Prospects for Rural Electrification in Africa

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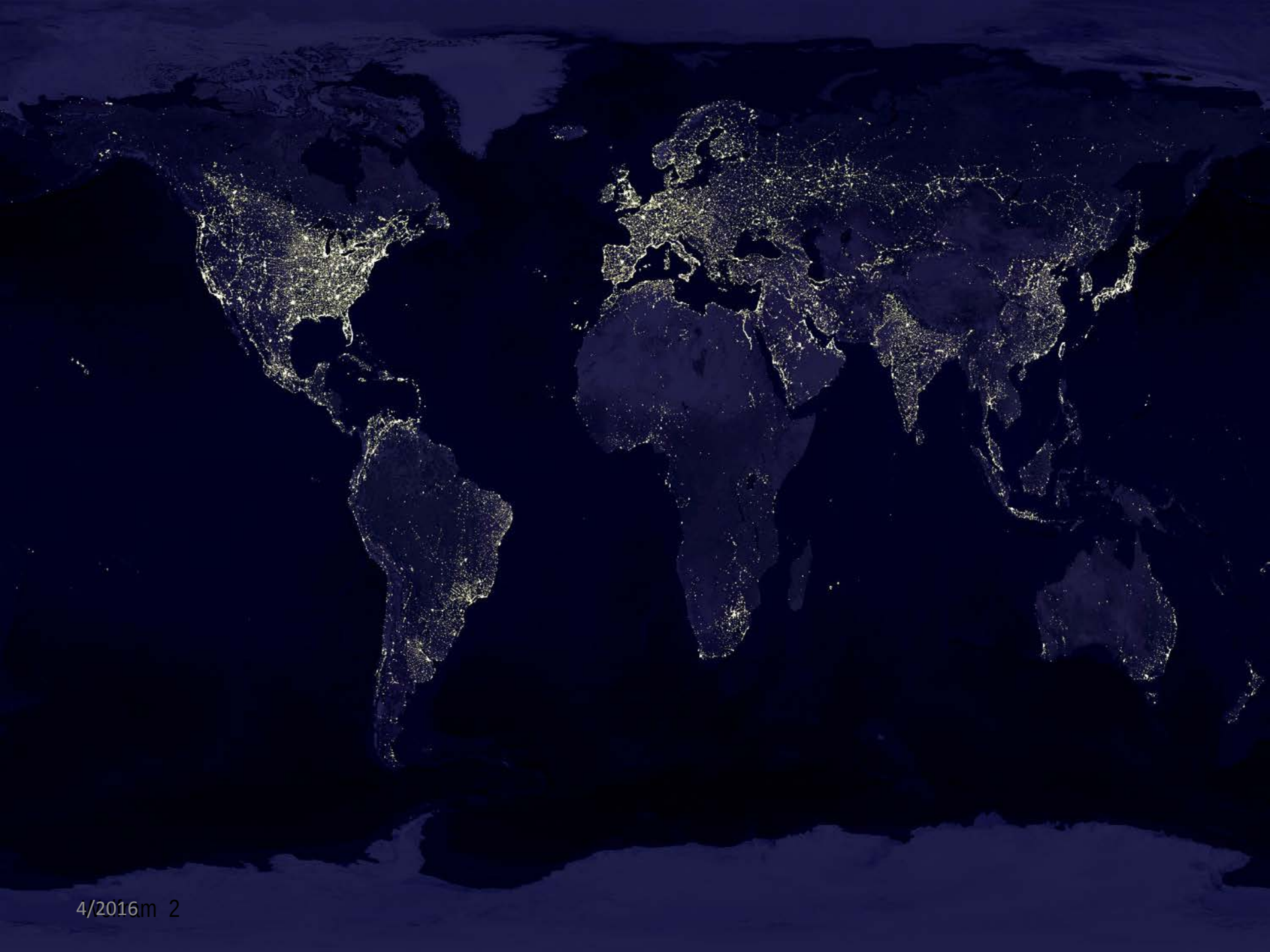
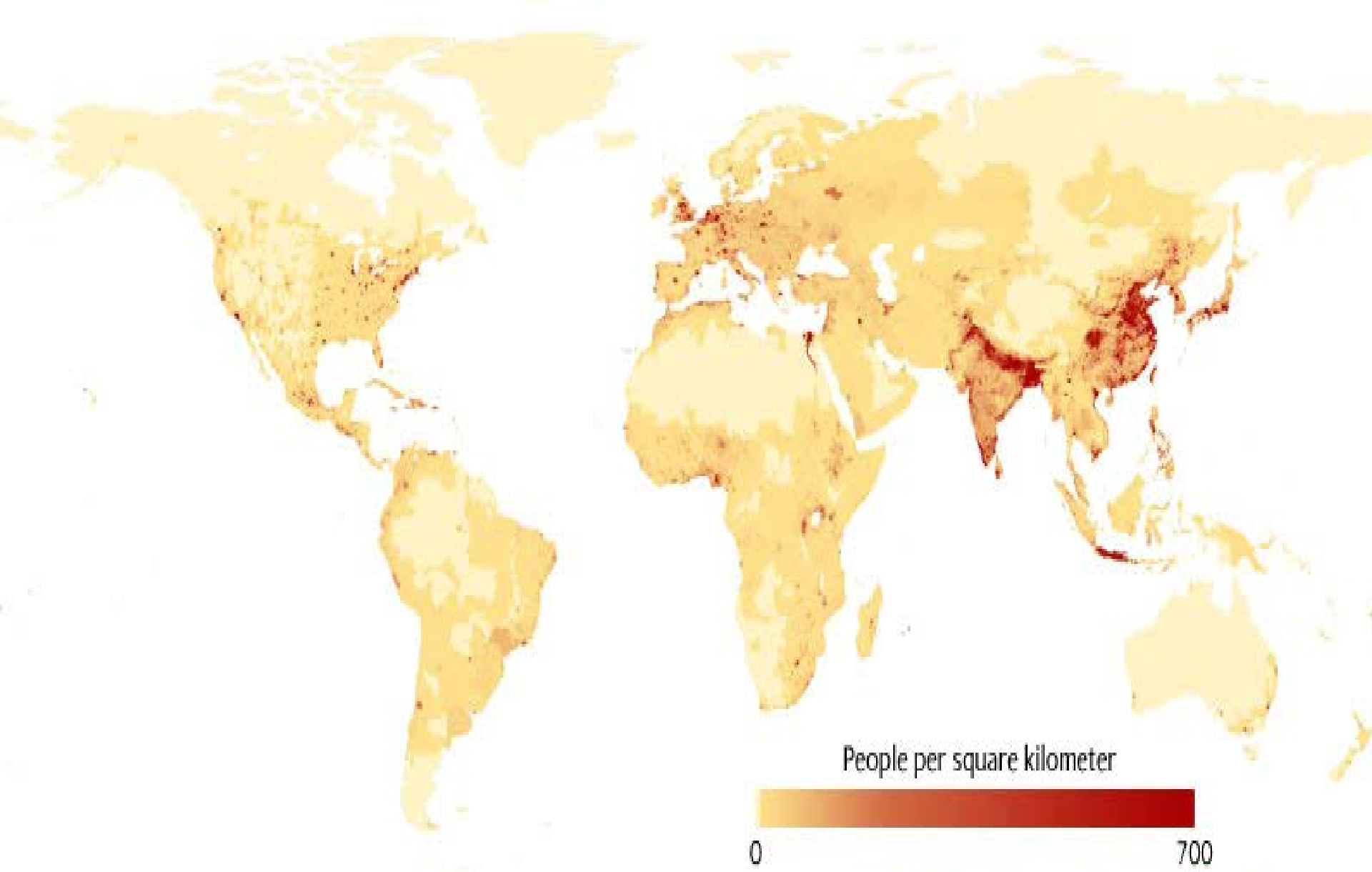
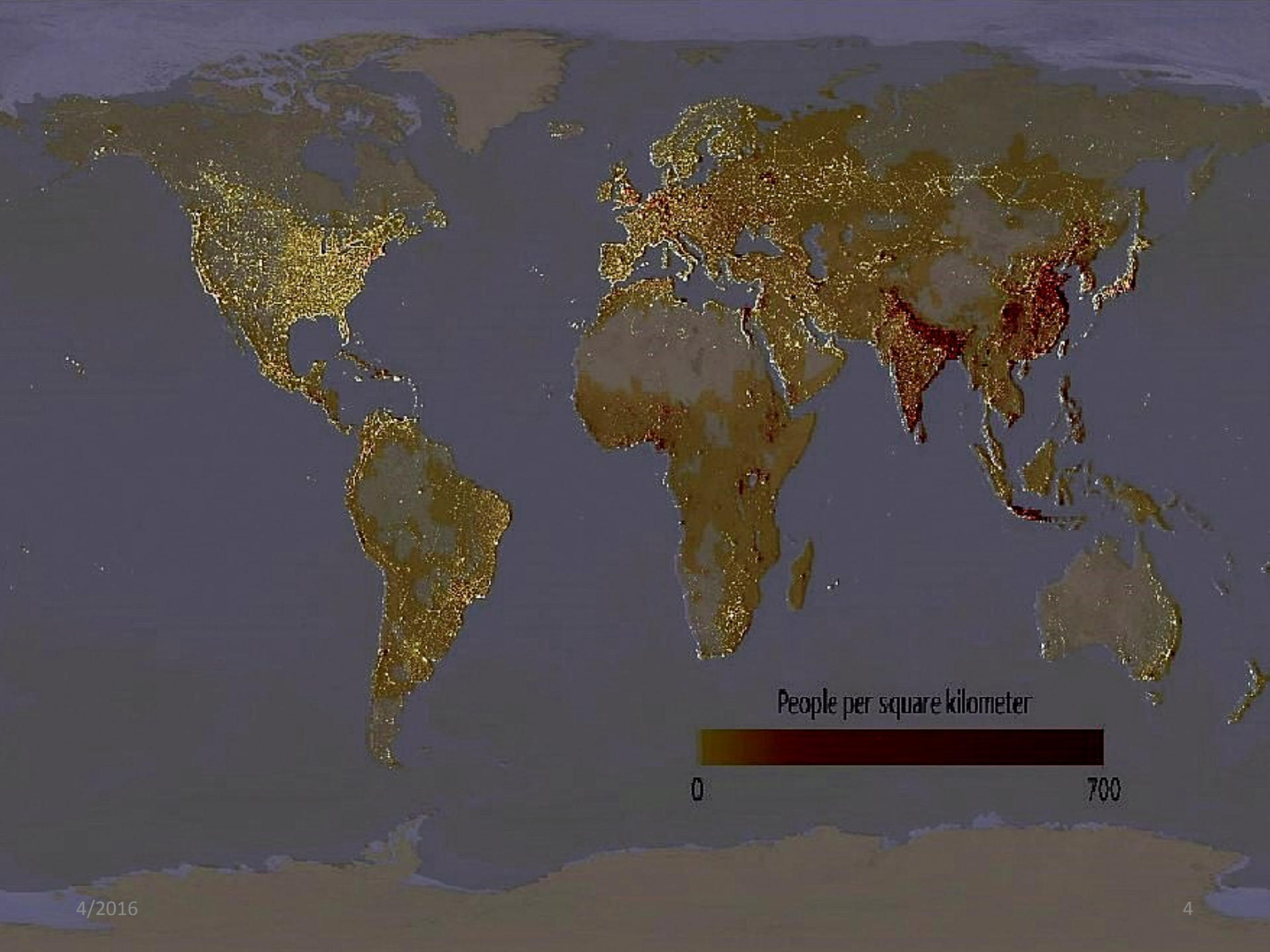



People per square kilometer
0
700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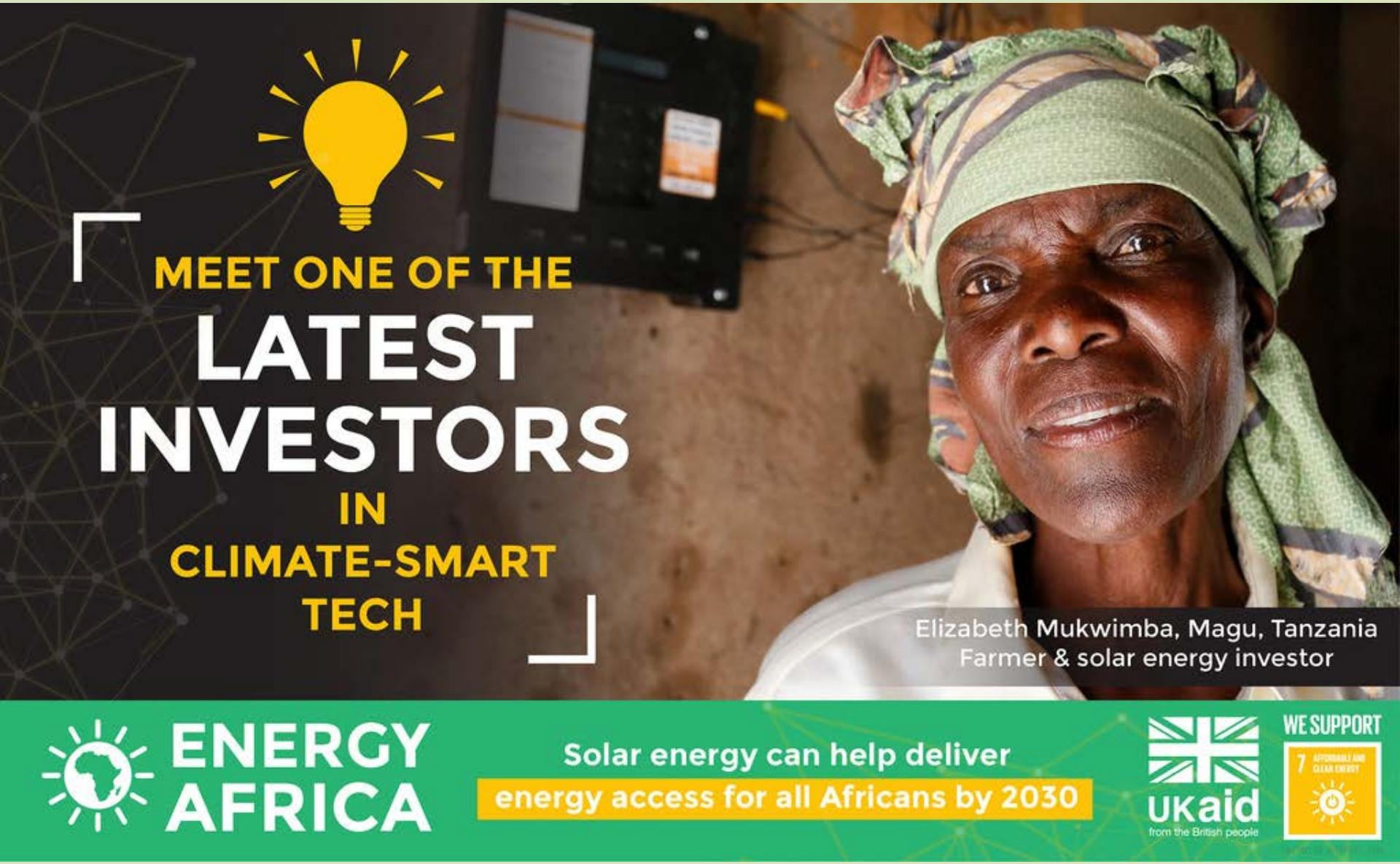
0
700

2013 – President Obama's *Power Africa*

2015: DFID *Energy Africa* campaign

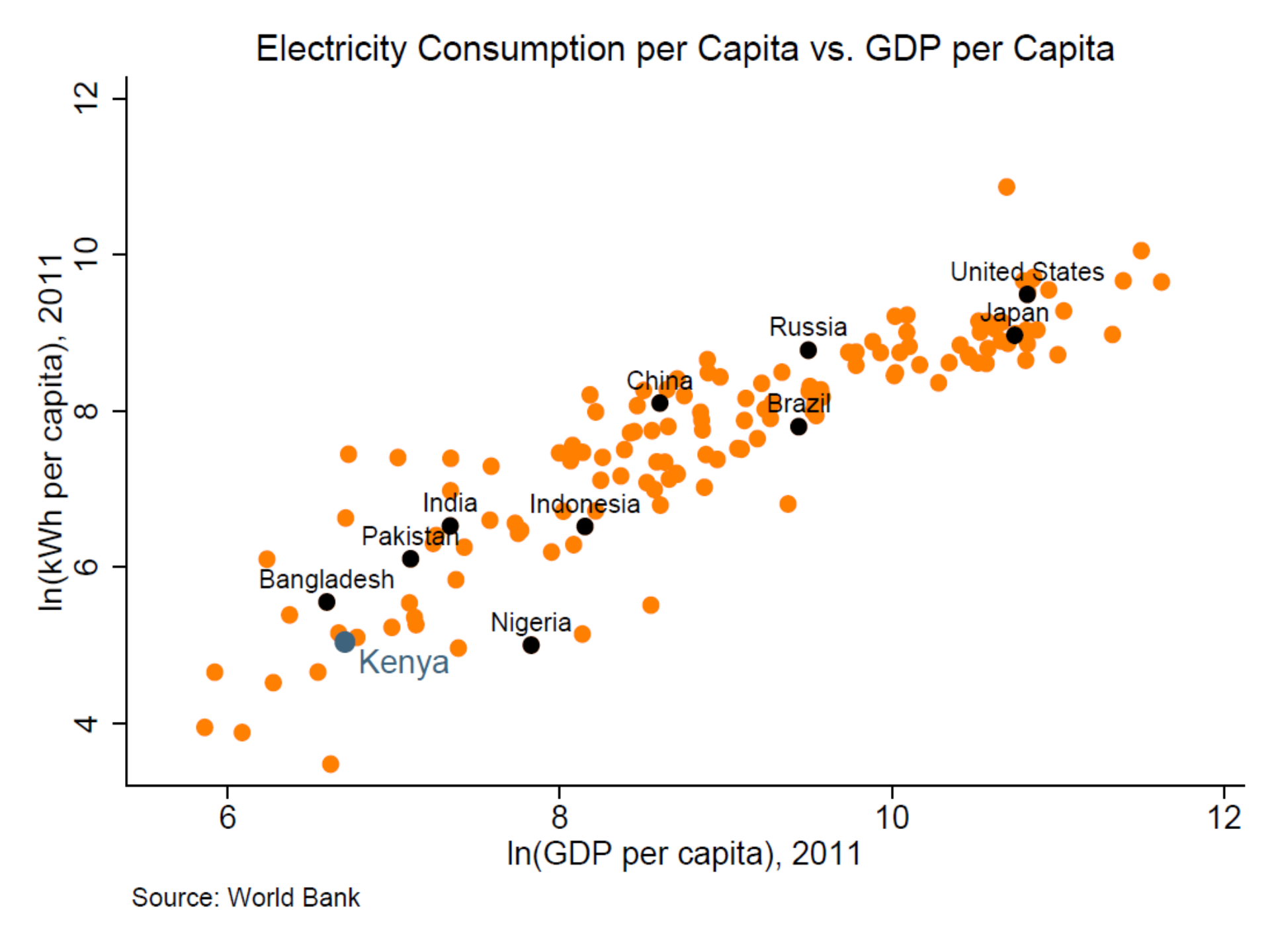


Powering Africa

- Energy may be the development sector with the biggest gap between public spending and research knowledge. Little is known about basic questions.

1. Should rural electrification be a policy priority in Africa today? (In particular, is it likely to reduce poverty?)

2. How should it be achieved? (In particular, through expansion of the electricity grid, or off-grid, eg, solar?)


Electricity Consumption per Capita vs. GDP per Capita
ln(kWh per capita), 2011
4
6
8
10
12
ln(GDP per capita), 2011
6
8
10
12
United States
Japan
Russia
China
Brazil
India
Indonesia
Pakistan
Bangladesh
Nigeria
Kenya
Source: World Bank

Electrification impacts

- There is little evidence on electrification impacts on economic growth in low-income countries.
- In part due to major methodological challenges to studying infrastructure impacts. (A broader issue as infrastructure is 40% of World Bank spending.)

- Many open issues on rural electrification:

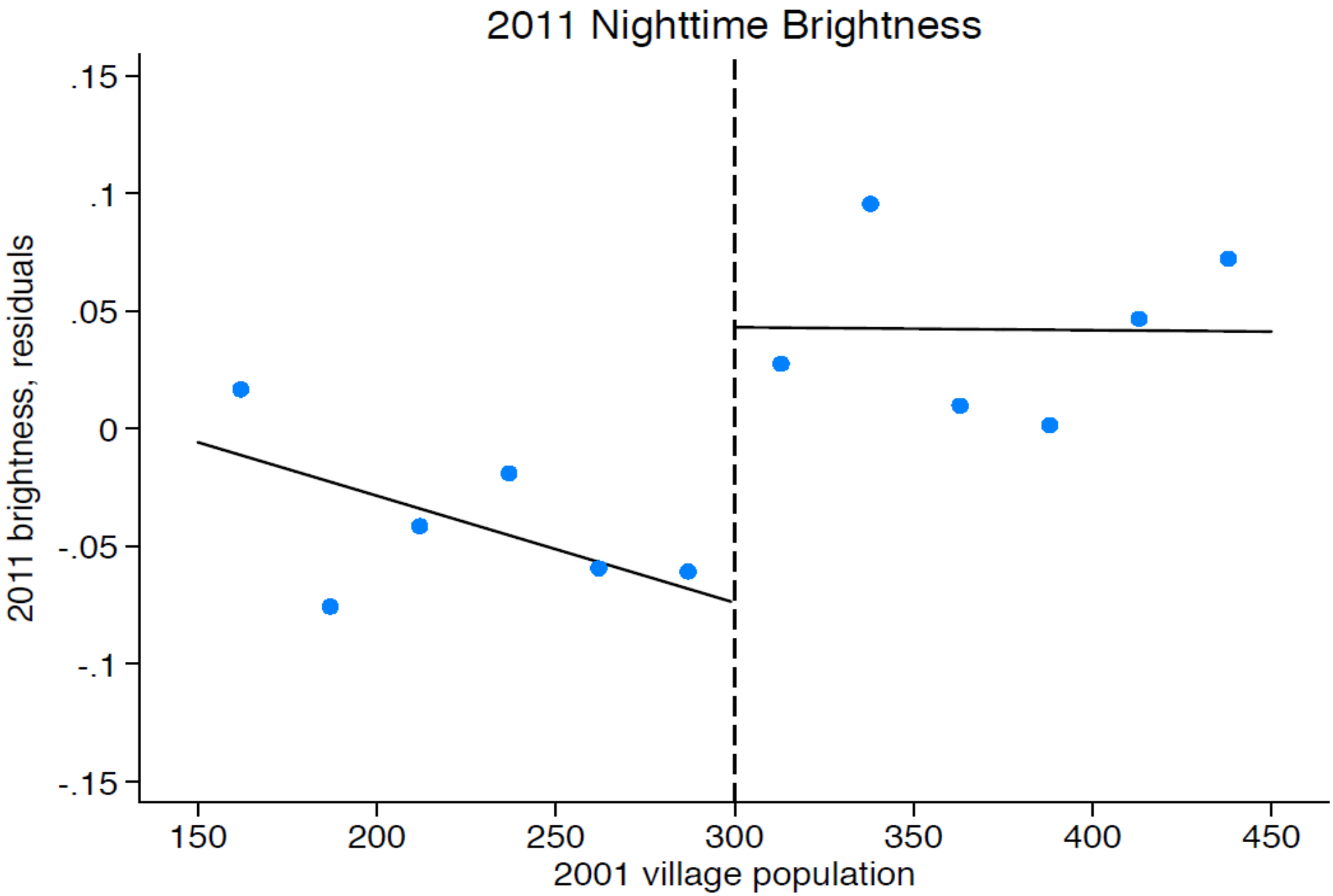
1. Effects could differ in urban versus rural areas;
2. Commercial vs. public vs. residential connections;
3. Productive benefits (e.g., self-employment) vs. consumption (TV), etc.

Electrification impacts

- Best-known study is Dinkelman (2011, AER)
- Results from a region in Kwazulu-Natal, South Africa with minimal agricultural employment may not generalize to other rural African settings

- New results (Burlig and Preonas 2016, working paper) in Indian villages may be more informative for rural Africa

Rural electrification impacts in India, Burlig and Preonas (2016)



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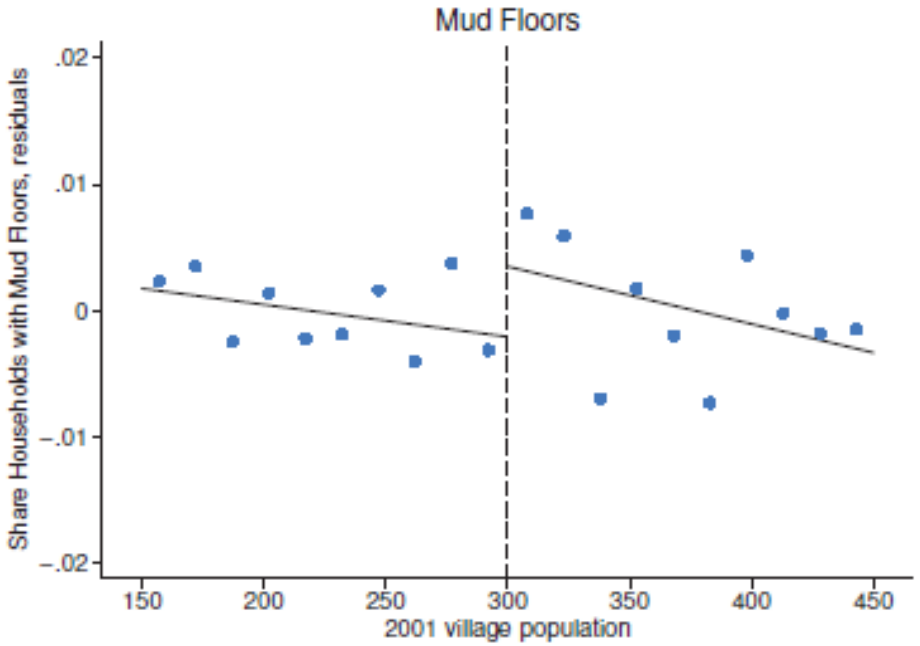

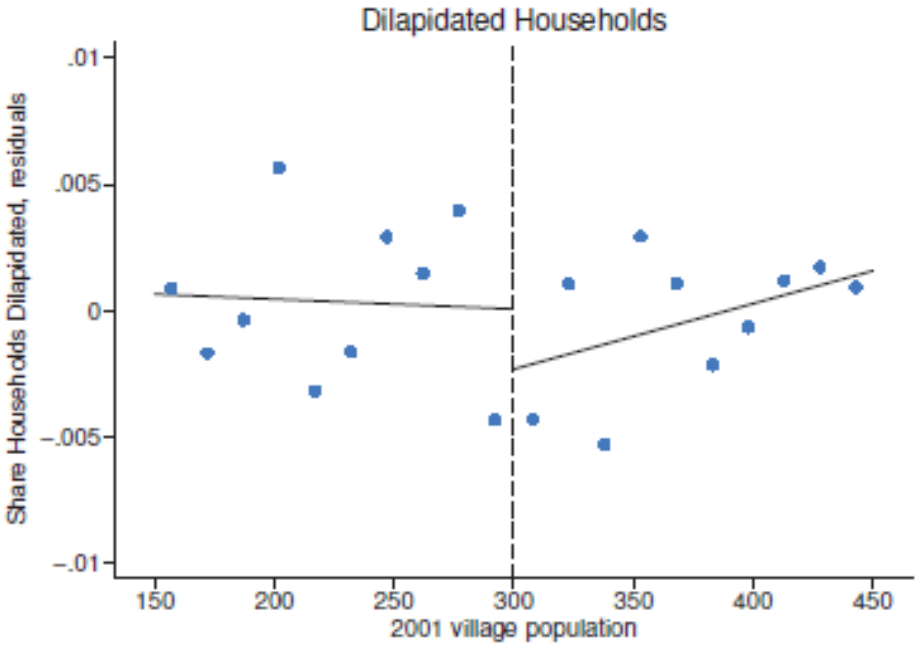

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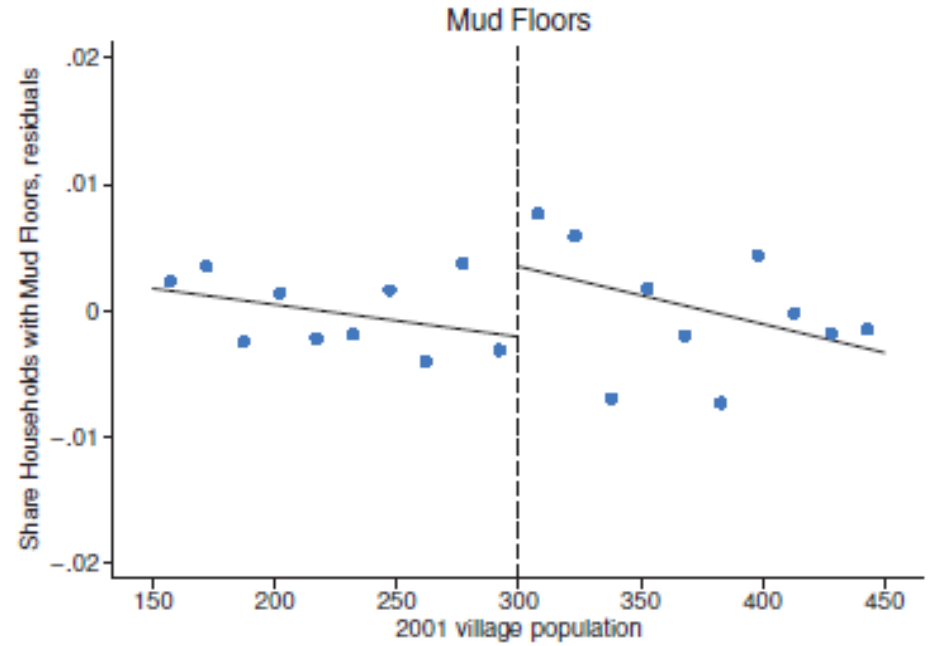
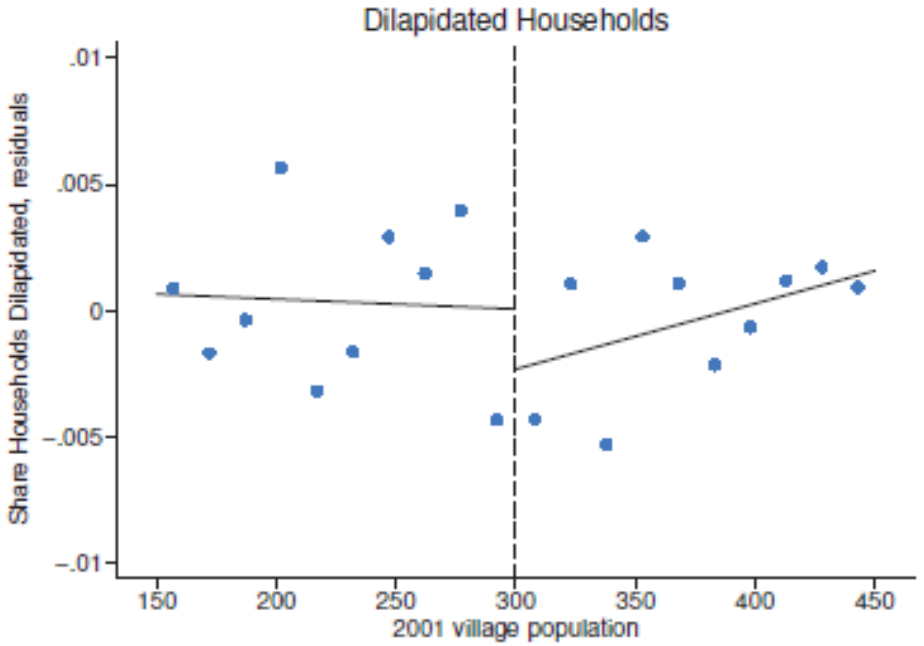
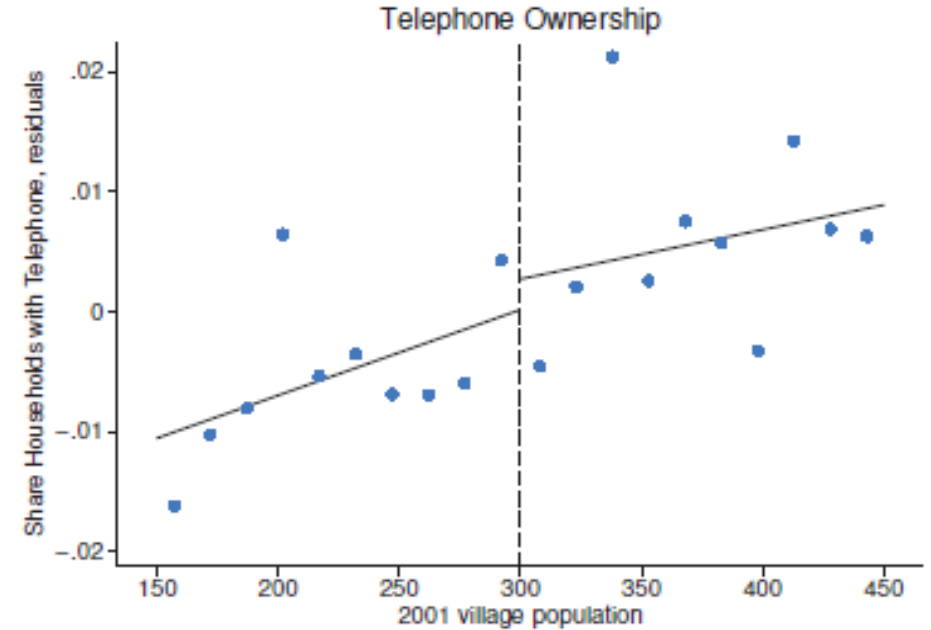
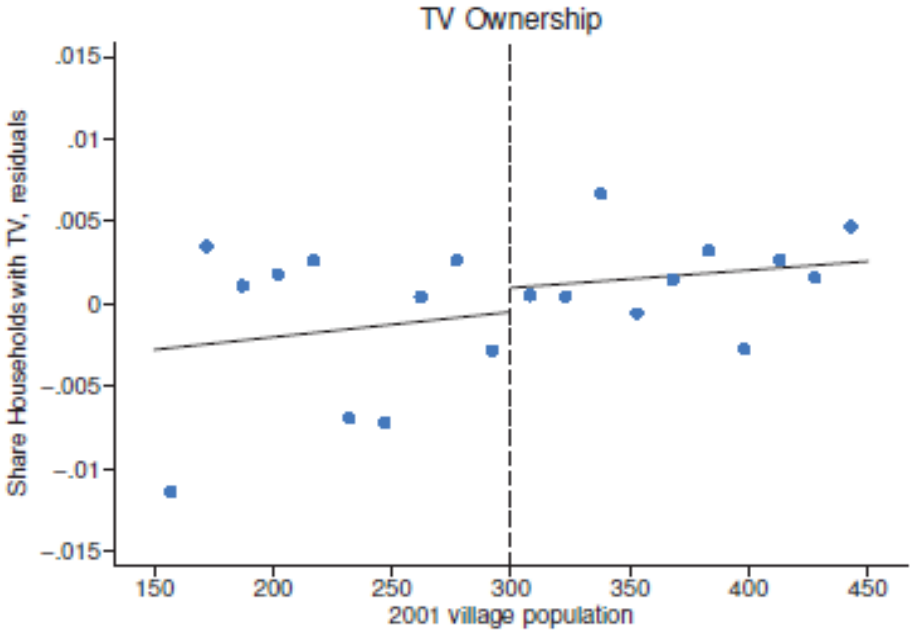








Electrification impacts

- Working with the national electricity utility, an ongoing project randomized subsidies for grid connections to rural Kenyan households (Lee, Miguel and Wolfram 2016a), N=150 villages.

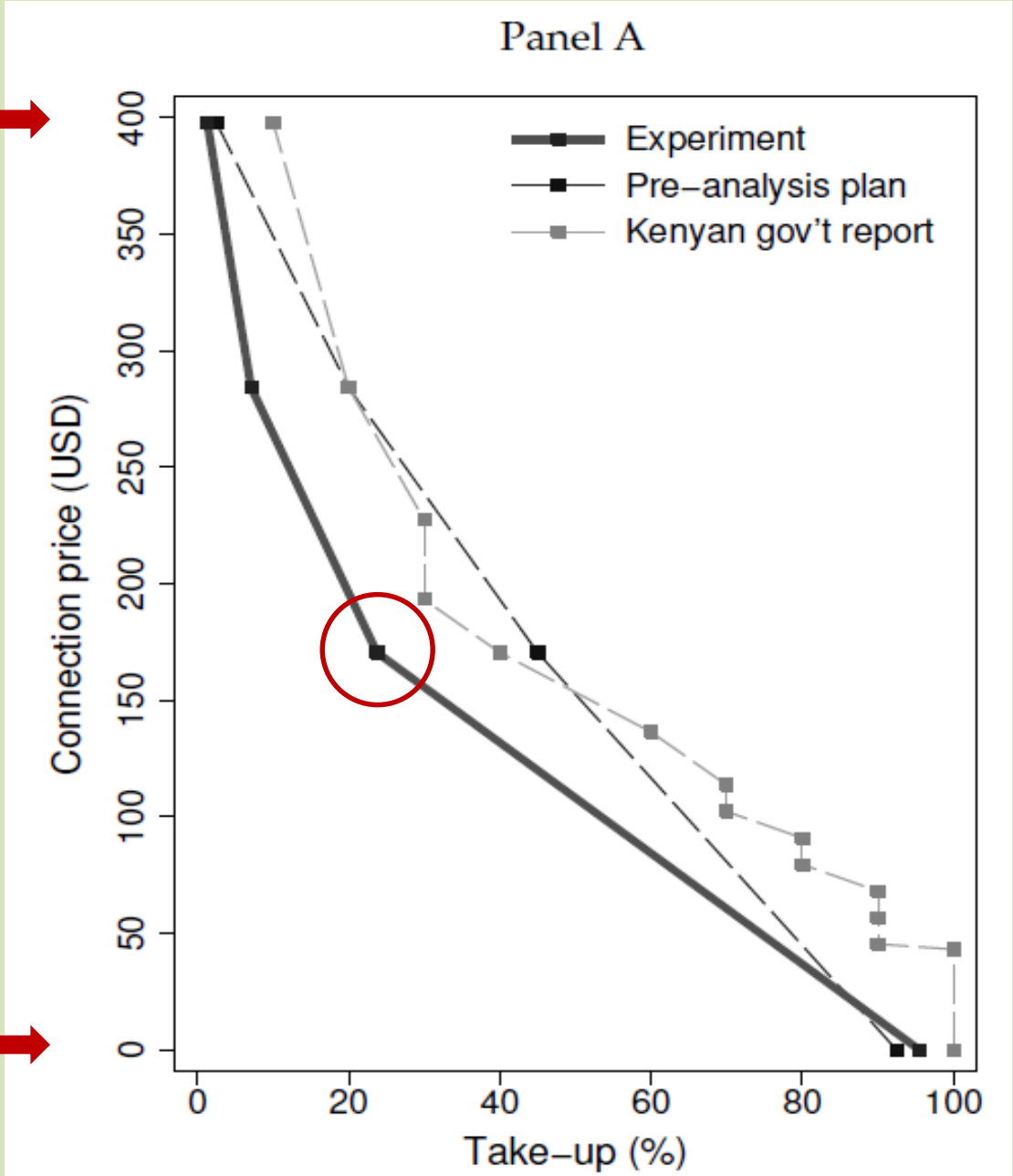
- Impact results soon (survey fielded summer 2016).
- But the demand for electricity connections may be informative about future households benefits.

Rural electrification demand, Lee, Miguel and Wolfram (2016a)

Status quo price in Kenya ($398).

Already heavily subsidized, at only 25-50% of actual connection cost.

Free connection



Achieving rural electrification

- Currently a polarized policy discussion, mainly off-grid solar (eg, lanterns, panels, micro-grid) vs. grid expansion

- Each approach has potential advantages:
- Solar: “greener” (lower emissions), better installation and maintenance by private firms?
- Grid: higher wattage applications, economies of scale, harness existing investments?

Lee, Miguel and Wolfram (2016b)

Non-fossil fuel generation:

65% Sub-Saharan African countries

29% other large developing economies (figure)

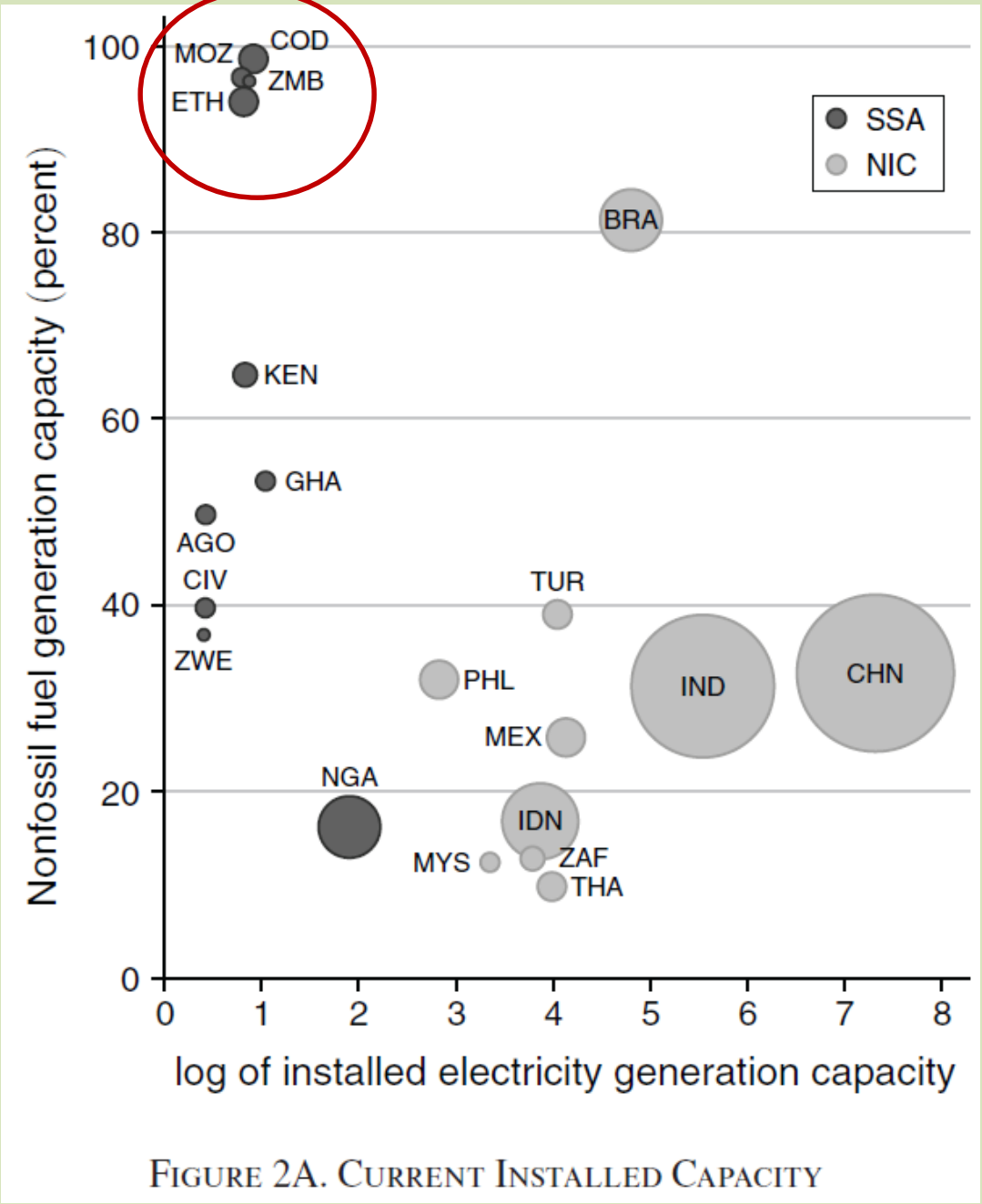


FIGURE 2A. CURRENT INSTALLED CAPACITY

Figure 2—Installed electricity generation capacity: Current and future targets

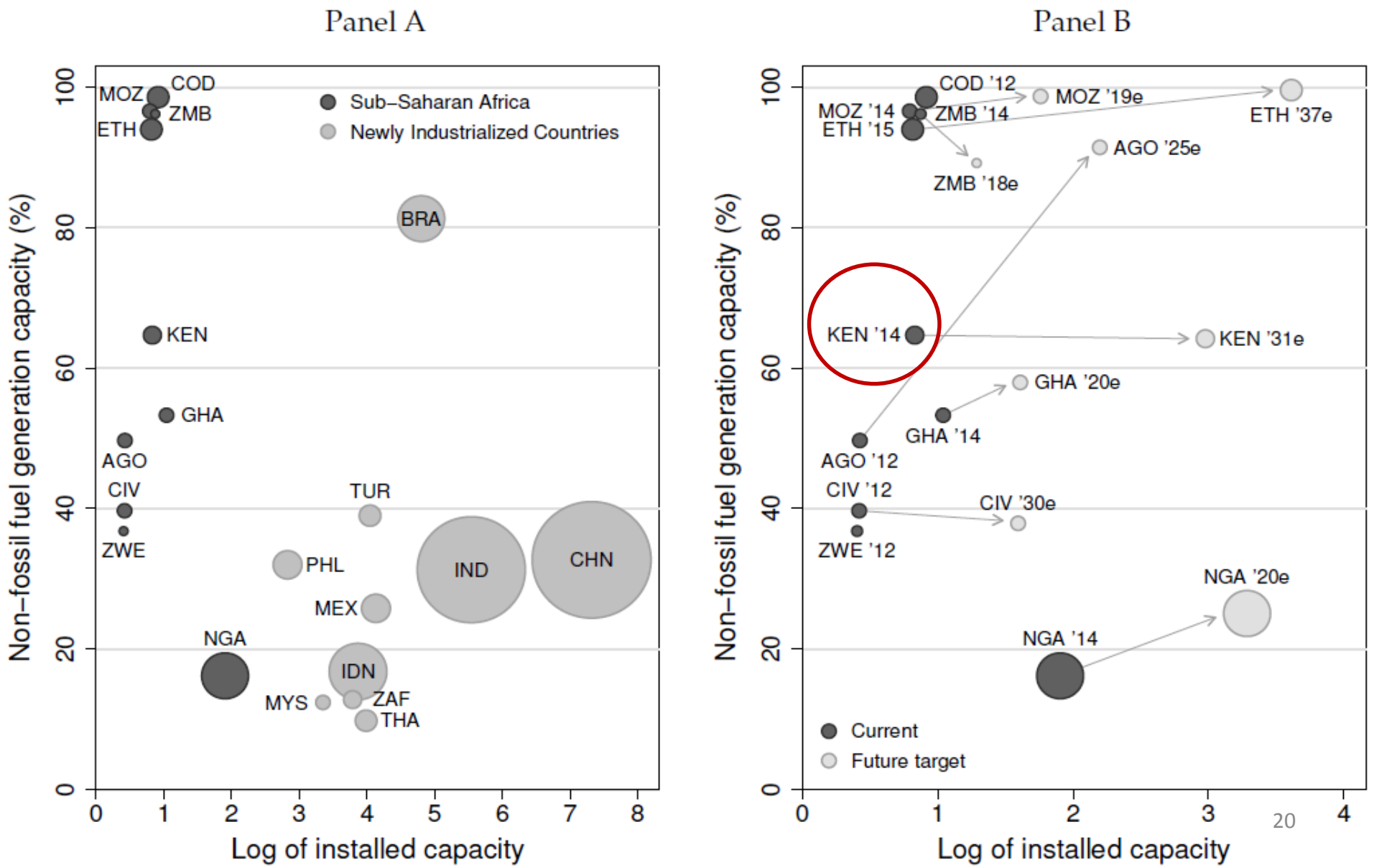
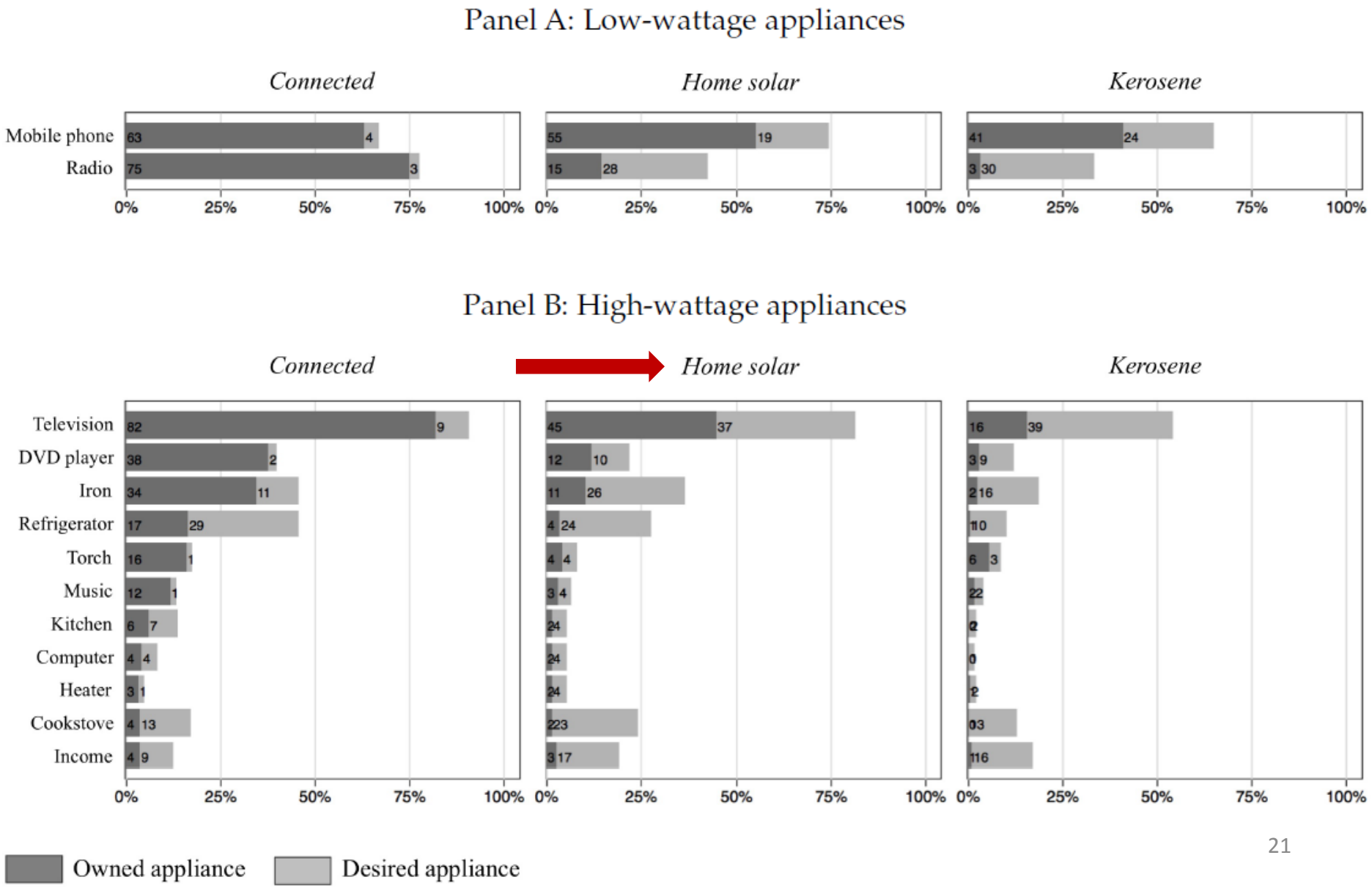


Figure 1—Electrical appliances owned and desired by rural households in Kenya



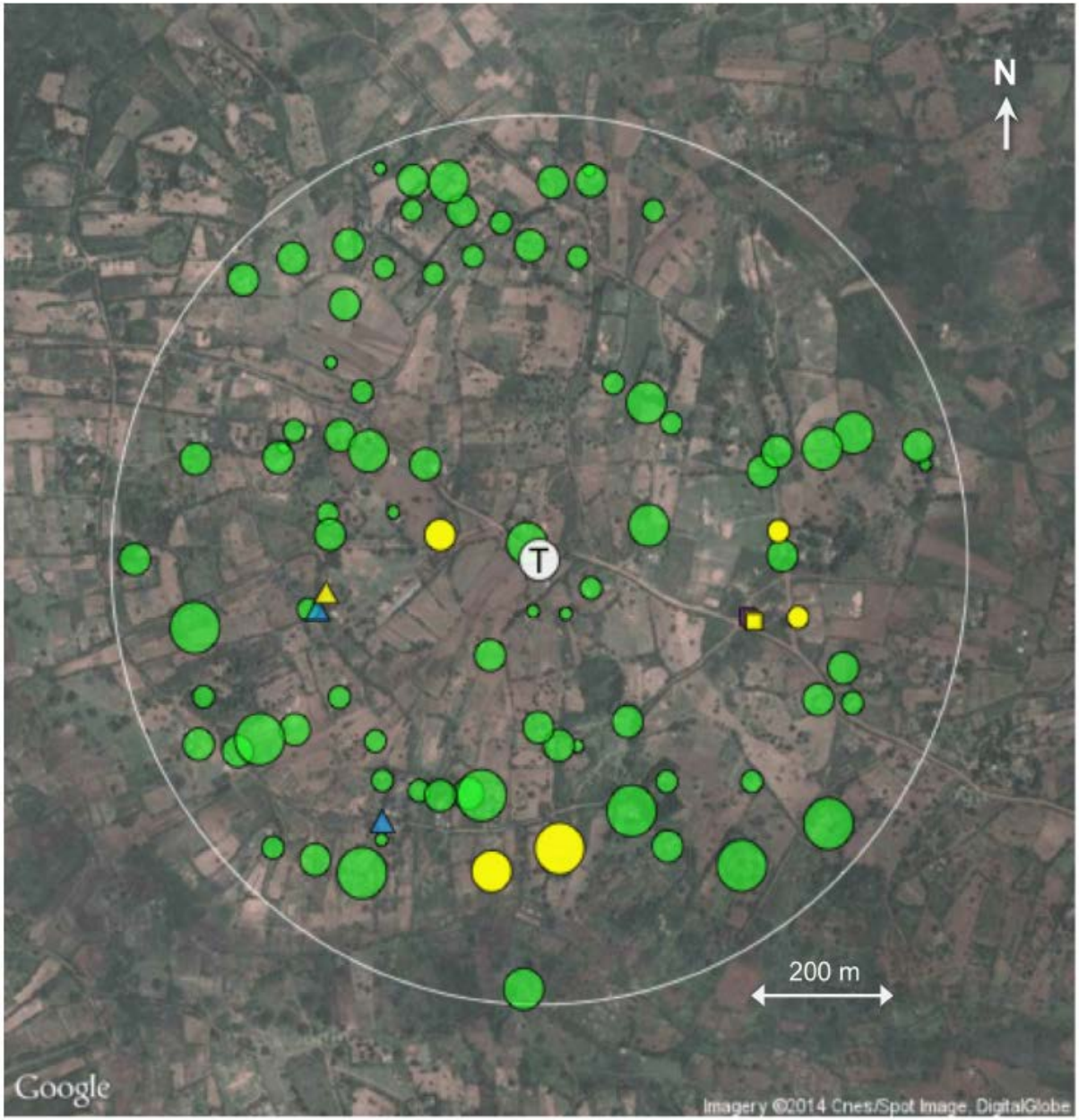
Living “under grid”

- Grid expansion can exploit existing investments

- E.g., the Kenyan government has installed tens of thousands of transformers in the past decade to connect public facilities (schools, clinics, markets) to power
- As a result over three quarters of Kenyans currently live “under grid” (<1 km from a low voltage line)

- CGD (Leo et al 2014) estimates that tens of millions of Nigerians are under grid, 100 million Africa-wide

Figure 2—Example of a "transformer community" of typical density



Legend

- Transformer & 600 meter radius
- Households (scaled by household size)
- Businesses
- Public facilities (e.g. schools, health)
- Electrified households
- Electrified businesses
- Electrified public facilities

Lee et al. (2015)

The economics of grid expansion

- The demand study (Lee, Miguel and Wolfram 2016a) allows us to estimate economies of scale in grid expansion, since subsidy levels generated different numbers of connections per village
- Important economies of scale, with average cost of connection dropping to <$700 at full saturation

- A major constraint to grid expansion is corruption in the construction process, as for other public services: leakage rates of 21-33%

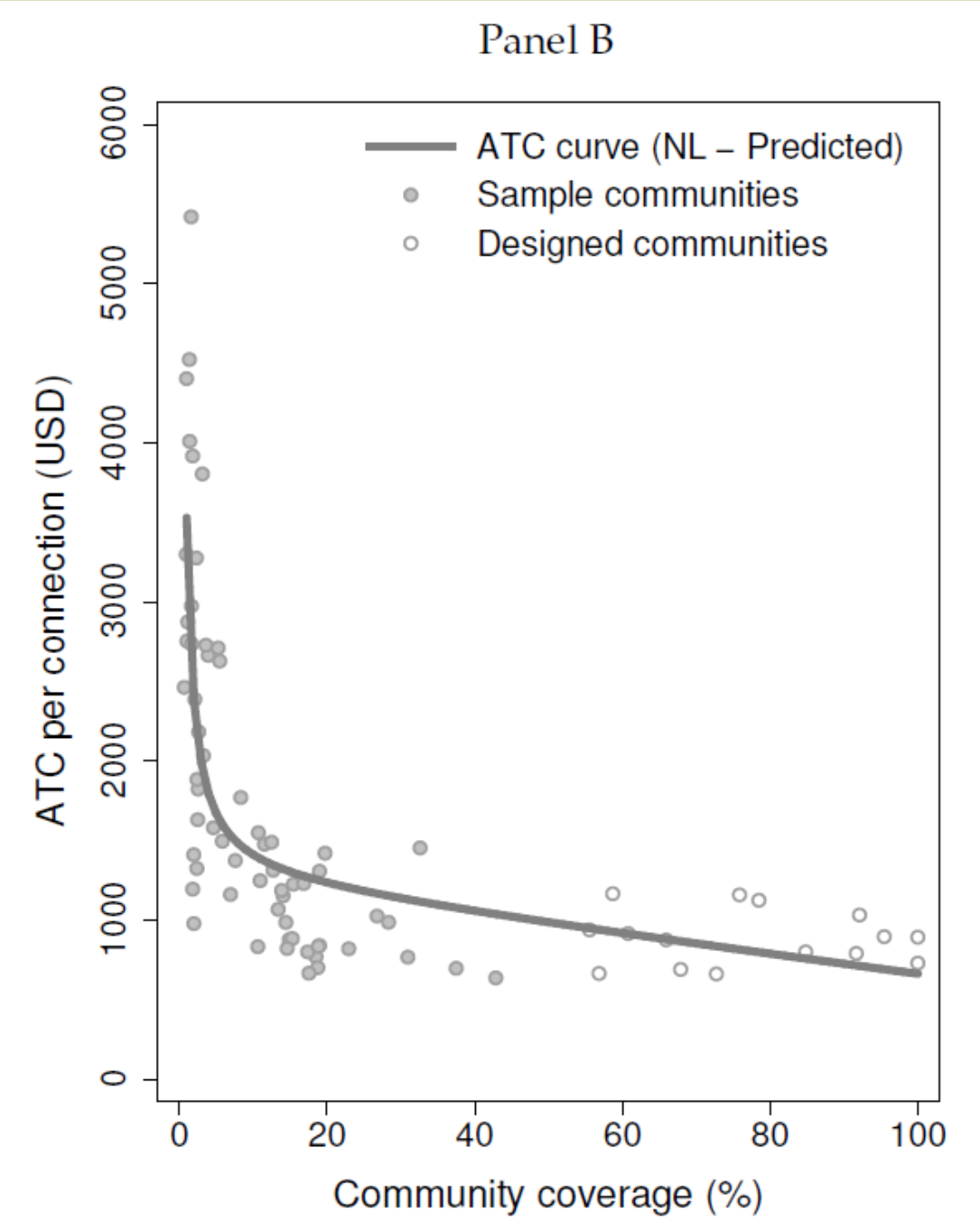
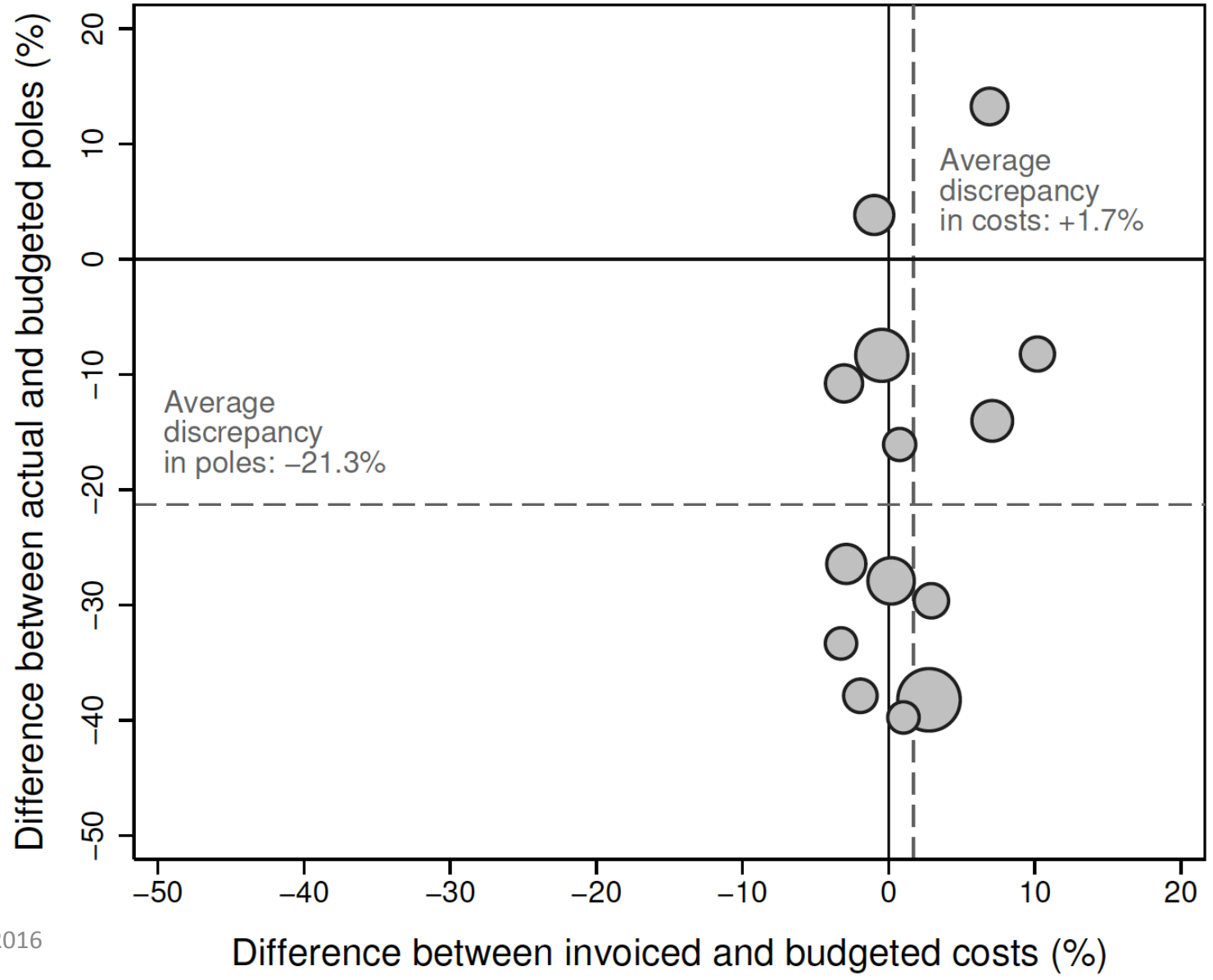

Panel B
ATC curve (NL – Predicted)
Sample communities
Designed communities
ATC per connection (USD)
0
1000
2000
3000
4000
5000
6000
0
20
40
60
80
100
Community coverage (%)

Figure 7—Discrepancies in project costs and electrical poles, by contractor



Powering Africa

1. Should rural electrification be a policy priority in Africa today? (In particular, is it likely to reduce poverty?)

› Economic (and broader) impacts remain poorly understood, and further evidence would be valuable.

› Evidence of only modest benefits in Indian villages.

2. How should it be achieved? (In particular, through expansion of the electricity grid, or off-grid, eg, solar?)

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2. How should it be achieved? (In particular, through expansion of the electricity grid, or off-grid, eg, solar?)

› Most current solar systems do not provide "real" power, and do not allow households to achieve their goals.

› Grid expansion would be relatively "green" in Africa and has major cost advantages, but its promise may only be realized if service provision improves.