



Kyoto University
Institute of Advanced Energy

THE IMPACT OF RURAL ELECTRIFICATION ON QOL: PV LAMPS USE IN THE PHILIPPINES

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Content

1 *Introduction*

- Electrification - QoL · SE Asia
- Literature gaps

2 *Lighting and quality of life*

- Methods · Hypotheses
- Results · Discussion

3 *Conclusions · Future directions*

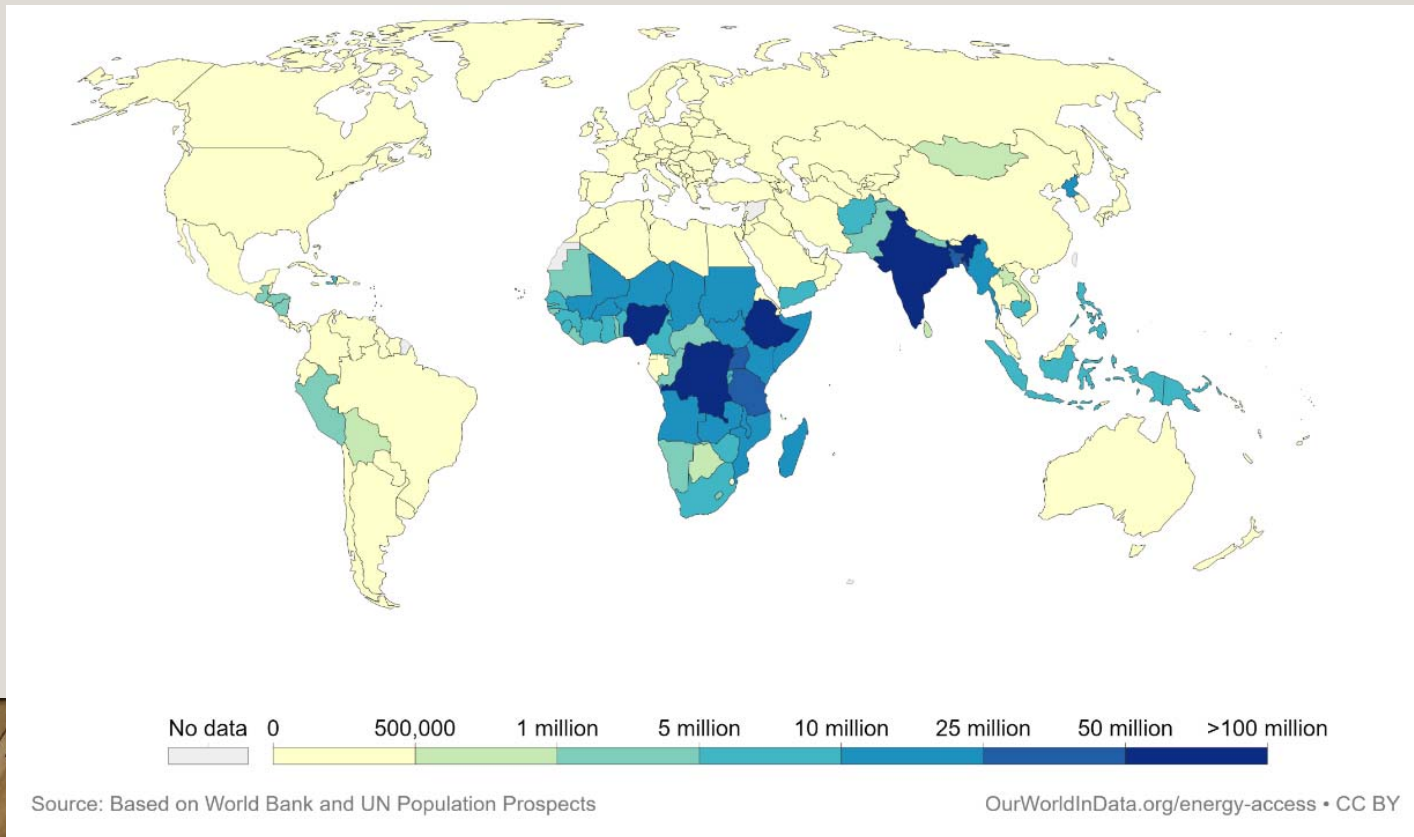
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ELECTRIFICATION IN THE WORLD (2020)

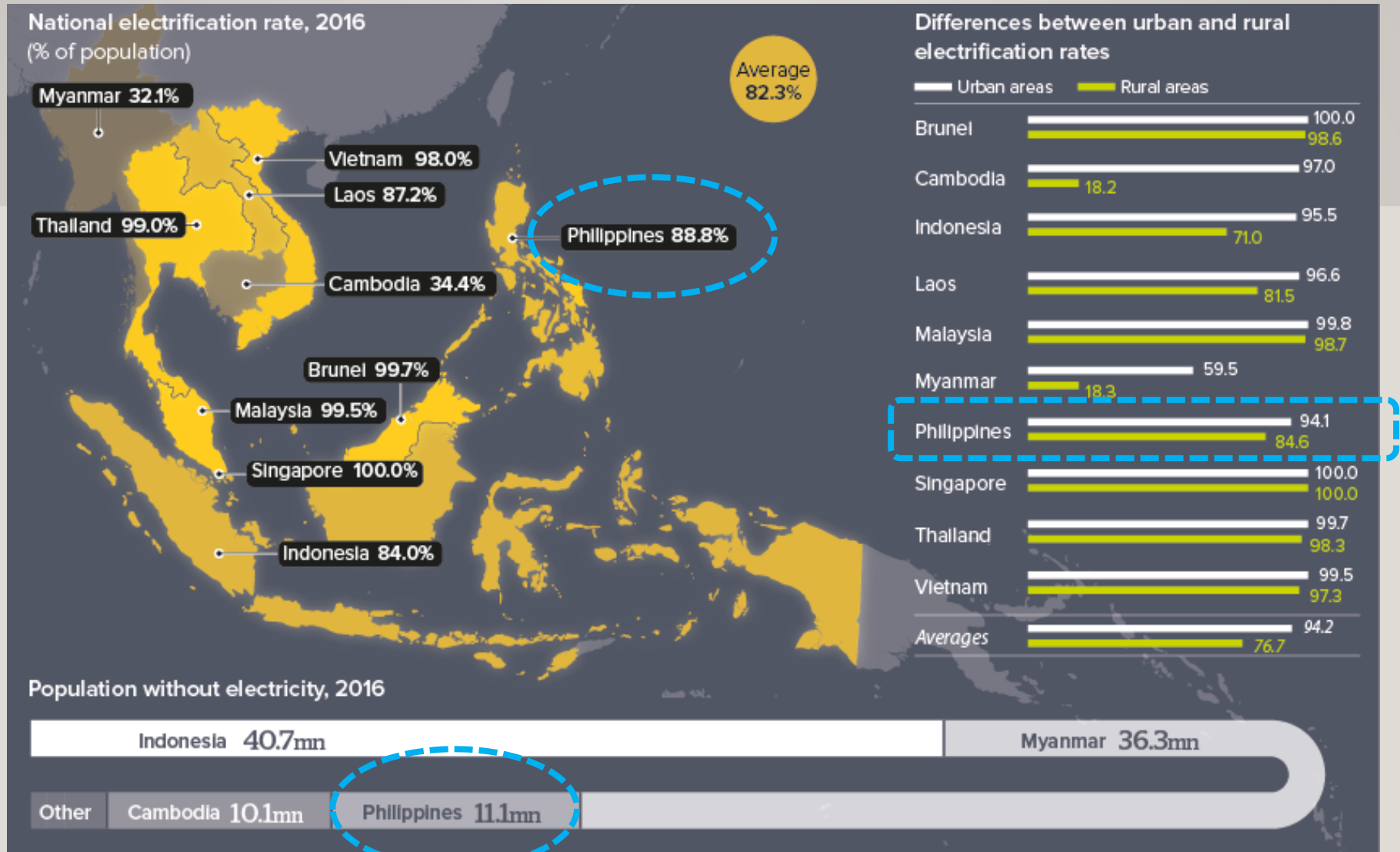
- 850 mill without electricity (11% of 7.8 bill / 7-times pop JAPAN!)



- Most live in *rural areas of developing countries*



ELECTRIFICATION IN SOUTH EAST (SE) ASIA



<https://dailybrief.oxan.com/Analysis/GA220581/Uneven-electrification-will-affect-ASEAN-competition>

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RECENT RURAL ELECTRIFICATION (RE) STUDIES

- Mostly focus on economic, technology, or institutional issues
- Place less emphasis on social effects
- Highly concentrated in South Asia and Africa

Article	Focus point	Setting
Riva et al. (2018)	Economic impacts	Review
Schillebeeckx (2012)	Electrification business models	Review
Winther (2015)	Gender (women's empowerment)	Africa
Winther (2015)	Impacts on living condition (household structures)	Mozambique, Tanzania, India
Kooijman-van Dijk & Clancy (2014)	Production, financial capital	Tanzania
Khandker et al. (2012)	Income, expenditure, poverty, schooling (infants)	India
Palit (2011)	Finance, institutions and governance	South Asia
Dinkelman (2011)	Employment, productivity, migration	South Africa

SE ASIA / PHILIPPINES LITERATURE

- Substantially fewer studies (only 2.5% in total lit.)
- Persistent less focus on social implications/effects

Article	Focus point	Setting
Lozano & Taboada (2021)	Risks to sustainable electrification (environmental, legal, and technological factors)	Philippines (island communities)
Cravioto et al (2020)	Electrification - QoL	Myanmar, Cambodia, Malaysia
Lozano & Taboada (2020)	Electricity poverty	Philippines (island communities)
Van Gevelt et al (2017)	Household preferences for electricity services (private use, public use, productive use...)	Malaysia
Bhattacharyya (2013)	Optimal systems in off-grid electrification	Indonesia, Philippines, Thailand, Vietnam

PROBLEM

- Solid knowledge about:
 - Economic effects (income, productivity, etc.)
 - Technology & applications
 - Institutional effectiveness

- Less so for social outcomes in short / longer spans
- Particularly, in the context of SE Asia:
 - Indonesia & Philippines (critical by total population)
 - Myanmar & Cambodia (critical by % of population)

OBJECTIVE

Analyse a PV lighting system effects on quality of life (QoL) domains in non-electrified communities in the Philippines

Significance

- Expand understanding of the social effects of electrification in uncommon cultural contexts
- Identify intersecting conditions of vulnerability
- Provide insights to design sustainable transitions / strategies to progress on SDGs

RE-QOL METHODOLOGY

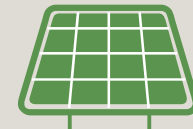
1. Villages selection:

- No electrification, similar conditions
- Willingness to participate in the research



2. Electrification scheme based on:

- Government / utilities / other stakeholders plans
- Project budget (solar home systems)



3. Surveys (QoL questionnaire):

- Prior (baseline) and after (endpoint) electrification
 - ❖ This study presents a cross-sectional study



4. Post-collection analysis:

- Use statistical methods to reveal differences between stages



WHAT IS A CROSS-SECTIONAL STUDY?

- A cross-sectional study involves looking at data from a population at one specific point in time
 - Unlike longitudinal studies, which look at a group of people over an extended period
- Often used to infer possible relationships
- To gather preliminary data
- To support further research and experimentation

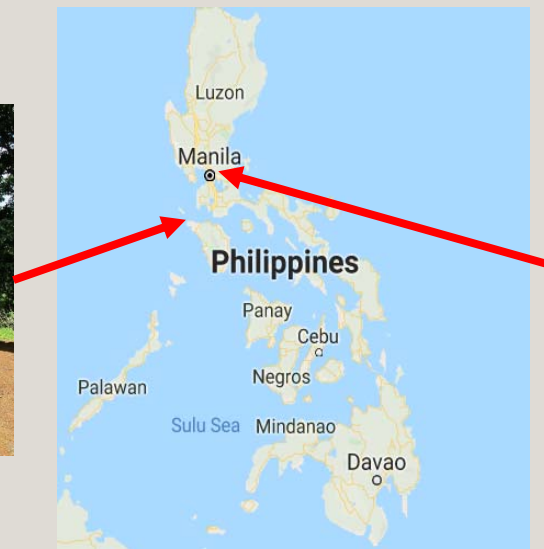


LOCATIONS

- Similar income levels/economic activities (farming and fishing)
- Similar climate (tropical typical of the South-east Asian region)



**Occidental Mindoro
1 community**

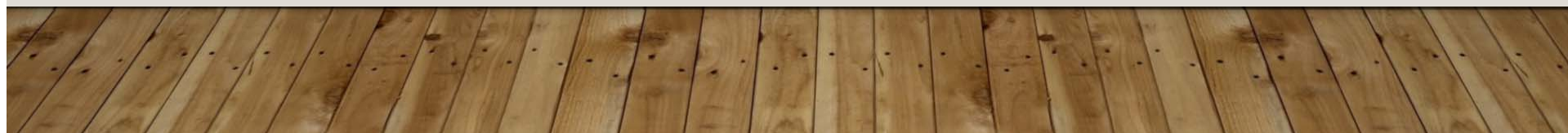


**Tanay
2 communities**

LIGHTING SYSTEMS

PV Lighting systems

	Portable solar PV lighting system [28]	Solar home lighting and charging system [29]
Manufacturer	Schneider Electric	Greenlight Planet
Model	Mobiya TS170L	Sun King Home 60
Type	Portable LED lighting systems with solar panel	3 individual ceiling-mounted fixed lamps
Light points	1	3 (with wall-mountable switches)
Light intensity	170 Lumens	300 Lumens
Duration	3 brightness levels High: 6 hrs / Mid: 12 hrs / Low: 48 hrs	24 hrs on a day's charge
PV panel	3.4W polycrystalline silicon	6W polycrystalline silicon
Battery	Lithium iron phosphate (LiFePO4) 3.2V, 3Ah	LiFePO4 3.3V, 6Ah
Bat lifetime	3y	5y
Power outputs	5.5V USB type	5.5V USB type 12V DC output
Mobile phone charging	Available	Available



QOL QUESTIONNAIRE

No.	Category	Dimensions	Domains	Items	Type of Variable
I	Demographics	-	(1) gender (2) age (3) education (4) family type (5) occupation	5	Nominal / Interval
II	Quality of Life	Self-reported	(1) Self-reported quality of life	1	Ordinal (5p-likert scale)
		Satisfaction sub-domains	Satisfaction sub-domains: (1) How time is spent (2) Time spent alone (3) Housing (4) Food and cooking (5) Personal safety (6) Main activity	6	Ordinal (5p-likert scale)

5p-likert Scale:

very unsatisfied (1) – unsatisfied (2) – neutral (3) – satisfied (4) – very satisfied (5)

Elements from the Wisconsin Quality of Life Index (Diamond, 1999)

QOL QUESTIONNAIRE (SAMPLE QUESTIONS)

0% ————— 100%

SOLAR HOPE

Electrification, QoL and gender in South East Asia (Tanay, Philippines Oct 2020)

English

Satisfaction domains

- Electricity (1)
- Lighting
- Appliances (1)
- Appliances (2)
- Appliances (3)
- Washing clothes (1)
- Cooking (1)
- Fuelwood (1)
- Water supply (1)

How satisfied or dissatisfied are you with the way you spend your time?

Extremely dissatisfied Somewhat dissatisfied Neither satisfied nor dissatisfied Somewhat satisfied Extremely satisfied

How satisfied or dissatisfied are you when you are alone

Extremely dissatisfied Somewhat dissatisfied Neither satisfied nor dissatisfied Somewhat satisfied Extremely satisfied

5-point likert scale

- **Positive (2 answers)**
- **Neutral (1 answer)**
- **Negative (2 answers)**

HYPOTHESES (LIGHTING WILL...)

- General QoL (Self-reported QoL)

Increase life satisfaction (cultural, leisure, productive activities / education children / communication from charging phones)

- How time is spent

Increase extended time and options for activities

- Time spent alone

Enhance / impair activities during personal time

- Housing

Positive effects of lighting on home satisfaction



HYPOTHESES (2)

- ❑ Food and cooking

Effects on cooking capabilities and the resulting food

- ❑ Personal safety

Effects on protection and communication for medical relief

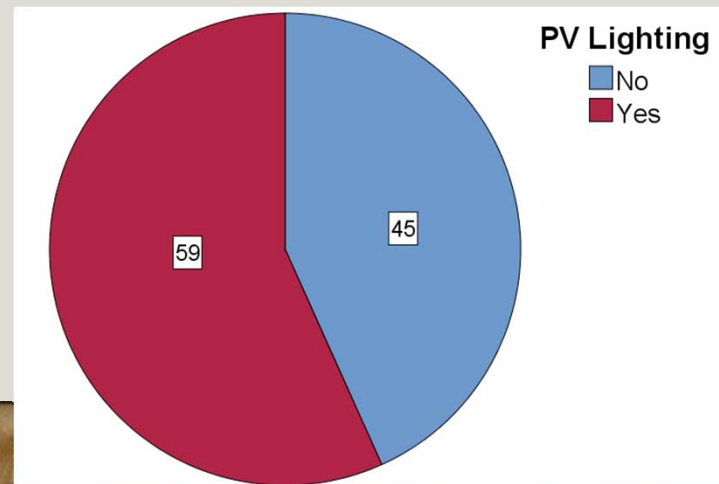
- ❑ Main activity

Lighting facilitates principal activities

SURVEYS

Village	County	Demographics	Surveys	
			First	Second
Rawang	Tanay	200 households (~1,500 inhab.)	Aug 2019 (n = 20)	Oct 2020 (n = 1)
Macantog	Tanay	50 households (~300 inhab.)	Aug 2019 (n = 30)	Oct 2020 (n = 8)
Paluan	Mindoro	195 households (~1,000 inhab.)	Oct 2019 (n = 45)	N/A

- Comparison Groups:
(n samples = 104)



DATA ANALYSIS METHODS

- Visualization analysis
 - Divergent stack-bar charts
 - Mean scores (1-5)
 - Net Promoter Score (NPS)
 - Positive minus negative answers

5-point likert scale

➤ Positive (2 answers)

➤ Neutral (1 answer)

➤ Negative (2 answers)

⇒ $NPS = Positive - negative$

DATA ANALYSIS METHODS

- Statistical testing

- t-test

- Hypothesis test for the difference between means of two populations

H_0 (null hypothesis): Means are equal ($\mu_A = \mu_B$)

H_a : Means are not equal ($\mu_A \neq \mu_B$)

- Conditions:

Significance level to 95% of confidence ($\alpha=0.05$)

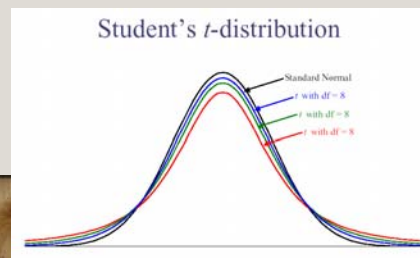
Values: means (μ_A, μ_B), std.dev (s_A, s_B), number of samples (n_A, n_B)

- Formulas:

$$t = \frac{\mu_A - \mu_B}{\sqrt{\frac{s_A^2}{n_A} + \frac{s_B^2}{n_B}}}$$

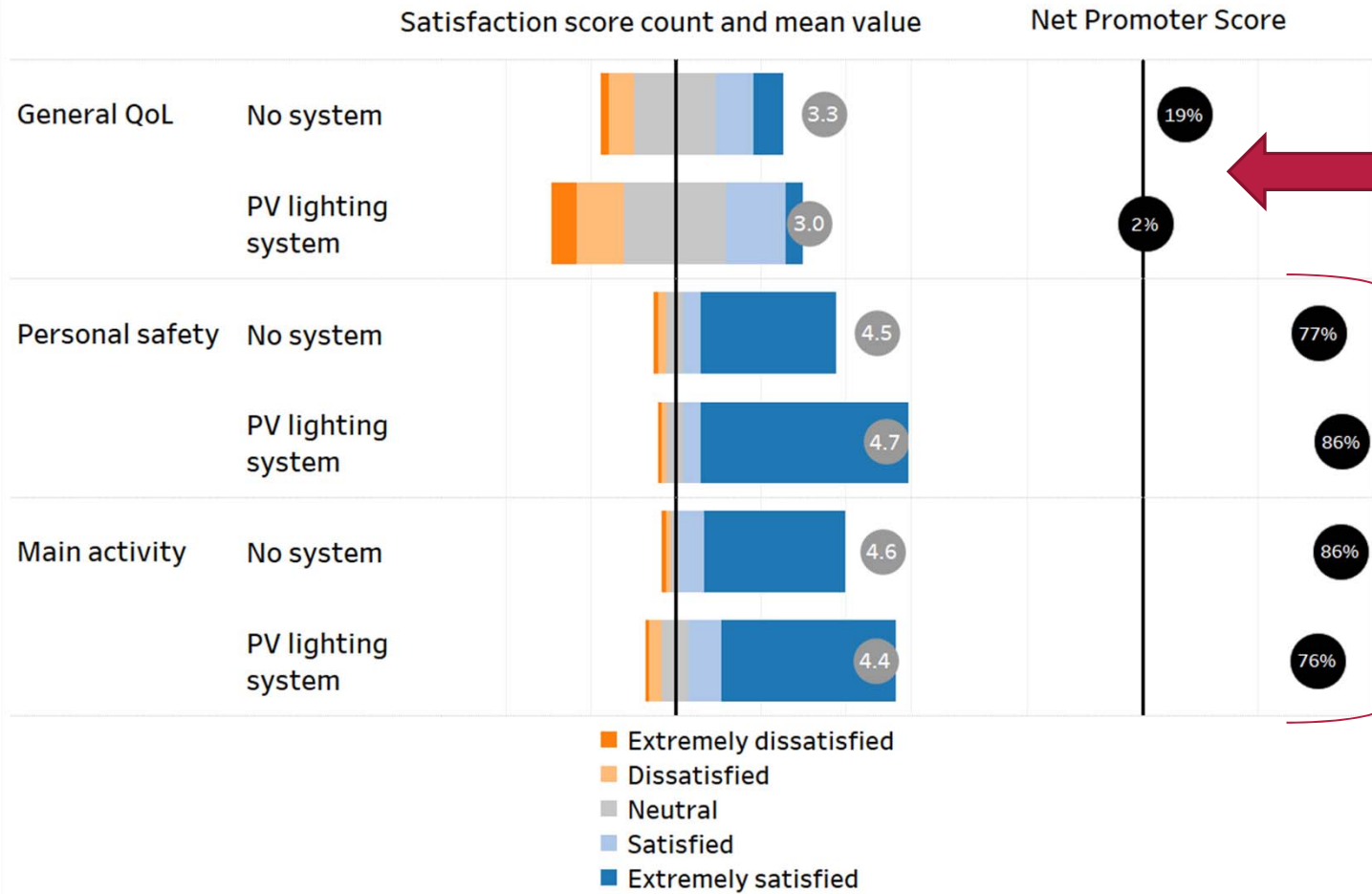
$\Rightarrow p_{\text{value}}$ using t, df and tables

$\begin{cases} p < 0.05, \text{reject } H_0 \text{ (difference)} \\ p > 0.05, H_0 \text{ (equal)} \end{cases}$



RESULTS: NEUTRAL DOMAINS (PV LIGHTING—QOL)

QoL and sub-domains before and after Solar PV Lighting System



General QoL

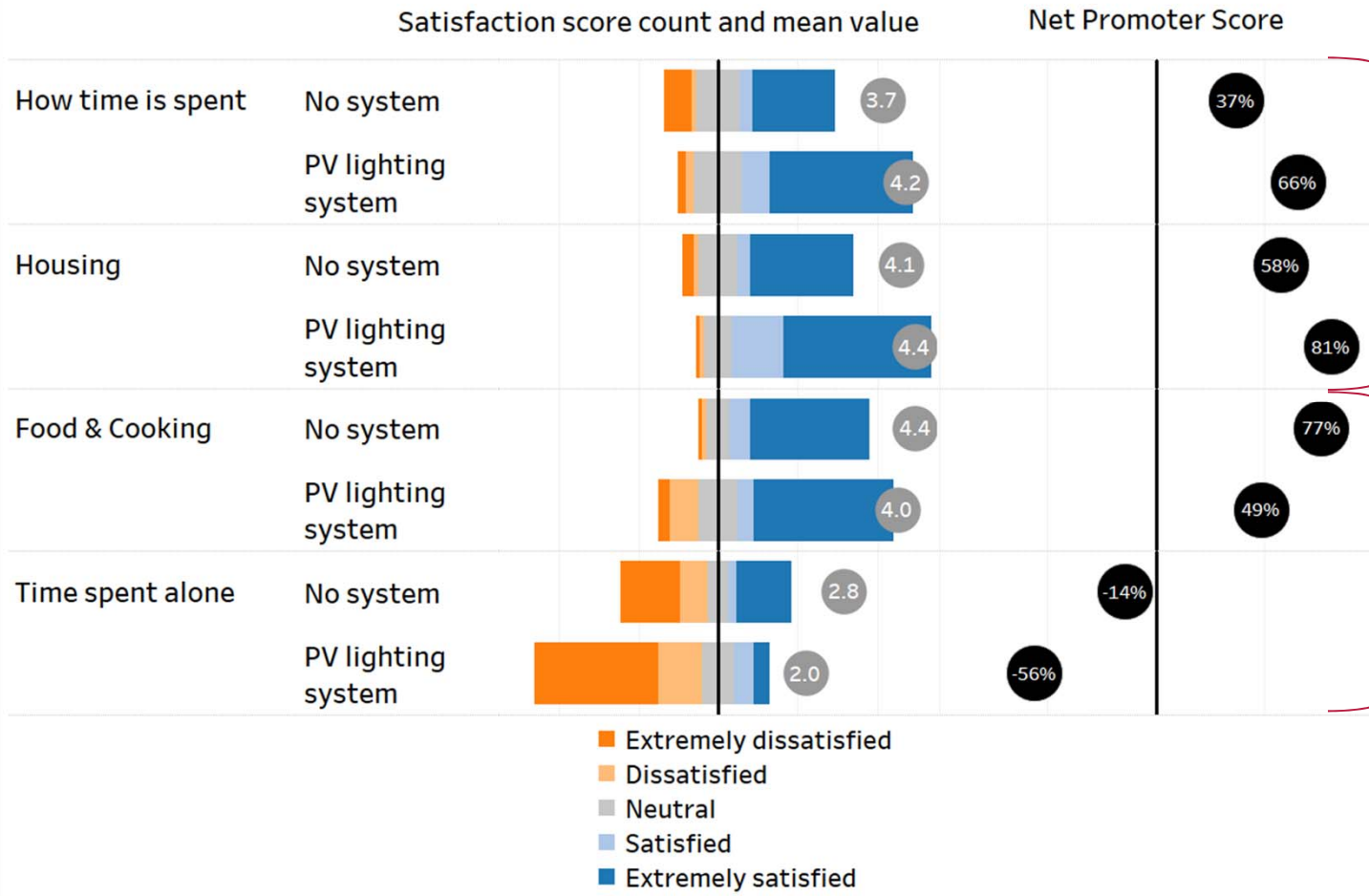
➤ **NO difference**
 $t(95.48)=1.68, p=0.576$

Neutral domains

➤ **NO difference**
 $t(78.85)=-1.01, p=0.076$
 $t(96.09)=0.88, p=0.167$

RESULTS: DOMAINS WITH EFFECT (PV LIGHTING—QOL)

QoL and sub-domains before and after Solar PV Lighting System



Positive domains

➤ **significant increase**
 $t(73.26)=-1.99, p<0.01$
 $t(71.63)=-1.37, p<0.01$

Negative domains

➤ **significant reduction**
 $t(99.91)=1.79, p<0.01$
 $t(74.09)=2.75, p<0.001$

- Extremely dissatisfied
- Dissatisfied
- Neutral
- Satisfied
- Extremely satisfied

DISCUSSION OF OUTCOMES

- ❑ General QoL (no change)
 - ✓ We question the recurring finding (electricity improves QoL) with our study
 - ✓ Plausible that PV lighting is not sufficient to multiply options (cultural, leisure, livelihood)
- ❑ Time use (increase)
 - ✓ Although options were not multiplied
 - ✓ An increase in duration of activities (children study?)
- ❑ Time spent alone (reduction)
 - ✓ Lighting might have impaired private activities further (already negative)
 - ✓ Not clear what private activities → More qualitative exploration needed



DISCUSSION (LESSONS)

➤ Importance of cultural meanings

Underlying explanations of the outcomes

- Family life and roles
- People's priorities
- What has changed in daily life

➤ Important to explore vulnerability & intersections

- Inequality among groups? → gender & household roles, family types, occupations, etc.

➤ Importance of longer spans of observation

- results reflect short-term effects

SUMMARY (PV LIGHTING—QOL)

Electrification is reported positive for Quality of Life...

- Solely, PV lighting systems has a more limited effect on QoL
- For specific domains we found positive and negative effects
 - ❖ Notably on the 'time' domain

Future directions

- Expand understanding w qualitative modes of enquiry
 - ❖ Expectations, system capabilities, etc. may influence outcomes
- Identify vulnerability intersections
 - ❖ Social position, gender, family composition, occupations/income/poverty, household features, etc.



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Thank you
for your attention



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