

The Role of Decentralized Solar in Rural Electrification

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Uneven Power is a Huge Barrier to Growth

Key Ingredients of Growth

- Health: People living longer are more capable and invest more in themselves
- Education: High returns to education can make the next generation better off than their parents
- Productivity: Enterprise creation drives employment and growth but requires energy

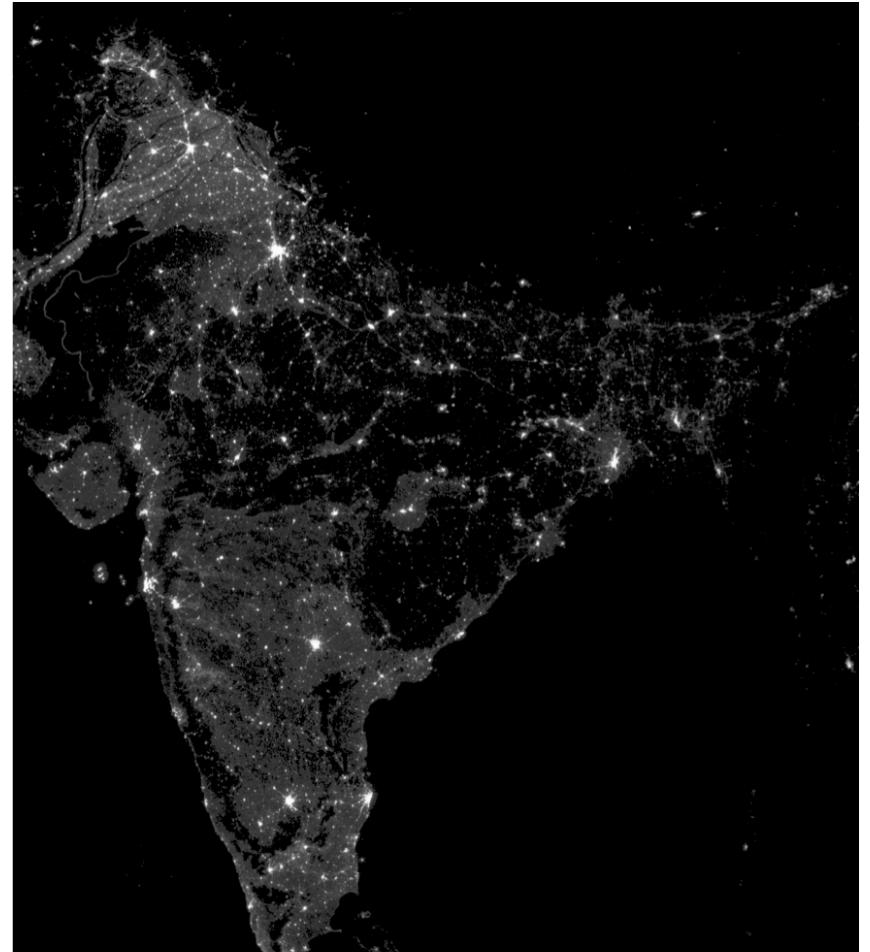
And if you Lack Electricity?

- Health
 - Kerosene and other fuels pollute indoor air
 - Vaccines spoil, clinics poorly equipped
- Education
 - Need light to study
- Productivity
 - Electricity fundamental to industrial growth (Allcott et al 2014)
 - Commerce, services and telecom inescapable in a modern economy (Jensen 2007)
 - Labor productivity depends on electricity (Dinkleman 2011, Lipscomb et al 2013, Somanathan et al 2015)

Can Decentralized Solar Play a Role?

About 95 percent of India's villages are electrified. And yet...

- Bihar : 122 kWh
- India: 626 kWh
- USA: 13,325 kWh



Could Solar Micro-grids Provide a Solution?

- Study Design

- Randomized Control Trial across 100 villages in East and West Champaran Districts of Bihar
- Intervention: solar product offering of two LED light bulbs and one mobile charging point
 - 34 control villages
 - 33 villages will receive the product offering at INR 200/month
 - 33 will receive it at INR 100/month



Demographics

Average household size	5.96	people
Average age	23.96	years
Average household income	68,181	INR/ year
Average number of livestock owned	2.22	animals

Occupation

Non-agricultural wage laborer	10.35	per cent of sample
Agricultural wage laborer	77.7	per cent of sample
Crop cultivation	5.93	per cent of sample

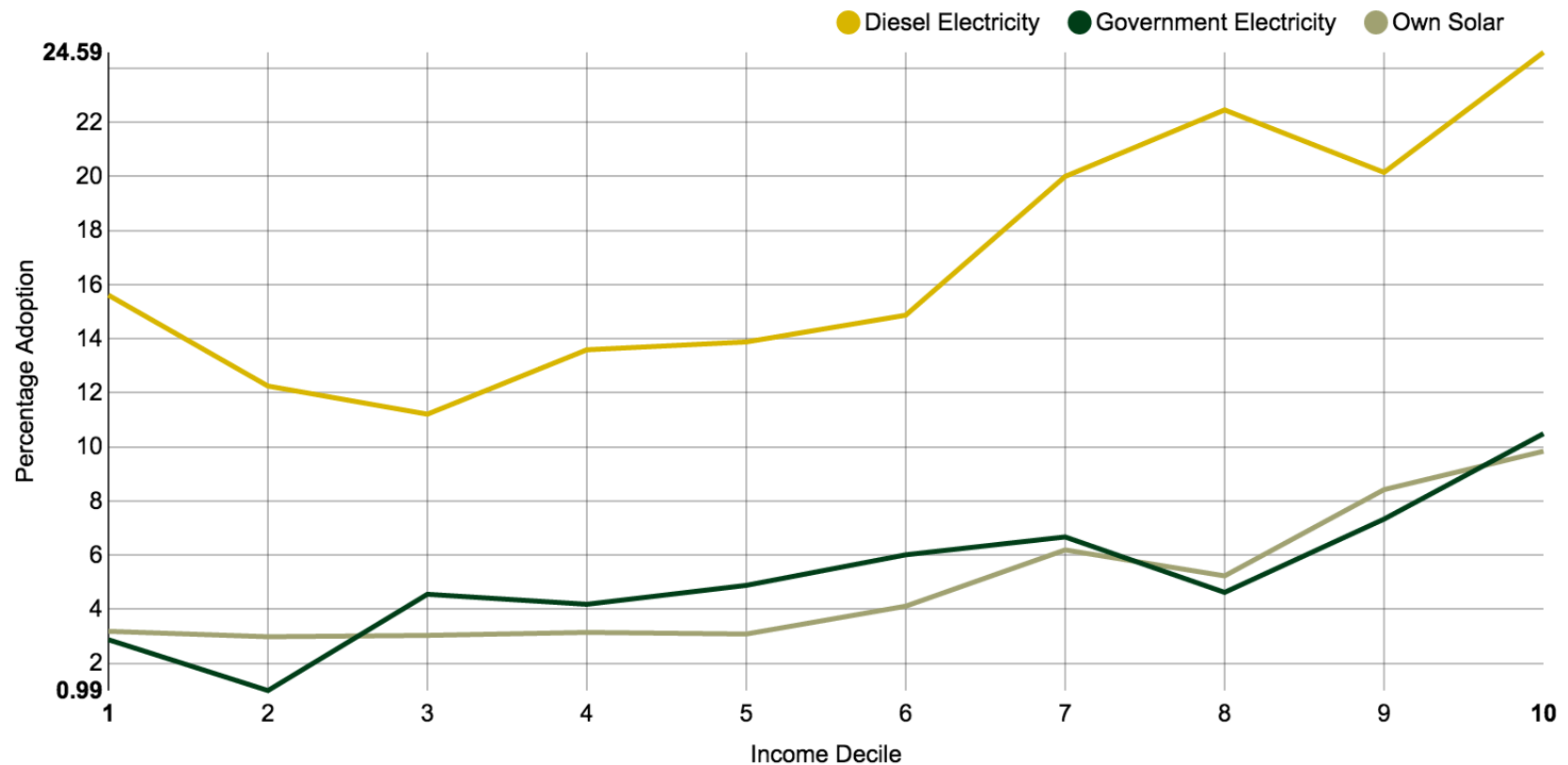
Household assets

Households with straw/ thatch roofs	52.67	per cent of sample
Households that own agricultural land	95.35	per cent of sample
Households that own their home	98.23	per cent of sample
Literacy Rate	59.06	per cent of sample
Respondents who have a MNREGA job card	35.1	per cent of sample
Respondents who are listed as BPL families	70.53	per cent of sample

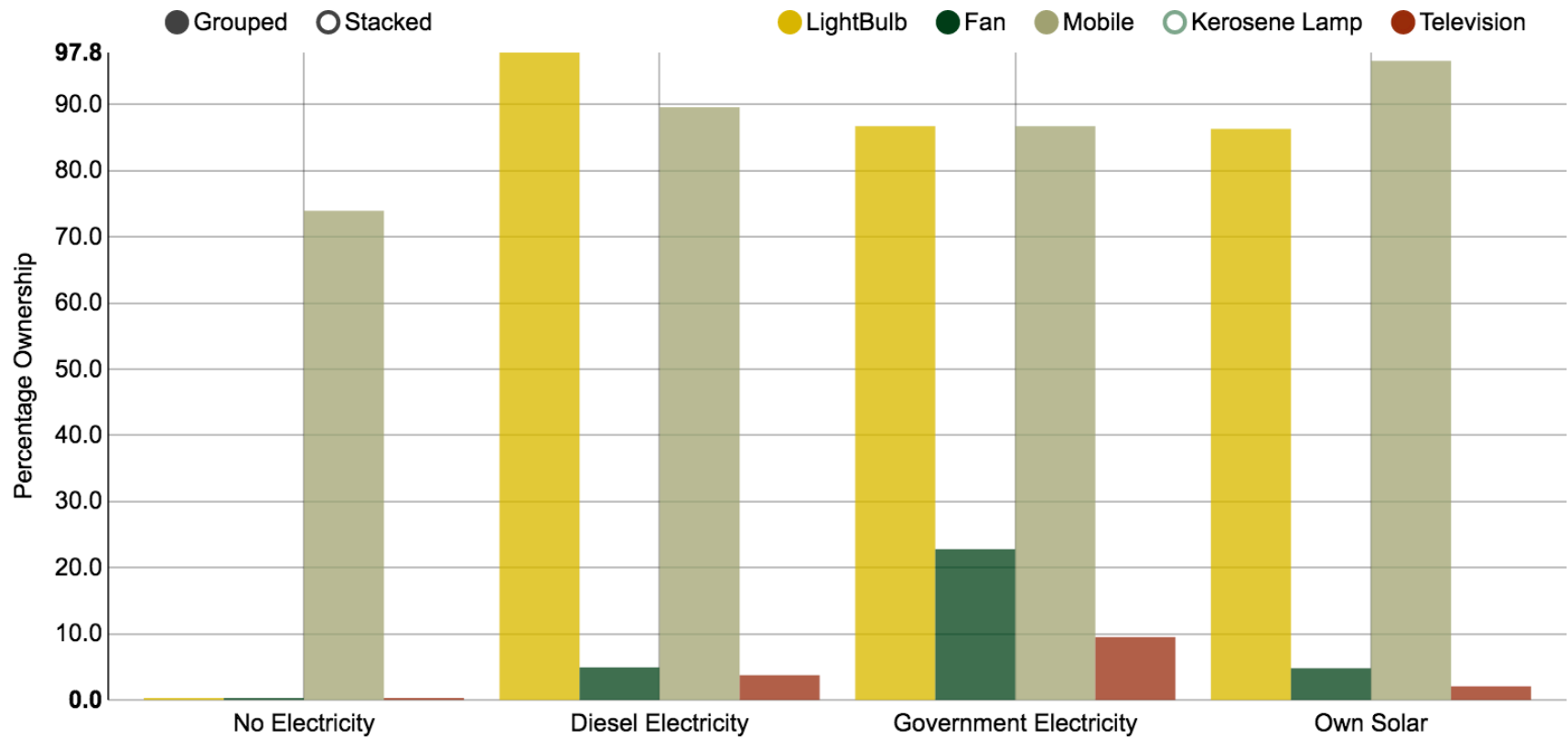
Electricity Connections Do Not Mean Supply

Percentage of households that feels they are billed and acknowledged with a receipt in a precise way	22.15%
Percentage of households that gets electricity when they have paid for the subscription	13.29%
Percentage of households that experienced a power outage in Oct-Dec 2013	37.97%
Percentage of households that experienced any drop in voltage in Oct-Dec 2013	36.08%
Percentage of sample that reported a maintenance officer showing up in time when a problem was reported	32.28%
Percentage of sample that trusts their grid connection	31.65%

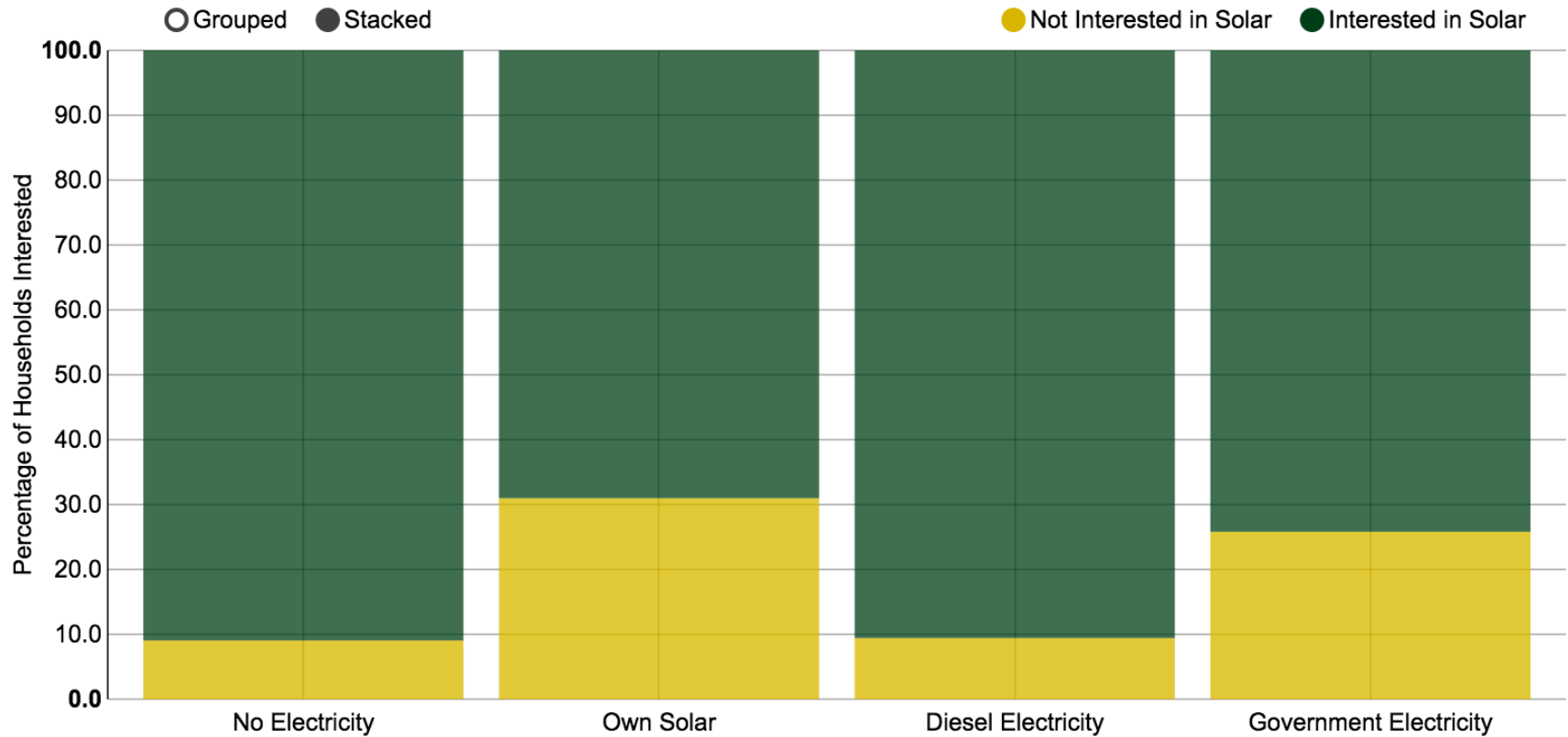
Electricity Take-Up by Income Decile



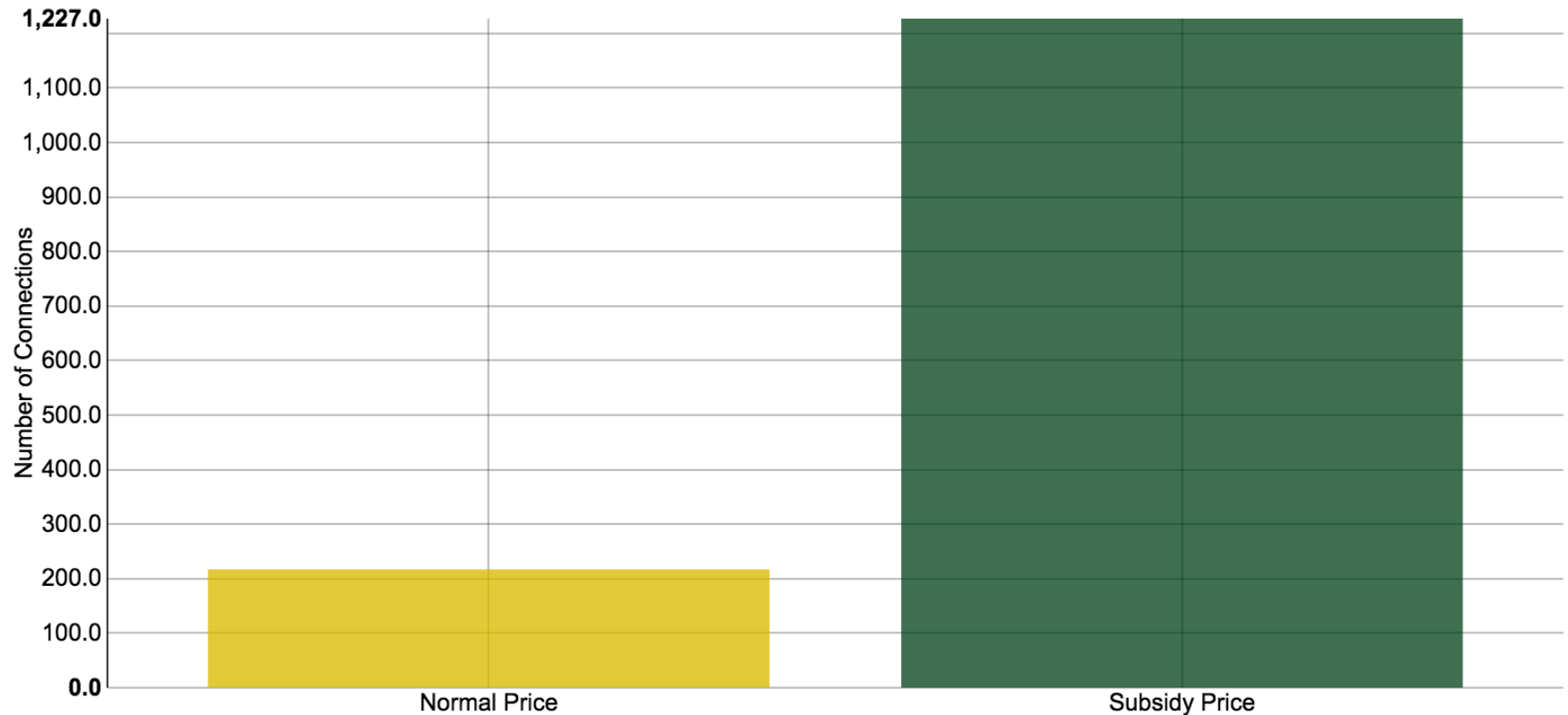
Appliance Ownership



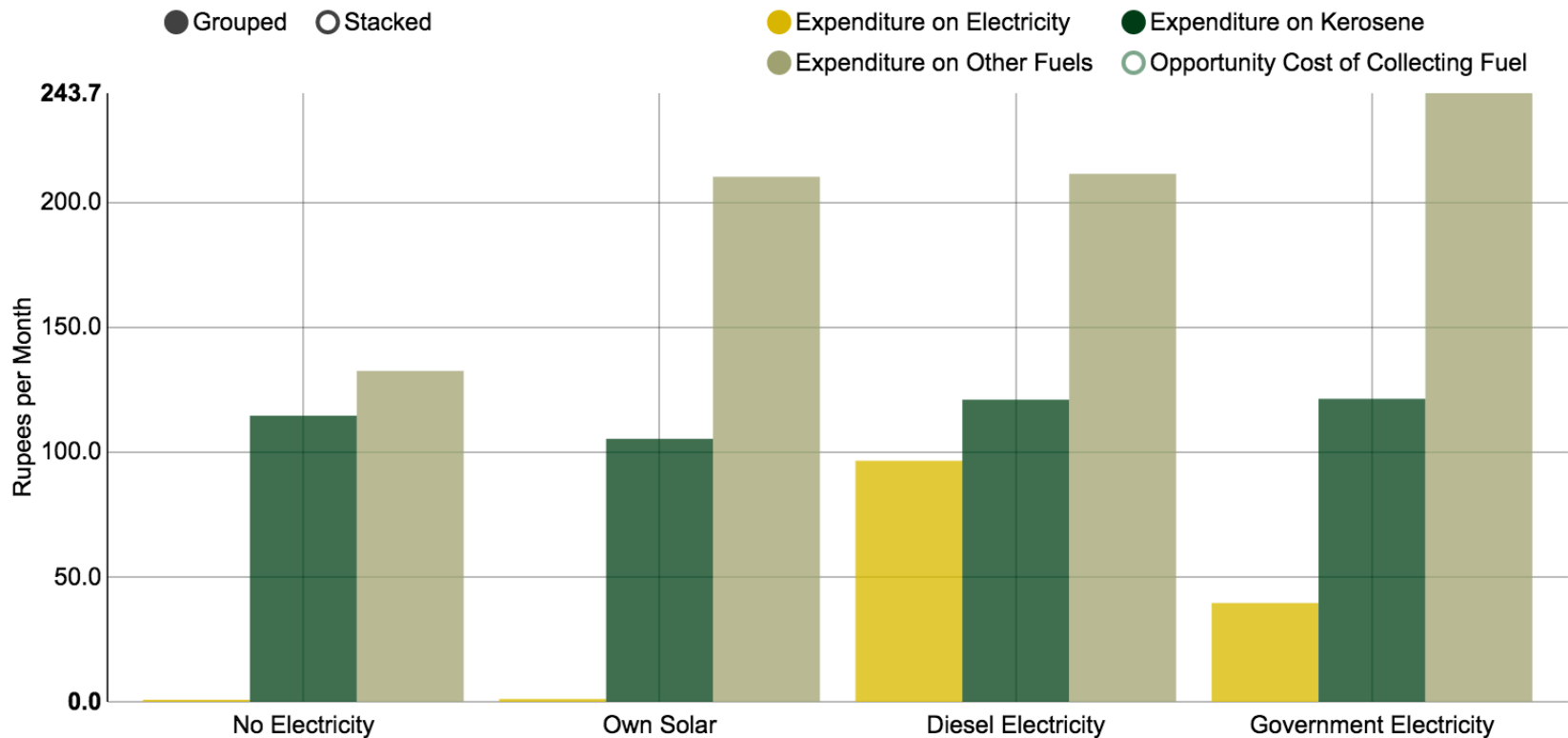
Interest in Solar By Energy Source



Stated Demand for Solar by Price

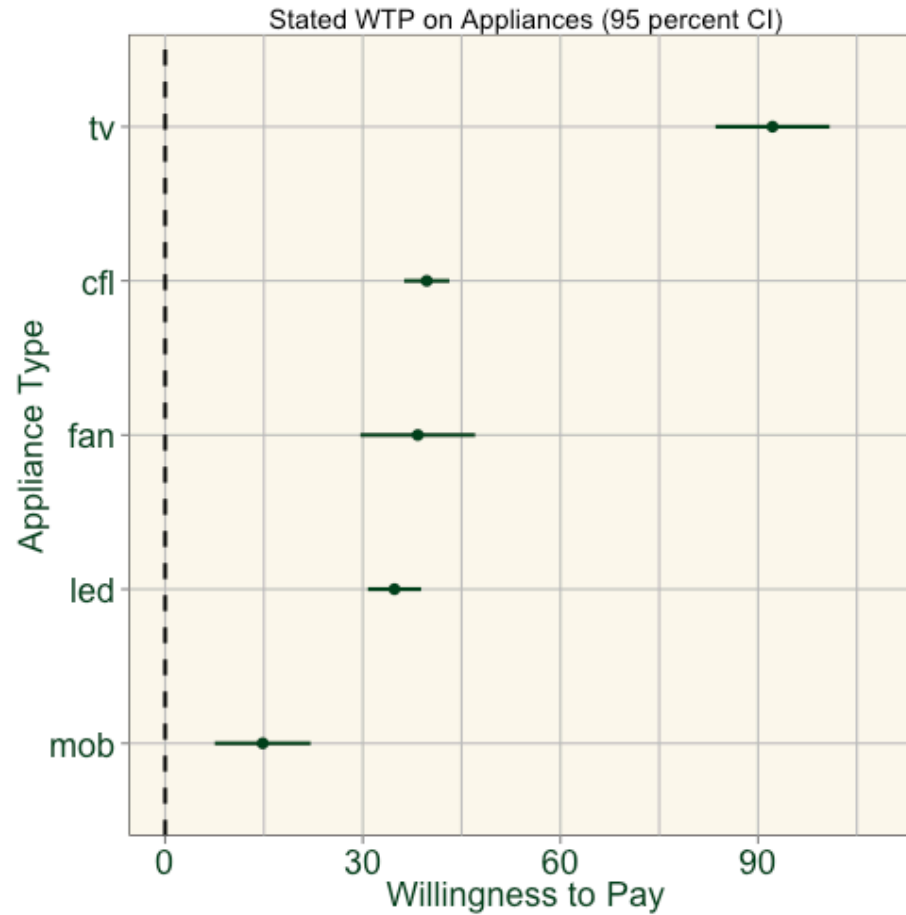


Energy Expenditures

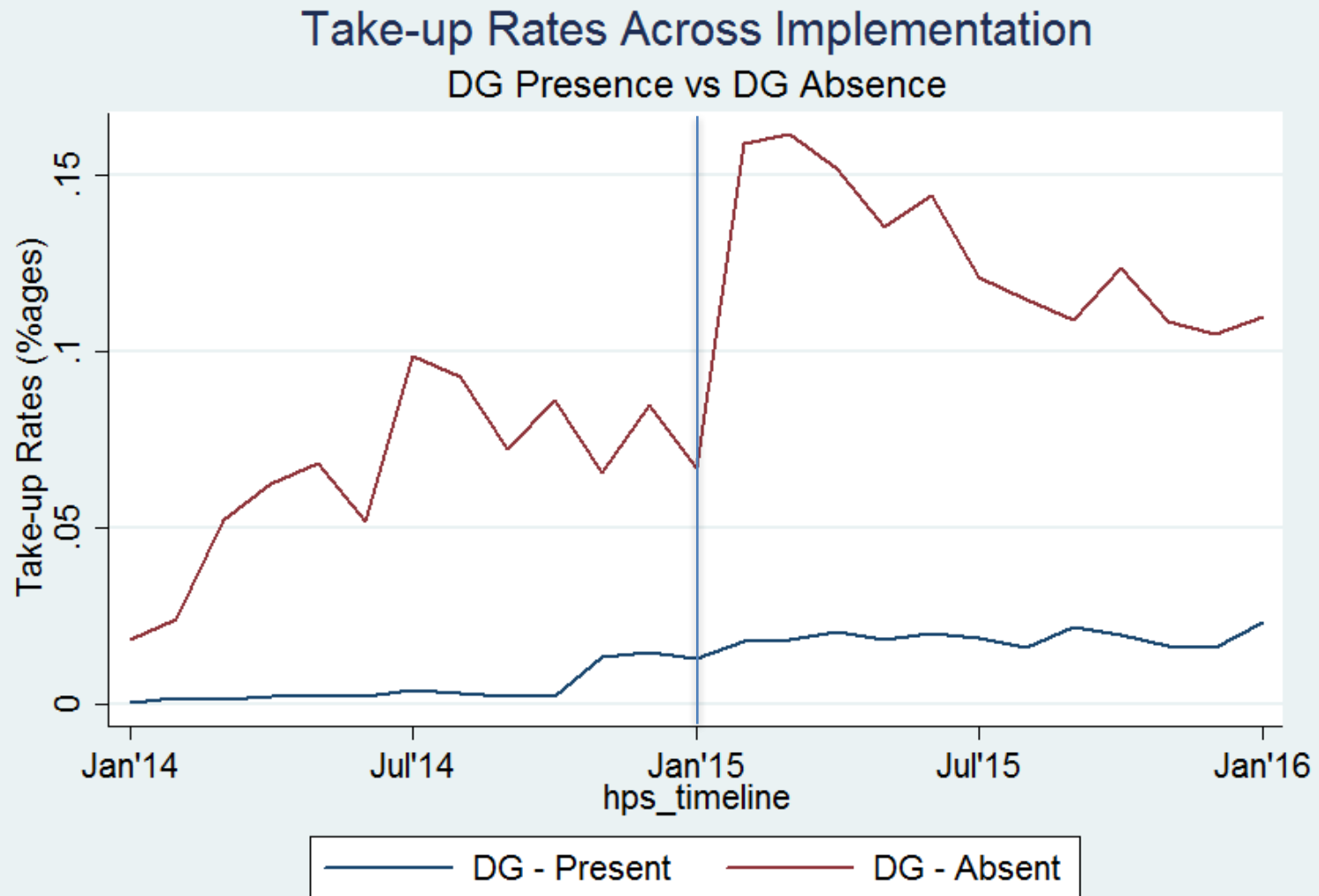


Other fuels include batteries, candles, wood etc

Stated Willingness To Pay



Take Up With Competition



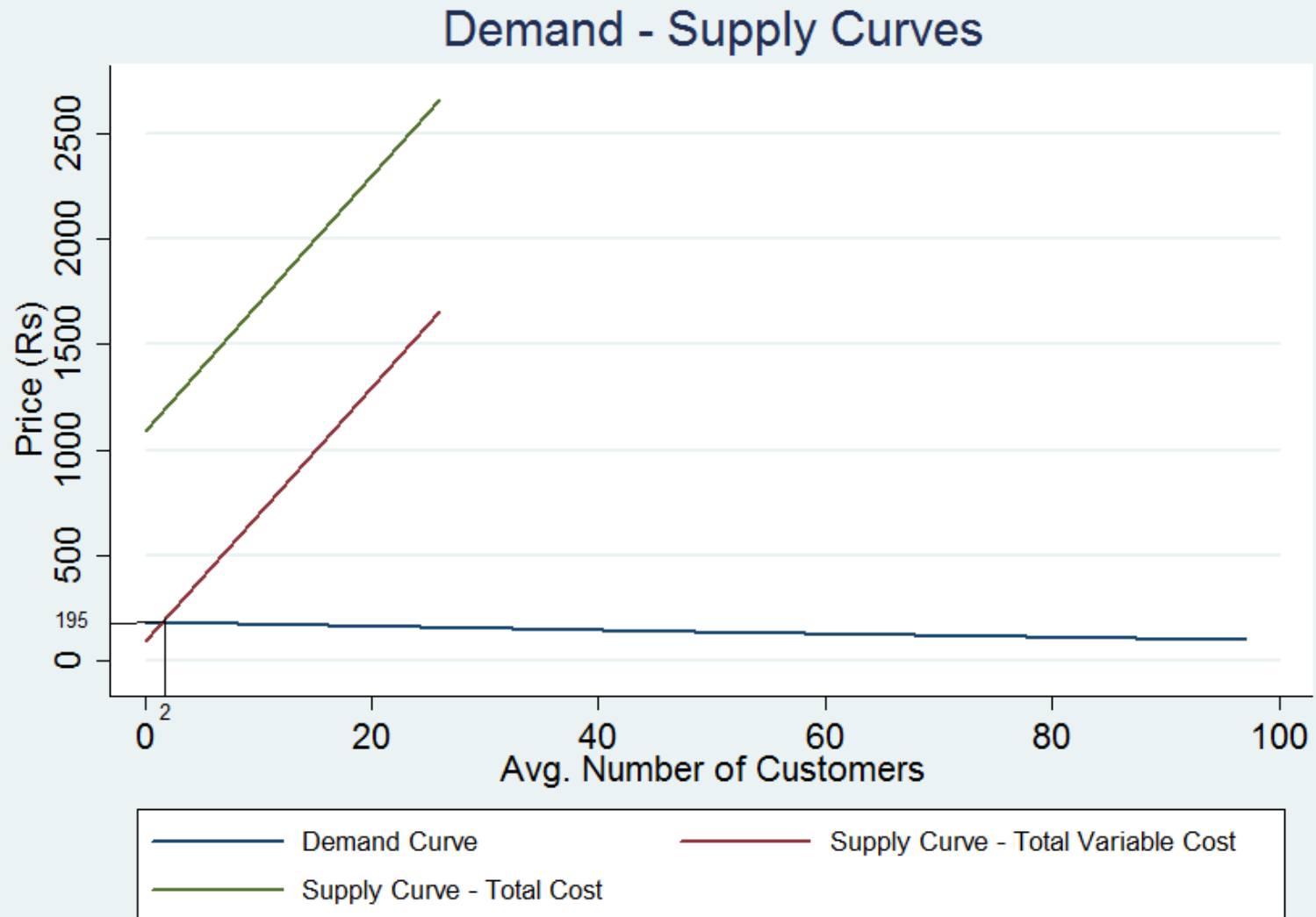
Implementation Difficulties

Village Type	Present Connections	Technically Feasible (Unmet Demand)
<i>Normal</i>	<i>301</i>	<i>328</i>
<i>Subsidy</i>	<i>3207</i>	<i>954</i>

Technical Infeasibility

- Transmission at low current implies maximum distance from panel must be 80m or less
- Within this radius, there must be a willing household with a concrete roof
- Trade-off between number of customers and hours of DC supply

Is Decentralized Solar Likely to Solve the Electricity Access Problem?



Going Forward

- Approximate supply and demand curves
- Understand and model the effect of competition from different sources
- What happens if the quality of grid supply improves? Can solar exist as a complement?
- Evaluate demand along the quality dimension i.e which appliances are supported

Thank you and fare thee well

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