

# Empirical assessment of sociotechnical factors that influence residential electricity use in India

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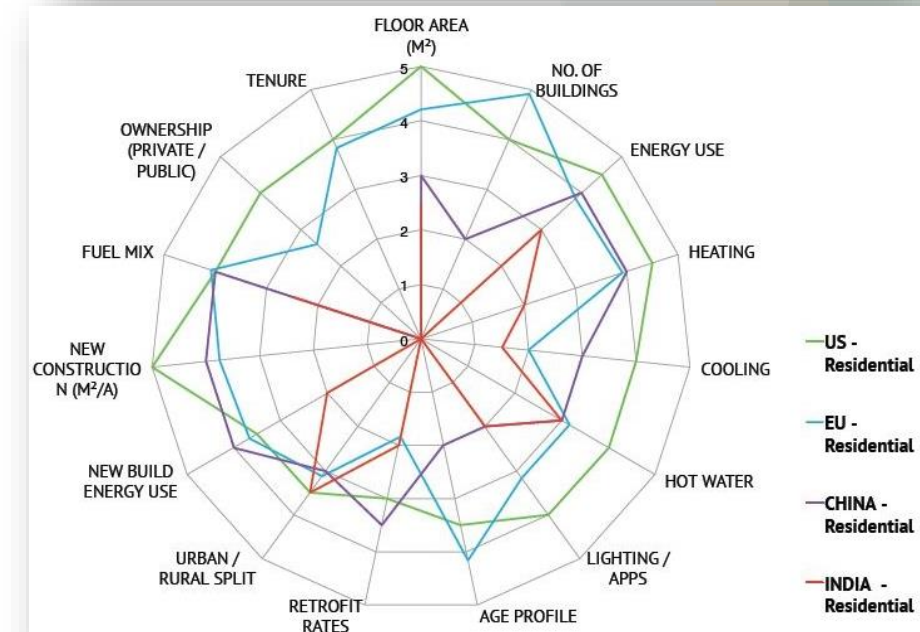
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**BEHAVE 2020-21**

6<sup>th</sup> European Conference on Behaviour and Energy Efficiency  
Copenhagen, 21-23 April 2021

# Rationale for the study

- Residential electricity consumption (REC) in India has nearly tripled since the past two decades, accounting for 24% of the overall electricity consumption during 2018-19.
- Residential energy demand is expected to increase five-fold by 2032 (Bureau of Energy Efficiency, 2019).
- Yet there is paucity of empirical data on residential energy use that is essential for developing energy policy or programme.
- A study by GBPN (2013) revealed that the quality of performance data pertaining to residential buildings in India was poor, amongst the four regions (US, EU, China, India).
- Studies examining determinants of residential energy use are clearly lacking in the Indian context. Such studies are necessary for developing energy efficiency programmes.
- Current study is part of a wider Indo-UK research programme called RESIDE – Residential Building Energy Demand Reduction.



Residential buildings data quality in four regions  
(Source: [Shnapp and Laustsen, 2013](#))

# Overview and methods

- Study empirically investigated *how* and *why* electricity is used in Indian dwellings with and without air-conditioning (AC).
- Interview-based survey approach applied in 41 dwellings located across two cities representing composite climate of India.
  - Hyderabad: 22
  - Jaipur: 19
- Historic electricity bills gathered for the year 2018-19.

Survey



Online Google Form

- Physical characteristics of dwellings (such as built form)
- Income group
- Occupancy patterns
- Socio-demographics
- Appliance usage in AC and non-AC dwellings

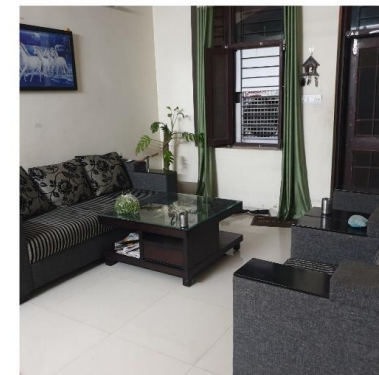
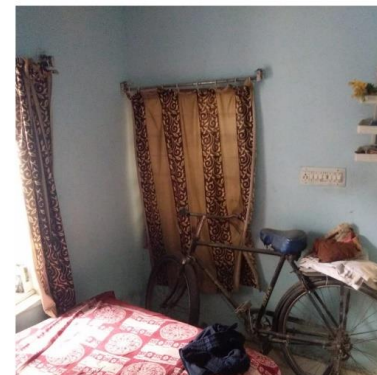
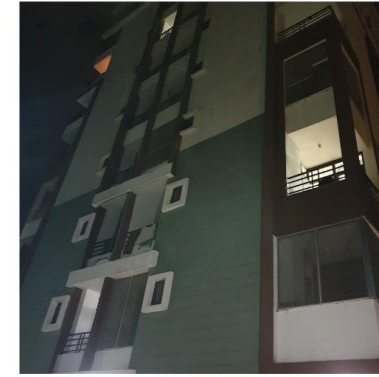
Statistical Analysis  
(regression)



# Case study dwellings characteristics



- Sample of dwellings split as
  - 16 low-income (LIG)
  - 16 middle-income (MIG)
  - 9 high-income (HIG)
- 28 dwellings with one or more AC units, 13 with no AC.
- 98% of dwellings owned refrigerator and television.
- About 29 stand-alone houses and 12 apartments, with an mean built up area of 154m<sup>2</sup> and mean annual electricity use of 3,590 kWh.



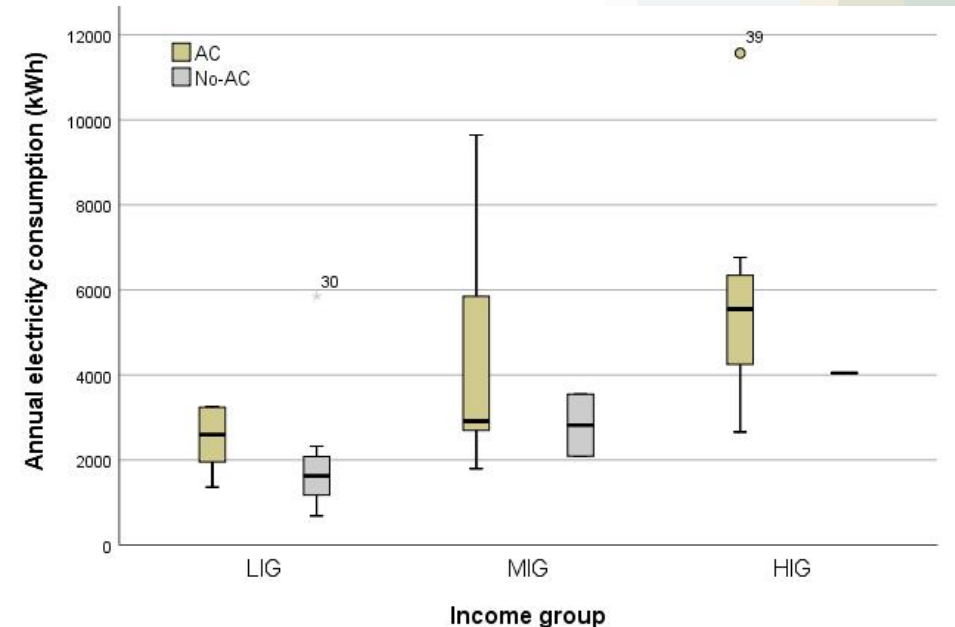


# Findings

# Variation by income group, AC use, seasons



- Mean annual electricity use by income group, was found to be:
  - **HIG dwellings: 5,618 kWh** (double that of **LIG**)
  - **MIG dwellings: 3,870 kWh**
  - **LIG dwellings: 2,169 kWh**
- Mean annual electricity use for AC dwellings was **4,208 kWh**, double that of dwellings without ACs (**2,260 kWh**)
- Monthly electricity use and energy cost by season was distributed as:
  - Summer/monsoon: 375.23 kWh, US\$29
  - Winter season: 182.12 kWh, US\$11

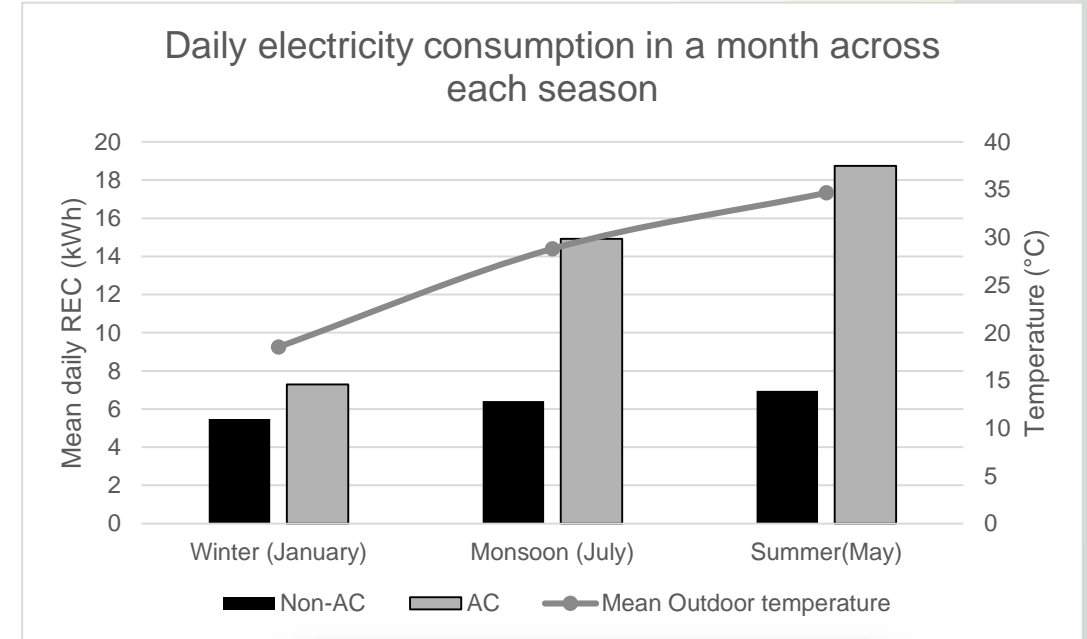




# Variation by income group, AC use, seasons



- Electricity use among AC dwellings had large variation by seasons.
- Summer/monsoon consumption was 2-3 times more than winter consumption, while electricity use was similar for non-AC dwellings across seasons.
- About 7% of AC dwellings reported non-usage of AC implying that having an AC unit does not mean it is also being used regularly.
- Despite owning less number of appliances, LIG dwellings had higher annual usage hours for appliances (excluding AC).



# Findings: variation in electricity use



- Step wise regression model developed to examine the variation in electricity use
- 81% of the variation in electricity use explained by:
  - Number of occupants
  - Presence of AC
  - Income group
  - Number of rooms (dwelling size)
  - Total appliance hours

<i>Model (Dependent variable)- Annual electricity consumption</i>	<i>Unstandardized Coefficients</i>		<i>Standardized Coefficients</i>	<i>t</i>
	B	Std. Error	Beta	
<i>(Constant)</i>	6.09	0.19		<b>31.29</b>
<i>Total number of rooms</i>	0.05	0.02	<b>0.29</b>	<b>2.95</b>
<b><i>Presence of AC</i></b>	0.48	0.11	<b>0.37</b>	<b>4.44</b>
<b><i>Total no. of occupants</i></b>	0.09	0.02	<b>0.39</b>	<b>4.9</b>
<i>Total Appliance hours</i>	0.0001	0	<b>0.31</b>	<b>3.41</b>
<i>Income group_HIG</i>	0.28	0.12	<b>0.19</b>	<b>2.27</b>
<b><i>R Square</i></b>	<b>0.808</b>			
<i>Durbin-Watson</i>	1.758			



# Summary of findings



- Effect of income group on electricity use is evident both through the regression model and statistical analysis of case study dwelling data. HIG dwellings **consumed twice the amount of electricity** than LIG dwellings over a year and across seasons, while MIG dwellings consumed 1.5 times more electricity than LIG dwellings.
- Appliance usage hours had a bigger effect on electricity use than number of appliances owned.
- Since summer/monsoon electricity consumption was 2-3 times more than winter consumption, there are implications for peak load management and grid stability during hot summer afternoons and night time.

# Thank you for your attention!



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## What is RESIDE?

RESIDE is a four-year **research initiative** designed to support the improvement of living conditions for millions of Indian citizens through establishing the knowledge base to develop a residential building code for high quality, low-energy housing across all five climatic zones in India. The project brings together an **interdisciplinary** team of architects, engineers, digital scientists, urban planners and behavioural researchers in India and UK to assess all aspects of the **residential energy use** problem, including performance of the building fabric; in-home appliances including heating, ventilation and air conditioning; indoor environment and occupant behaviour.



## Latest news

**1.2.19** RESIDE project launches a unique residential energy and thermal comfort repository for India. >>

**1.8.18** RESIDE at the Roundtable on Residential Electricity

[www.reside-energy.org](http://www.reside-energy.org)