

Plug In, Power Up! Connecting to Grid Electricity in Africa

***A Center for International Policy Research and
Evaluation Webinar and Forum
Washington, DC***

November 29, 2017

Anu Rangarajan • Candace Miller • Kathleen Auth
Duncan Chaplin • Jörg Peters • Shreena Patel

MATHEMATICA

———— CENTER FOR ————
**INTERNATIONAL POLICY
RESEARCH AND EVALUATION**

Today's Speakers



**Candace
Miller,
Mathematica
(Moderator)**



**Kathleen Auth, Power
Africa!**



**Duncan Chaplin,
Mathematica**



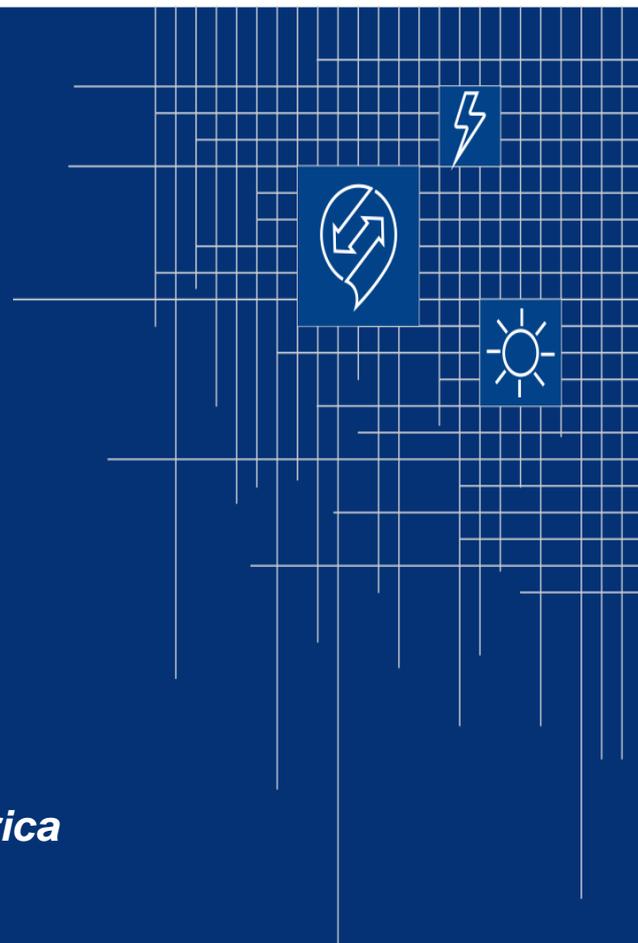
Jörg Peters, RWI



Shreena Patel, MCC

POWER AFRICA

A U.S. GOVERNMENT-LED PARTNERSHIP



Plug in, Power up! Connecting to Grid Electricity in Africa

Kathleen Auth

Deputy Energy Office Director & Grid Roll-Out Team Lead



USAID
FROM THE AMERICAN PEOPLE



The Challenge



- Estimated **600+ million people** in sub-Saharan Africa without electricity
- For those with access, power is often **expensive and/or unreliable**
- Estimated **\$835 billion investment needed** to achieve universal electricity access by 2030
- Electricity access is critical for economic growth, health, education, and stability. It is a **development and security imperative**



WHO WE ARE



HOW WE WORK



WHAT WE WILL ACHIEVE



"The Cap des Biches financing agreement is tangible evidence of the power of Power Africa. It is by far the fastest project that I have ever worked on in Africa, and Power Africa made all the difference. **This project would have taken four years in the absence of Power Africa. Instead it took one year.** This is the power of an idea that is embraced and sponsored by the United States." -Joseph Brandt, CEO of ContourGlobal

RESULTS TO DATE

- 84 transactions (**7,351 MW**) to financial close
- Over **10 million new connections** (on-grid, off-grid, mini-grid)



An Integrated Approach to Access

Optimizing On- and Off-Grid Solutions

Beyond the Grid (BTG) Opportunities

- Price decreases
- Quality improvements
- Scalable products

Grid Roll Out Opportunities

- Under-grid populations
- Rapid urbanization
- Commercial and industrial users
- Improved technologies / lessons learned from the off-grid sector

Our Goals:

- Optimize the mix
- Accelerate universal access
- Ensure long-term viability





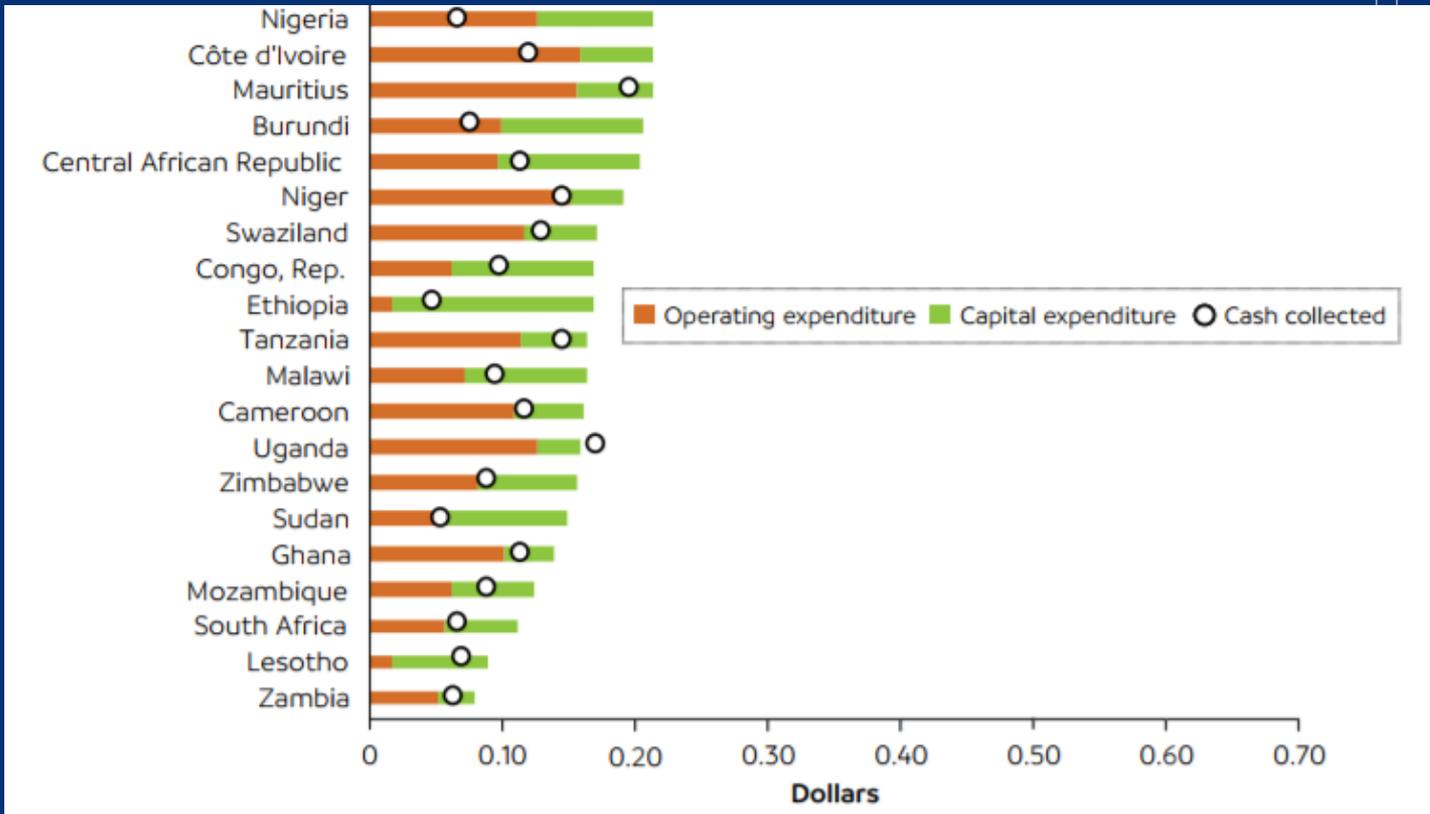
Challenges for Grid Connection

- Dispersed, low-income populations
- Politically driven electrification plans
- Dilapidated infrastructure → high technical losses
- Theft + billing/collection challenges → high commercial losses
- Non cost-reflective tariffs
- High upfront cost of connection



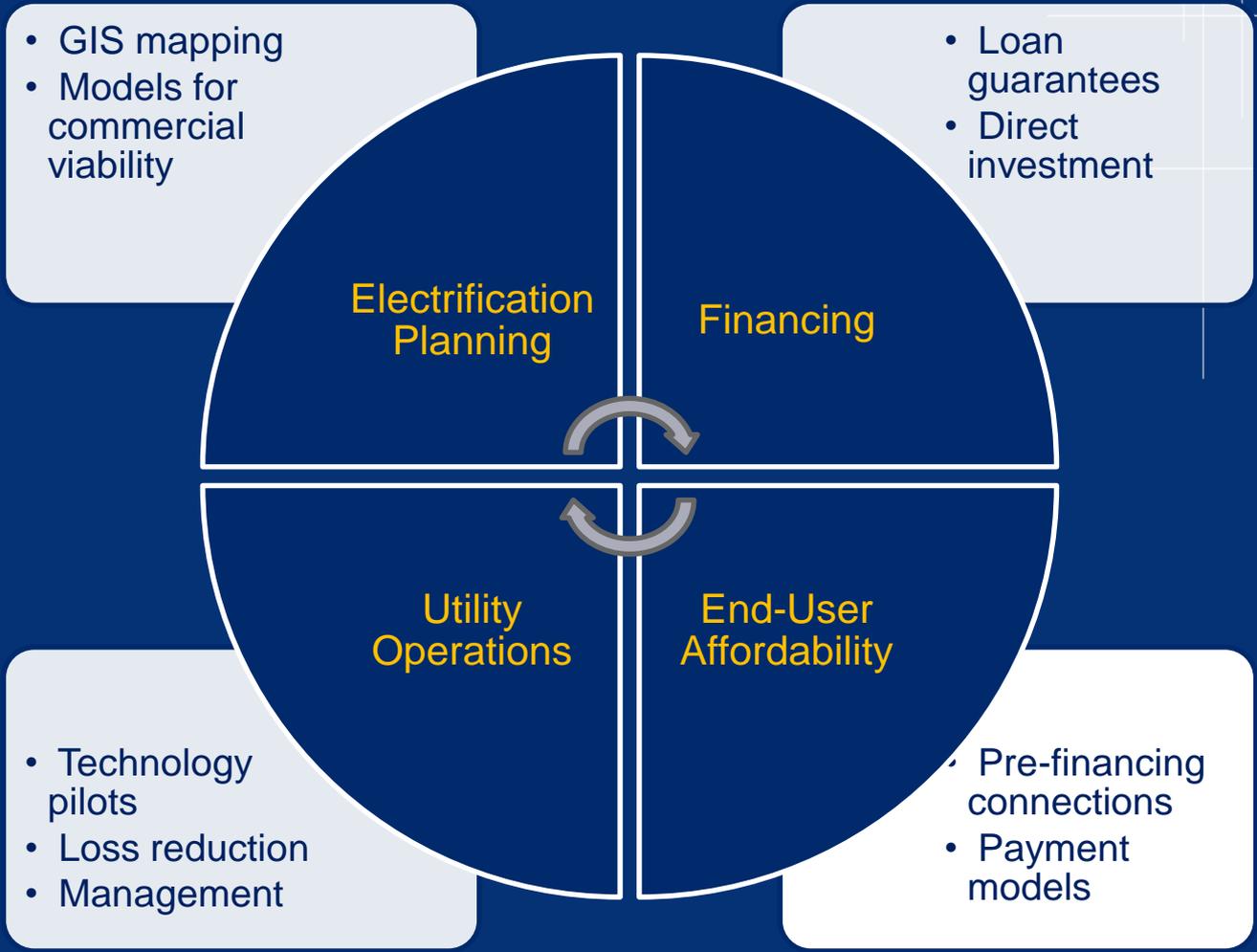


Only 2 utilities in sub-Saharan Africa actually cover their costs



Source: Kojima, Masami; Trimble, Chris. 2016. *Making Power Affordable for Africa and Viable for its Utilities*. World Bank, Washington, DC.

Strategic Pillars for Grid Roll Out





Key Questions We Consider

- Where, and in what sequence, **can we intervene** to have the greatest positive impact on a distribution system?
- Do **incentive structures** need to be changed? If so, how?
- What **political considerations** are in play?
- What **data** is available to inform electrification planning, and the optimization of on- and off-grid solutions? What data do we need?



Impacts of MCC Electricity Line Extensions and Low- Cost Connection Offers in Tanzania

***Presentation at Plug in, Power up! Connecting to
Grid Electricity in Africa forum***

Mathematica Policy Research, Washington, DC

November 29, 2017

Duncan Chaplin • Arif Mamun • Ali Protik • John Schurrer •
Divya Vohra • Kristine Bos • Hannah Burak • Laura Meyer •
Anca Dumitrescu • Christopher Ksoll • Thomas Cook

Millennium Challenge Corporation's Energy Sector Project in Tanzania

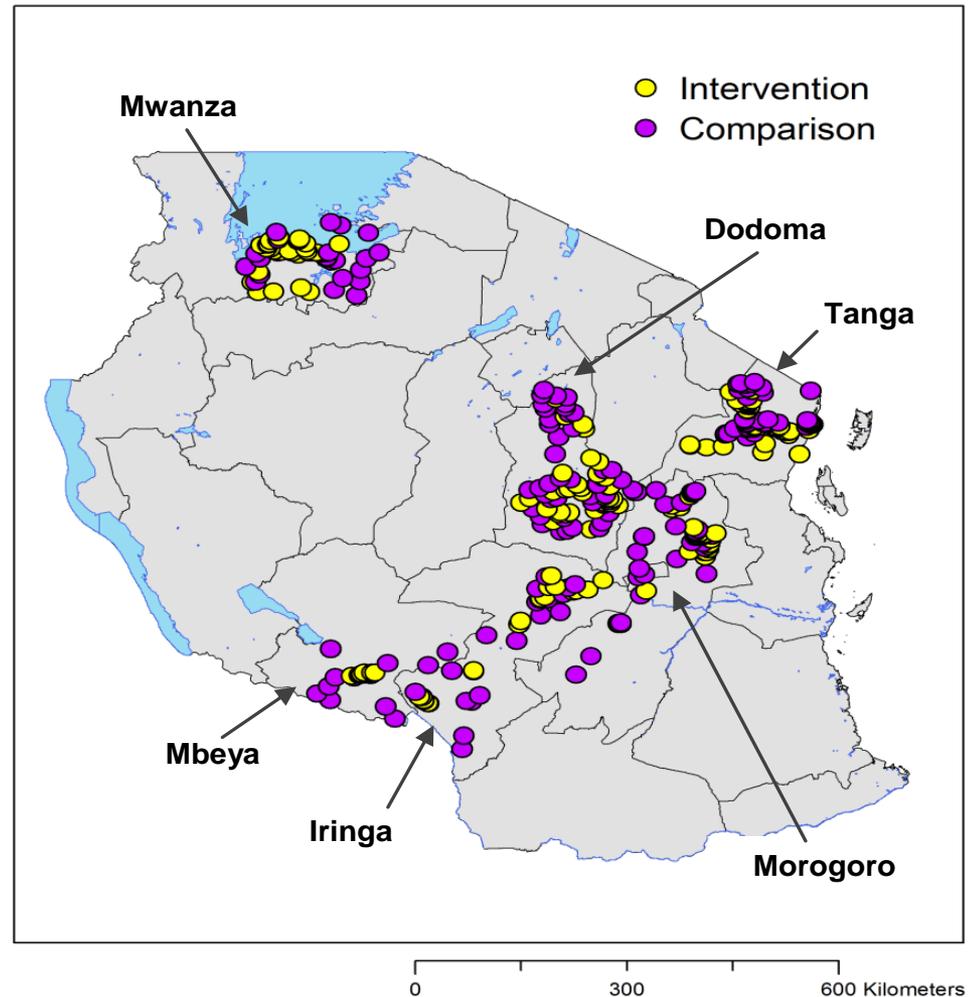
- **Compact (\$700 million)**
 - Roads
 - Water
 - Energy (\$200 million)
- **Today's presentation focuses on two components of the energy project**
 - Line extensions (\$126.2 million)
 - Low-cost connection offers (\$2 million)

Evaluation Questions

- What impacts do line extensions have on connection rates?
 - What impacts do low-cost connection offers have on connection rates?
 - What impacts does actually connecting have on household outcomes related to energy use, education, health, and economic well-being?
 - Provides suggestive estimates of potential impacts of line extensions and/or low-cost connection offers if connection rates were high
-

Line Extensions (\$126 million)

- **Rationale:** 4% of rural Tanzanians have electricity
- **The Initiative:** Communities targeted for line extensions based on estimated costs and benefits
- **The Evaluation**
 - 178 treatment communities
 - 182 matched comparison communities
 - 2,595 km of lines



Low-Cost Connection Offers (\$2 million)

- **Rationale**

- Connection fee high: \$110 (rural) to \$200 (urban)

- **The initiative**

- Fee lowered by at least 80%
- Communication campaign

- **The evaluation**

- 178 line extension communities
- Randomly chose 27 for treatment
- All households in treatment communities given low-cost offers



Baseline and Follow-up Data

- **Baseline surveys: 2011**

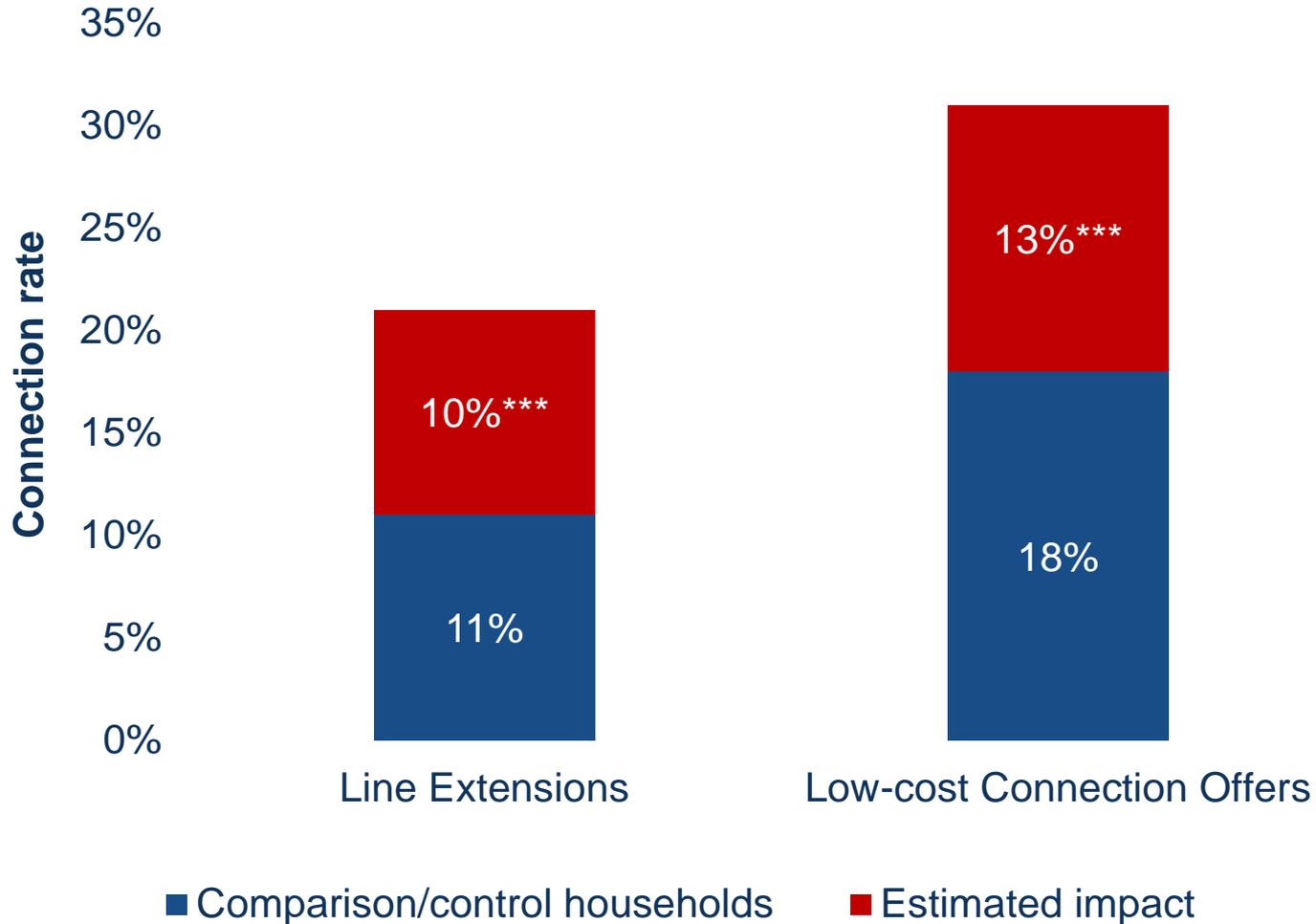
- 10,210 households in 360 communities
- Excluded those connected or within 30 meters of grid at baseline

- **Follow-up surveys: 2015**

- 8,899 households in 360 communities
- 20-34 months after new lines,
- 14-24 months after low-cost connection offers

	2011	2012	2013	2014	2015	2016
Line Extensions		→				
Low Cost Connections		→				
Data Collection	→				→	

Line Extensions and Low-Cost Connection Offers Increased Connection Rates

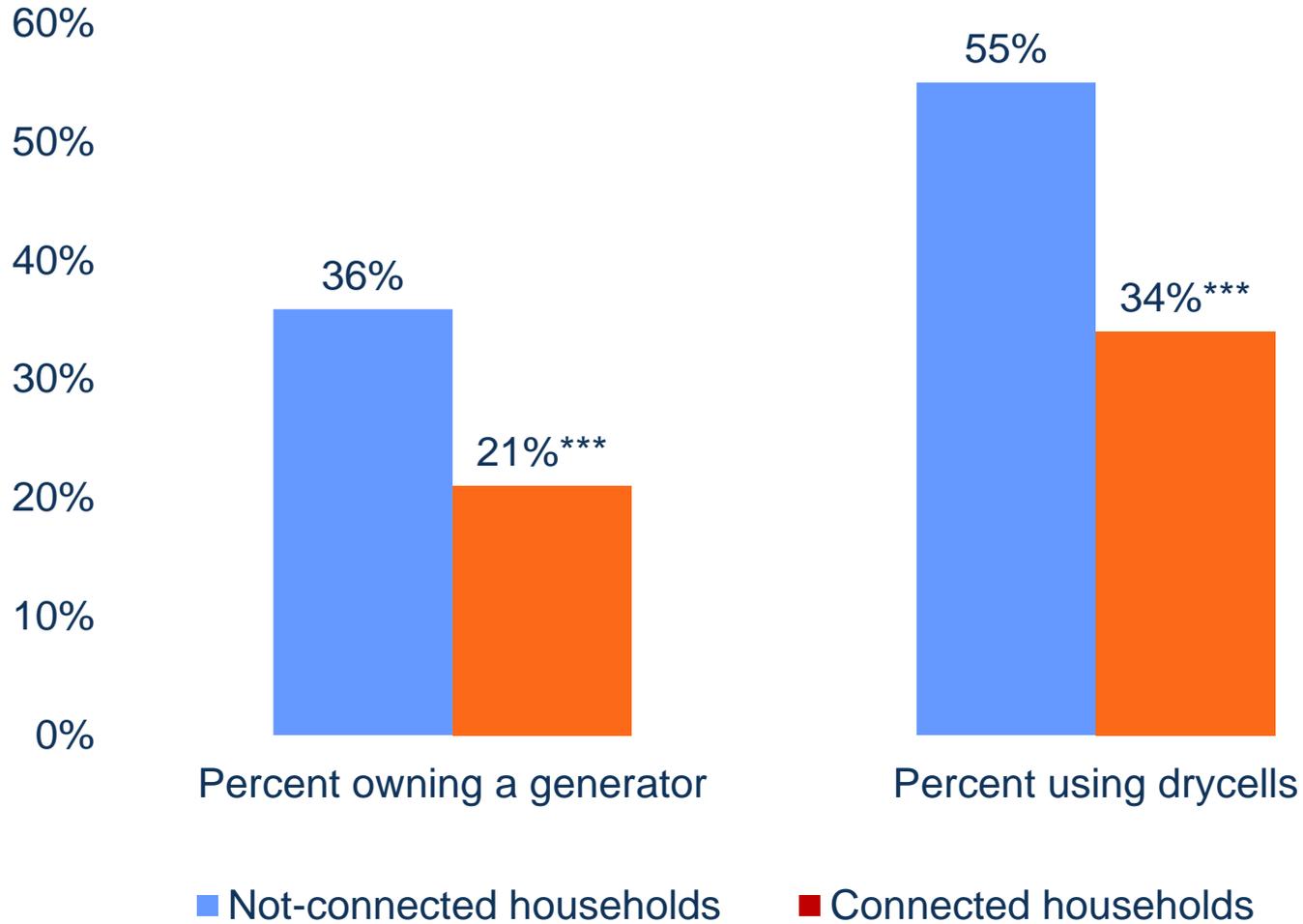


Methods: Estimated Impacts of Actually Connecting

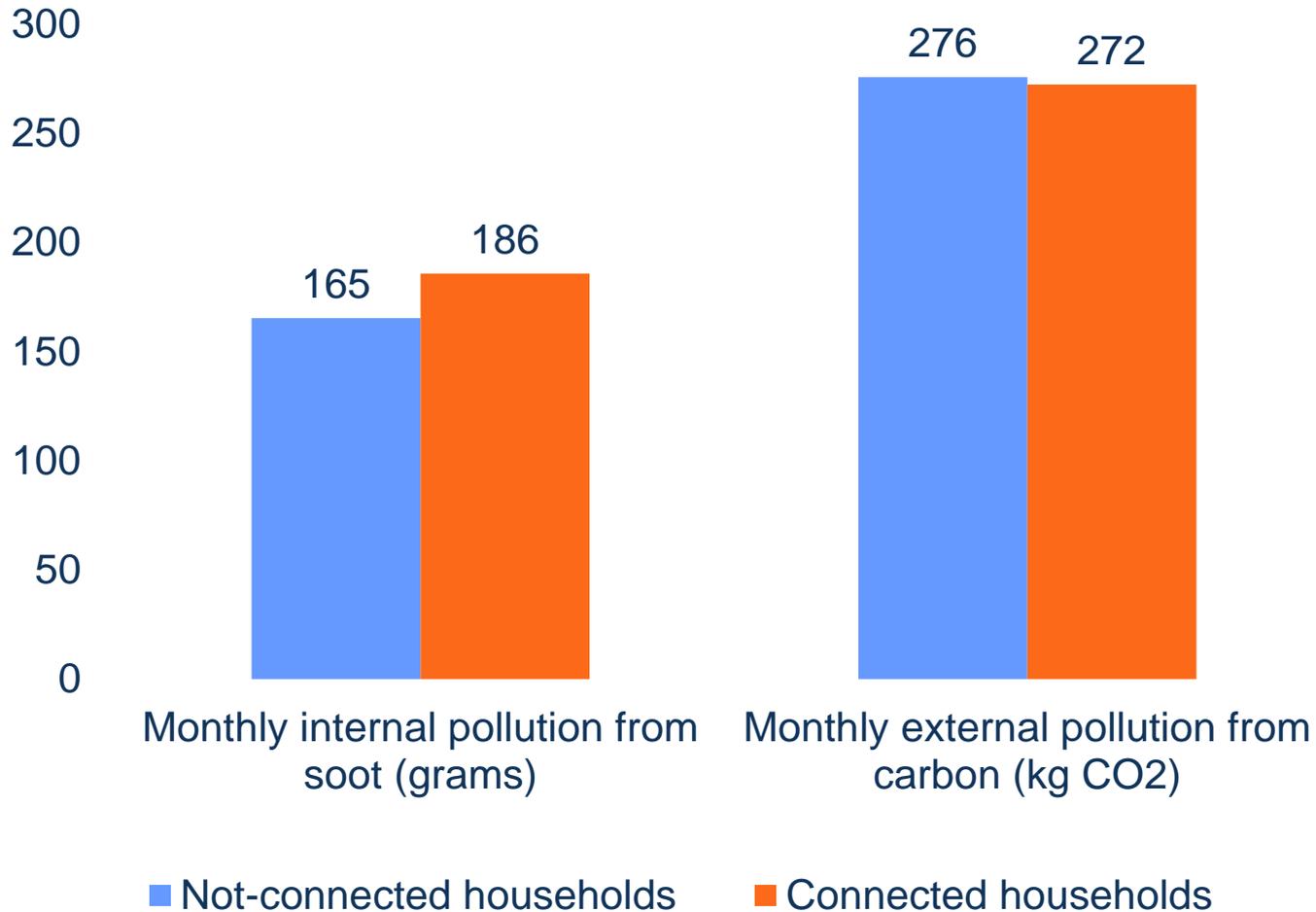
- Treatment group = households connecting to MCC and non-MCC lines
- Comparison group = matched non-connected households in study communities
- We addressed potential limitations of a quasi-experimental design



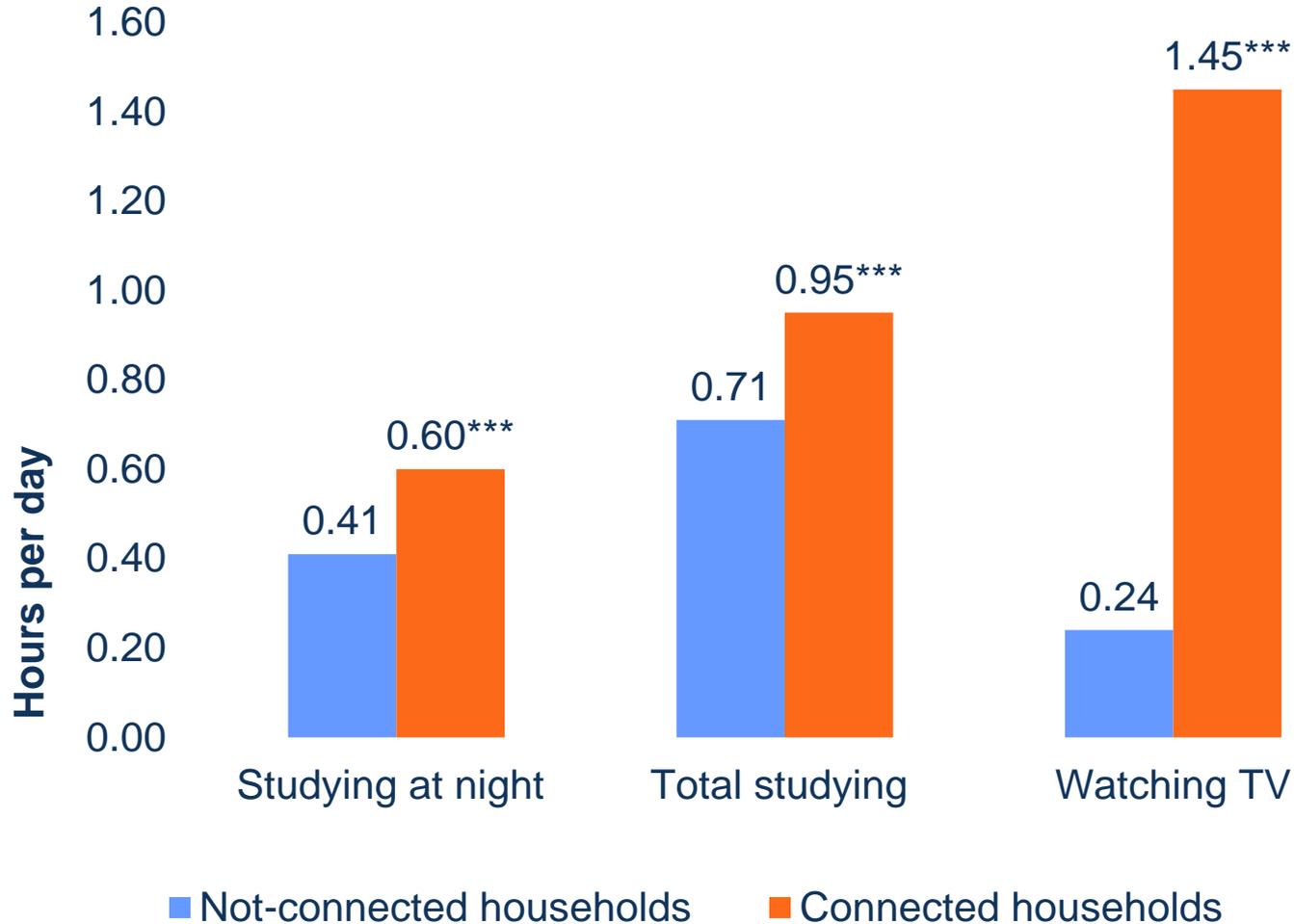
Actually Connecting Reduced Generator and Battery Use



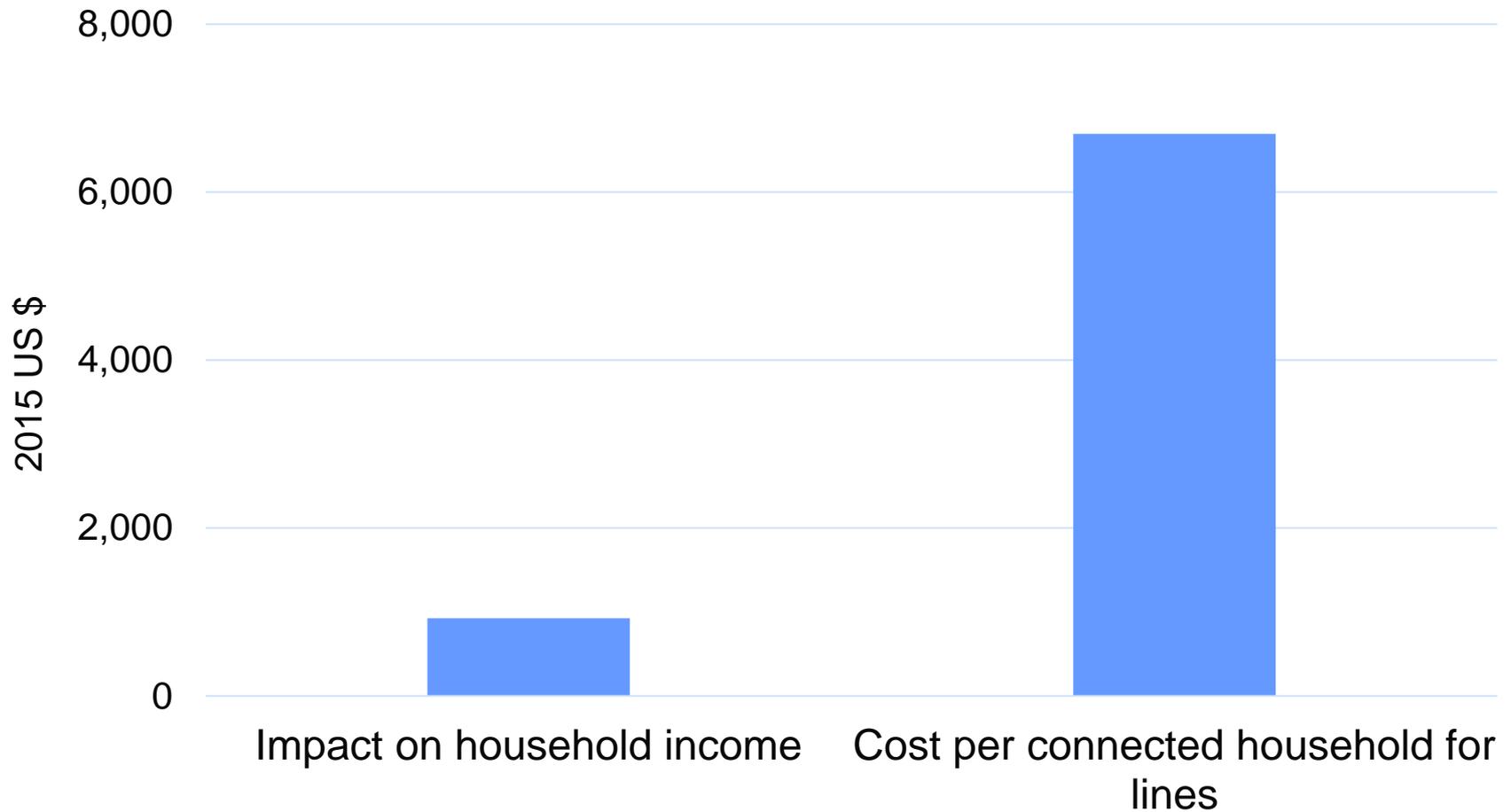
Actually Connecting Had No Clear Impact on Internal or External Air Pollution



Actually Connecting Increased Studying and TV



Impacts of Actually Connecting on Income much Lower than Costs of Lines



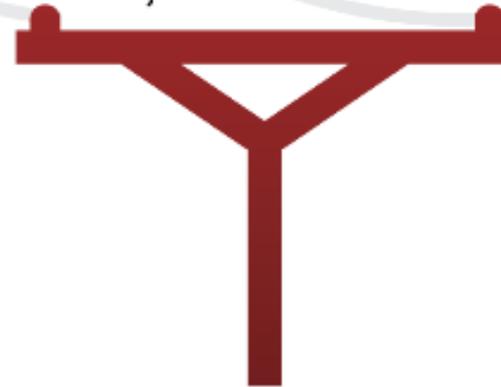
1 USD = 2,126 TZS

Actual Number of Connections to the Grid were Much Lower than Assumed

35,000 assumed by MCC



10,794 actual



Challenges to Increasing Connection Rates

- Line placement
- Utility capacity
- Customer costs
- Customer awareness



Housing that poses challenges to electrification



Lines follow the road, but the population lives away from the road

Summary

- **Impacts of new lines on connection rates modest**
- **Cost of lines \$6,694 per connected household**
- **Impacts on household income \$500-\$900**
- **Other benefits found on education and safety**
- **Expanding access cost-effectively challenging**
- **Future research could target**
 - Longer-term impacts on connection rates
 - Reduced wiring costs
 - Better information
 - Improving incentives for utilities

Why we need an Electrification Masterplan for Africa

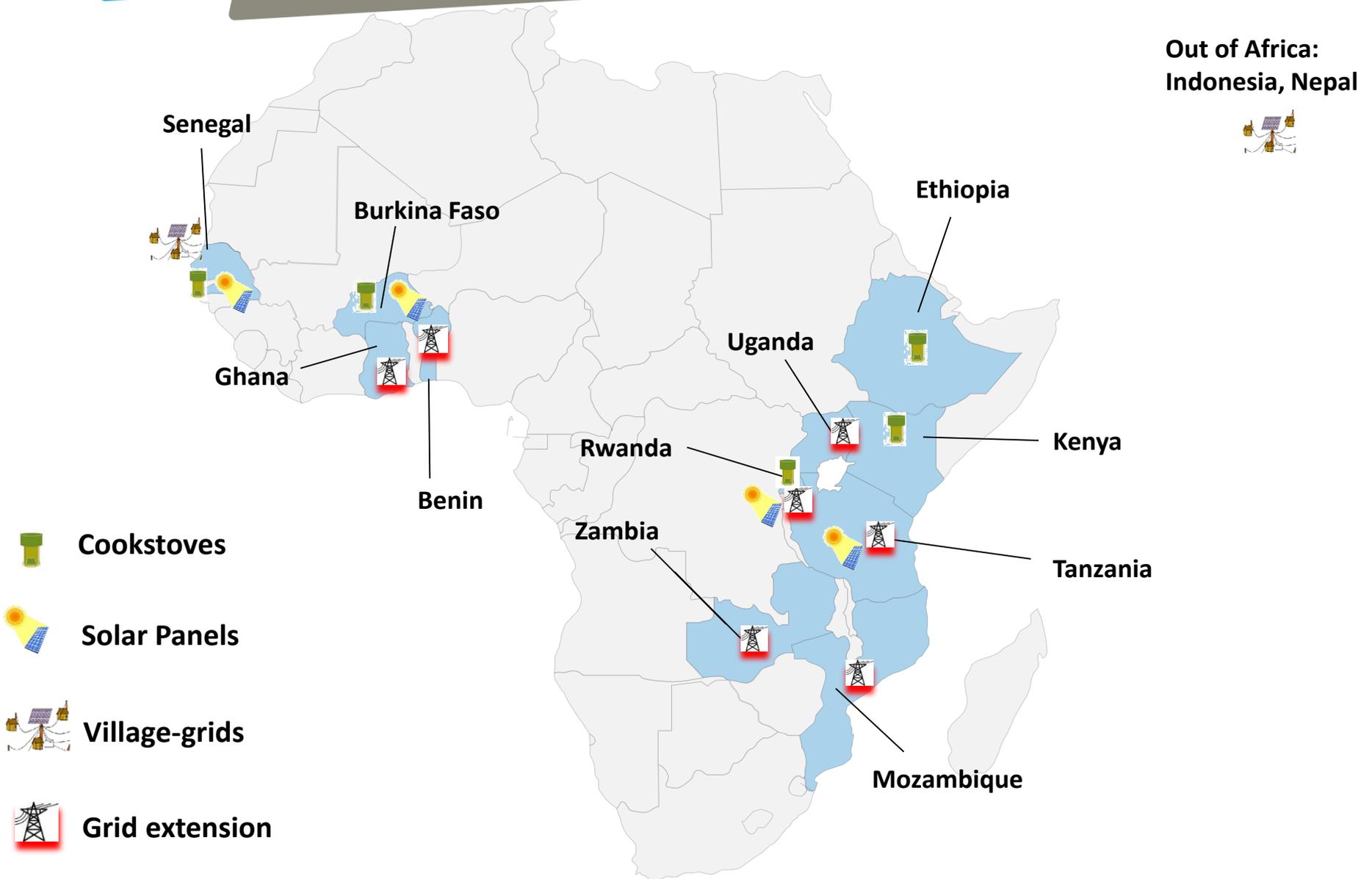
Jörg Peters

RWI

Passau University



Our Work on Energy Access: Impacts and Adoption



Four Key Messages

1. Electricity has a high priority for the rural poor
2. Electricity consumption in connected areas is very low
3. Impacts on economic development are modest
4. On-grid electrification is rarely cost-effective

Electricity has a high Priority for the rural Poor

Süddeutsche Zeitung

NEUESTE NACHRICHTEN AUS POLITIK, KULTUR, WIRTSCHAFT UND SPORT

SCHENKUNG

HF2

MÜNCHEN, FREITAG, 3. NOVEMBER 2017

73. JAHRGANG / 44. WOCHEN

Verpflichtung

...als die Männer noch
...weiß man in aller Reals
...als dass sie vorbei sind.
...on so. Als vor Jahrtau-
...des Jagens und Sam-
...kultur des Ackerbaues
...en die Männer aus der
...eine Mannmuts mehr
...chluss, dass ihre beste
...jüngeren Vergangen-
...n in den Dimensionen
...aber ähnlich bitterer
...den Siebzigern dürf-
...Männer fühlen, wenn
...feuerzeug aus Bestän-
...esaffen, zweitens des-
...stein wechseln konn-
...der Lage waren, mit
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...so anzuwerfen, dass
...te wie im dritten Auf-
...ger damit heute punk-
...gefragt zu werden, ob
...Parkplatz für seinen
...e.

...urmfeuerzeug zu sich
...n den Sinn ihres Dar-
...f anderen Gebieten.
...re Augen auf, wenn
...ndkerzen ausbauen
...ürste wieder funkti-
...onnten. Stottern des
...Verteilerkappe: was
...ch solchen Leistun-
...m Bier, öffnete die
...gendwie frauenhaft,
...sich vorstellte, dass
...geöffnet haben: mit
...ger an der Flasche,
...ack und plopp. Die
...g aller Seligkeiten,



Das Wichtigste

Ihre Kinder, Wasserkrüge und ein Solarmodul zum Kochen – das konnten diese Rohingya auf der Flucht mitnehmen. Staatenlos sind sie, und einige strandeten zwischen Myanmar und Bangladesch. Nun sind auch sie über die Grenze gelangt wie schon 600 000 Menschen, die vor der Gewalt des Militärs nach Bangladesch geflohen sind. Myanmars De-facto-Regierungschefin Aung San Suu Kyi besuchte am Donnerstag erstmals die Region Rakhine, aus der die Minderheit vertrieben wurde. FOTO: SARKAR/AFP

> Seite 7

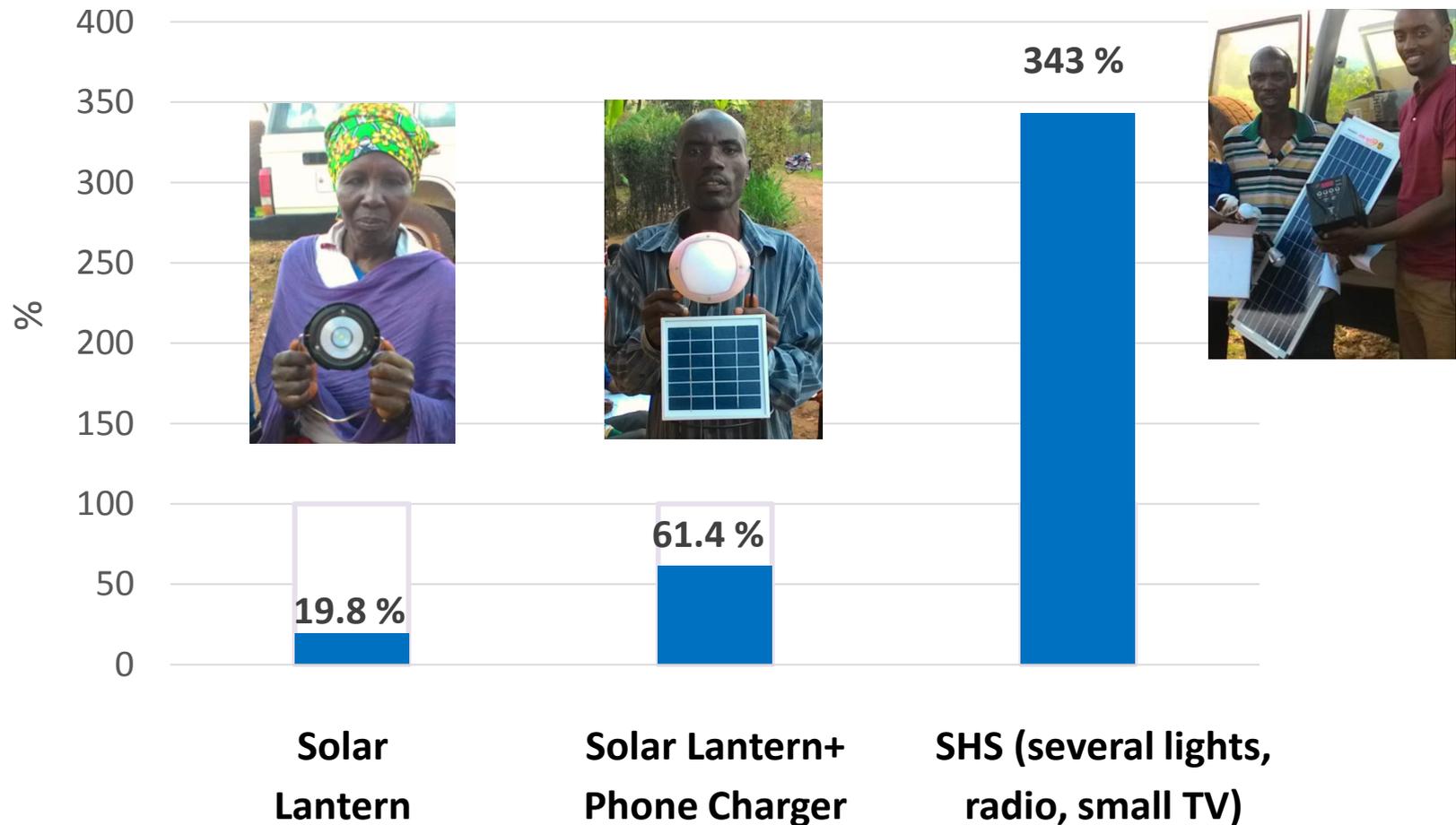
Gezeichnete
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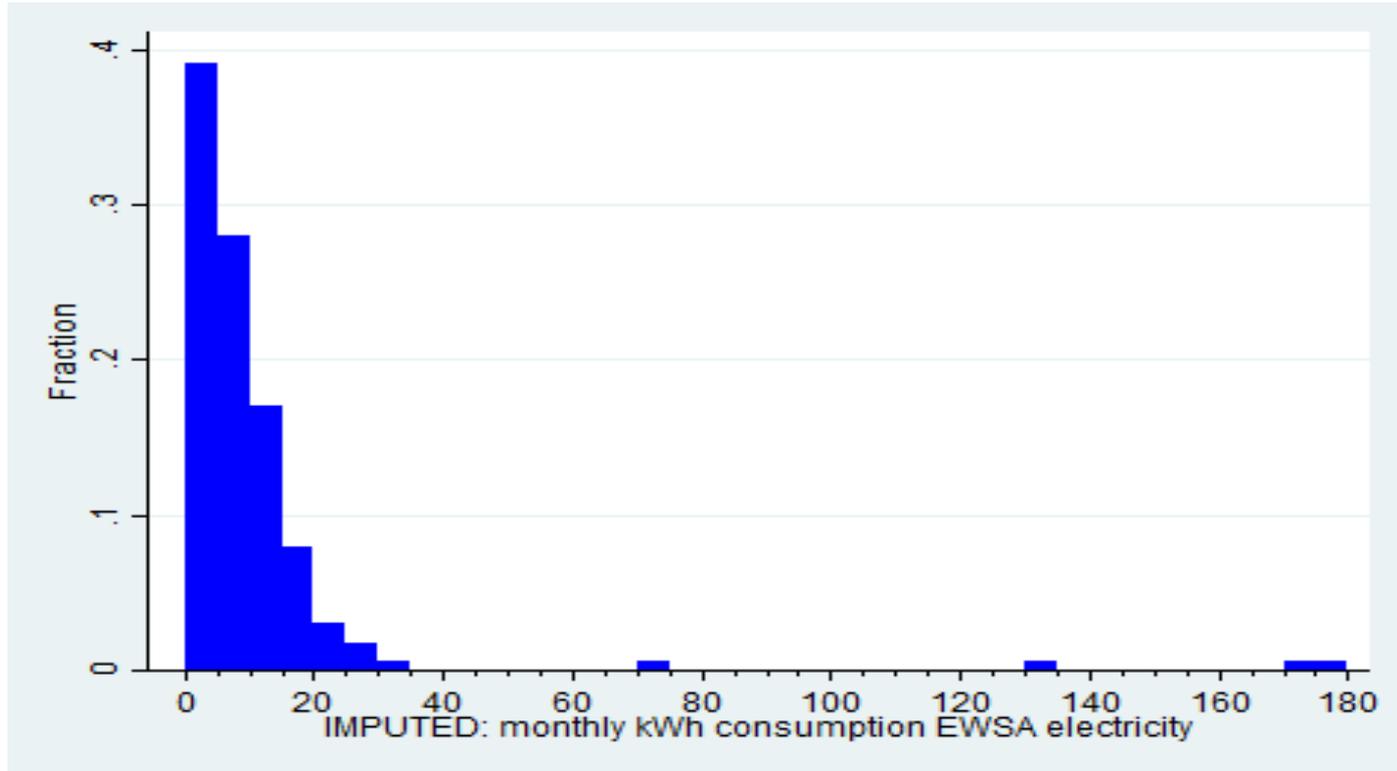
Electricity has a high Priority for the rural Poor

Willingness to pay for off-grid solar as a share of monthly expenditures



Source: Grimm et al. 2017

Monthly electricity consumption in Rwanda (in kWh)



- Rural households use lighting, radio and sometimes TV sets
- Electricity is (virtually) never used for cooking and refrigeration

Modest Impacts on Economic Development

- Impacts on home business activities, firm creation and expansion are very modest
- Electricity is not the main bottleneck
- Access to supra-regional markets is extremely limited
- If business potentials exist they are already exploited using generators
- No electric pumps for irrigation

On-grid Electrification is hardly cost-effective



15 USD

**Solar
Lantern**



35 USD

**Solar Lantern+
Phone Charger**



200 USD

**SHS (several lights,
radio, small TV)**

>1,500 USD

**Grid
Connection**

- Whatever the true costs and benefits of rural electrification are...
- ...connecting every single African village to the grid is not reasonable
- Given the SE4All-goal and the limitations of public budgets we have to develop an

Electrification Masterplan

....that is pro-poor and more cost-effective

- Grid extension should focus on selected thriving regions and rural industrial zones
- Off-grid solar should be promoted (subsidized?) to reach the vast majority of the rural poor

thank you!

Some further reading: [Mike Toman & myself on Let's Talk Development](#)

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Director of

Rural electrification: How much does Sub-Saharan Africa need the grid?

SUBMITTED BY **MICHAEL TOMAN** ON TUE, 07/11/2017
CO-AUTHORS: **JÖRG PETERS**

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An intense debate continues on how best to provide electricity to the 1.1 billion people currently without access to it -- of whom 600 million are living in Sub-Saharan Africa, many of them in rural areas. According to a **2015 IEG evaluation**, low-access countries received about 3.6 billion USD per year into the electricity sector from all sources over 2000 - 2014. The bulk of these funds has gone into extension of the traditional electricity grid. The IEG report also states that to achieve universal grid access in current low-access countries by 2030 will require over 17 billion USD per year, including about 12 billion USD per year for new transmission and distribution capacity. An additional 20 billion USD per year will be needed to address current supply inadequacies and expand generation capacity to meet growing demand. The largest share of this investment would be in Sub-Saharan Africa, given the size of the population

Blogroll

- MDGs and Beyond 2015
- Open Data Blog
- All About Finance
- Development Impact
- Education for Global Development

more

Resources

- Newsletter: MDGs and Beyond
- Global Monitoring Report
- Economic Monitoring
- Policy Research Working Papers

Discussant Remarks



Shreena Patel, MCC



MILLENNIUM
CHALLENGE CORPORATION

UNITED STATES OF AMERICA

Question & Answer Session



**Candace
Miller,
Mathematica
(Moderator)**



**Kathleen Auth, Power
Africa!**



**Duncan Chaplin,
Mathematica**



Jörg Peters, RWI



Shreena Patel, MCC

For More Information

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