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

Professor Rajat Gupta and Dr Anu Antony

Oxford Brookes University, Oxford, United Kingdom

rgupta@brookes.ac.uk

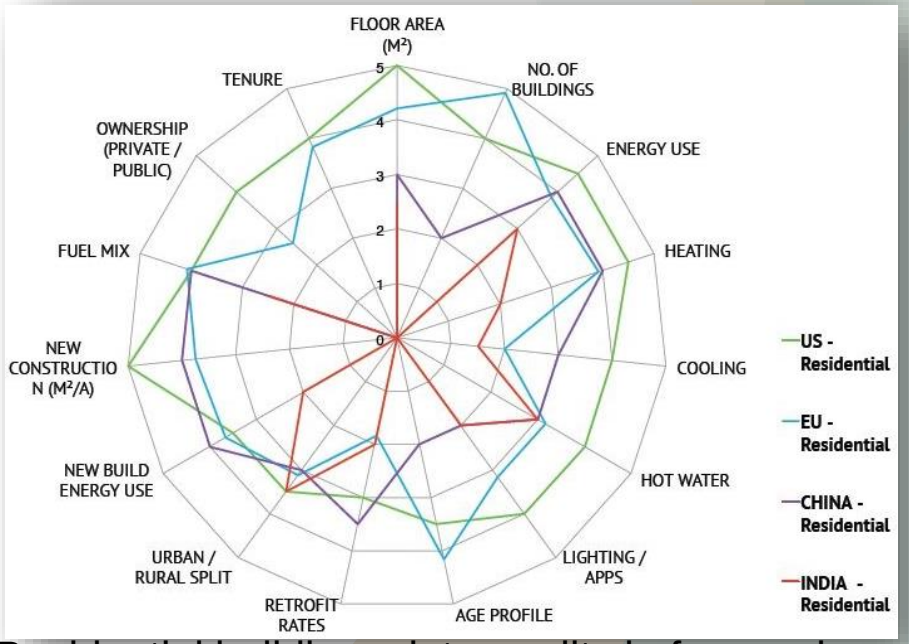
BEHAVE 2020-21

6th European Conference on Behaviour and Energy Efficiency

Copenhagen, 21-23 April 2021

Rationale for the study

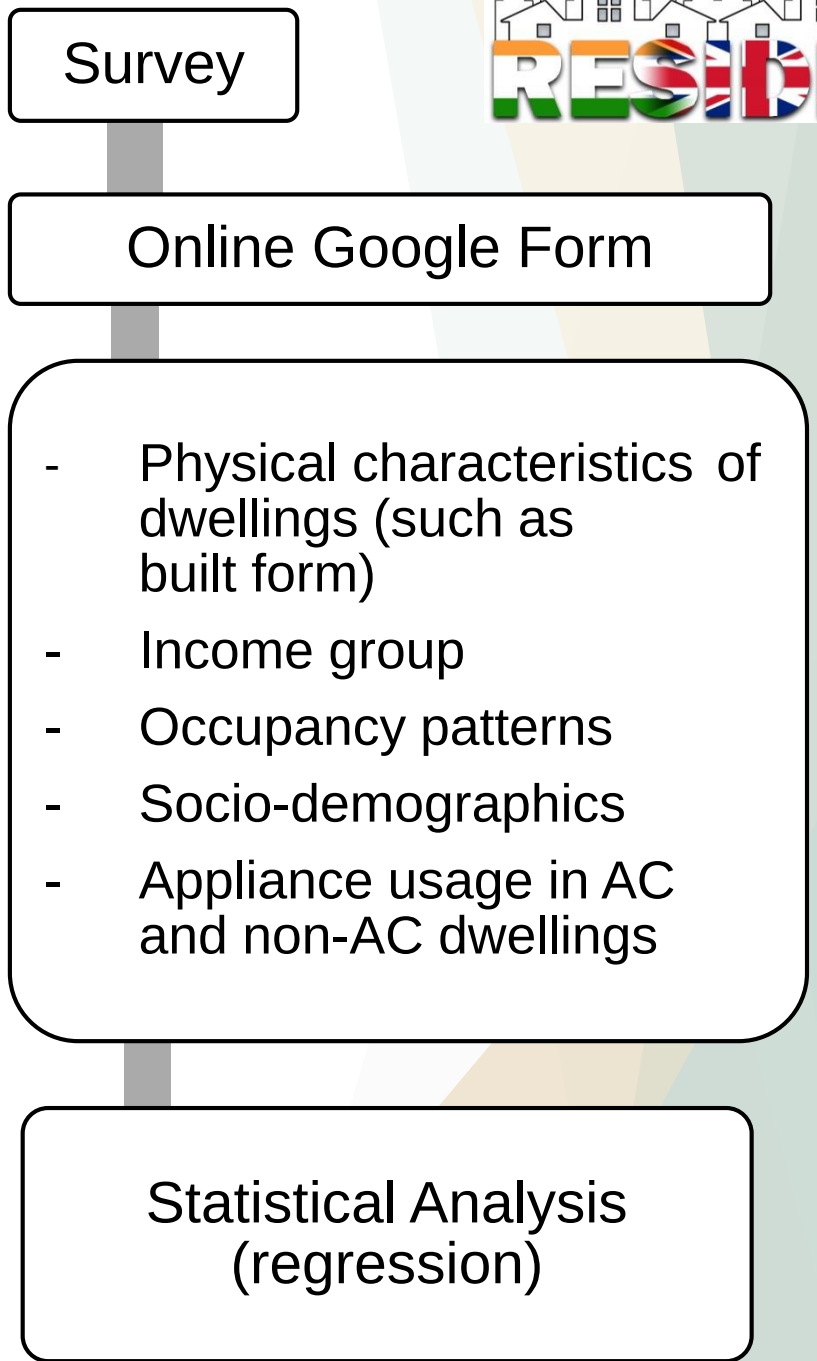
- Residential electricity consumption (REC) in India has nearly tripled since the past two decades, accounting for 24% of the overall electricity consumption during 2018-19.
- Residential energy demand is expected to increase five-fold by 2032 (Bureau of Energy Efficiency, 2019).
- Yet there is paucity 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)

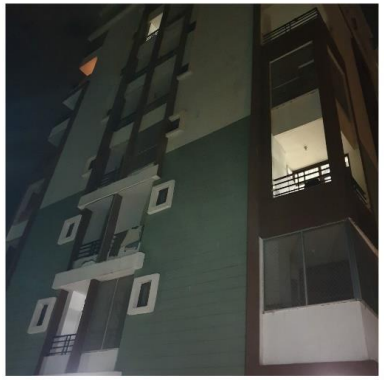
Overview and methods

- 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.

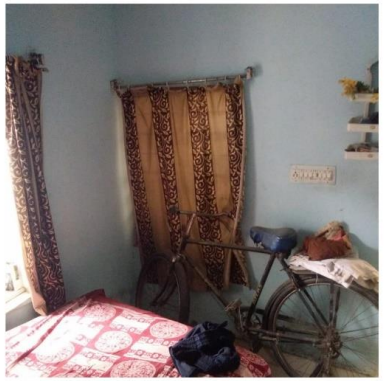


Case study dwellings characteristics

- 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^2 and mean annual electricity use of 3,590 kWh.



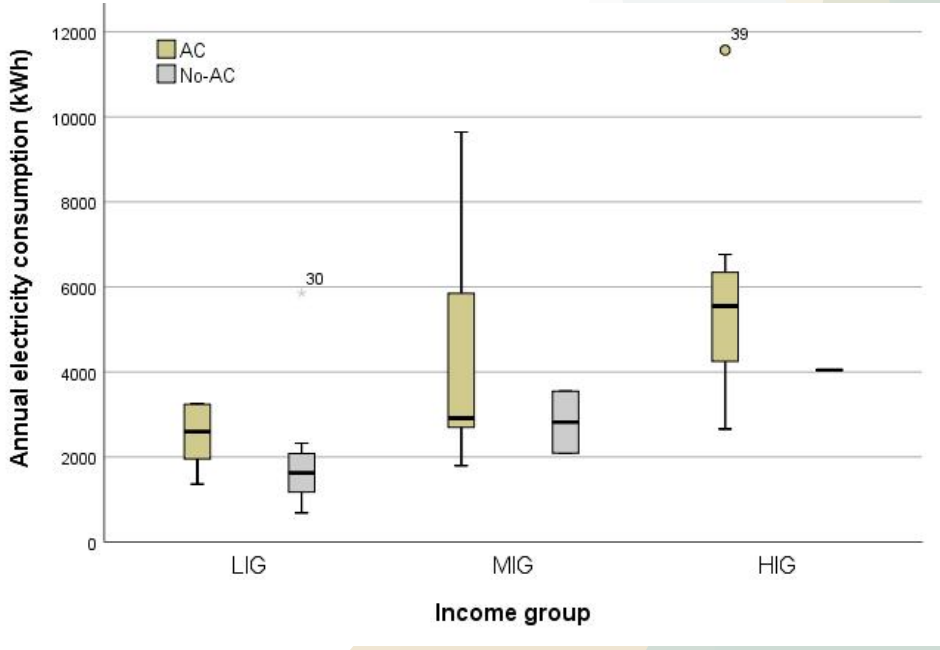


Findings

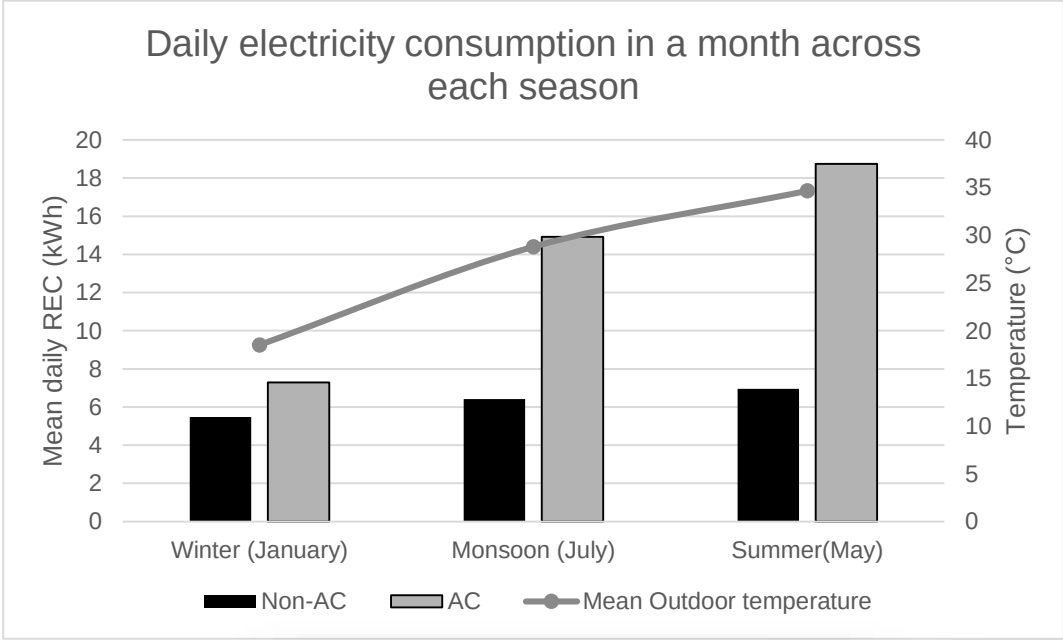
Variation by income group, AC use, seasons

- 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

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

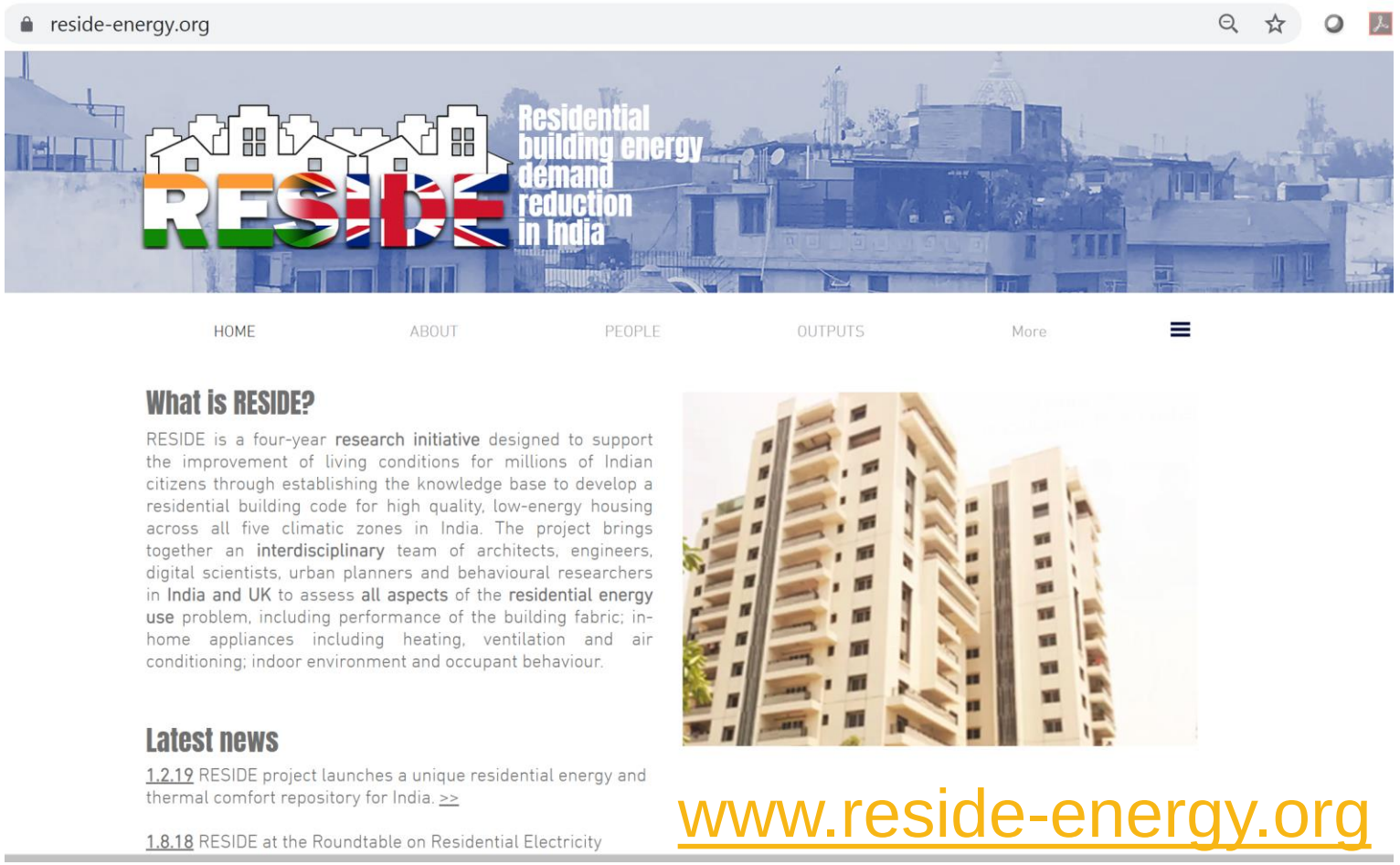
Summary of findings

- 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!



www.reside-energy.org