Energy for Development Conference: Promoting a Gender Inclusive and Pro-Poor Sector

September 10, 2015

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Session 7 Presentations

Title: Measuring and Evaluating Impacts

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Measuring impacts of new access to electricity: Household electrification and work in rural South Africa

Taryn Dinkelman
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Conference on Gender, Poverty and Energy

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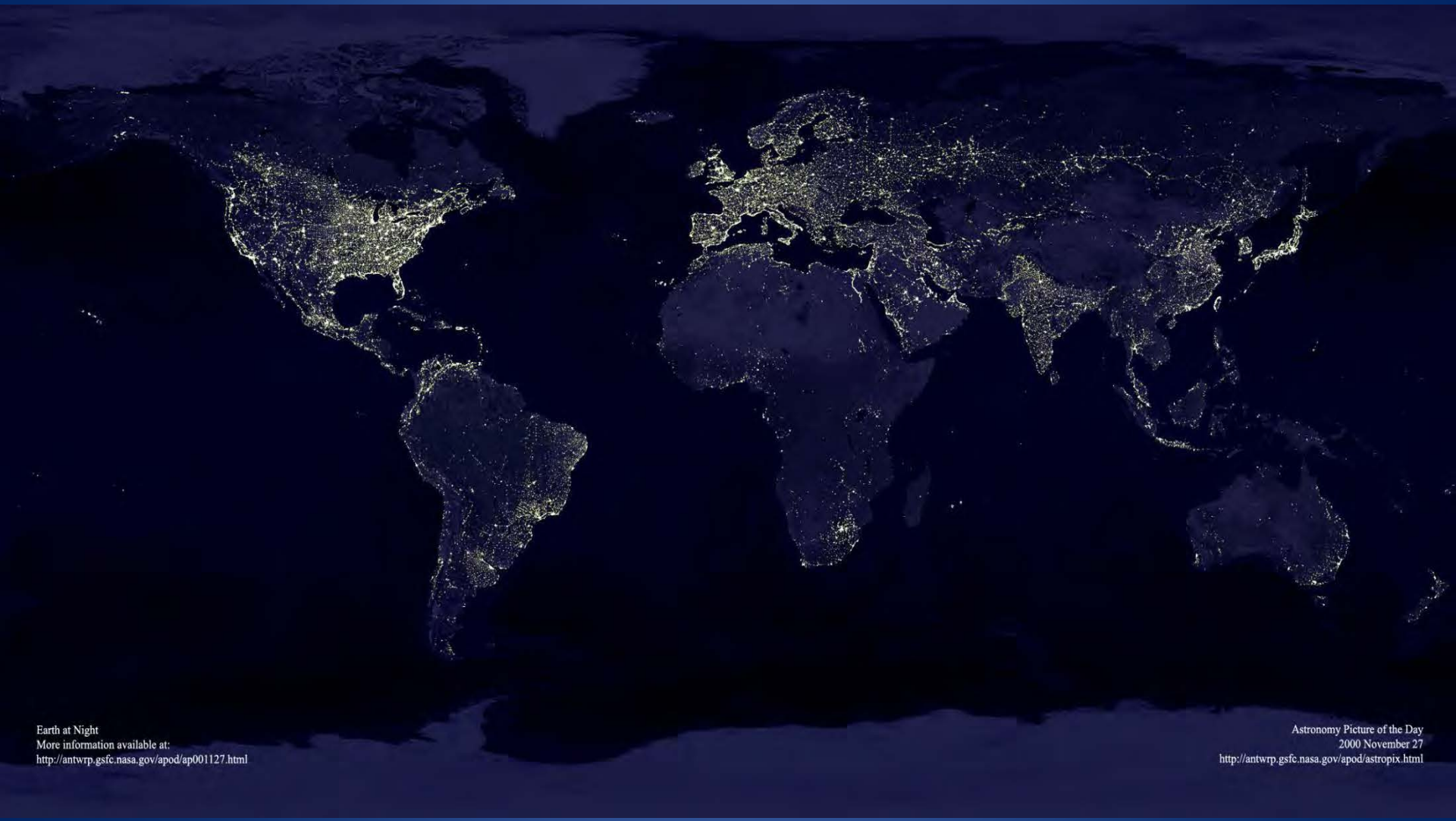
Nightlights from space



~ 1.5 billion people use traditional fuels for home production

Energy poverty and home production

1. Reliance on traditional fuels is TIME costly
   - Collecting wood, dung, crop residue
   - Daily (inefficient) cooking, heating….refrigerating?
   - Poor quality lighting limits activities to daytime

2. Rural SA (and other places): Time costs borne largely by women and girls

Don't we already know that better home production technologies help women?

- Not really
- Large-scale electrifications not informative (confounders)
  - US 1930s, 40s; Russia 1920s; India 1960s+
  - Linked to politics, mechanization, industrialization

- Diffusion of home appliances, US 1900-1980s, linked with higher female employment
  - "More work for mother"?
  - Relevance of home production of middle class America vs rural Africa?

Electrification in South Africa

- Study area: Rural KwaZulu-Natal
- Time period: 1996 – 2001 → medium run changes
- Extent: 470,000 households connected for free
- Enabled small appliances → *not* for industrial purposes

Settlement without electricity

Settlement with electricity

Quantifying the impact of household electrification using IV methods

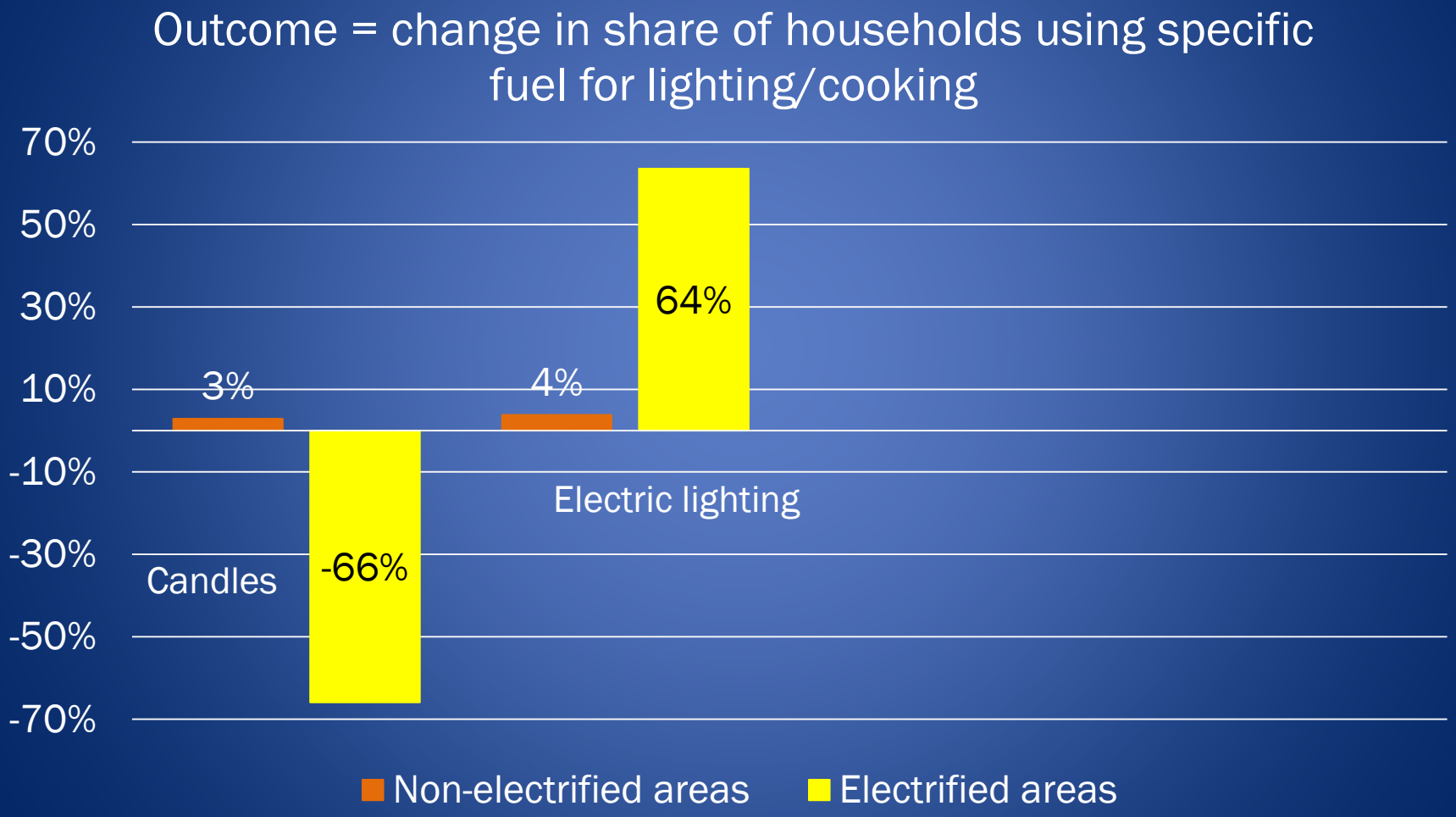
- Comparison of connected *vs* unconnected areas likely biased. New connectors might be:
  - Richer/Politically connected/important
  - Populated by women who *WANT* to work more

- We want something "like" an experiment
- Key question: What *else* drives new connections? → COST = function(population, distance to grid, gradient)
  - Compare outcomes across high cost *vs* low costs areas

Quantifying the impact of household electrification using IV methods

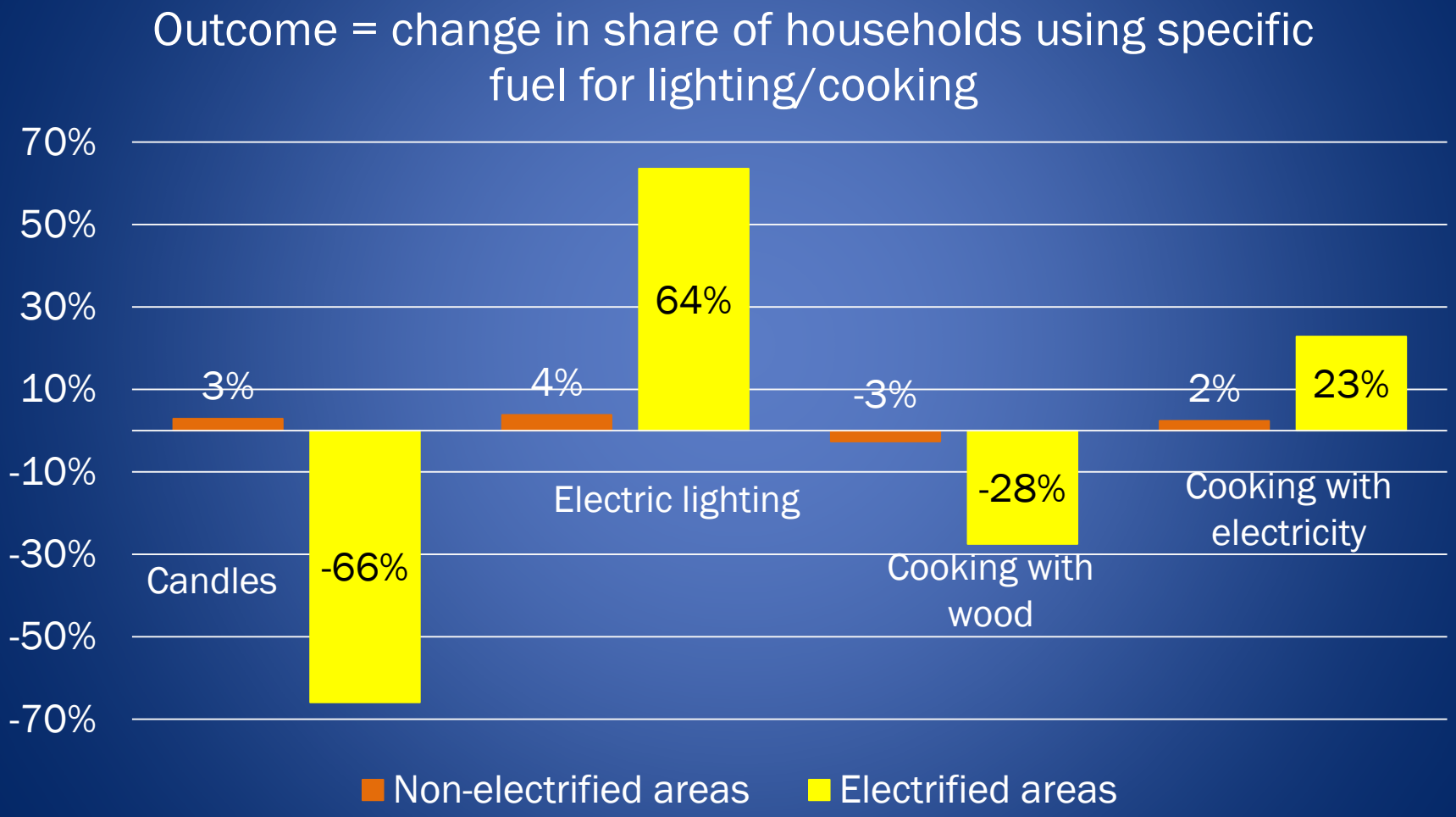
- Idea: Take two areas, same population, same distance to grid, slightly different gradient → lower gradient area electrified first!
- ~ Compare changes in outcomes over time (2001-1996) in lower gradient areas that are electrified to changes in outcomes over time in higher gradient areas that are not electrified, controlling for other observables
- Differencing over time controls for many confounders
- Outcomes
  - Census: Sources of energy for light, heat, cooking
  - Census: Labor force participation rates
  - LFS: Hours of work
  - LFS: Wages/earnings per week

Electrification and home production (1)



Data sources: South African Census 1996, 2001

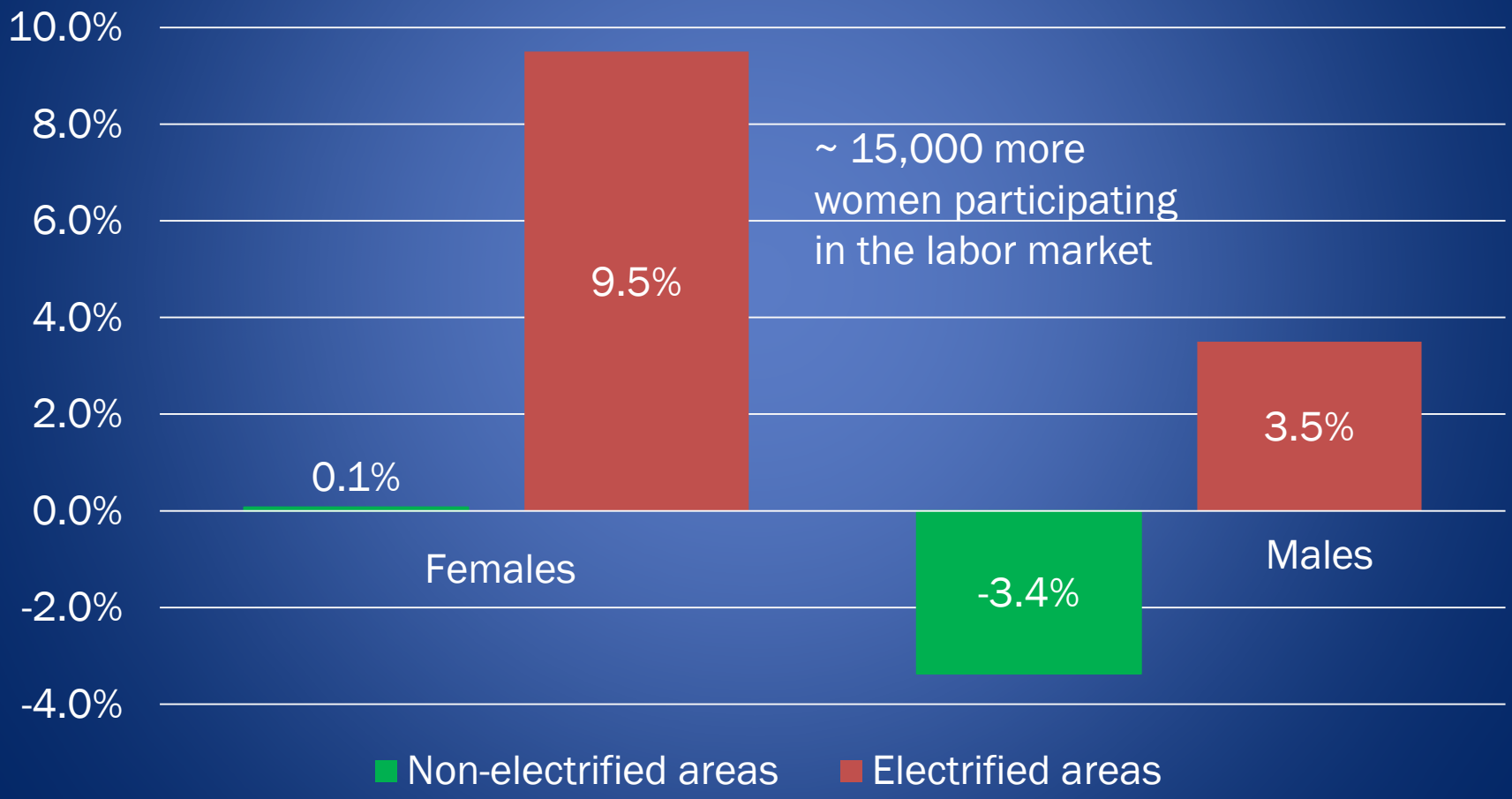
Electrification and home production (1)



Data sources: South African Census 1996, 2001

Electrification and employment (2)

Outcome = change in share of adults in each community doing market work between 1996 and 2001



Data sources: South African Census 1996, 2001

Corroborating evidence from LFS data

1. Create panel dataset of districts constructed from multiple waves of LFS data

2. Fixed effects strategy: compare changes in outcomes across districts with different electrification rates, control for district FE and district trends

3. In districts w/ average change in electrification rates, women work 8.9 more hours/week (3.5% increase); female wages (not earnings) fall → some labor supply effects

Implications of the study for M&E

1. You can use observational data/quasi-experimental methods to estimate impacts, but you need
   - CLEAR understanding of reasons for rollout (legwork!)
   - Comparable data over time; baseline controls (Census? LFS?)
   - Credible IV (context-specific; & placebo experiments useful)
   - Outcomes showing mechanisms (esp. for SR *vs* LR impacts)
2. Other data that would have been useful here?
   - Time use diaries -- potentially huge time savings? SR vs LR?
   - Self-employment/entrep. Activities to get at demand side changes
   - Complementary goods (child-care…?)
   - Migration: unintended consequences of infrastructure projects

References

- Dinkelman, Taryn 2011 “The effects of rural electrification on employment: New evidence from South Africa” Vol. 101(7): 3078-3108

- Dinkelman, Taryn and Sam Schulhofer-Wohl, 2015 “Migration, congestion externalities and the evaluation of spatial investments”, *Journal of Development Economics* Vol. 14:189-202

The Impact of Rural Electrification: Challenges and Ways Forward

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Outline –
Moving Forward on Rural Electrification

- What we know on rural electrification
- What we know on expected outcomes and impacts
- Challenges in evaluating the impacts
- Importance of complementarities
- Key messages to move forward

What we know

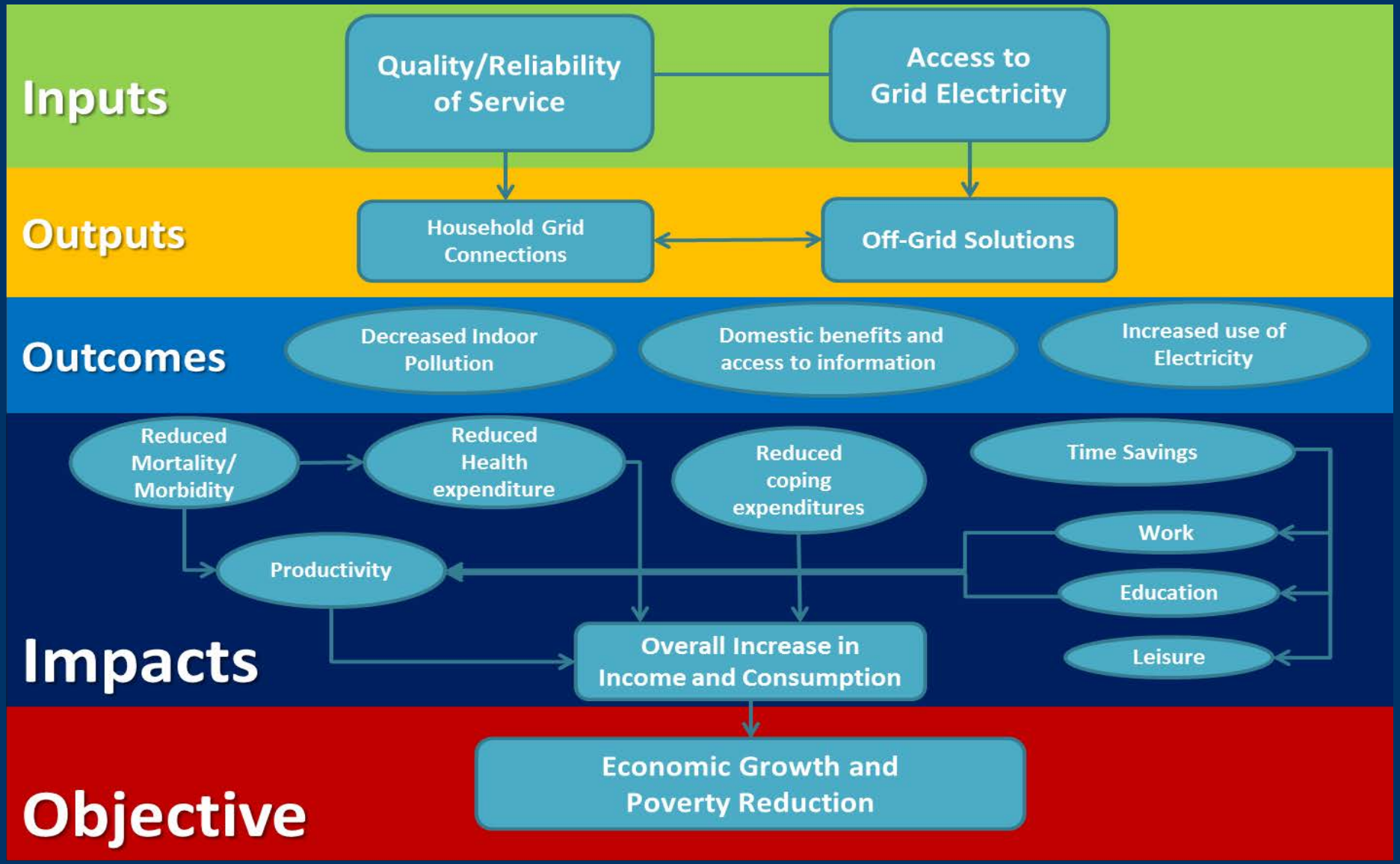
- New papers look at the impact of electricity interventions in terms of:
  - Large development gains consistent with productivity improvements [Lipscomb et al (2013)]
  - The impact of privatization of electricity on health [Gonzalez-Eiras and Rossi (2007)],
  - Rural electrification rollout on female labor participation and cooking technologies [Dinkelman (2011)], and also on schooling of girls [van de Walle et.al, 2013]
  - Rural electrification roll out on different dimensions of welfare [Bernard and Torero 2011, 2014] in Ethiopia; [Davis, 1998, Dinkelman 2011 and Spalding-Fecher and Matibe 2003] in South Africa; and in Bangladesh and Vietnam [Khandker, Barnes and Samad, 2009 and Khander et.al 2009]
  - Rural electrification impact on employment [Davis 1988]

What we know

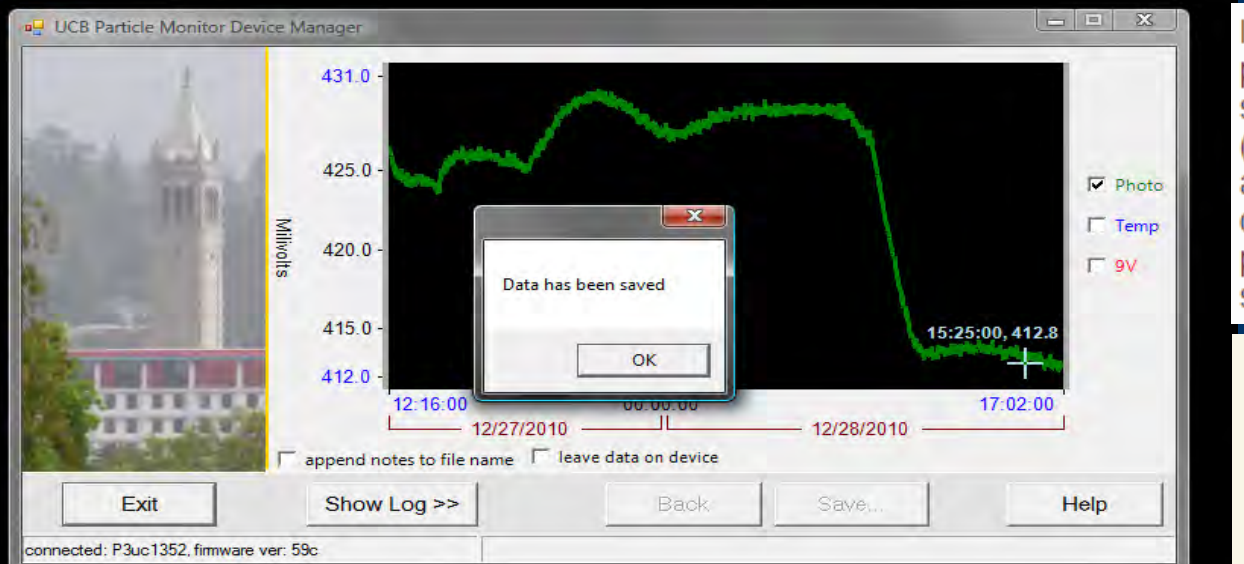
A quasi-meta evaluation of the evidence on the impact of rural electrification in 12 countries by IEG showing:

- generally successful in establishing electricity infrastructure but weak in strengthening supplier institutions;
- the largest share of benefits from rural electrification is captured by the non-poor;
- high connection fees and community selection criteria that emphasize economic returns continue to be barriers to reaching the very poor;
- consumer education and promotion of productive uses would enhance the benefits of electrification; and
- properly calculating willingness to pay can demonstrate good rates of return on rural electrification projects.

Impact Pathways of Rural Electrification



Measuring Reduction of Indoor Pollution



In 2009, less than one percent of the population in Africa was using modern LED solar lighting products.Now about five percent (4.8%) of the population is using solar lighting as a result of Lighting Africa's market development work, implemented in partnership with various players along the supply chain.

Source: Dalberg Global Development Advisors, editor. Solar lighting the base of the pyramid: Overview of an emerging market. IFC and the World Bank; 2010. Available at http://www.lightingafrica.org/files/Solar_Lighting_for_the_Base_of_the_Pyramid_Overview_of_an_Emerging_Market.pdf.

Results of Rural Electrification

Term	Theme	Ethiopia	Other studies
Immediate	Coverage and Access	15% points more likely to connect	11% to 19% more likely to connect
		Spillover effects: 2% from baseline of 41% connection rate	25% of the effect of the voucher
Short term	Coping costs	Changes in use of kerosene for lighting	Changes in use of kerosene for lighting
		No changes in cooking practices	No changes in cooking practices
	Health	N.A	65% reduction in overnight air pollutants
		N.A	Reduction of 37-44% on acute respiratory infections incidence among children < 6
	Education, Leisure, and Information	No effect	Increase hours of studying in 7%
		No effect	More appliance ownership
		No effect	Leisure reduced in average by 0.7 hours per day
	Productivity	No changes	Non agricultural independent activities increased by 13%
Long term	Economic Growth	N.A	Annual per capita income increased in $ 186 (34% of baseline income)
		N.A	Positive distributional effects

Key problems in existing work

- **Problem 1**: Causality between the intervention and the impact
- **Problem 2**: Implementer solve a cost minimization problem when deciding where to extend an existing grid
- **Problem 3**: Complementarities

Solution to Problem 1:
Randomization on the last mile connection

Objective: Randomize the probability of connecting to the grid through incentive mechanisms

Instrument to used: Discount voucher

Procedure:

- Between 10-50% of eligible survey respondents are randomly assigned vouchers for a discount charge to cover the connection of the HH or business

Methodologically:

- Vouchers serve as an IV for intensity of electricity access across communities and for the probability of a household connecting to the grid.
- Difference in difference estimators.

Solution to Problem 1:
Randomization on the last mile connection within identified treated and control towns

Potential problems:

- How to define the size of the voucher
- Local providers must comply with protocol established for the distribution of the vouchers.
- How to avoid contagion effects/anticipation effects
- Competitive underground market of vouchers

Solution to Problem 1:
Randomization on the last mile connection within identified treated and control towns

Potential problems:

- *Problems of non compliance*
  - Alternatively we can use random assignment as an IV for actual connection (Duflo and Kremer 2003; Angrist and Krueger, 2001).
  - Local treatment effects paper of Imbens and Angrist (1994)
  - *Political feasibility of limited number of vouchers* – implement a sequencing in the distribution.

Example: Randomized- Barriers to connection in Ethiopia (Bernard and Torero 2010)

- Connection fees range between USD 50 and USD 150 (drop down line and meter). Need to find ways to facilitate connection for the poorer.
- What is best: 2 years loan or 5 years loan for connection fee?
- Pilot study on 20 towns to assess optimal subsidies.
- Experimental approach (randomize encouragement through distribution of vouchers of 10% and 20%)
- Vouchers requirements: official, clear and understandable, non-transferable, allocated publicly, and allocated randomly

ETHIOPIAN ELECTRIC POWER CORPORATION
የኢትዮጵያ ኤሌክትሪክ ኃይል ኮርፖሬሽን

THE BEARER OF THIS VOUCHER IS ENTITLED A 10% (TEN PERCENT) DISCOUNT
ON THE FULL PRICE OF CONNECTION TO THE ECTRICAL POWER GRID

AND A 20% (TWENTY PERCENT) DISCOUNT
TOWARDS THE PURCHASE OF A COMPACT FLUORESCENT LAMP FROM THE LOCAL *WOREDA* EEPCO OFFICE

THIS VOUCHER IS OF NO VALUE FOR ANY OTHER PURCHASES OR SERVICES.
THIS VOUCHER MAY ONLY BE USED BY THE BEARER WHOSE NAME IS INDICATED BELOW.

ይህን ኩፖን የያዘ ግለሰብ ኮምፓክት ፍሎረሰንት አምፖል ከወረዳ ኢ.ኤ.ኮ በሚገዛበት
ጊዜ የ፲% (አስር ፐርሰንት) የዋጋ ቅናሽ የማግኘት መ ብ ት አ ለ ው።

ይ ህ ኩ ፖ ን ሌ ላ ግ ዢ ለ መ ፈ ፀ ም ወ ይ ም አ ገ ል ግ ሎ ት ለ ማ ግ ኘ ት የ ሚ ያ ስ ች ል ዋ ጋ የ ለ ው ም።
ኩፖኑንም መጠቀም የሚችለው ስሙ ከታች የተመለከተው ባለይዞታ ብቻ ነው።

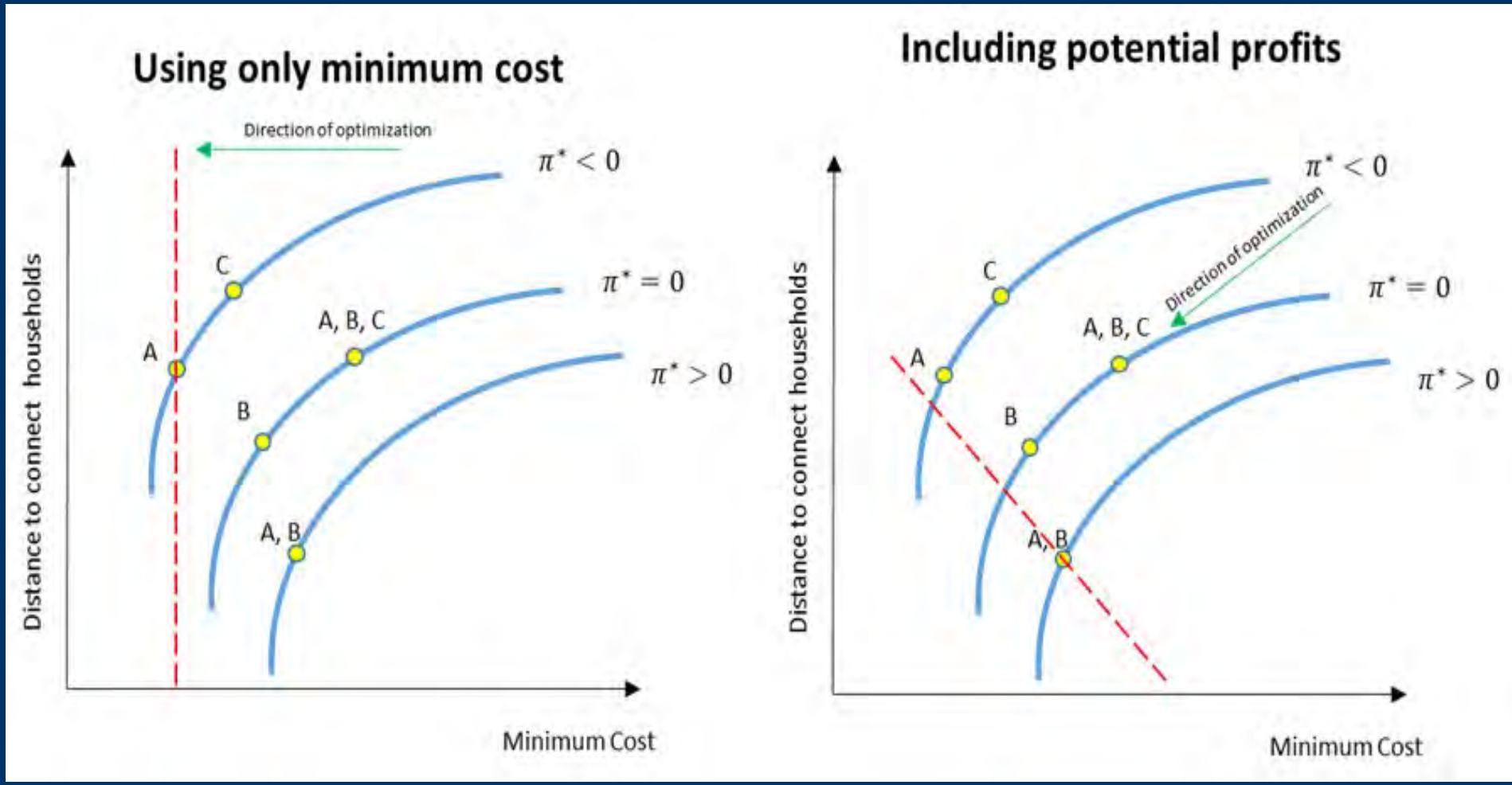
Name of the bearer _____ ID number _____
(የባለይዞታው ስም) (የመታወቂያ ቁጥር)

Address: _____
(አድራሻ) _____

VOUCHER SERIAL NUMBER (የኩፖኑ ተራ ቁጥር): 01- 001

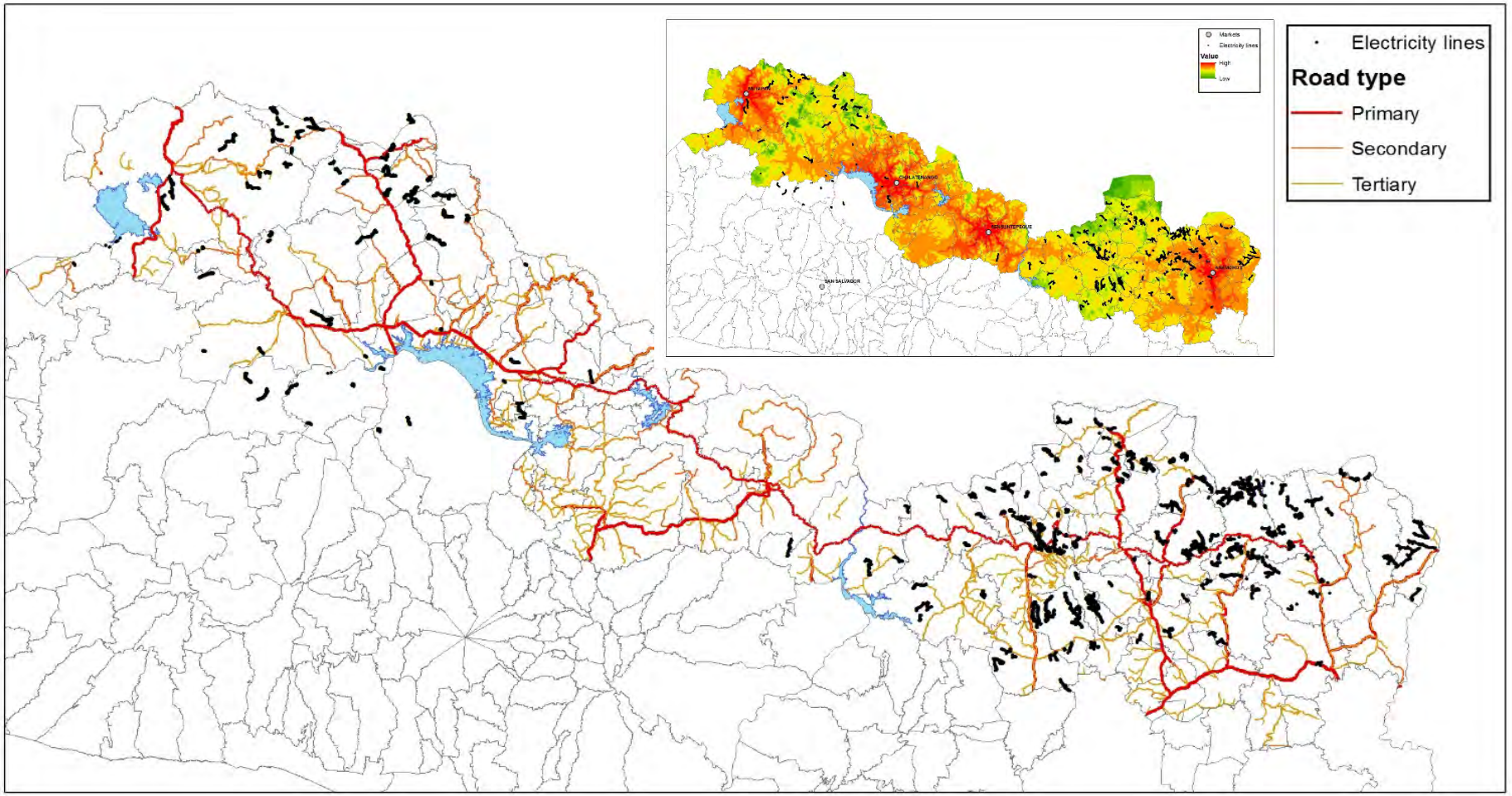
Random selection…

Solution to Problem 2:
Modeling Isoprofits



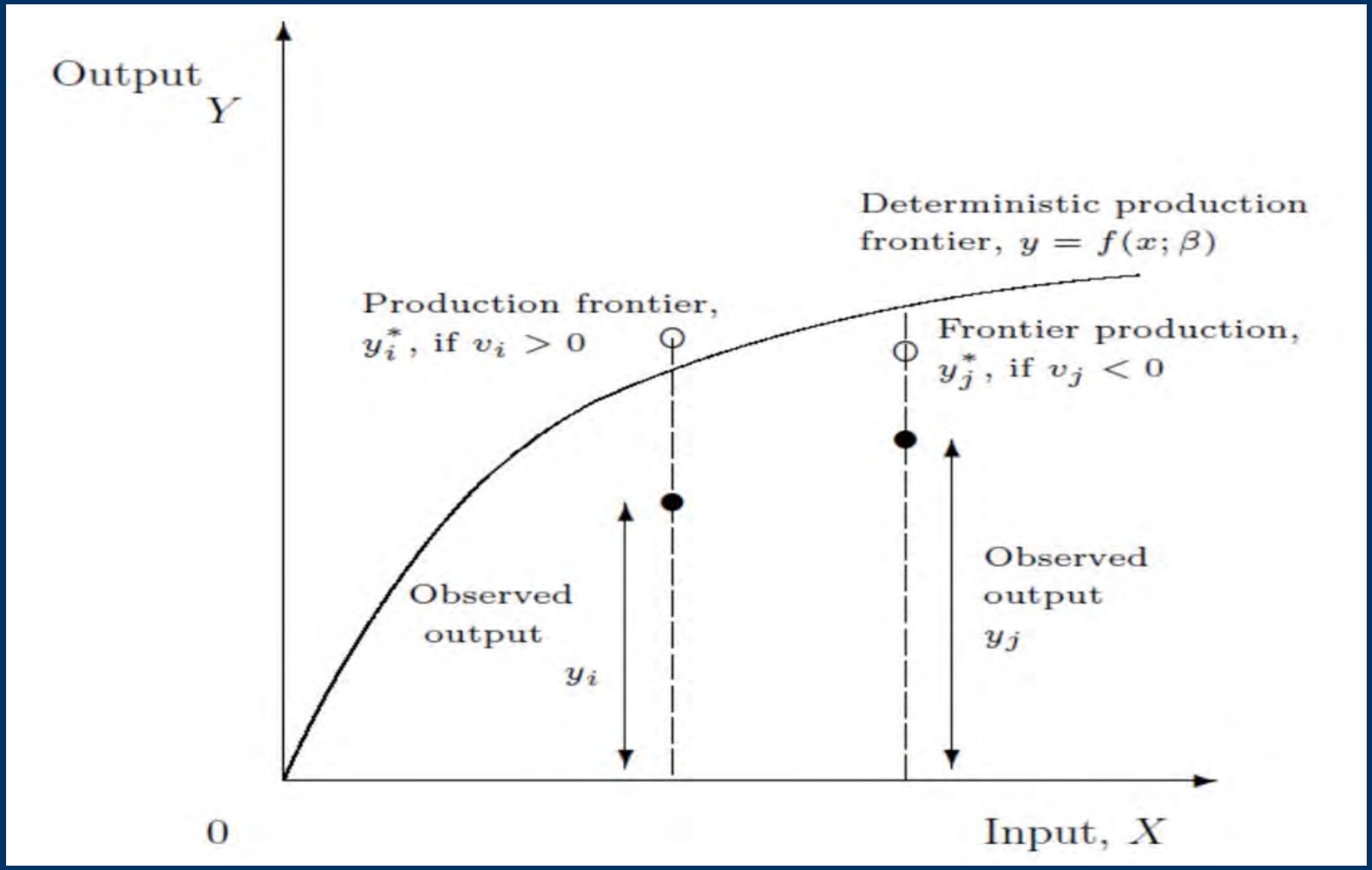
Solving Problem 2: Modeling Isoprofits

Roads versus Electric Grid: Northern Zone of El Salvador



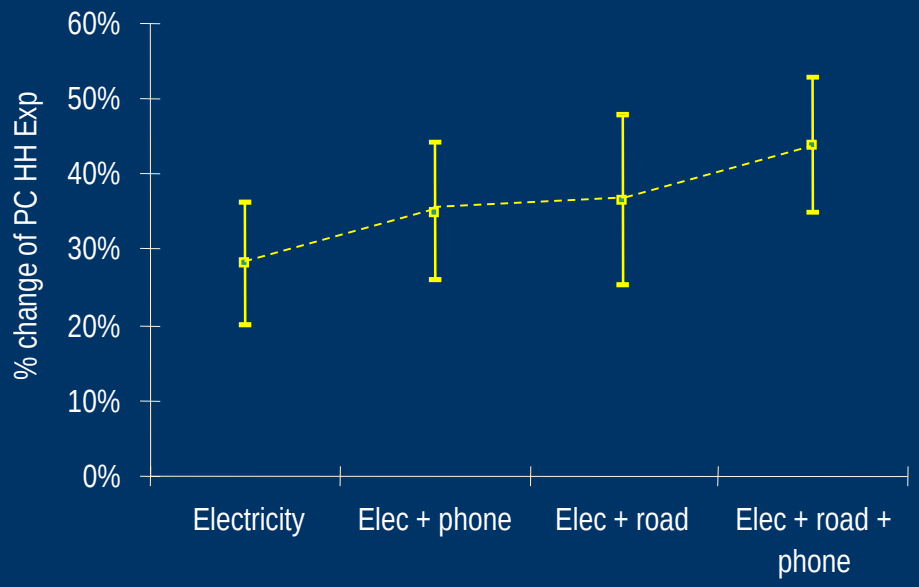
Solving Problem 2: Modeling Isoprofits

Graphic representation of a stochastic production frontier in the single-output, single-input case



Problem 3:
Complementarities of infrastructure

Bangladesh, 2000-2004

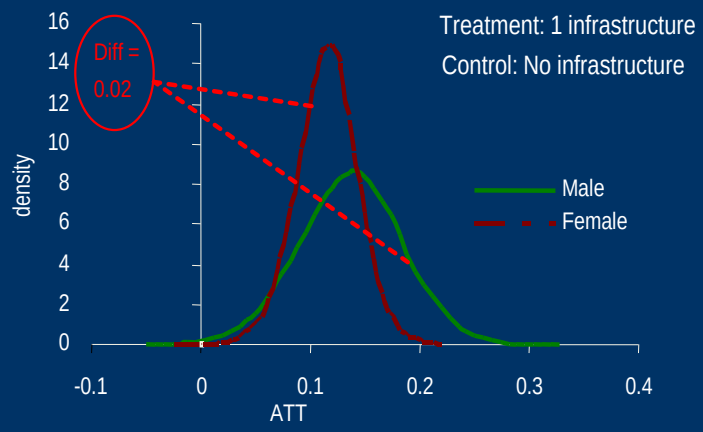


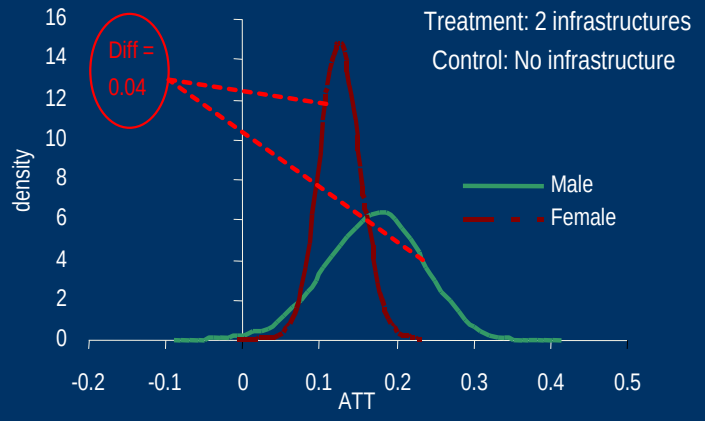
Source: Chowdhury and Torero, 2006

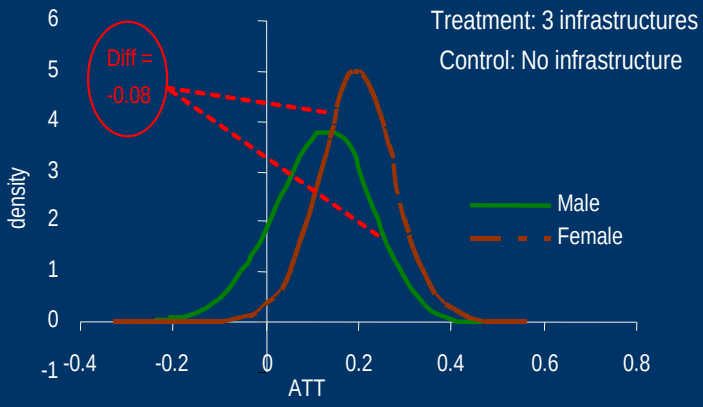
- **Infrastructure does seem to have an impact on household's welfare**
- **There exists complementarities in the provision of different types of infrastructure**

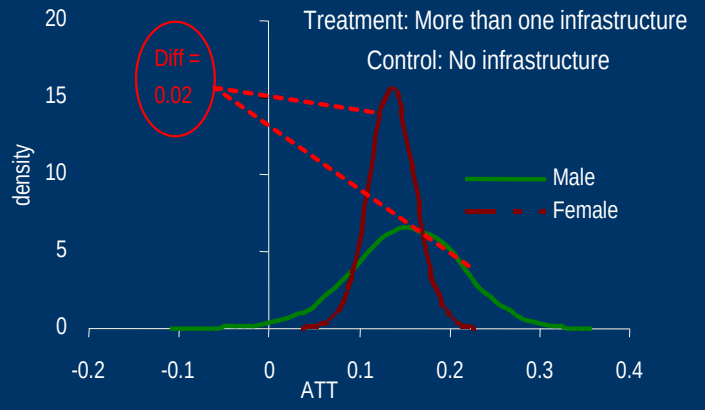
Infrastructure Impacts and Gender Heterogeneity

Bangladesh, 2004: ATT effects of infrastructure among men and women
(PSM among men and women)









Lessons Learned

- Rigorous impact evaluation that includes appropriately selected control groups must be a part of rural electrification program designs

- We also need to focus on external validity

- Continuous treatment methodologies need to be further developed to address:
  - Contamination
  - Quality of the service
  - Price issues linked to continuous treatment

- Focusing solely on cost minimization can result in missed opportunities. When deciding where to deploy the electric grid in rural areas it is imperative to take into account the potential profits