How Valuable are Improvements in Residential Electricity Supply? Evidence from Nepal

Anna Alberini (AREC, University of Maryland)
Jevgenijs Steinbuks (INFCE, World Bank)
Govinda Timilsina (DECRG, World Bank)

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1818 H Street NW

Washington DC 20433

Telephone: 202-473-1000

Internet: www.worldbank.org

Presentation Outline

1. Research Questions (and Answers)
2. Nepal Load-Shedding Crisis
3. Research Design and Data
4. Key Results

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Research Questions and Answers

Q: *How much are Nepali households willing to pay for reliable power supply?*

A1: Quite a bit. On average 123.32 NR ($1.11) per month, or 65 percent of the actual average monthly bill.

A2: Not so much. 26 percent of the households aren't willing to pay anything (if we believe them). Lots of heterogeneity [TBC!]

Research Questions and Answers

Q: *What is the Value of Lost Load (VoLL) borne by Nepali households during the load-shedding crisis?*

A1: About as much as the cost of grid electricity service (0.045 to 0.135 $/kWh) . A lot for Nepal but little for developed economies!

A2: Large differences between VoLL for load shedding vs. unscheduled outages. Again, lots of heterogeneity [TBC!]

Research Questions and Answers

Q: *Does it pay off to improve residential power supply?*

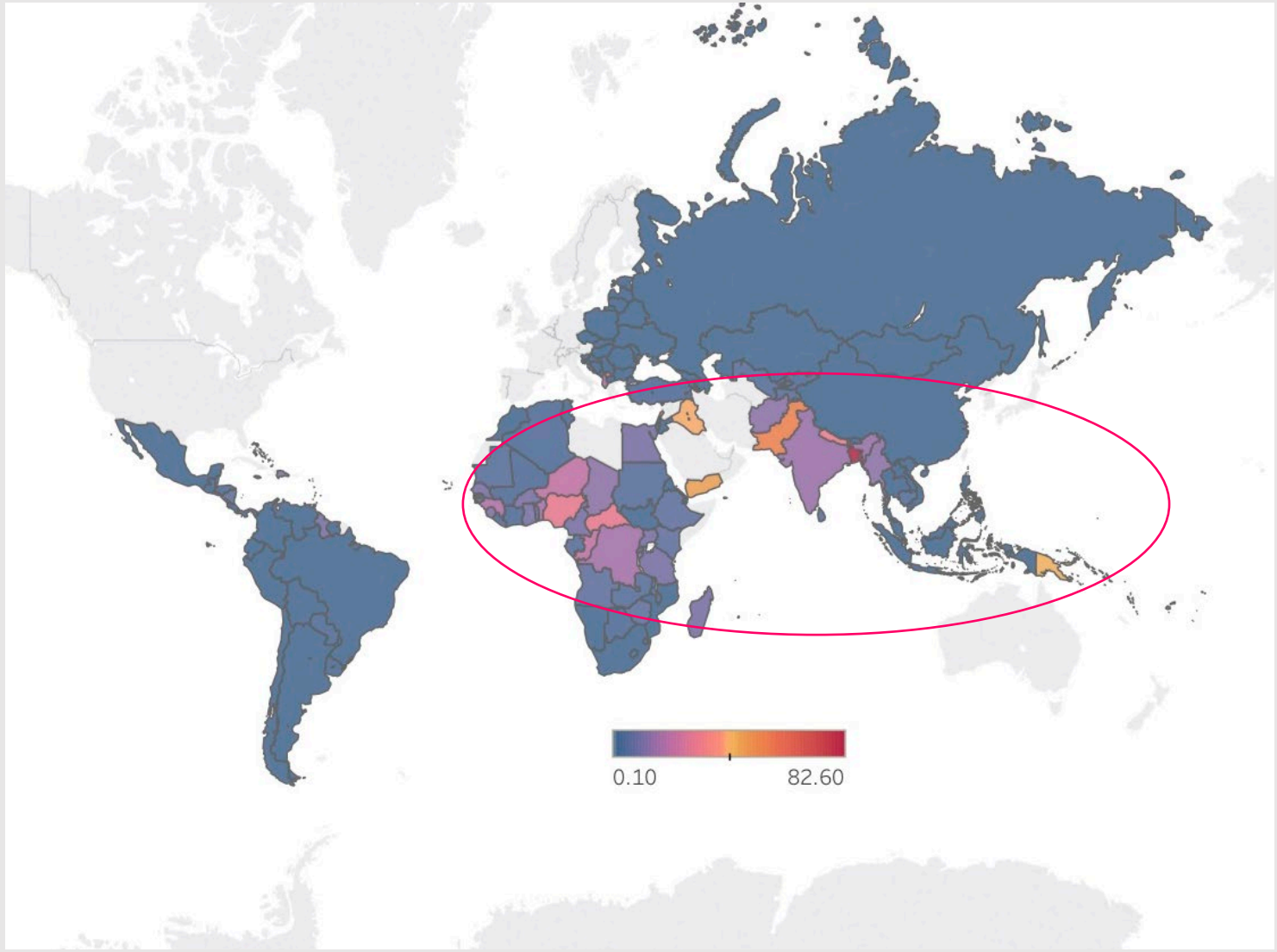
A1: Not really, as our VoLL estimates are lower than marginal cost of improving reliability of power supply

A2: Yes it does, if we think beyond direct benefits to households

Presentation Outline

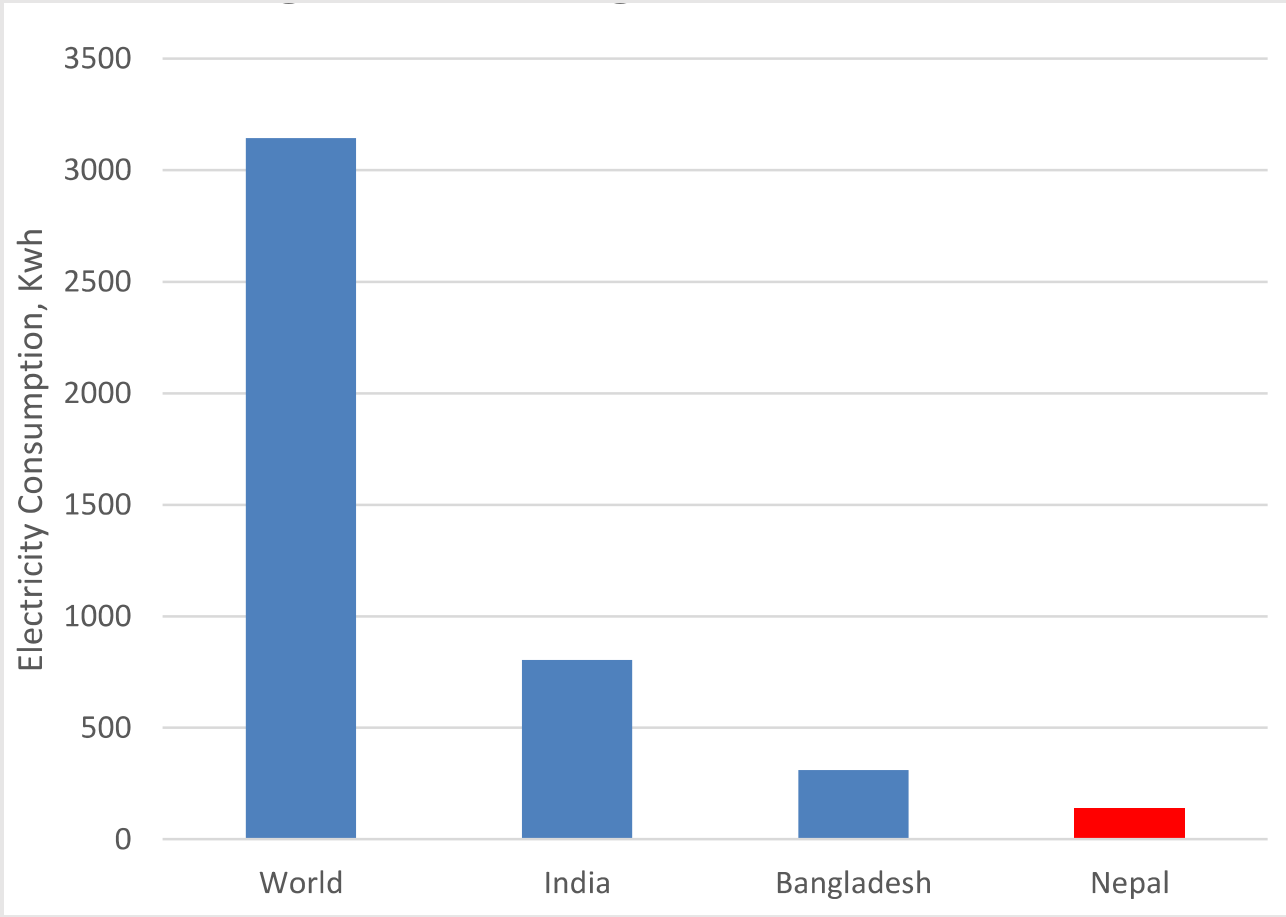
1. *Prelude:* Research Questions (and Answers)
2. ***Setting the Playground: Nepal Load-Shedding Crisis***
3. *Attacking the Problem:* Research Design and Data
4. *Reconciliation:* Key Results

Unreliable Power Supply is a Major Problem in South Asia



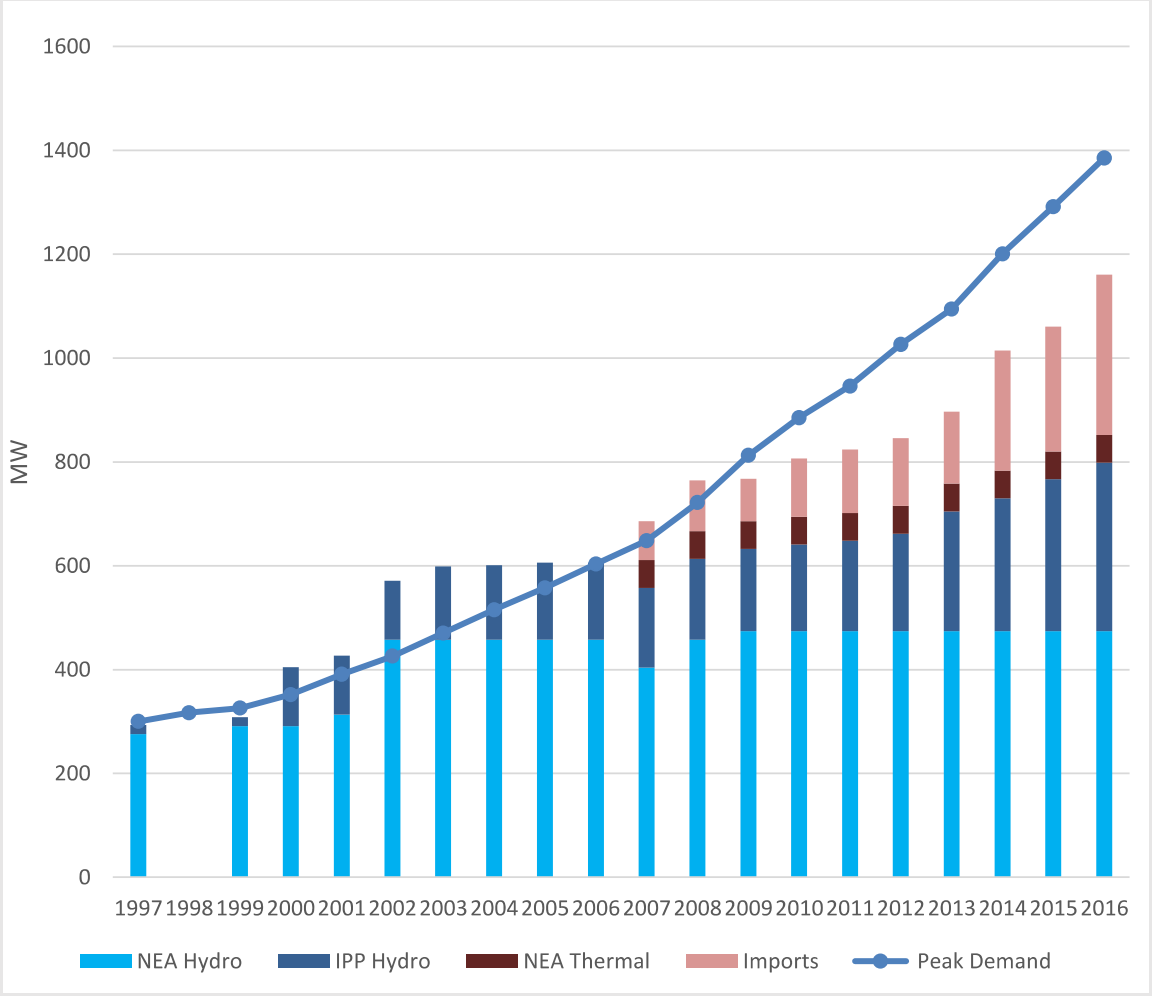
Average power outages in firms in a typical month, 2006-2018. Source: WDI, 2018

Nepal is one of the poorest countries in the world in terms of electricity consumption …



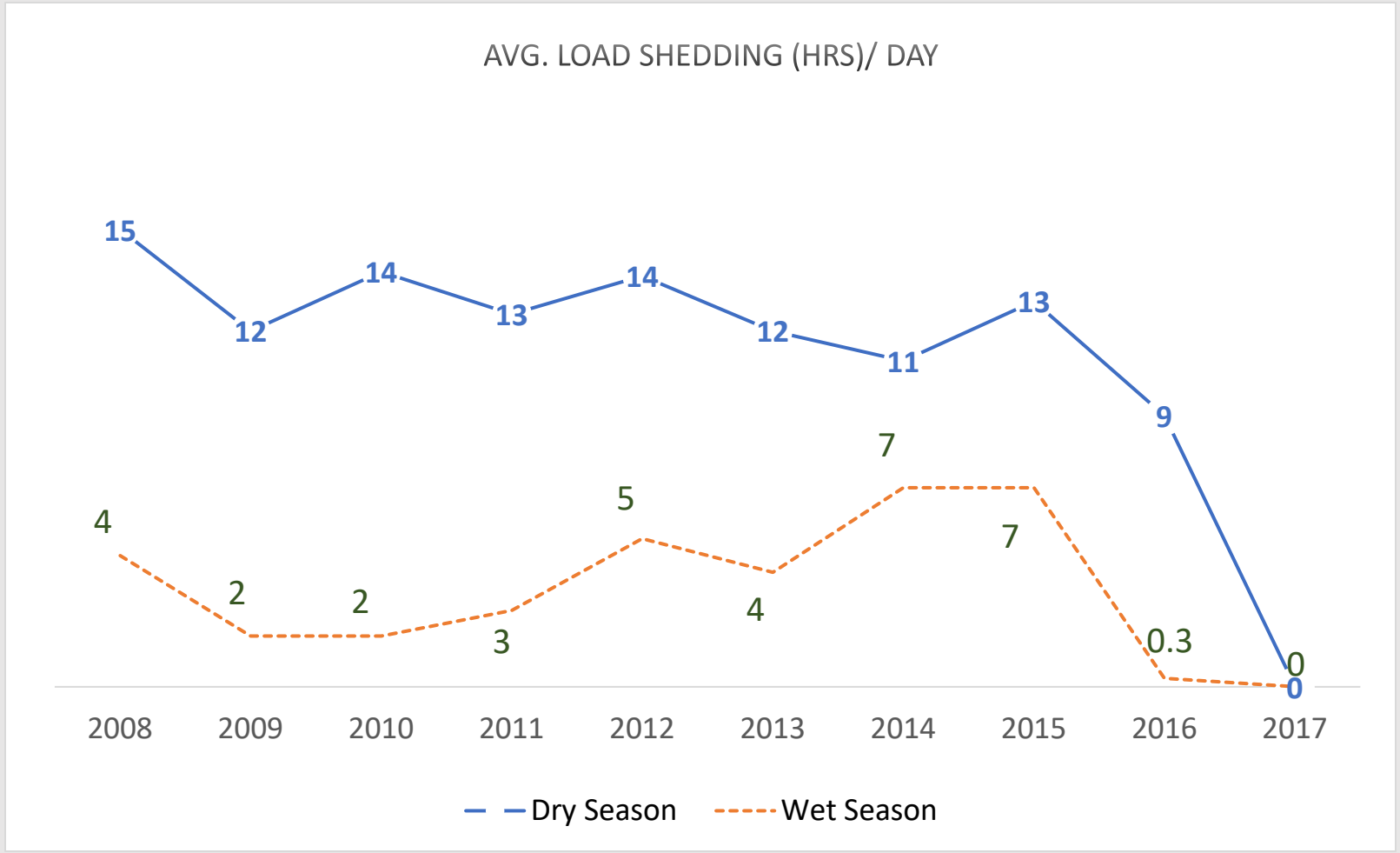
Source: World Bank (2014), WDI

… but the demand has been growing, strongly outpacing supply …



Source: Nepal Electricity Authority (2018)

… leading to increasingly severe power outages since 2008 …



Source: Nepal Electricity Authority

… until NEA has eliminated load shedding in 2017

- Shifting parts of load from industrial to residential customers
- Improved management of supply
- Loss reduction initiatives
- New generation capacity
- Increased imports from India
  - facilitated by completion of high capacity transmission interconnections
- Consumer awareness and demand side management
- Unscheduled outages still a problem!

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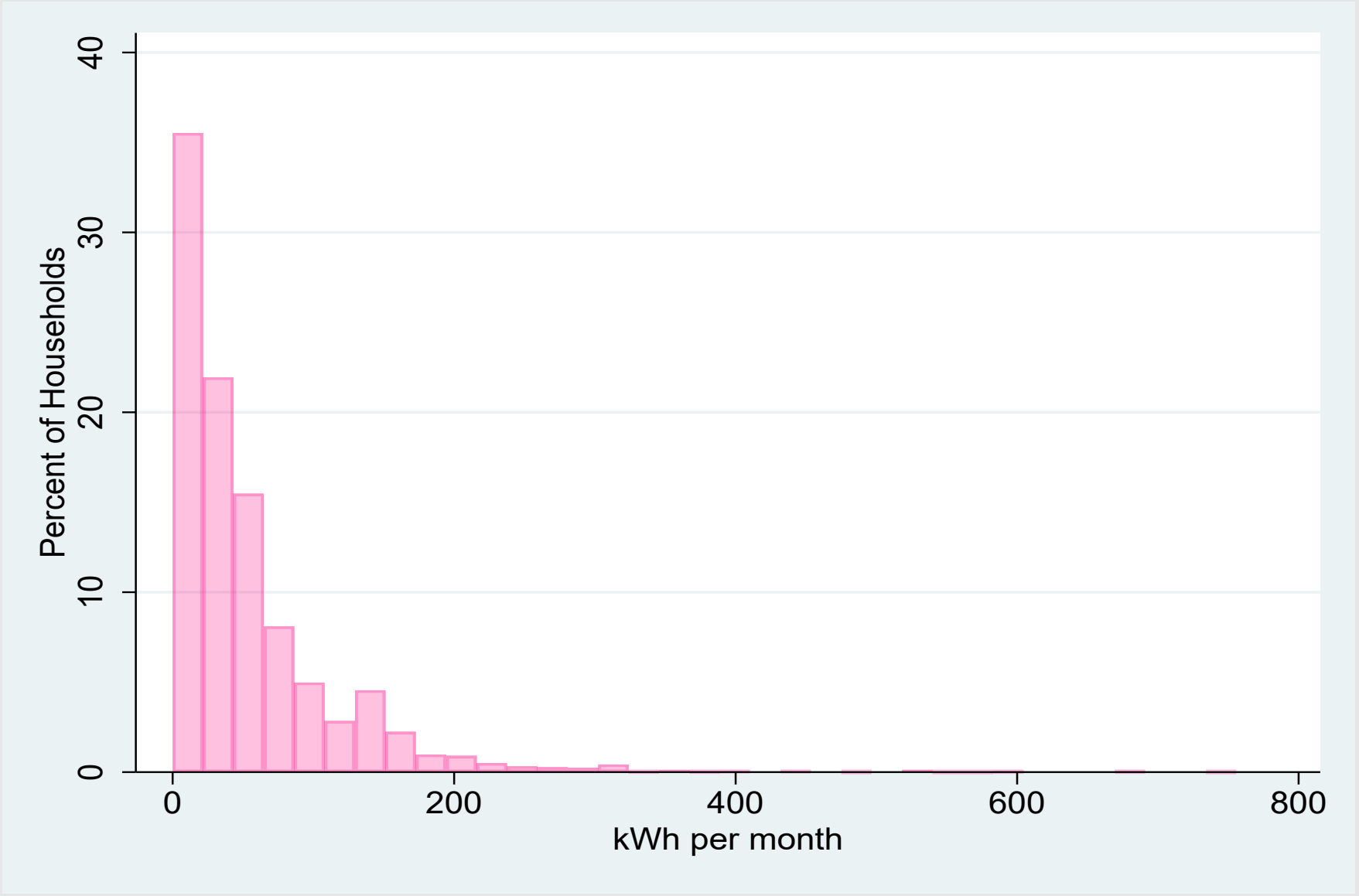
Contingent Valuation Design

- Key idea: survey households after load-shedding eliminated
- “Do still experience power outages at the time of the survey?” ->
- “Did you experience power outages one year before?” ->
- “Would you willing to pay a specified amount of money on top of their monthly bill to avoid going back to the situation of the year before?” ->
- Randomly chosen amount out of a list of possible values
  - (100, 200, 300, 400 and 500 NR) ->
  - Followed by “best” estimate

Data

- The WBG MTF Survey Data for 2017 (4,047 grid-connected households)
  - Reported outages in a “typical” and “worst” month
  - Electricity consumption
  - Whether or not household use power back-up (inverter / solar system)
  - Other households’ characteristics
- Zonal load-shedding schedules reported by NEA
- Records of power outages at substation-level for 2016-2017

Distribution of monthly electricity consumption

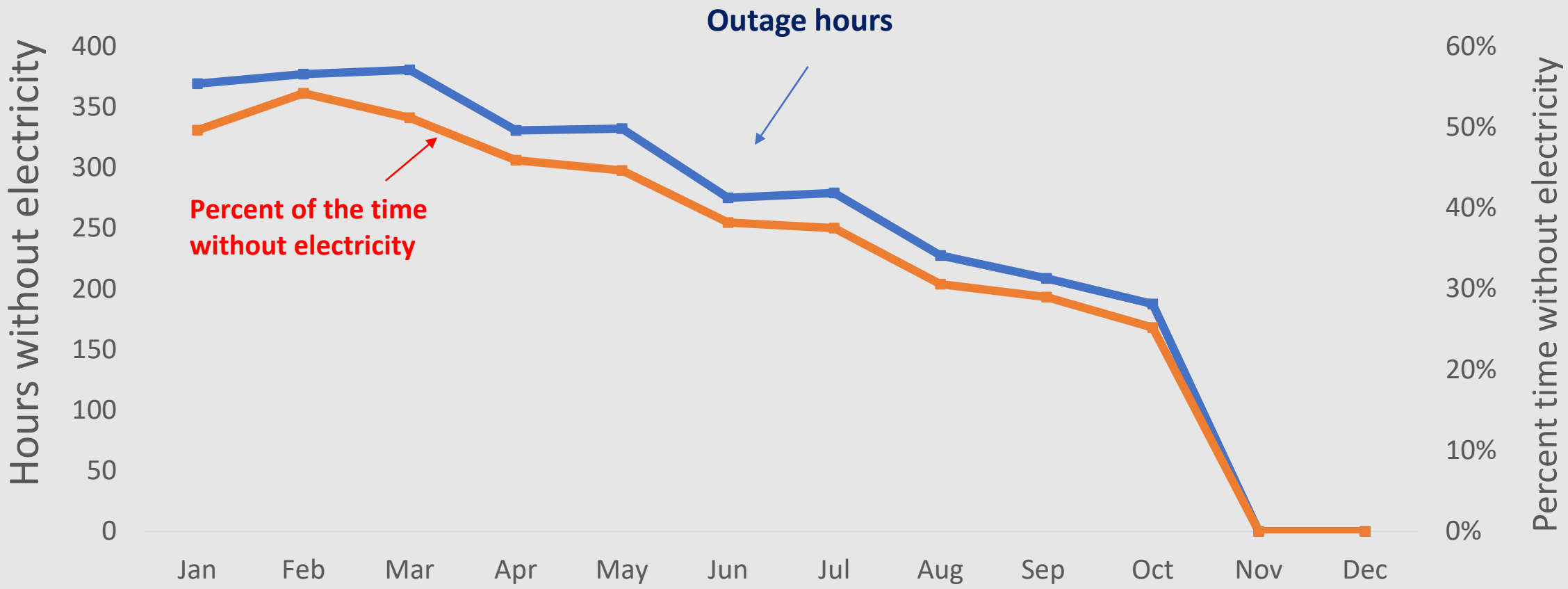


Average: 57.60 kWh/mo.

Median: 37 kWh/mo.

People use about 1-2 kWh/day

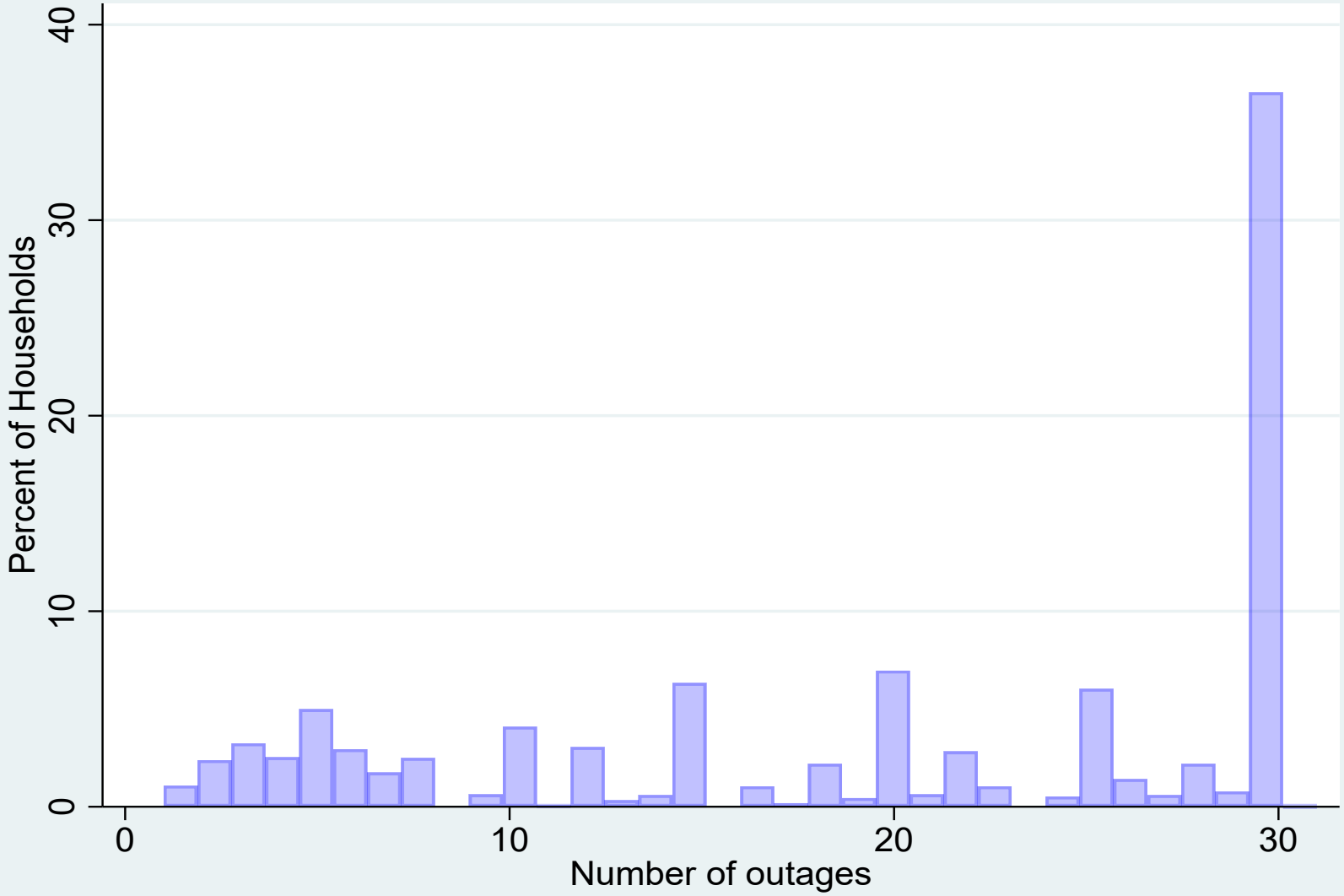
Scheduled Outages in 2016



Unscheduled outages (reported by the respondents)

- In the typical month:
  - average 40 outages (median: 22.5)
  - average 30.82 hours without electricity (median: 13.5)
- In the worst month:
  - Average 76.7 outages (median 40.5)
  - Average 92.38 hours without electricity (median 63)
- People were still experiencing outages (at the time of the survey)
  - No electricity on average 2.99 hours per outage-day (median 1.5)

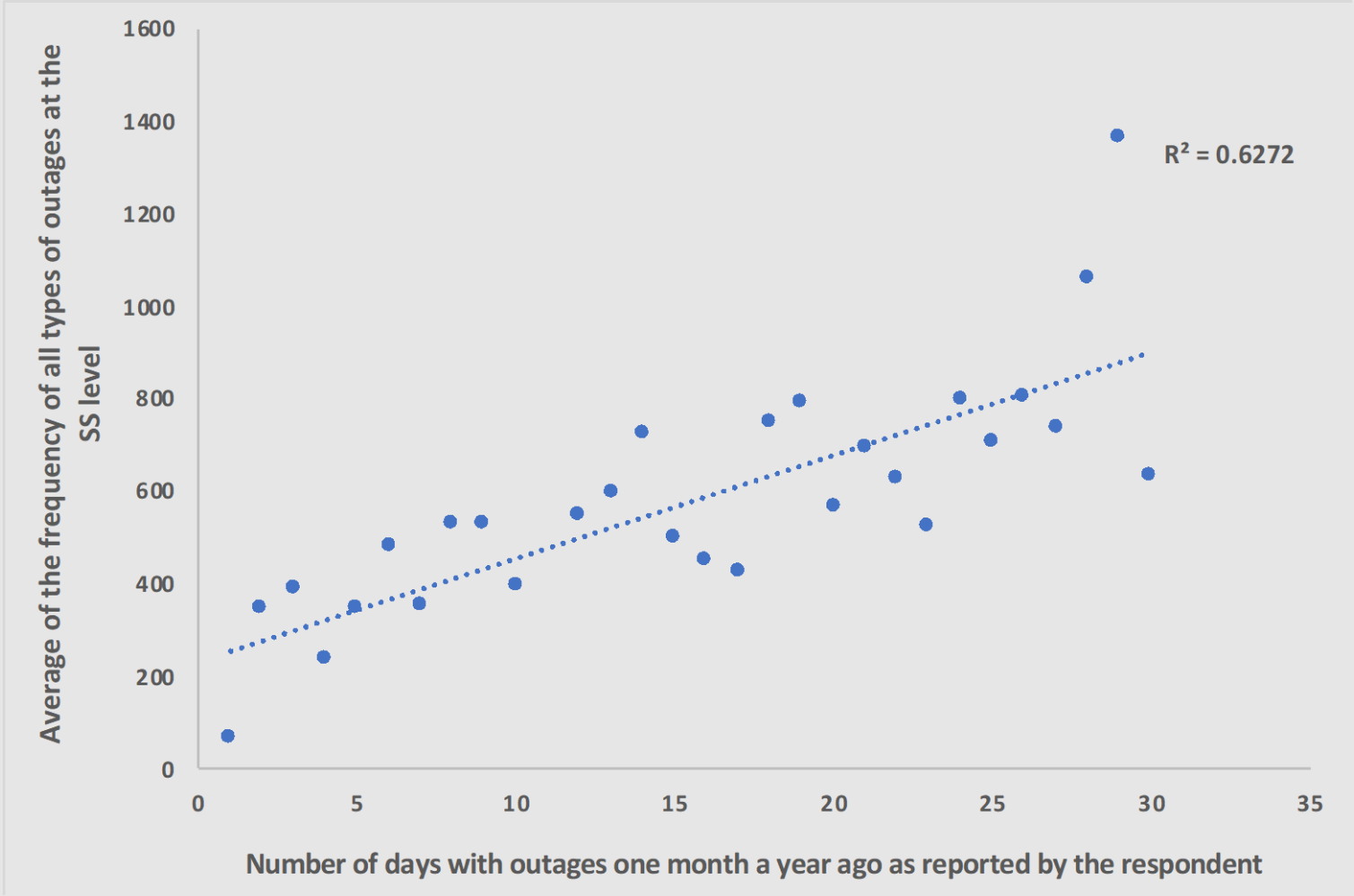
Distribution of Number of Outages “this month” but “a year ago”



Average 20 (median 22)

37% of the households reported 30 or more outages (i.e., there were outages every day)

Strong Correlation of Respondents' Recall and Substation level Data



“How much would you pay on top of your monthly bill to avoid the outages this month a year ago?”

- 2723 households report outages this month last year
- Reported WTP:
  - average 123.16 NR (median: 100NR)
- 26% report zero WTP
  - Low Income (+)
  - Poorly educated (+)
  - Use of disposable batteries (-)
- WTP per outage-day: 10.96 NR

Quantitative Analysis of Value of Lost Load (VoLL)

- "Explicit" VoLL = WTP / Total Number of Outages [scheduled + unscheduled]
- Regression 1:

$$WTP\ per\ outageday_i = \theta_1 \cdot kWh_{lost_{unsch\,i}} + \theta_2 \cdot kWh_{lost_{sched\,i}} + u_i,$$

  - θ_1 and θ_2 are the VoLL per unscheduled kWh loss and unscheduled kWh lost
- Regression 2:

$$WTP_{\ i} = \alpha_i \cdot outageday_i + X'\beta + u_i$$

  - Reported outages instrumented by observed substation outages to address recall bias.
  - VoLL = α_i / kWh_{lost_i}

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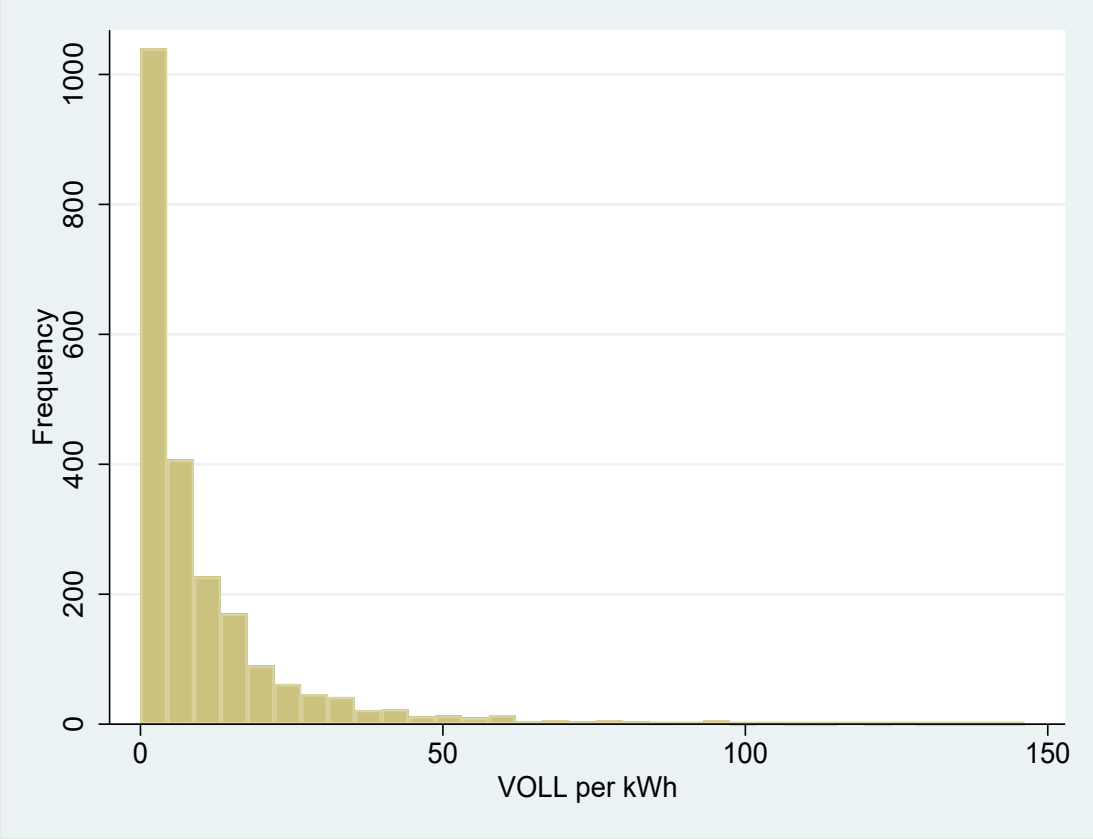
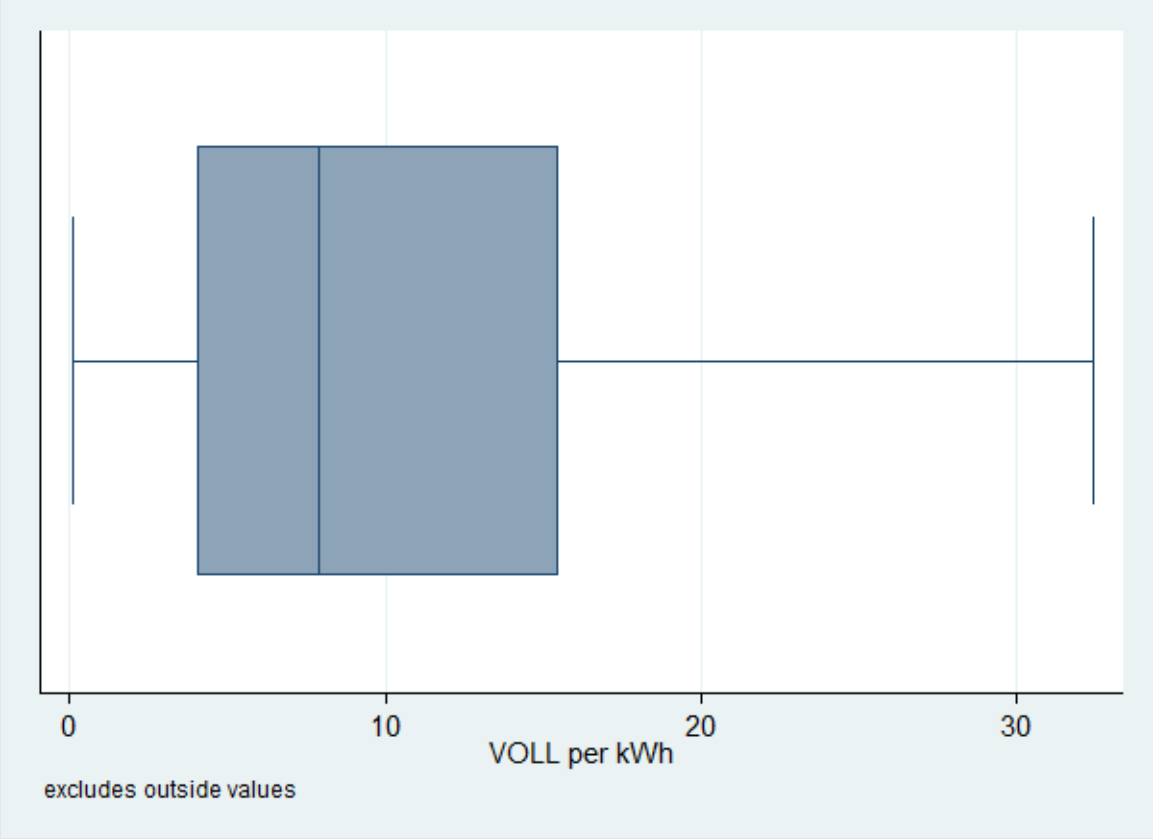
Best estimate of VoLL ranges between 5-15NR/kWh



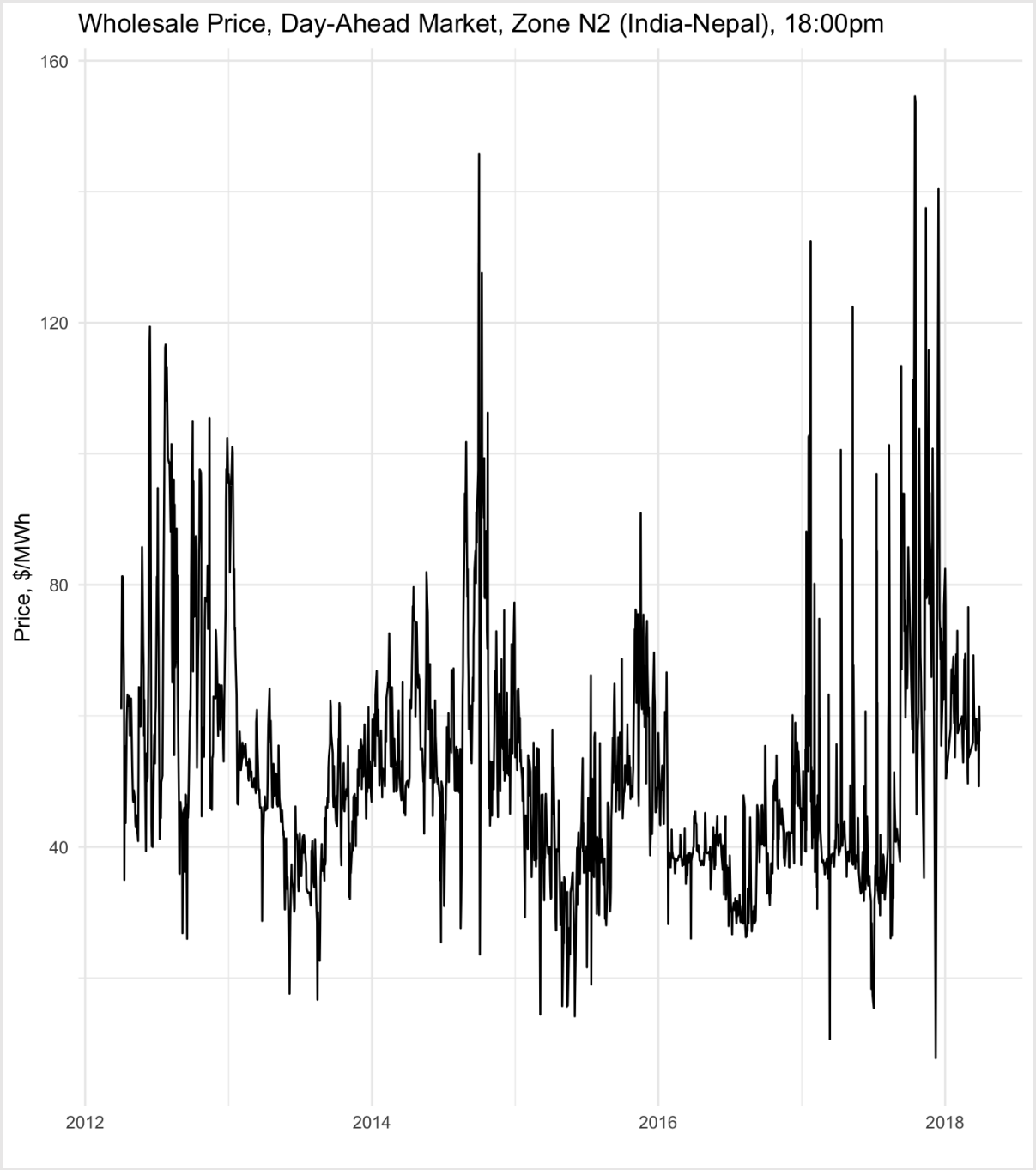


Unscheduled outages matter more

	N=2251			
	coeff	t stat	coeff	t stat
kWh_lost_unscheduled	14.65	13.90	13.27	12.83
kWh_lost_scheduled	8.52	12.94	3.75	4.42
Equipment Controls	No		Yes	

Note. Dependent variable: WTP per outage day

Dependent Var: WTP	OLS	IV
Constant	64.84*** (10.38)	-52.12 (45.08)
# of Outage days	0.428 (0.286)	6.847*** (2.413)
Monthly expenditures	0.000182*** (6.19e-05)	0.000232*** (6.54e-05)
Kathmandu valley (1 = Yes)	-9.937 (11.99)	(17.90) 21.87
Recharg_battery and backup for appliances	-47.29*** (9.129)	-76.29*** (14.53)
Disposable batteries	-14.66 (9.849)	-23.97** (10.98)
Solar system	-25.91 (23.29)	-40.31 (28.26)
Kerosene lamp	-29.42*** (9.723)	-64.20*** (16.27)
Subsidies	-1.777 (6.377)	2.460 (7.082)
Reliable 1	87.90*** (6.199)	84.28*** (7.008)
Robust standard errors and t statistics	Yes	Yes



Residential VoLL estimate
(0.045 to 0.135 $/kWh)
is LESS than needed
to meet
wholesale demand
at peak times!

Thank you!

Not only the poor experience outages!