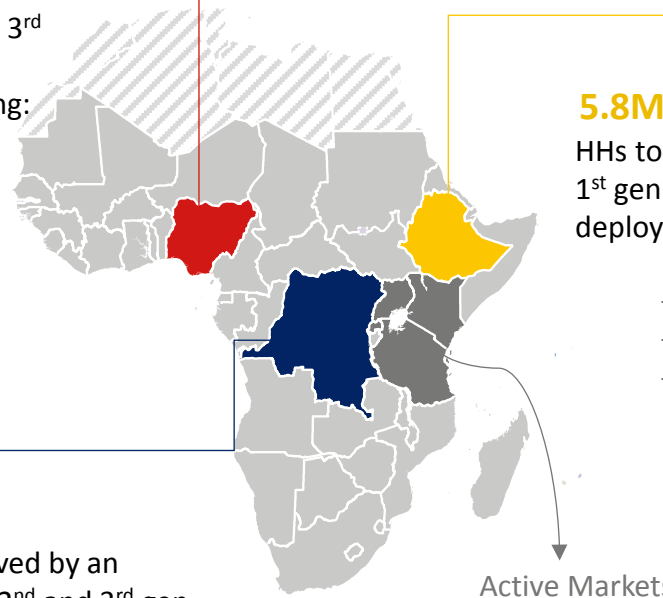
HHs to be served by **10** 1<sup>st</sup> gen company deployments requiring:

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

**7.3M**

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

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



**\*\*Modelling Assumptions:**  
40% market captured by 1<sup>st</sup> generation deployments, remainder captured by 2<sup>nd</sup> and 3<sup>rd</sup> 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** 1<sup>st</sup> gen company deployments requiring:

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

**4.5M**

HHs to be served by an estimated **19** 2<sup>nd</sup> and 3<sup>rd</sup> 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** 1<sup>st</sup> gen company deployments requiring:

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

**7.6M**

HHs to be served by an estimated **31** 2<sup>nd</sup> and 3<sup>rd</sup> 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**

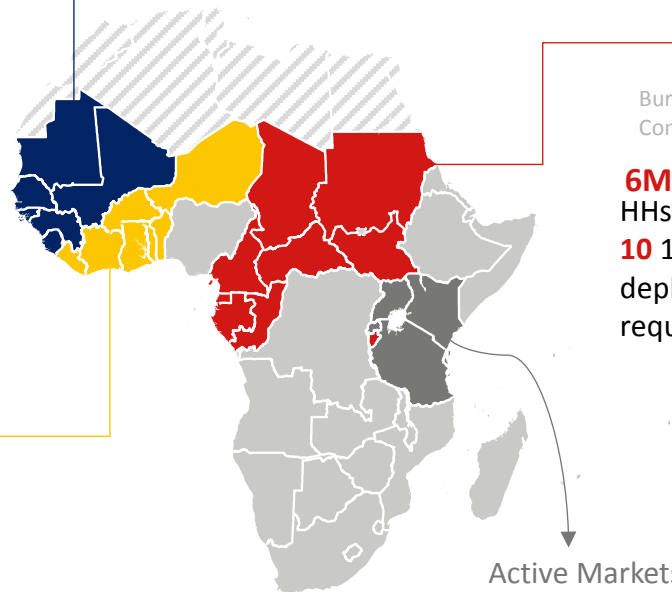
HHs to be served by **10** 1<sup>st</sup> gen company deployments requiring:

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

**9M**

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

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



**\*\*Modelling Assumptions:**  
40% market captured by 1<sup>st</sup> generation deployments, remainder captured by 2<sup>nd</sup> and 3<sup>rd</sup> 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** 1<sup>st</sup> gen company deployments requiring:

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

**3.4M**

HHs to be served by an estimated **14** 2<sup>nd</sup> and 3<sup>rd</sup> 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**

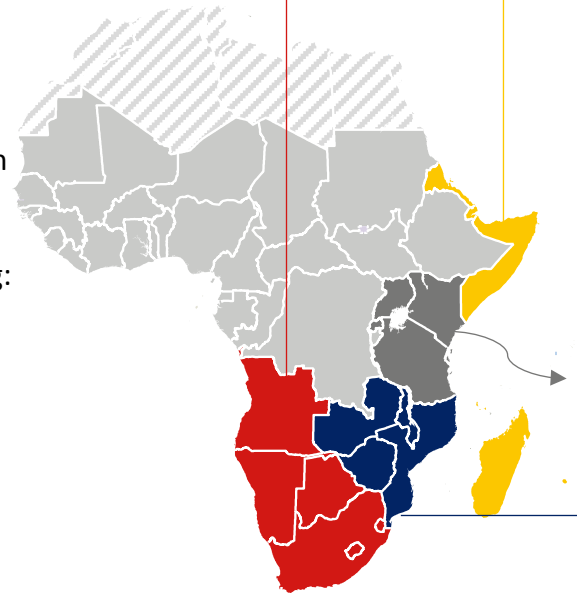
HHs to be served by **10** 1<sup>st</sup> gen company deployments requiring:

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

**4M**

HHs to be served by an estimated **17** 2<sup>nd</sup> and 3<sup>rd</sup> 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** 1<sup>st</sup> gen company deployments requiring:

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

**5.9M**

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

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

\*\*Modelling Assumptions:

40% market captured by 1<sup>st</sup> generation deployments, remainder captured by 2<sup>nd</sup> and 3<sup>rd</sup> 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 1<sup>st</sup> gen company deployments

**62M HHs** to be served by 2<sup>nd</sup> and 3<sup>rd</sup> gen company deployments

**10** 1<sup>st</sup> gen company deployments requiring:

**211M** In grant finance

**2.9B** In equity

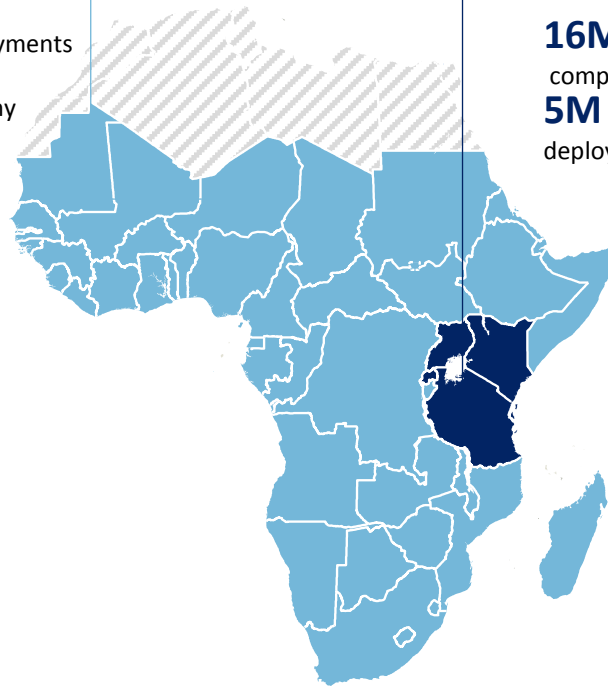
**4.5B** In debt

**254** 2<sup>nd</sup> and 3<sup>rd</sup> 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 1<sup>st</sup> gen company deployments

**5M HHs** to be served by 2<sup>nd</sup> and 3<sup>rd</sup> gen company deployments

**10** 1<sup>st</sup> gen company deployments requiring:

**80M** In grants

**1.1B** In equity

**2.3B** In debt

**24** 2<sup>nd</sup> and 3<sup>rd</sup> gen company deployments requiring:

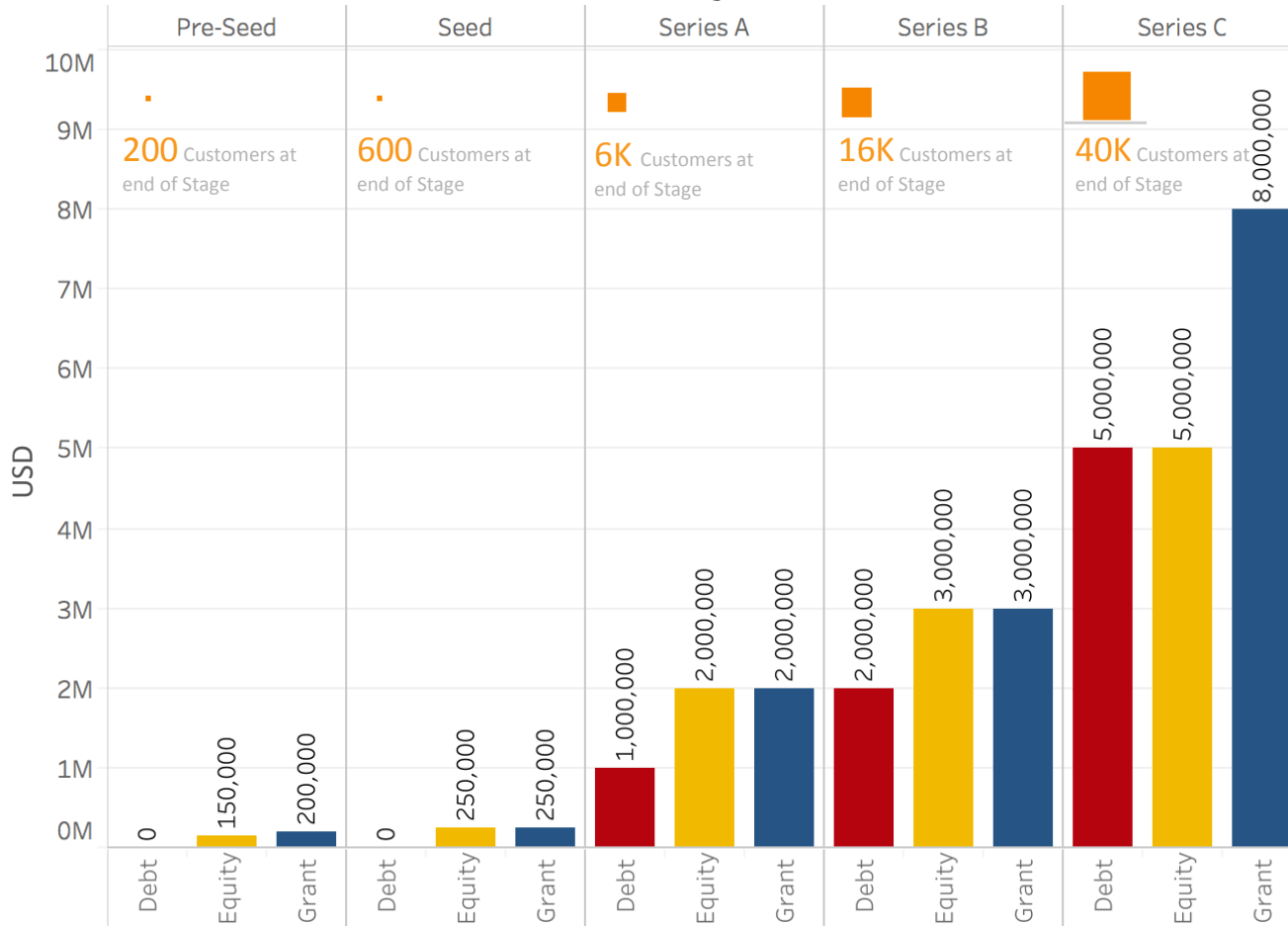
**56M** In grant finance

**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

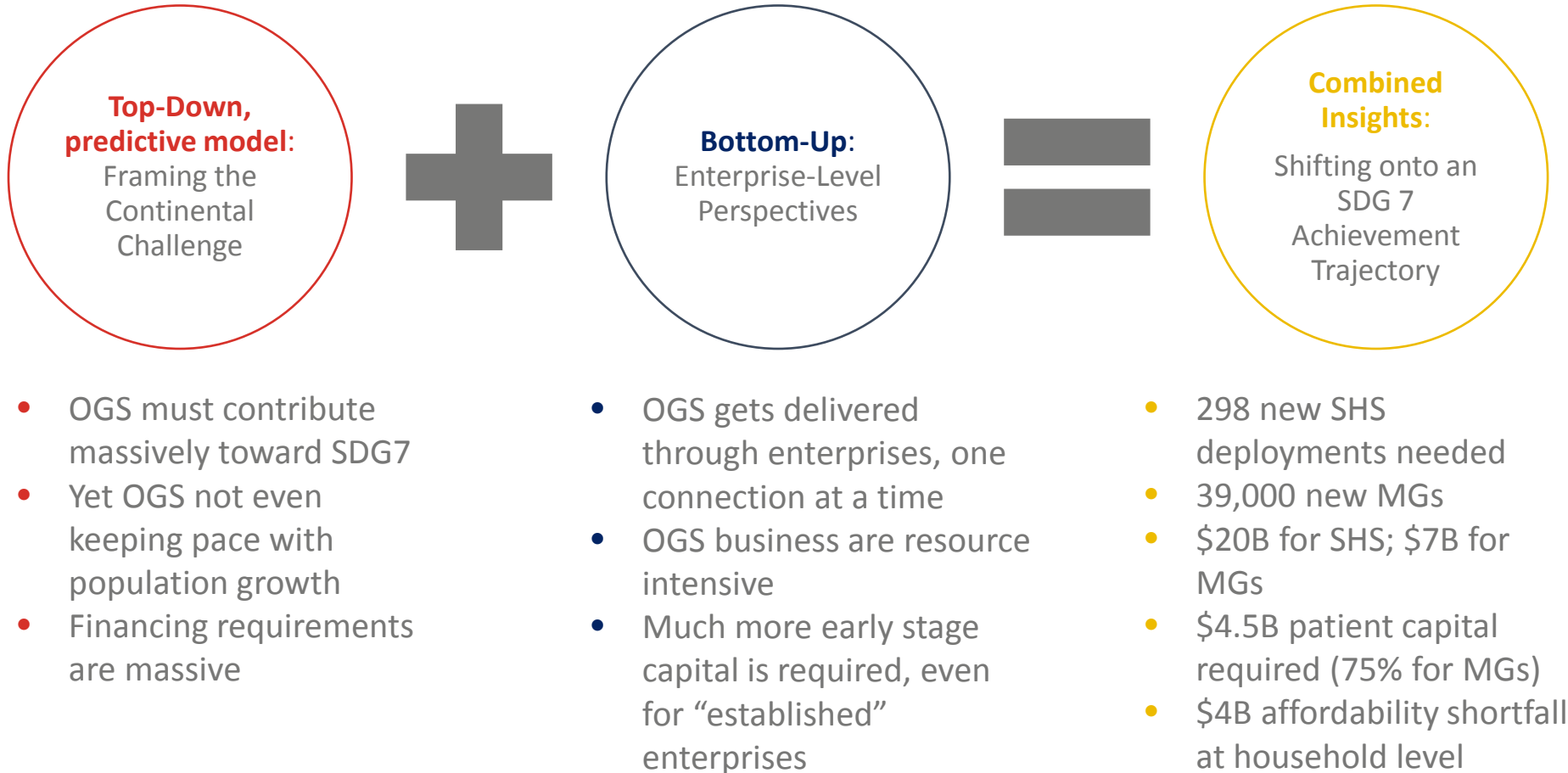




# Shifting onto an SDG 7 Achievement Trajectory



# 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**

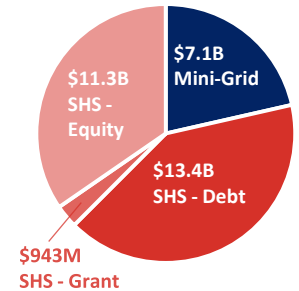
In mini-grid and OGS investment

**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 2<sup>nd</sup> and 3<sup>rd</sup> 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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