

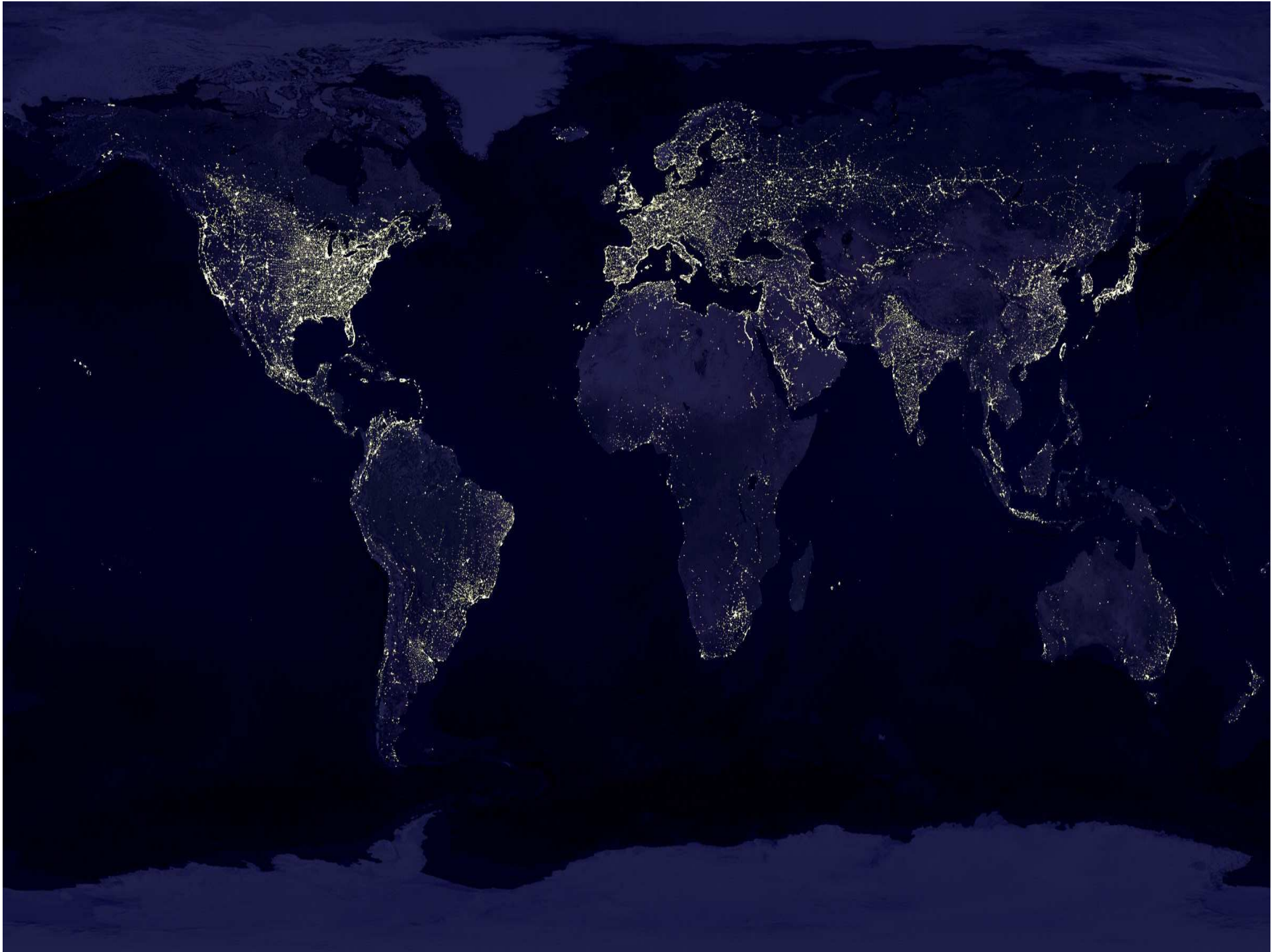
Household Energy Use in Developing Countries

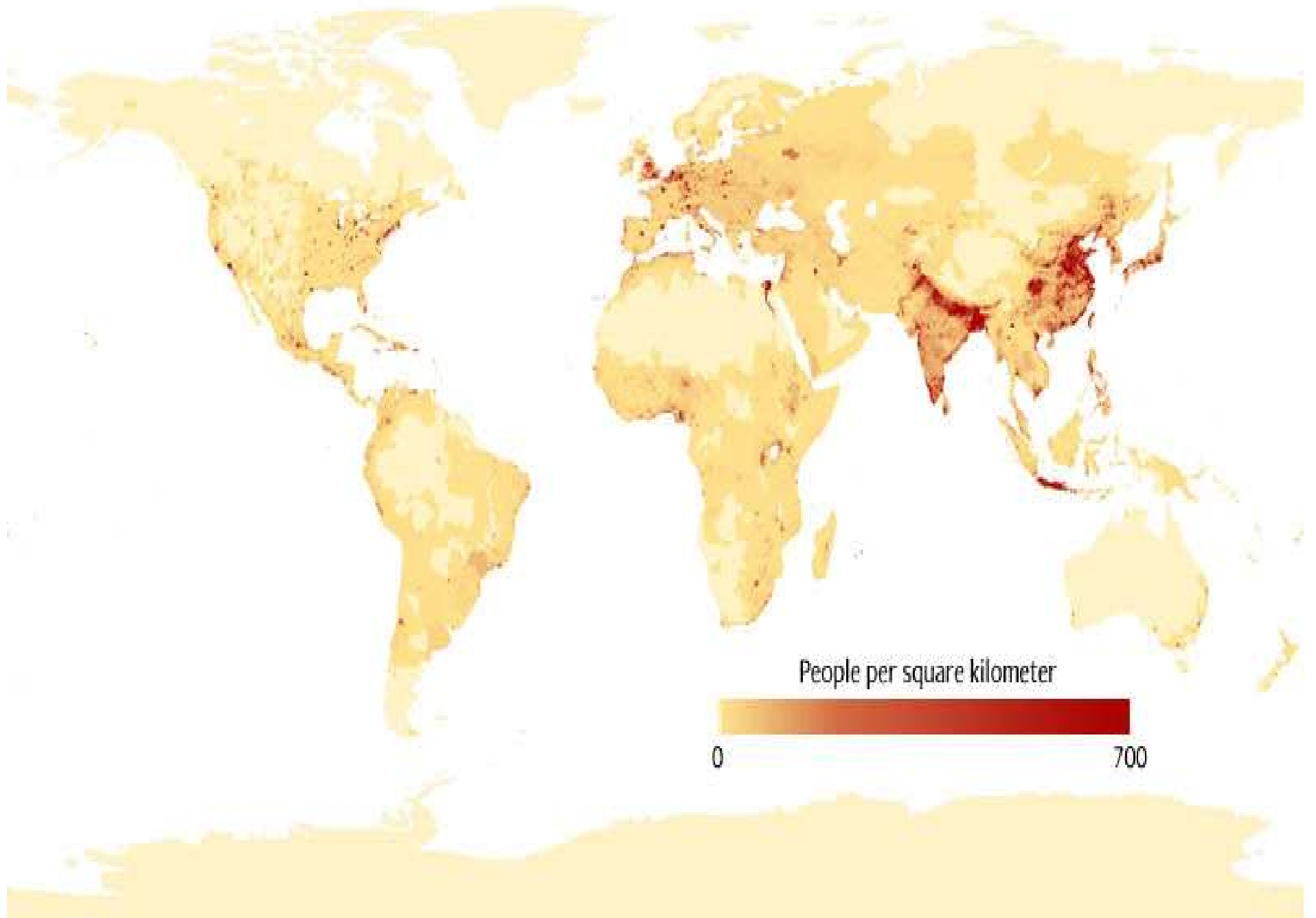
Catherine Wolfram

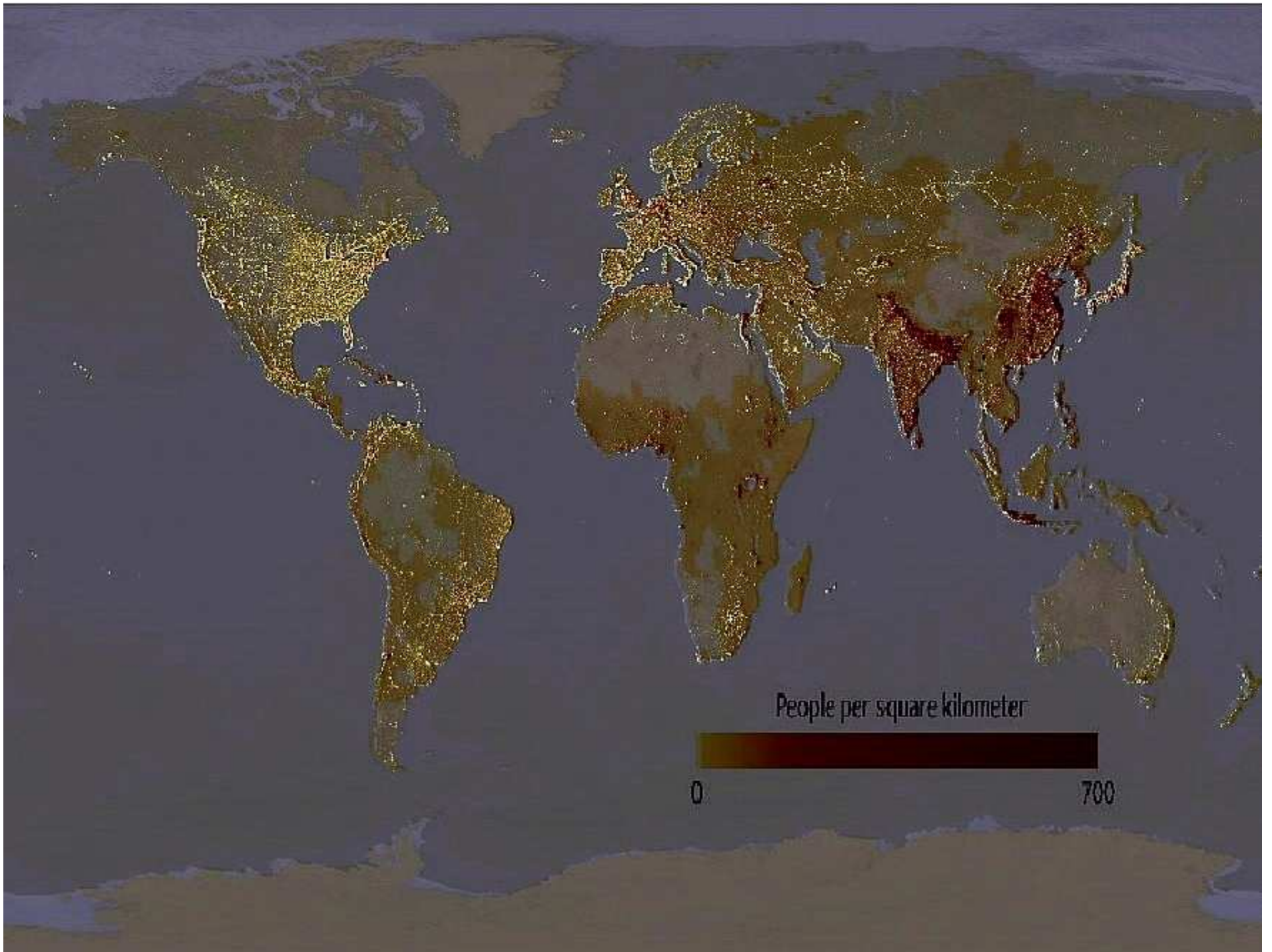
UC Berkeley

Eleventh Annual NBER Neemrana Conference

January 18, 2010 ♦ Neemrana Fort, Rajasthan







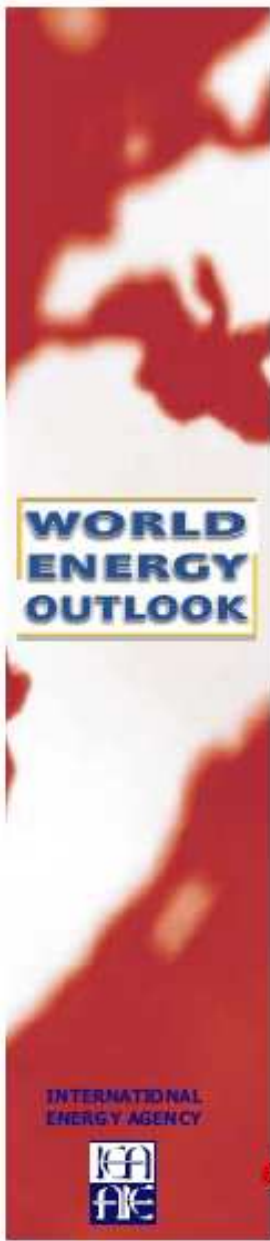
Electrification supports development

Electrification promotes:

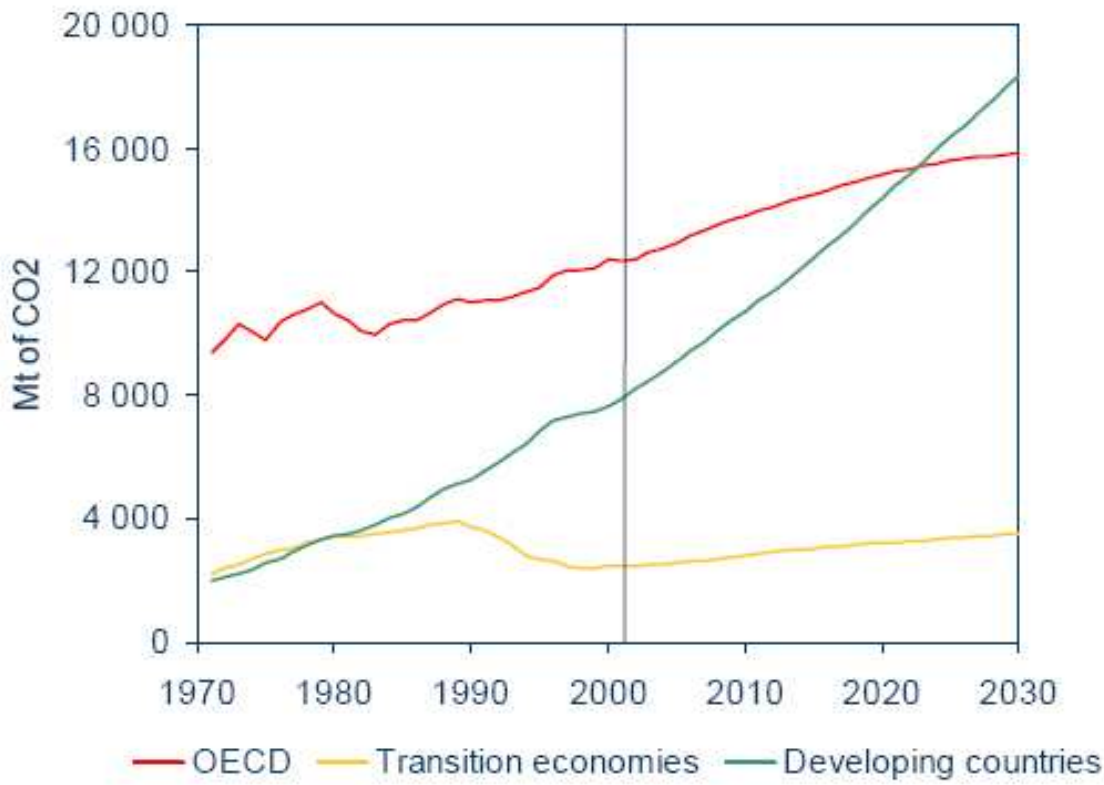
- Access to clean water, labor-saving agricultural processing, micro-enterprise, early education, etc.

Empirical work has established a causal link between electrification and development.

- Dinkelman (2009) shows female employment rates increase in KwaZulu-Natal province in South Africa.
- Lipscomb, Mobarak and Barham (2009) find similar results in Brazil.



World Energy-Related CO₂ Emissions



Global emissions grow 50% between now and 2030, and developing countries' emissions will overtake OECD's in the 2020s

My own research

Understand role of household energy use.

- Focusing here on developing world.
- Examining linkage between anti-poverty programs, particularly conditional cash transfer program, and energy use.

Motivations:

- Improve projections.
- Inform more micro-level policy decisions.

Policy questions – investments in energy efficiency

If you could spend a dollar to improve the energy efficiency of each household energy-using asset by $x\%$, for which asset would you save the most energy (or GHGs)? Vehicles? Refrigerators?

- Assuming that the costs of energy efficiency improvements are the same across assets.
- This requires an accounting of the current proliferation of assets.
- Also requires projections about likely changes in ownership.
 - We will focus on raising income of the world poor, as promoted by the UN World Development Goals.

Policy questions – influencing purchase decisions

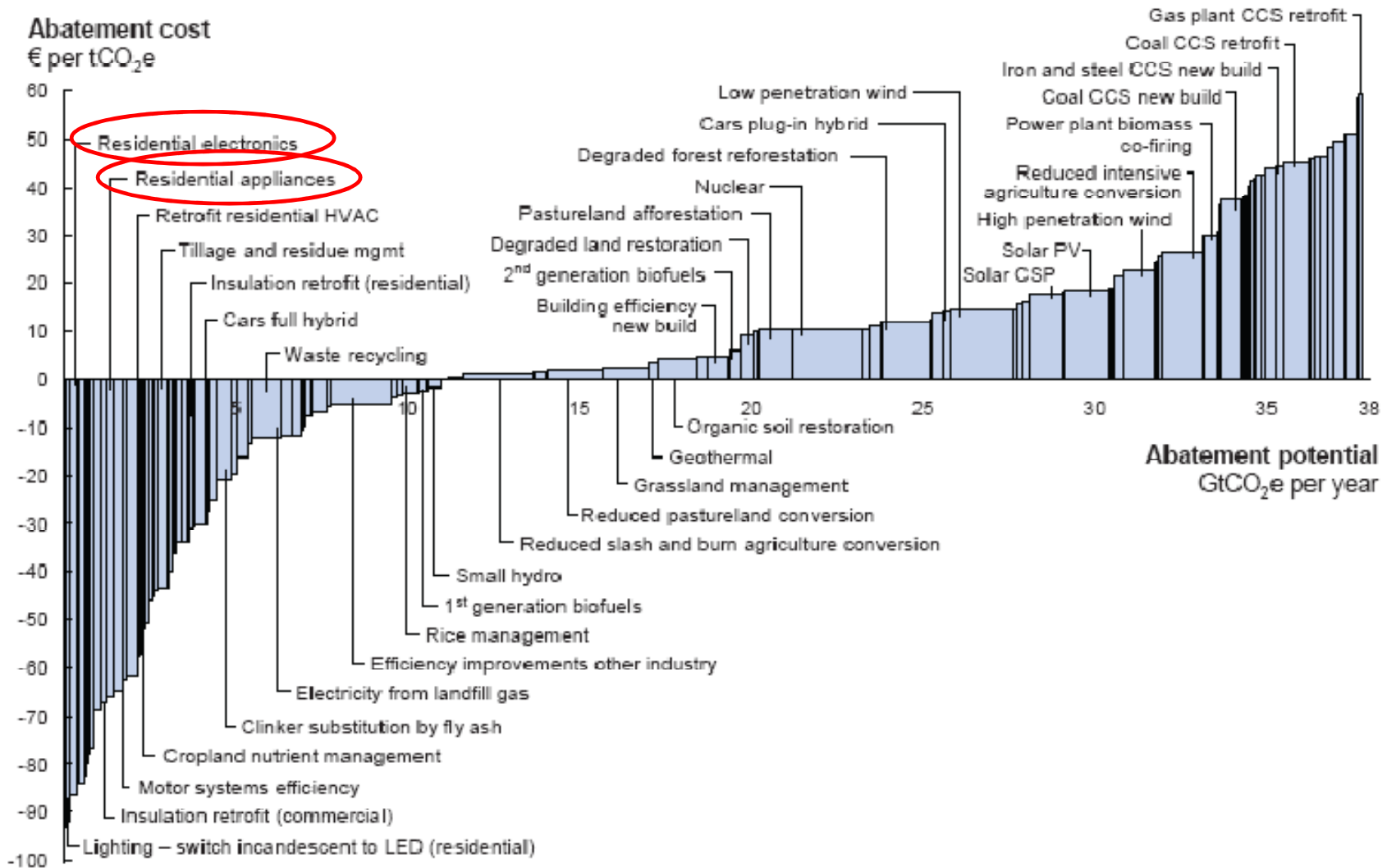
What instruments can policymakers use to influence the types of assets that are acquired?

- Information and labeling.
- Standards.
- Rebates for energy-efficient models.
- We consider the frequency of transfer payments.

The McKinsey graph

Exhibit 3.0.1

Global GHG abatement cost curve beyond business-as-usual – 2030



To what extent should energy efficiency be part of the set of policies used to respond to climate change?

One view: if a billion households are going to acquire vehicles and refrigerators, we'll need RE < C or adaptation.

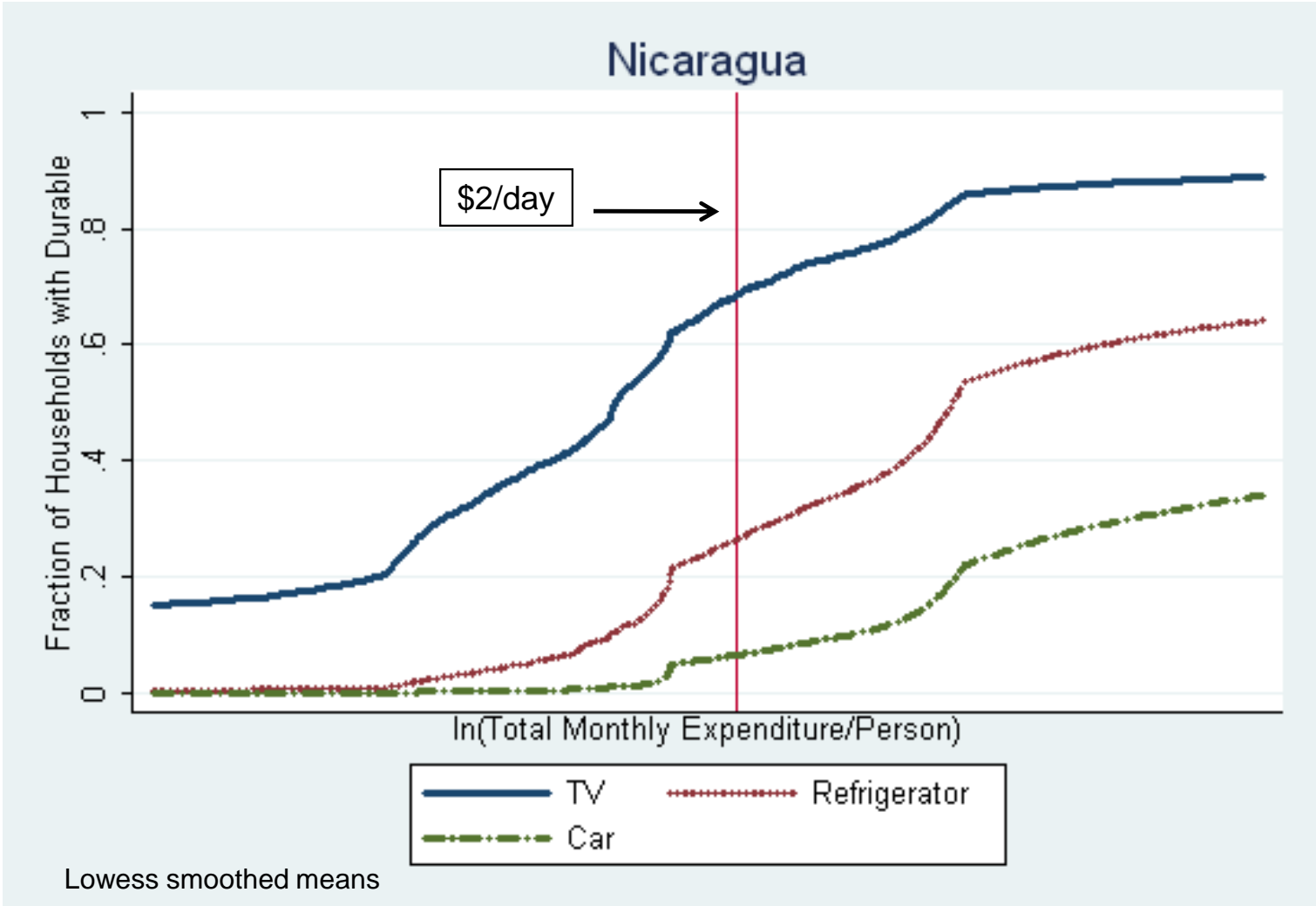
But...

- There are generically several broad strategies for addressing climate change:
 - Reduce demand, for example through energy efficiency programs.
 - Reduce the GHG-intensity of energy production.
 - Adaptation/mitigation.
- It's hard to believe that the optimal solution *rules out* any of these strategies.

Outline

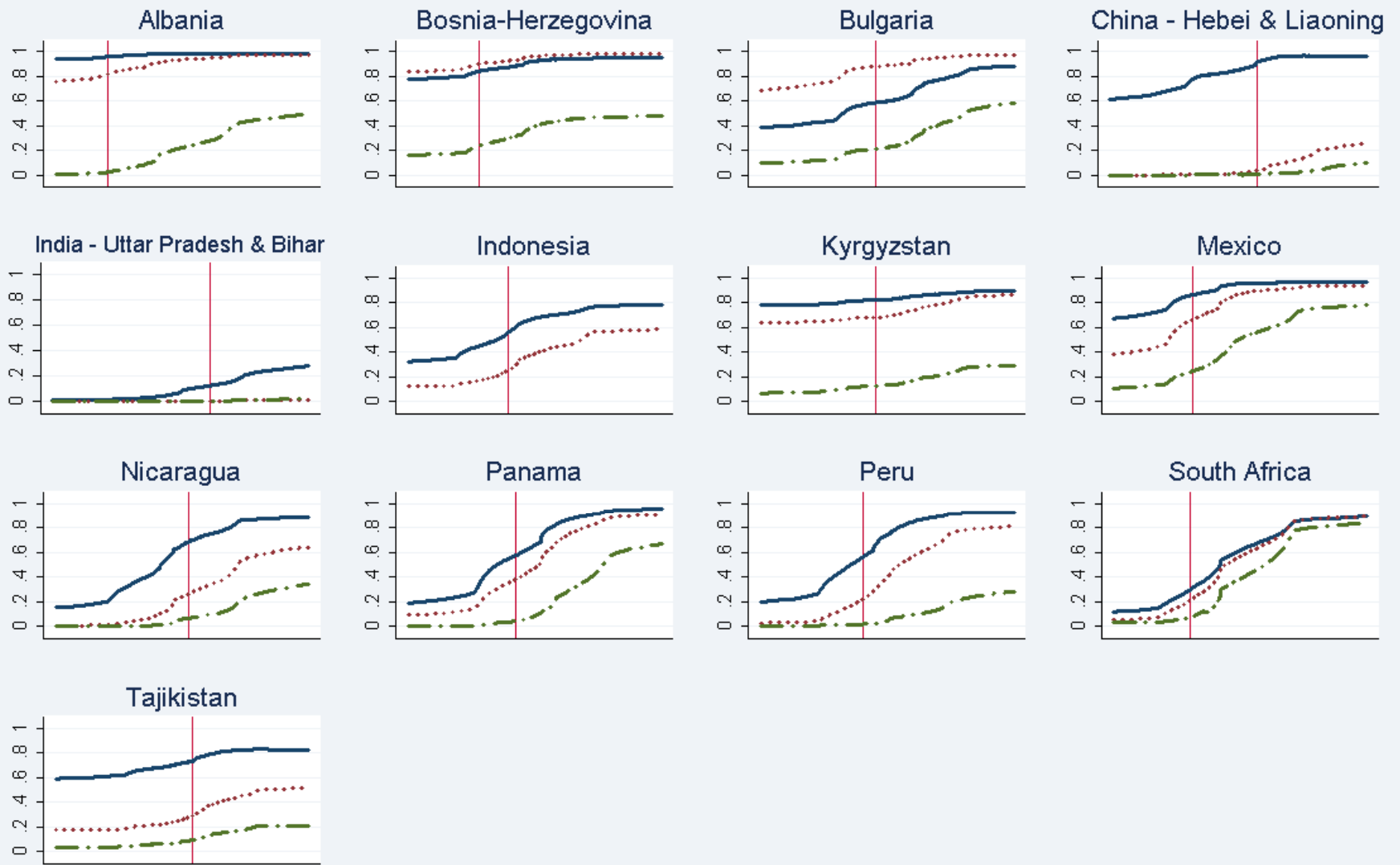
- Cross-country data.
 - Collected from cross-sectional household surveys (mainly Living Standards Measurement Survey)
- Preliminary results from Mexico.
 - Based on data collected as part of the conditional cash transfer program Oportunidades.

Appliance ownership as a function of income



Source: 2001 Living Standards Measurement Survey, N = 4,191

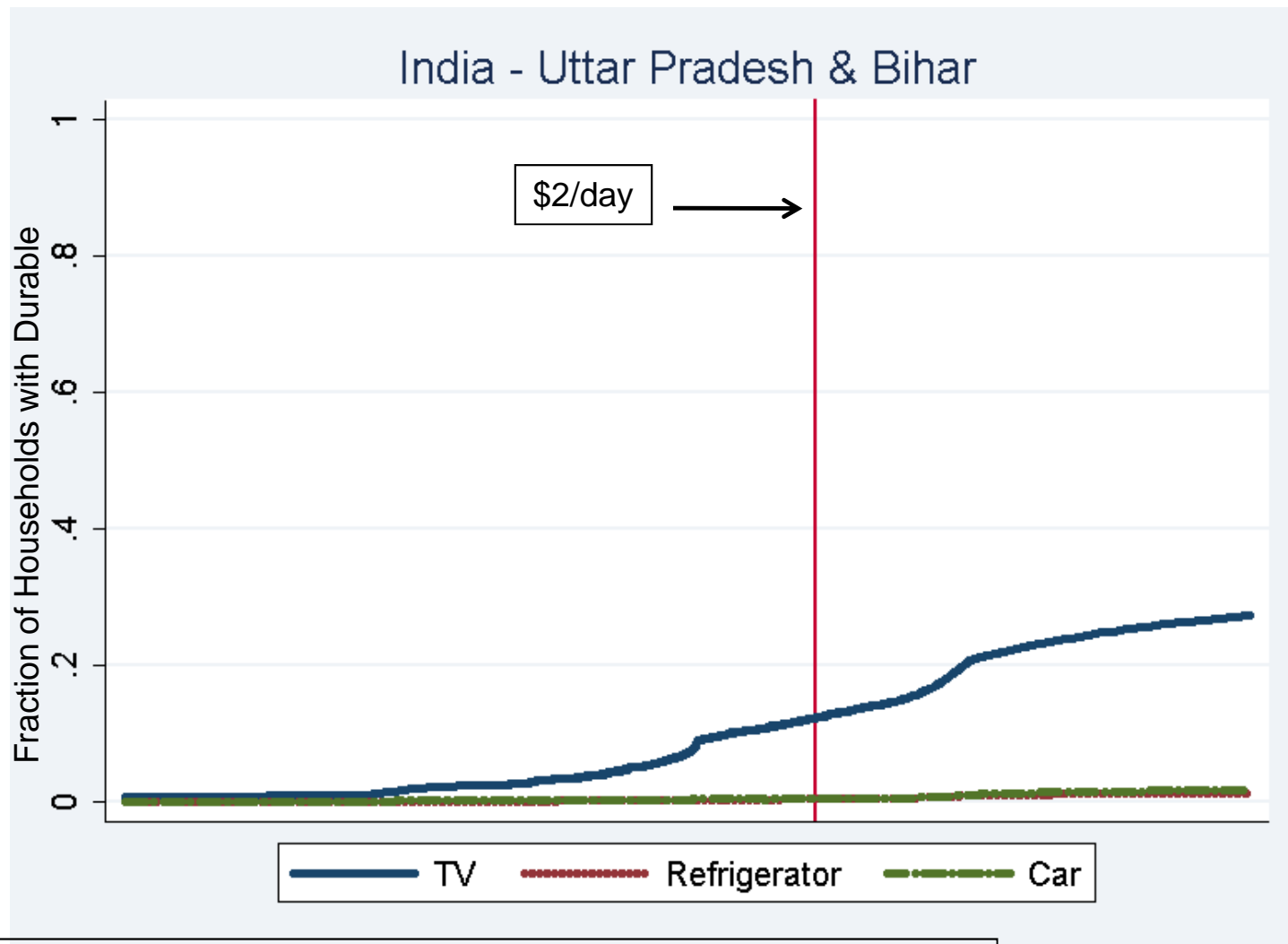
Fraction of Households with Durable



ln(Total Monthly Expenditure/Person)



Data on India (that I have found) are limited



Source: 1997-8 Living Standards Measurement Survey, N = 2,000

In Mexico, we study Oportunidades (formerly Progresa)

- Conditional cash transfer program
 - Families receive cash conditional on acquiring preventative medical care and keeping children in school.
 - Transfers average 20% of household income.
- Rural program initially randomized
 - 60% of the villages began receiving benefits in April 1998.
 - Remaining 40% began receiving benefits in November 1999.
- Today
 - 20% of Mexicans on Oportunidades.
 - Annual Budget: US\$3.4 Billion (0.75% of GDP).
- Extensive data collection to support rigorous program evaluation.

Short-run income elasticities are essentially zero

**Table 8: Short-Run Income Elasticities for Energy Demand
Oportunidades Households 2007**

	Dependent Variable: ln(Monthly Electricity Expenditures)		
	OLS	IV	IV
Appliance Ownership Index	0.7382*** [0.0391]	1.0955*** [0.2146]	1.1163*** [0.2931]
ln(Monthly Transfer)	0.0128 [0.0153]	-0.0473 [0.0477]	-0.0367 [0.0760]
N	4,665	4,665	4,125
R ²	0.352		
First-stage F-stat (Asset Index)		27.24	14.56
First-stage F-stat (ln(Monthly Transfers))		92.35	41.19

Note: All specifications include village- fixed effects and household controls, including household size, head of household's sex, age. In columns (2) and (3), instruments include: ln(Potential Monthly Transfers), ln(Potential Cumulative Transfers as of 2007), ln(Potential Cumulative Transfers as of 2003), ln(Potential Cumulative Transfers as of 2000).

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.10.

Appliance acquisition

- Nonlinear in cumulative transfers → threshold effect.
- The pace of transfer payments matters.
 - For two households that both have received \$1500 in transfers by 2003, the one that received nothing for 1998 and 1999 is more likely to acquire a refrigerator.
 - Foregone consumption in 1998 & 1999?
 - Behavioral explanation?
 - Transaction costs?

Bottom line

- As households come out of poverty, growth in energy demand will be driven by appliance acquisitions.
- Pace of transfers seems to affect appliance acquisition rate.
- This growth in energy demand is likely to be much higher than growth driven by rising incomes of the middle classes.
- Many more households own refrigerators than vehicles in developing countries.

CO₂ emissions associated with different appliances

	Usage	Carbon Dioxide Emissions	Approximate Annual Carbon Dioxide Emissions per Unit
Television	100-400 kWh/year	2 lbs/kWh	200-400 lbs
Refrigerator	950-1300 kWh/year	2 lbs/kWh	1,900-2,600 lbs
Motor Vehicle	25-50 km/day	120-520 gm/km	2,900-16,200 lbs

Compared to refrigerators, vehicles are approximately 1.2 – 8 times as polluting per unit.

Thank you!