

Electrification: Impacts and adoption



A non-systematic review

Jörg Peters

RWI – Leibniz Institute for Economic Research & University of Passau



Should governments invest in (nationwide) grid extension?

- Parts of the literature says 'yes', others say 'no'
- Different perspectives on the 'divide in the literature'

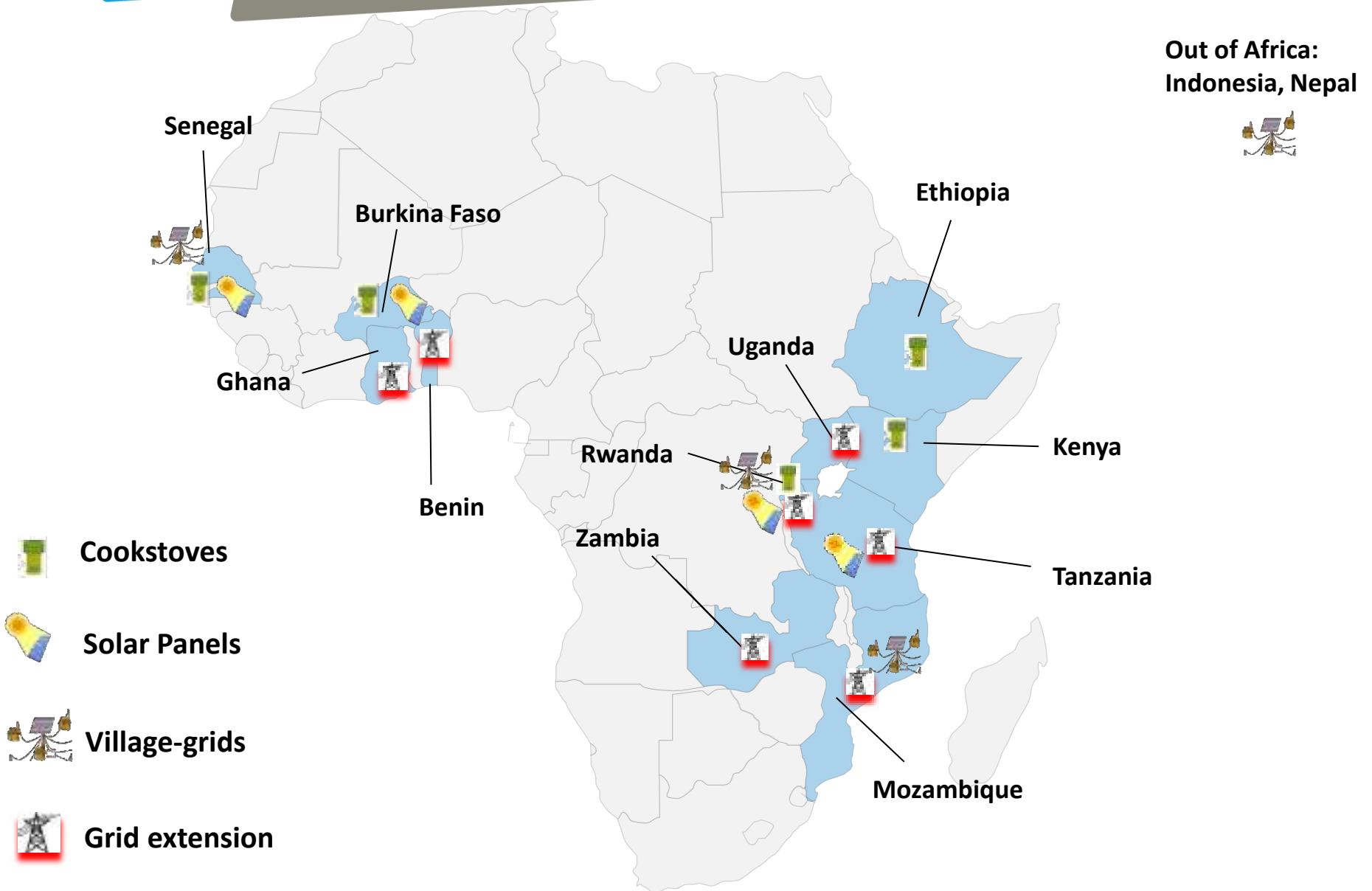
Leapfrogging the grid? The prospects of off-grid solar

- Mini-grids walk the line between grid and off-grid, but many barriers
- How about home-scale solar?

Substance of this talk

- Our own work
- Recent systematic reviews of the literature (Bayer et al. 2019, Bos et al. 2018, Hamburger et al. 2019, Jimenez 2017, OXFAM 2019)

Our Work on Energy Access: Impacts and Adoption



Impacts of grid electrification

For long, the reading in the academic literature has been that electrification has substantial impacts on economic and social development

Development Effects of Electrification: Evidence from the Topographic Placement of Hydropower Plants in Brazil

Molly Lipscomb
A. Mustafiq Moherak
Tania Barbieri

AMERICAN ECONOMIC JOURNAL: APPLIED ECONOMICS
VOL. 5, NO. 2, APRIL 2013
(pp. 200-231)



Journal of Development Economics
Volume 97, Issue 2, March 2012, Pages 352-367



Electricity provision and industrial development: Evidence from India ☆

Juan Pablo Rud

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<https://doi.org/10.1016/j.jdeveco.2011.08.010>

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[Economic Develo...](#) / [Vol. 61, No. 3...](#) / [Welfare Impacts...](#)



JOURNAL ARTICLE

Welfare Impacts of Rural Electrification: A Panel Data Analysis from Vietnam

Shahidur R. Khandker, Douglas F. Barnes and Hussain A. Samad

Economic Development and Cultural Change
Vol. 61, No. 3 (April 2013), pp. 659-692

Yet, no evidence on Africa

Recent evidence on on-grid electrification in Africa

Three large-scale recent studies in rural Africa have shifted the prior in the literature



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Grid Electricity Expansion in Tanzania by MCC: Findings from a Rigorous Impact Evaluation, Final Report

Publisher: Washington, DC: Mathematica Policy Research

Duncan Chaplin, Arif Maman, Ali Profik, John Schurrer, Dhya Vohra, Kristine Bos, Hannah Burak, Laura Meyer, Anca Dumitrescu, Christopher Kroll, and Thomas Cook



World Development

Volume 89, January 2017, Pages 88-110



Does Large-Scale Infrastructure Investment Alleviate Poverty? Impacts of Rwanda's Electricity Access Roll-Out Program

Luciane Lenz ^a, Anicet Munyehirwe ^b, Jörg Peters ^{a, c}, Maximiliane Sievert ^a

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<https://doi.org/10.1016/j.worlddev.2016.08.003>

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Experimental Evidence on the Demand for and Costs of Rural Electrification

Kenneth Lee, Edward Miguel, Catherine Wolfram

NBER Working Paper No. 22292

Issued in May 2016

NBER Program(s): Development Economics, Environment and Energy Economics, Industrial Organization, Public Economics

We present results from an experiment that randomized the expansion of electric grid infrastructure in rural Kenya. Electricity distribution is the canonical example of a natural monopoly. Randomized price offers show that demand for electricity connections falls sharply with price. Experimental variation in the number of connections combined with administrative cost data reveals considerable scale economies, as hypothesized. However, consumer surplus is far less than total costs at all price levels, suggesting that residential electrification may reduce social welfare. We discuss how leakage, reduced demand (due to red tape, low reliability, and credit constraints), and spillovers may impact this conclusion.

A regional divide?

D. Hamburger, et al.

Energy Research & Social Science 58 (2019) 101236

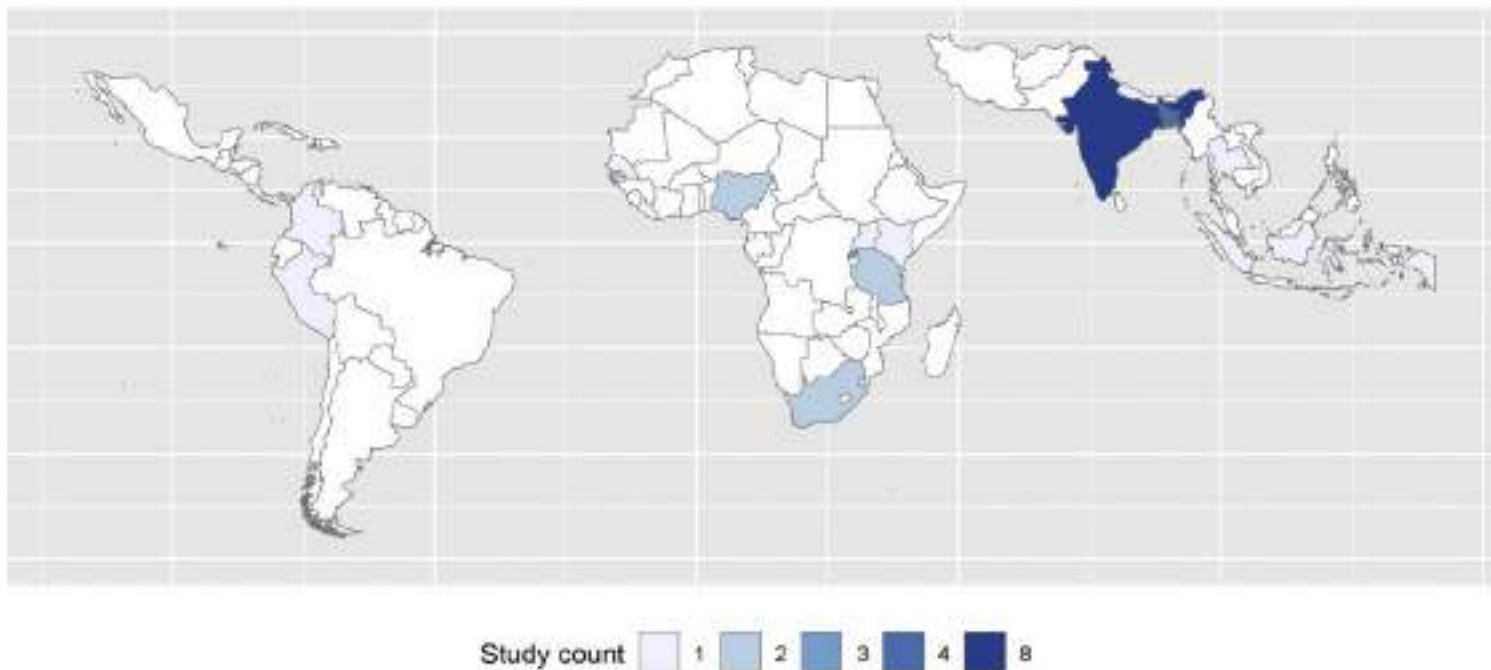


Fig. 1. Geographic distribution of impact evaluations of energy access.

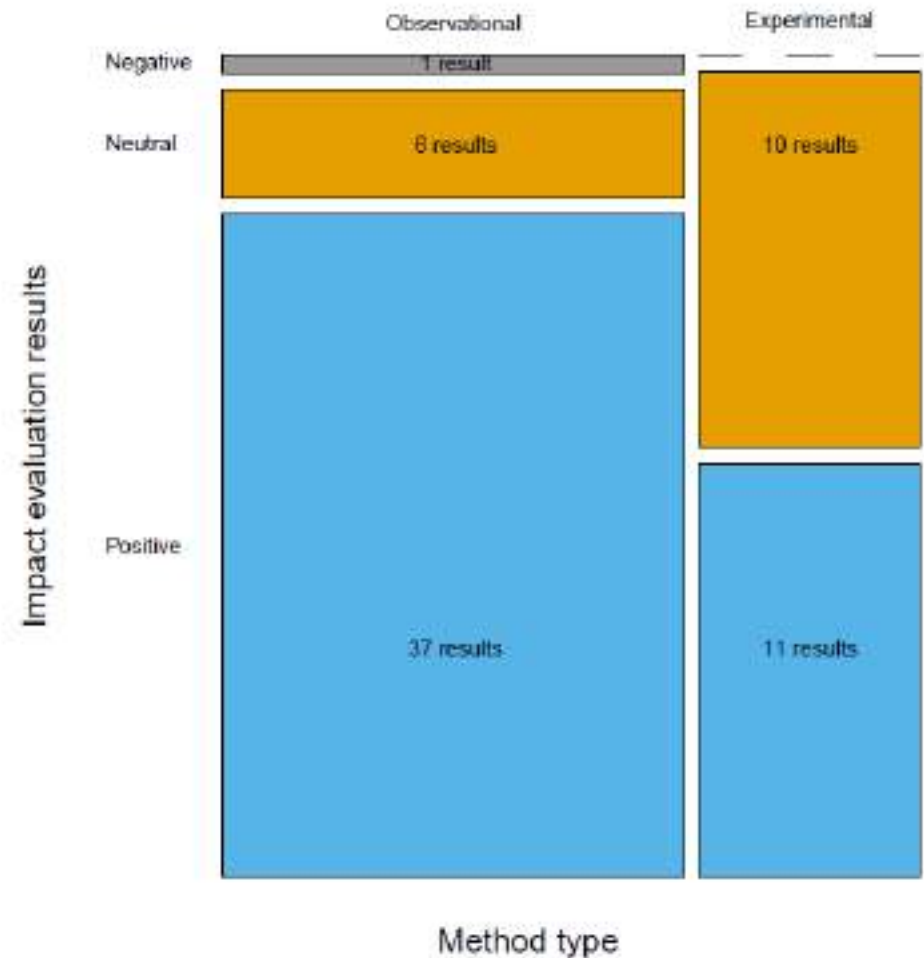
Indeed, evidence from Africa is less optimistic (see as well Bos et al. 2017 and [Peters/Sievert 2016](#))

Divide in the literature: Possible explanations

A methodological divide?

Bayer et al. 2019:
“Findings in RCTs are less positive”

Results of impact evaluation by method



Divide in the literature: Possible explanations

A methodological divide?

Indeed, many IV-based papers find large and significant effects while...
...well-crafted impact evaluations find modest or no effects

[Honi soit qui mal y pense: “Methods matter: P-Hacking and Causal Inference in Economics”, Brodeur et al. (2018)]

Table 1: Significant at the 5% Level

	(1)	(2)	(3)	(4)	(5)
	Z > 1.96	Z > 1.96	Z > 1.96	Z > 1.96	Z > 1.96
DID	0.132 (0.044)	0.133 (0.044)	0.134 (0.046)	0.130 (0.047)	0.163 (0.051)
IV	0.177 (0.045)	0.179 (0.045)	0.186 (0.045)	0.178 (0.044)	0.169 (0.057)
RDD	0.056 (0.053)	0.058 (0.053)	0.043 (0.051)	0.038 (0.051)	0.027 (0.061)
Observations	13,440	13,440	13,440	13,440	13,440
Pseudo R-squared	0.013	0.018	0.038	0.039	0.057
Top 5		Y	Y	Y	Y
Journal FE			Y	Y	Y
Reporting Method				Y	Y
Article Weights					Y

Notes: This table reports marginal effects from probit regressions (Equation (1)). The dependent variable is a dummy for whether the test statistic is significant at the 5% level. Robust standard errors are in parentheses, clustered by article. In columns 4 and 5, we control for the way author(s) report statistical significance, i.e., p-value, t-statistic or coefficient and standard error. In column 5, we use the inverse of the number of tests presented in the same article to weight observations.

In any case, it seems fair to conclude that impacts of on-grid electrification are much smaller than previously thought.

How about the costs?

Lee, Miguel, and Wolfram (2016) in Kenya

- ‘welfare loss’ from grid intensification of 511-1,100 USD per household.

Lenz et al. (2017) in Rwanda

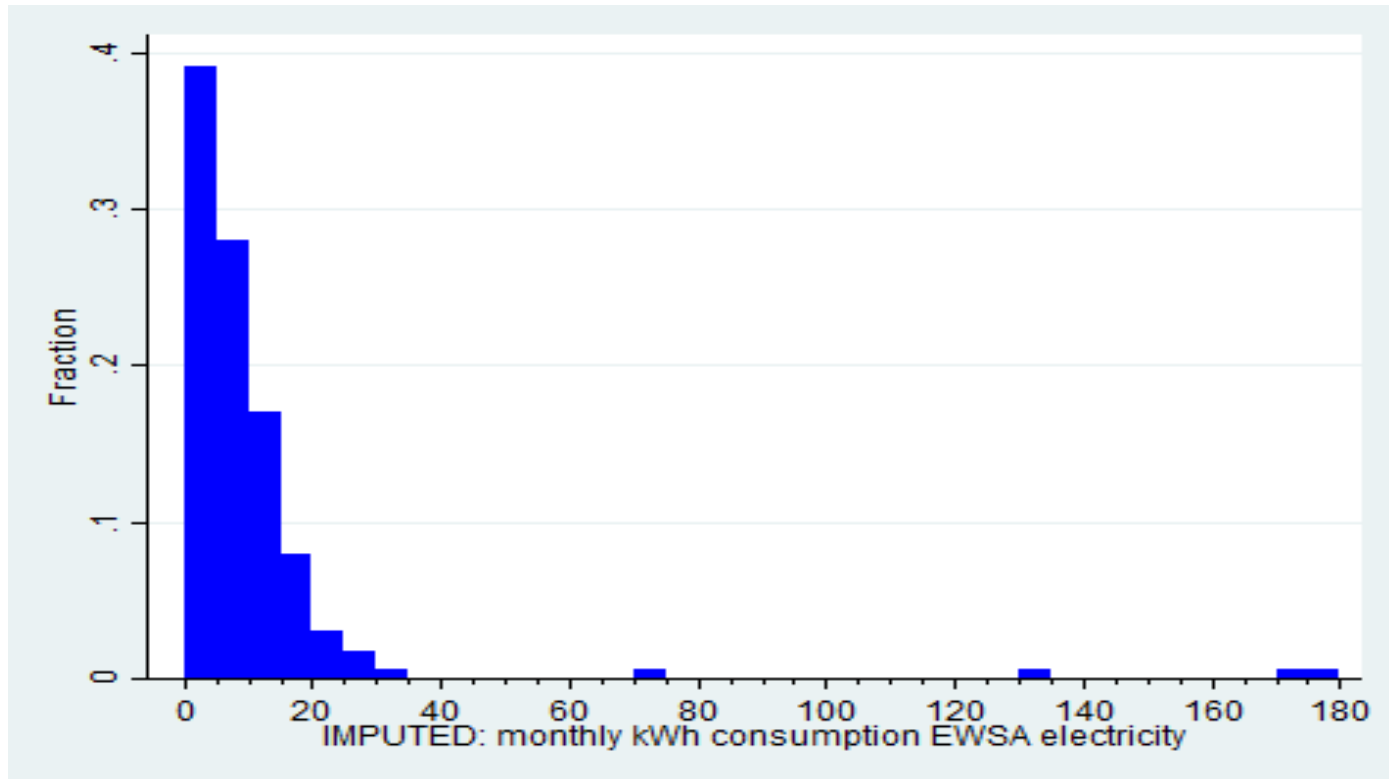
- Costs per connection: 1,500 USD

Chaplin et al. (2017) in Tanzania

- Costs per connection: 6,600 USD

„Does Africa’s energy future even lie with the grid?”

Monthly electricity consumption in Rwanda (in kWh)



[Source: Lenz et al. \(2017\)](#)

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

- Whatever precisely the true costs and benefits of rural electrification are...
- ...connecting every single African village to the grid is not reasonable

Let's rethink the on-grid-off-grid balance of electrification portfolios



How about off-grid solar?

From solar lanterns to mini-grids

Mini-grids: The silver bullet alternative to the grid?

- Huge potentials in principle, but...
- few examples of sustainably working mini-grid programs in Africa have matured beyond the pilot village (“boutique electrification”, Tenenbaum 2014)

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Rural electrification through mini-grids: Challenges ahead

Jörg Peters^{a,b,*}, Maximiliane Sievert^d, Michael A. Toman^c

^aAWI – Leibniz Institute for Economic Research, Germany
^bUniversity of Posen, Germany
^cWorld Bank, Development Research Group, Washington DC, USA




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ABSTRACT

Recent debates on how to provide electricity to the roughly one billion still unconnected people in developing countries have identified mini-grids as a promising way forward. High upfront costs of transmission lines are avoided, and unlike home-scale solar, mini-grids can provide sufficient electricity for productive uses. Indeed, mini-grids play a crucial role in accomplishing the goal of the UN Sustainable Energy for All (SE4All) Initiative to provide universal access to electricity by 2030. This note outlines the challenges the mini-grid sector faces to achieve that goal. To date, few examples of sustainably working mini-grid programs exist. We identify

Randomized Controlled Trials on off-grid solar are mushrooming



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Volume 31, Issue 3
October 2017

A First Step up the Energy Ladder? Low Cost Solar Kits and Household's Welfare in Rural Rwanda ^{FREE}

Michael Grimm, Anicet Munyehirwe, Jörg Peters, Maximiliane Sievert

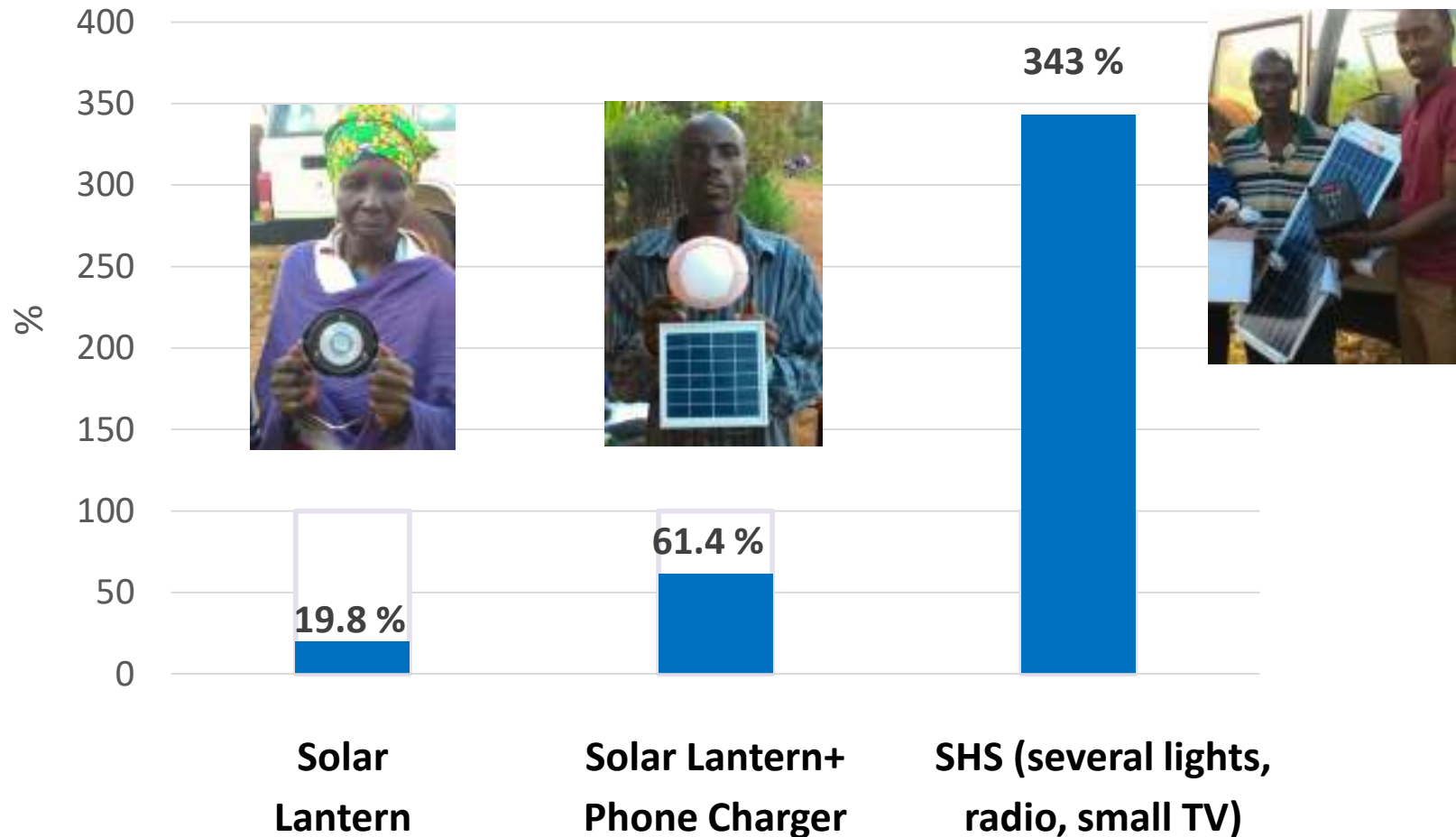
The World Bank Economic Review, Volume 31, Issue 3, 1 October 2017, Pages 631-649, <https://doi.org/10.1093/wber/lhw052>

Published: 20 October 2016

- Impact findings are not euphoric, but overall positive – especially in proportion to low investment costs
- People value off-grid solar highly!

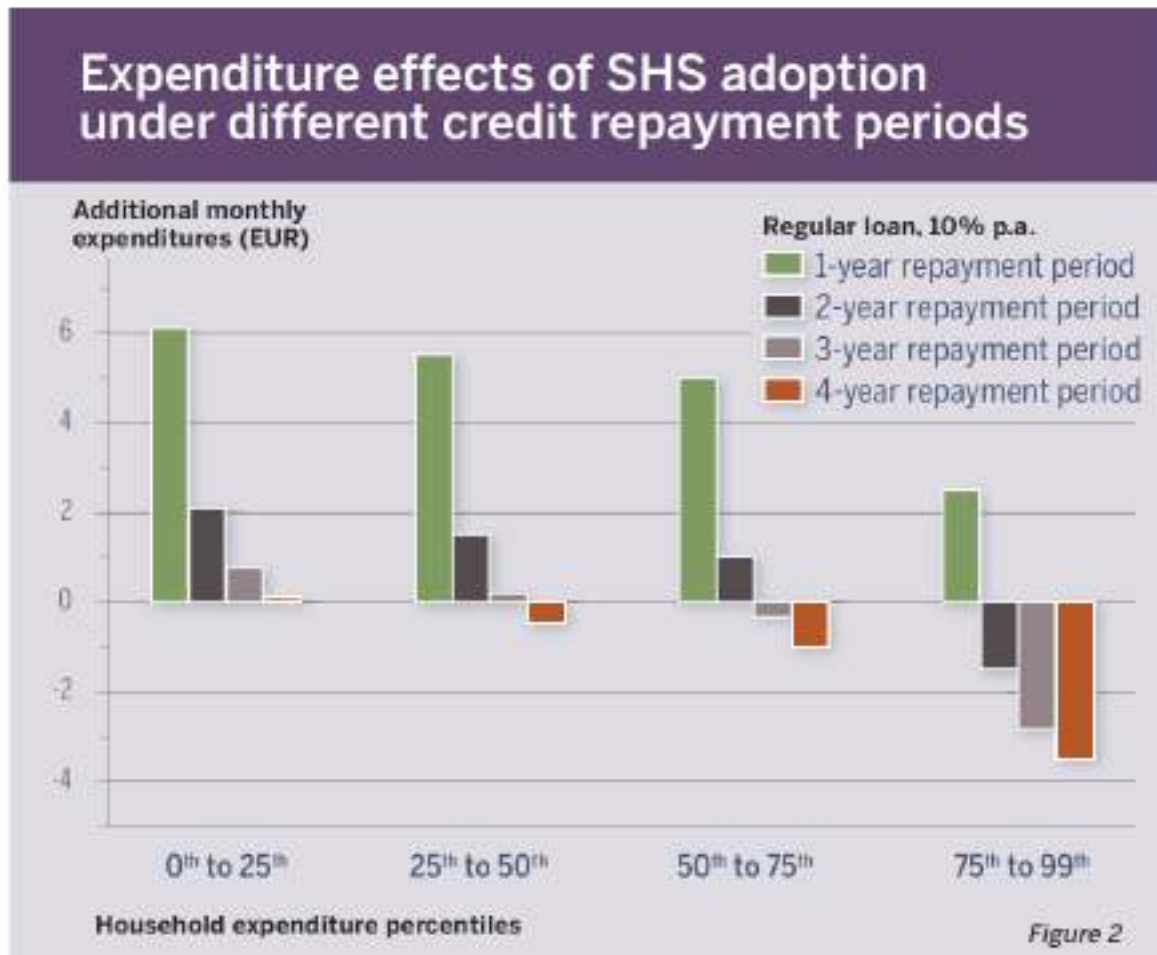
The rural poor value off-grid solar highly...

Revealed willingness to pay as a share of monthly expenditures



Source: Grimm et al. 2018

...but only the better-off strata can afford



[Source: Grimm and Peters 2016](#)

Because of higher replaceable energy expenditures, wealthier households have higher saving potentials

The LED-Lighting Transition:

“Low-quality” solar and dry-cell batteries



Kerosene is no longer the baseline situation



[Source: Bensch et al. \(2017\)](#)



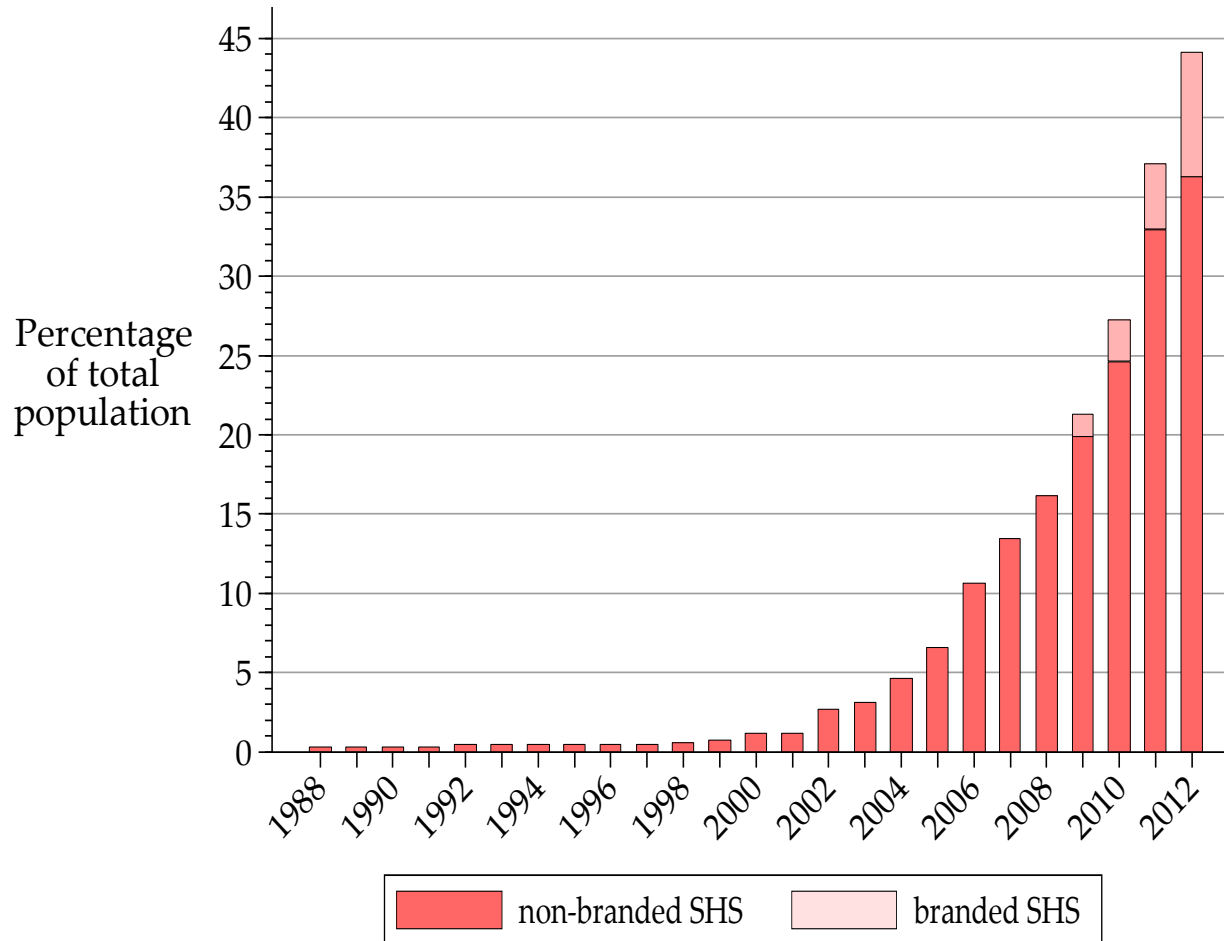
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The lighting transition: “low-quality” solar

SHS take-up over time in Kéné Dougou region, Burkina Faso



Source: Bensch et al. (2018)

Towards an Electrification Masterplan

- Rethink the on-grid-off-grid balance electrification portfolios

Challenges ahead:

- How to improve energy planning systems (i.e. where should the grid go)?
- Viable business models for mini-grids
- What is the role for “high-quality” off-grid solar vis-à-vis La Chinoiserie?
- How to establish effective waste management systems for solar?

thank you!

 @jrgptrs

A couple of related Blogposts:

[Lighting transition in rural Africa, *The Conversation*](#)

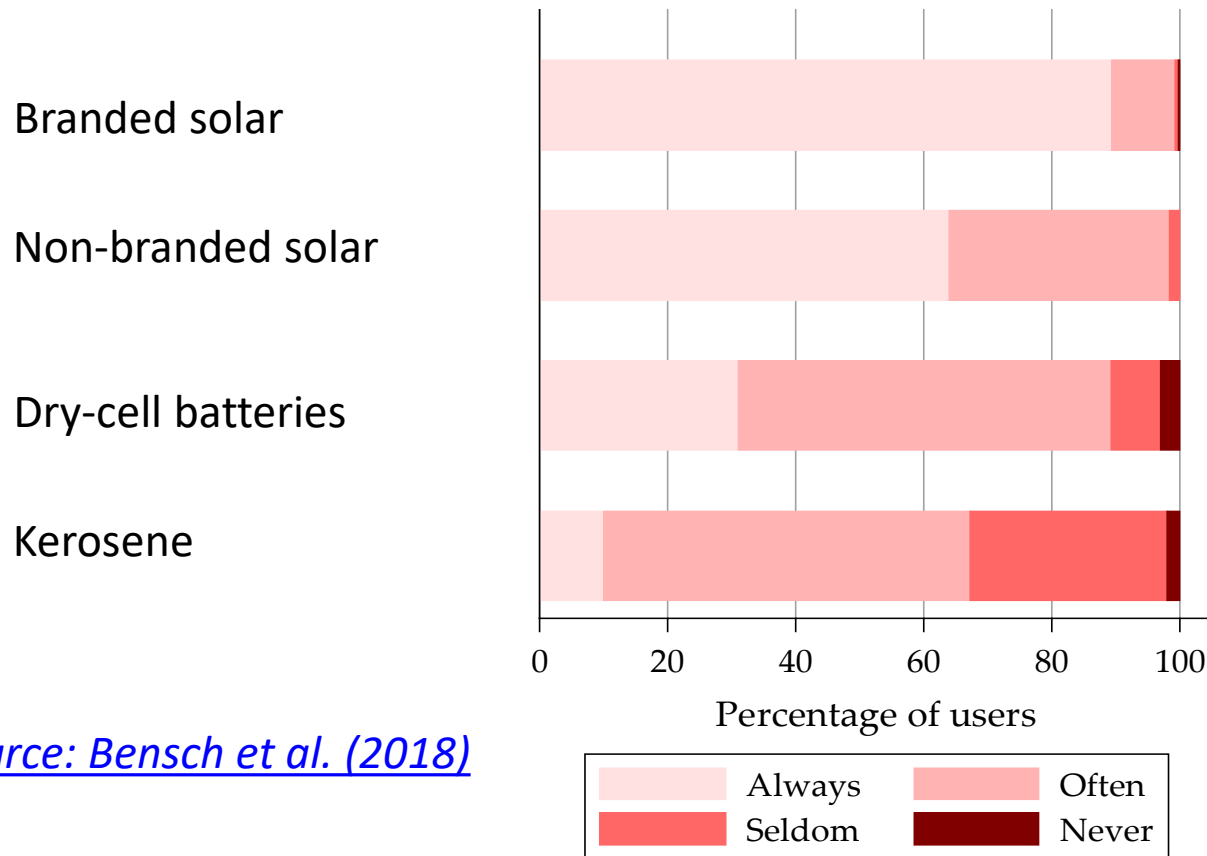
[How much does Africa need the grid?, World Bank's *Let's Talk Development*](#)

[Impacts of on-grid electrification in Rwanda, *The Conversation*](#)

[Lighting up rural Africa, *Green Growth Knowledge Platform*](#)

“High-quality” vs. “Low-quality” solar

Satisfaction with lighting quality in Kéné Dougou region, Burkina Faso



[Source: Bensch et al. \(2018\)](#)

Neither objective nor subjective indicators point at a striking superiority of “high-quality” solar