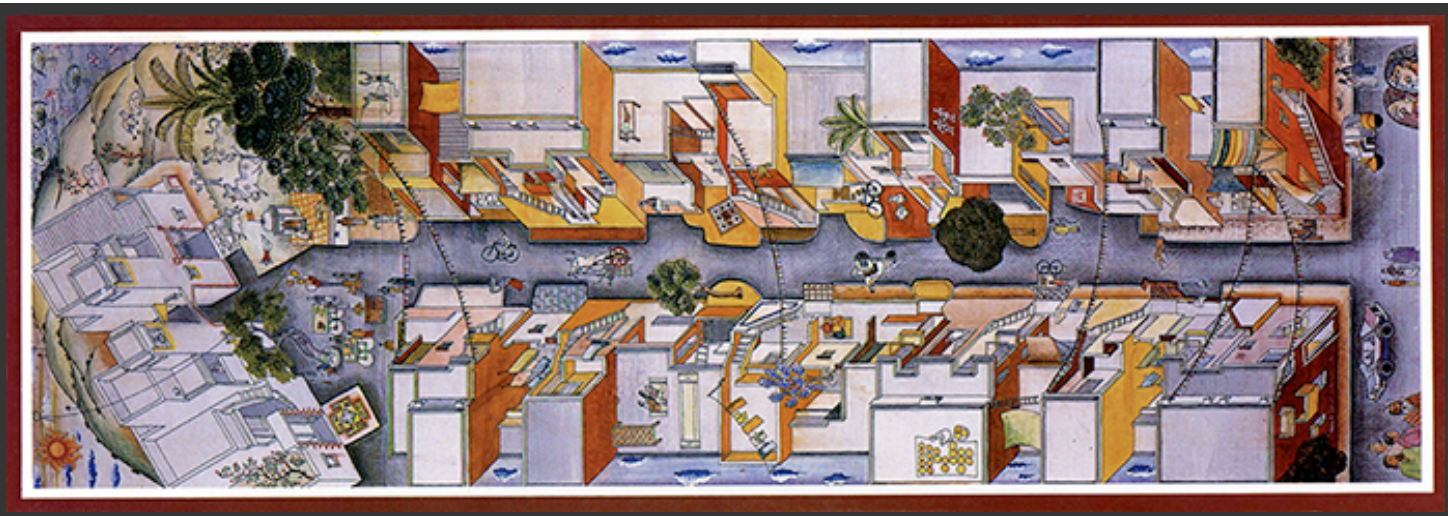

# Residential Buildings in India:

## Energy Use Projections and Savings Potentials

Yash Shukla, Rajan Rawal, Sophie Shnapp
presented by *Sanyogita Manu*

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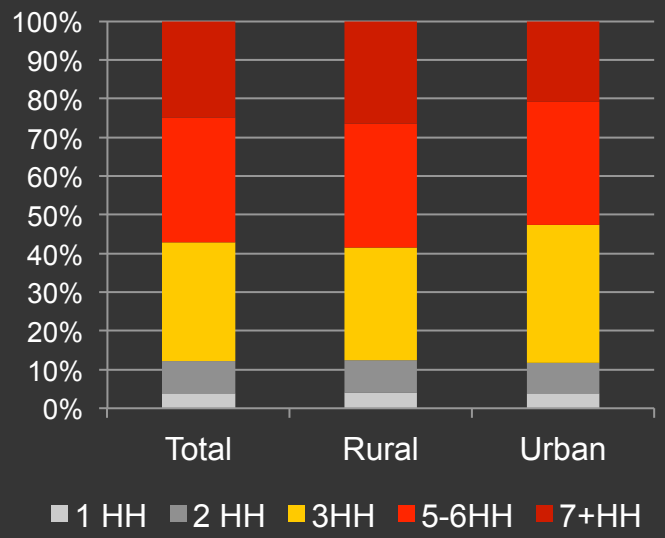
# Context




**833M (69%) in Rural India**
**377M (31%) in Urban India**

Population: 1237 Million *(313.9)*
Households: 220 Million *(120.7)*
Avg. Household size: 5.3 *(2.6)*

8000 Towns and 6,00,000 Villages
Avg. household energy consumption per year 900 kWh/year

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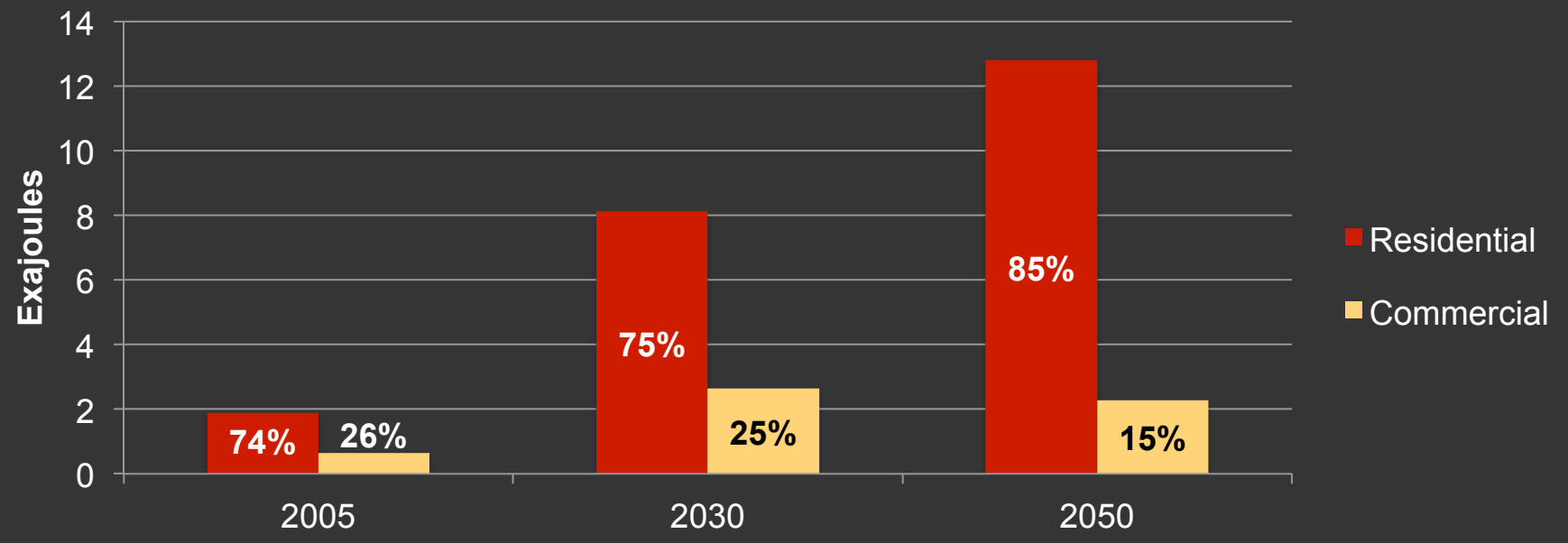
# Context




Moderate efficiency scenario projected energy consumption of India's buildings in 2030 and 2050; percentages represent the ratio of residential and commercial buildings floor space

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# Context: Power Cuts, Summer 2014

| City | Avg. Temp (°C) | Peak Demand (MW) | Peak Supply (MW) | Power cut (hrs) |
|---|---|---|---|---|
| Srinagar | 28 | 822 | 750 | 10 |
| Raipur | 41 | 410 (375) | 410 | 14-16 |
| Kolkata | 35 | 1986 (1865) | 1986 | Unscheduled |
| Patna | 40 | 2400 (2200) | 1900 | 3-5 |
| Bhopal | 45 | 330 (280) | 330 | Unscheduled |
| Mumbai | 32 | 3365 (3212) | As per Demand | No |
| Ahmedabad | 39 | 1534 (1372) | As per Demand | No |

Source: Indian Express, Sunday , June 1, 2014

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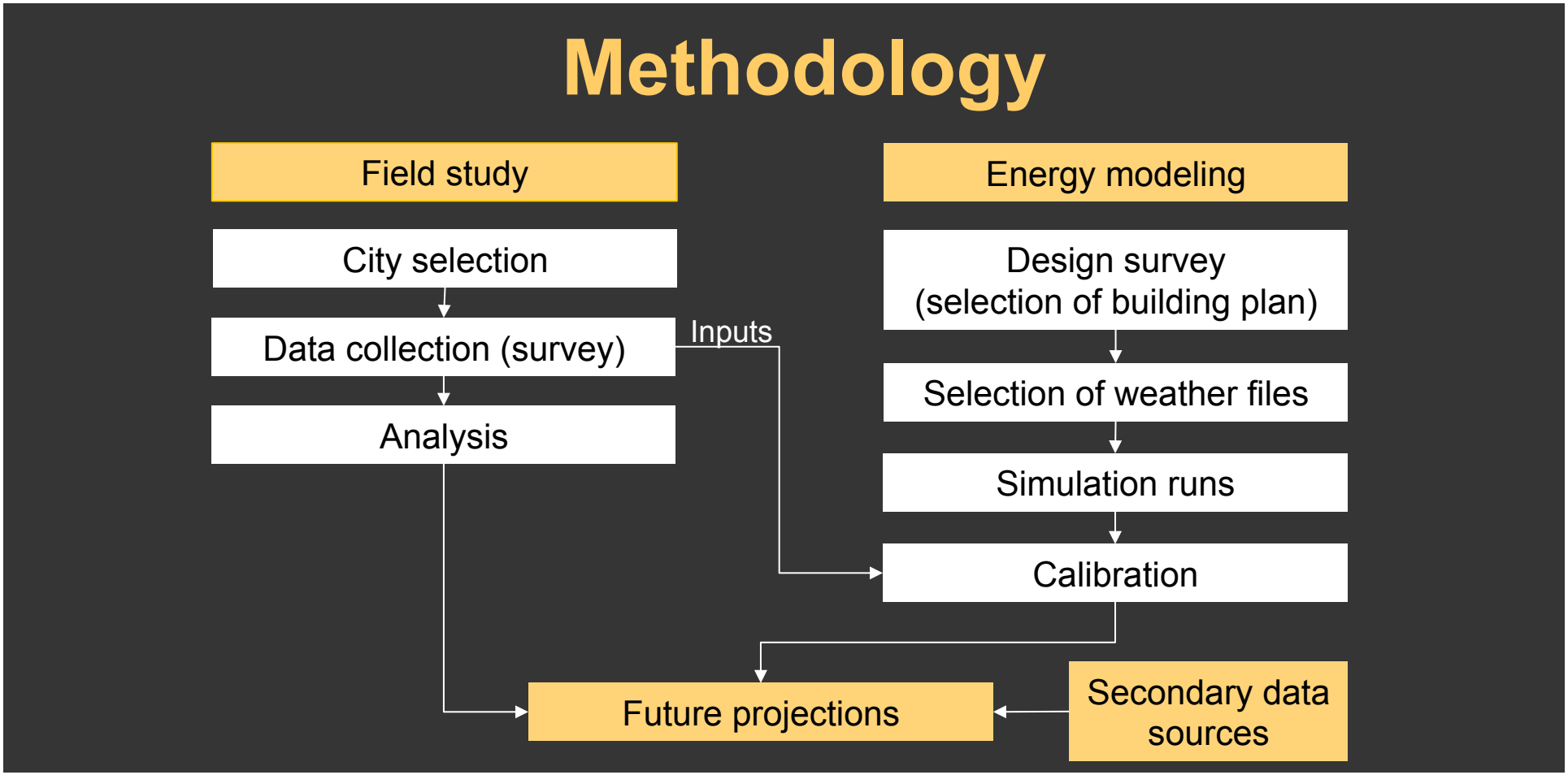
# Methodology

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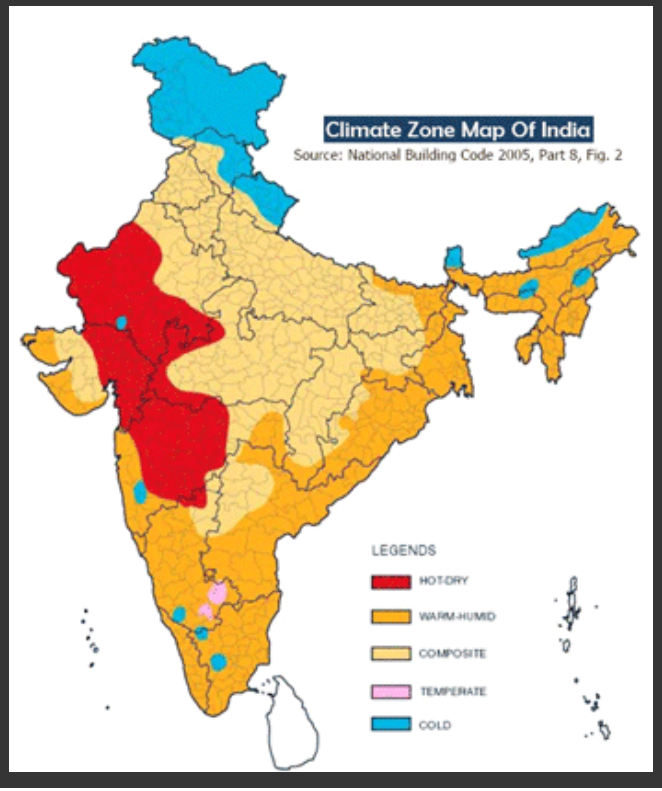
# Methodology: Field Study




- Four cities – four climate zones
  - Ahmedabad – hot and dry (CDD 3441 – HDD 131)
  - New Delhi – composite (CDD 2928 – HDD 429)
  - Mumbai – warm and humid (CDD 3567 – HDD 0)
  - Pune – moderate (CDD 2485 – HDD 175)

About 800 households – 200 per climate zone

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# Methodology: Field Study

- Housing typology
  - Ground + 3
  - Ground + 12
  - Row houses – Tenements
  - Independent Bungalows
- Family of 2 to 7
- Neighborhoods
  - City center
  - Suburbs

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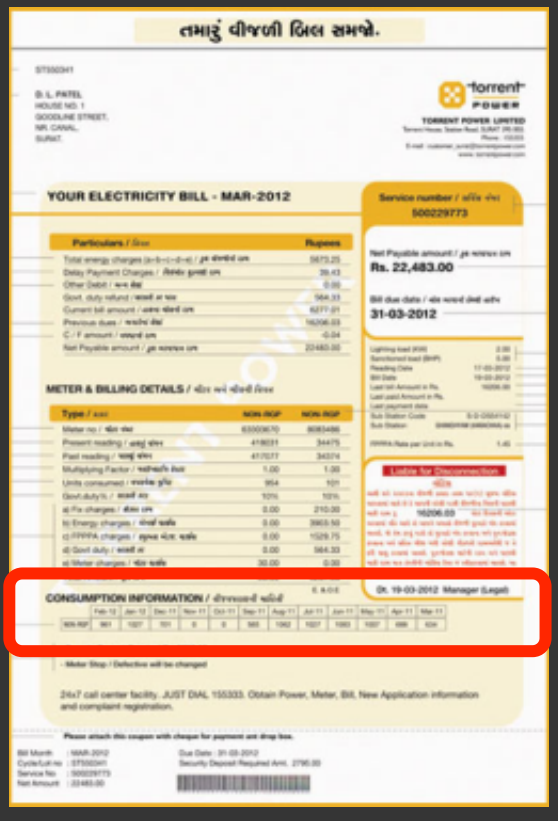
# Methodology: Field Study




- Carpet / built-up / super built-up area
- Construction characteristics
- Building facilities – common loads, lifts, water pumps
- Floor plans – number of bedrooms
- Family profile
- Location, number and rating of appliances
  - Appliances operation pattern
- One year of electricity bills and connected load

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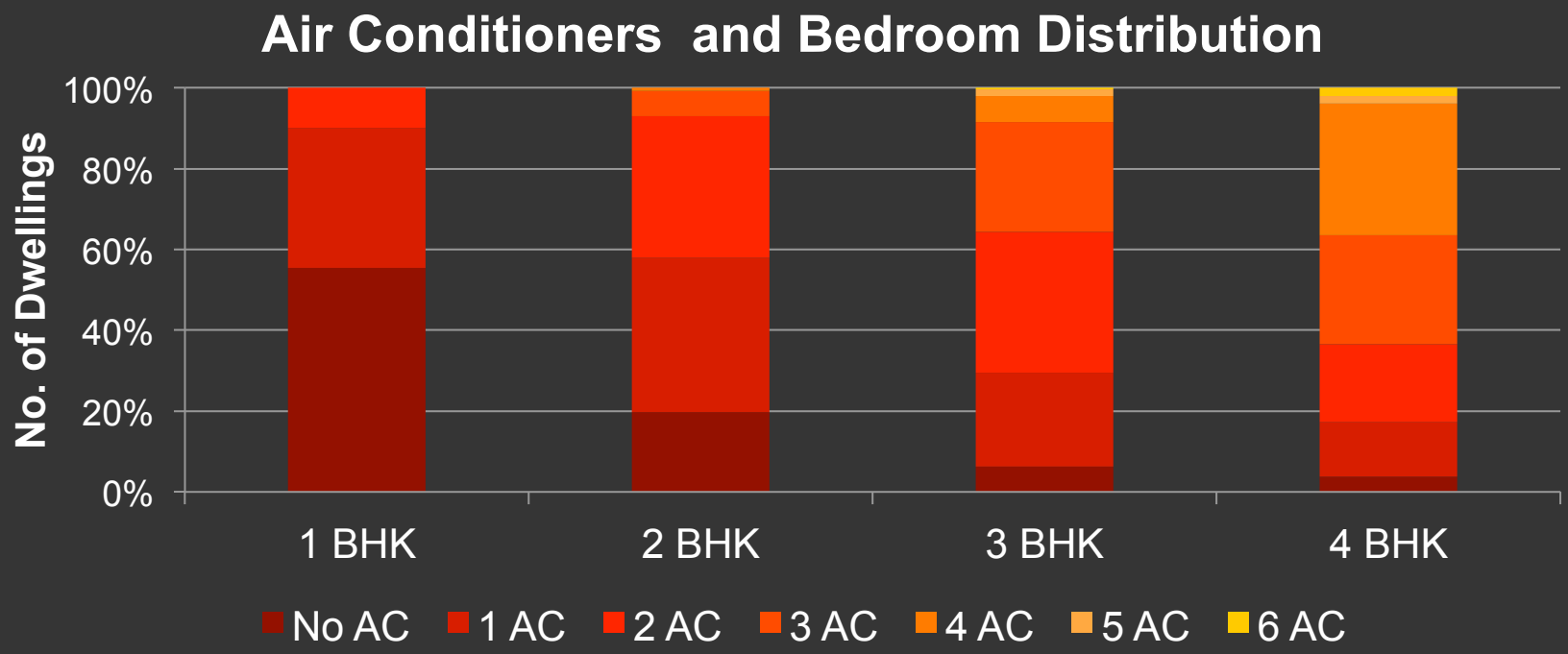
# Observations and Analysis

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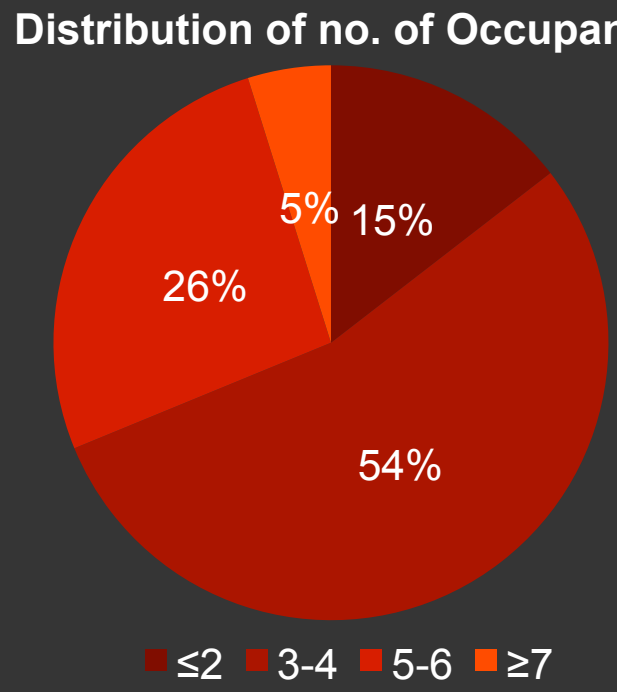


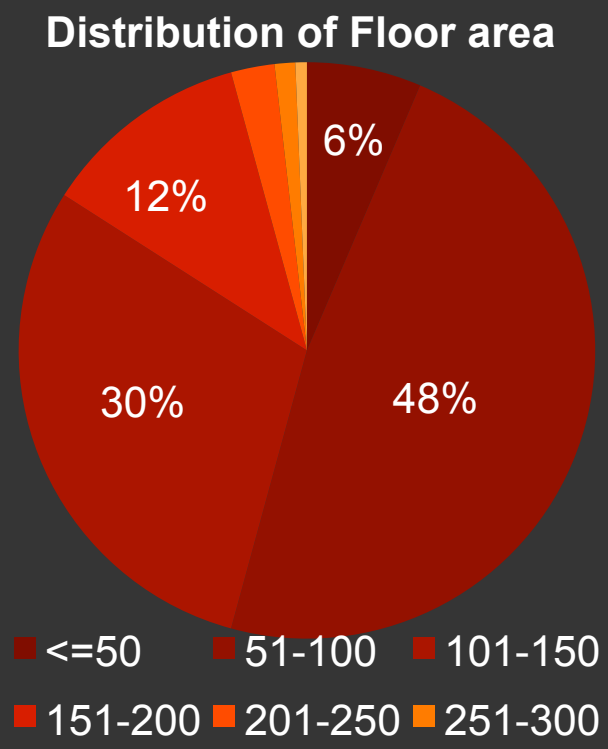


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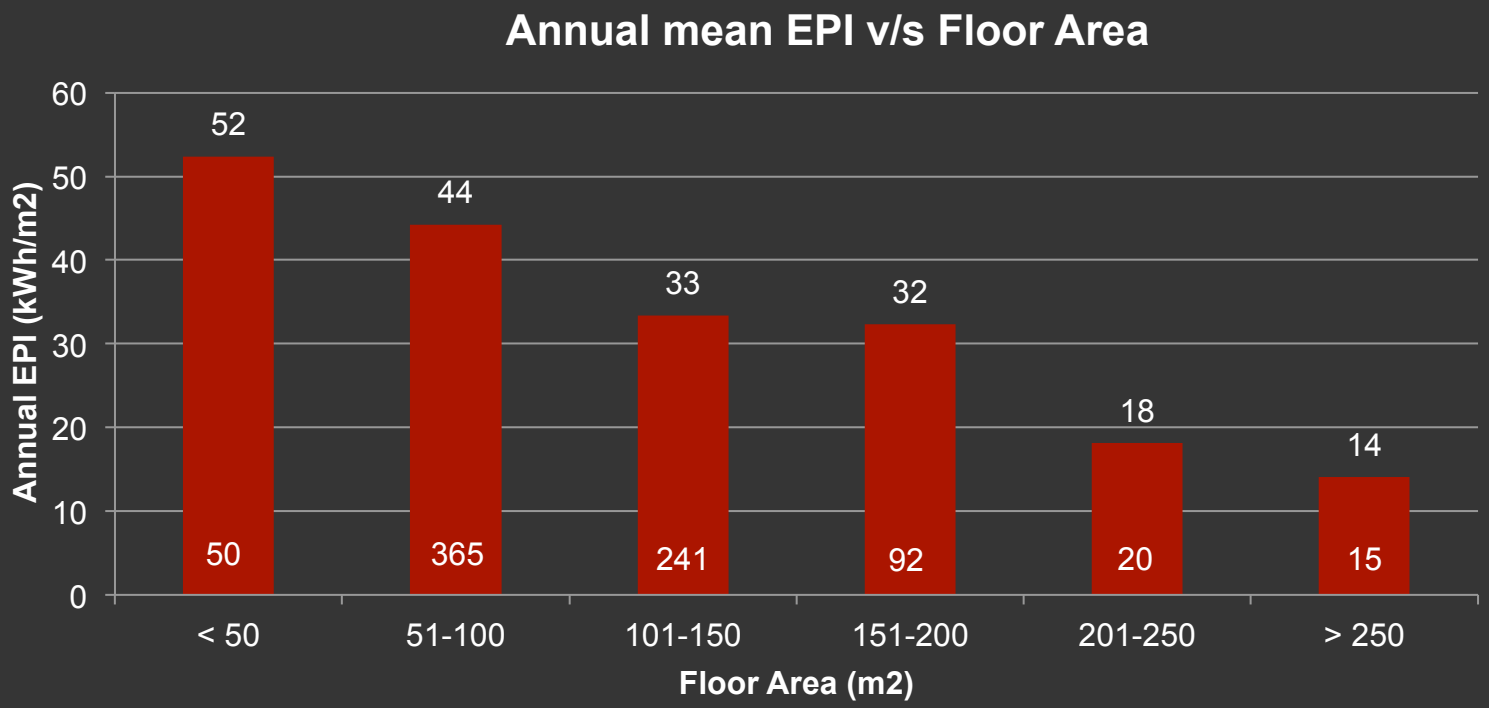


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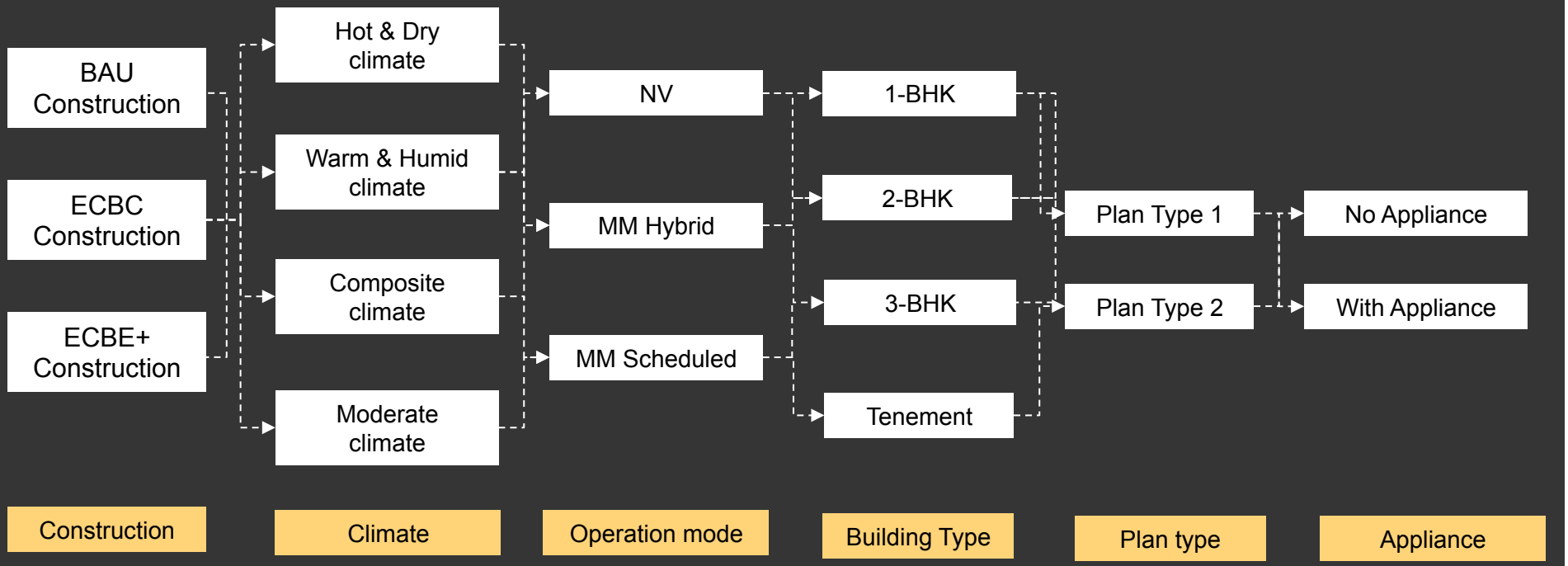
# Methodology: Energy Modelling Run Chart

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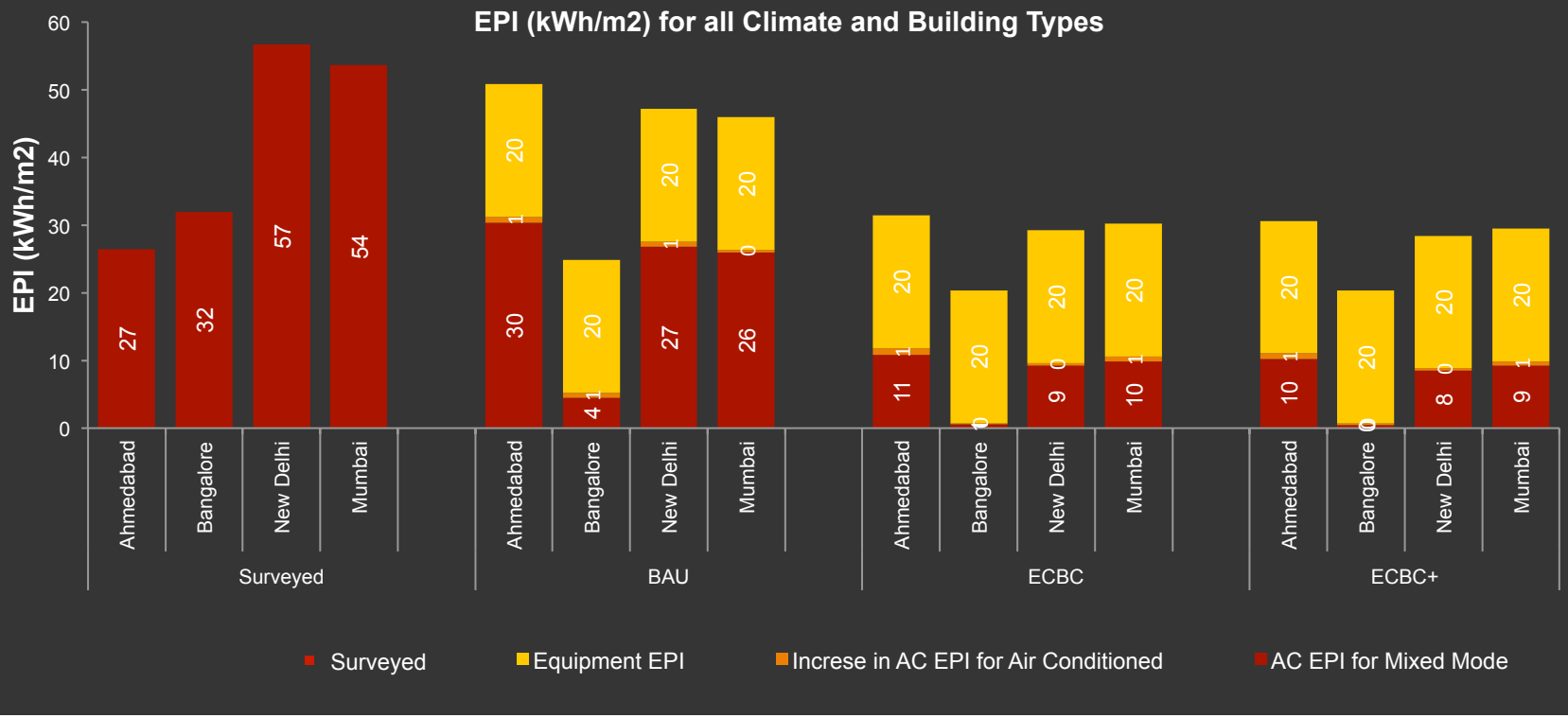


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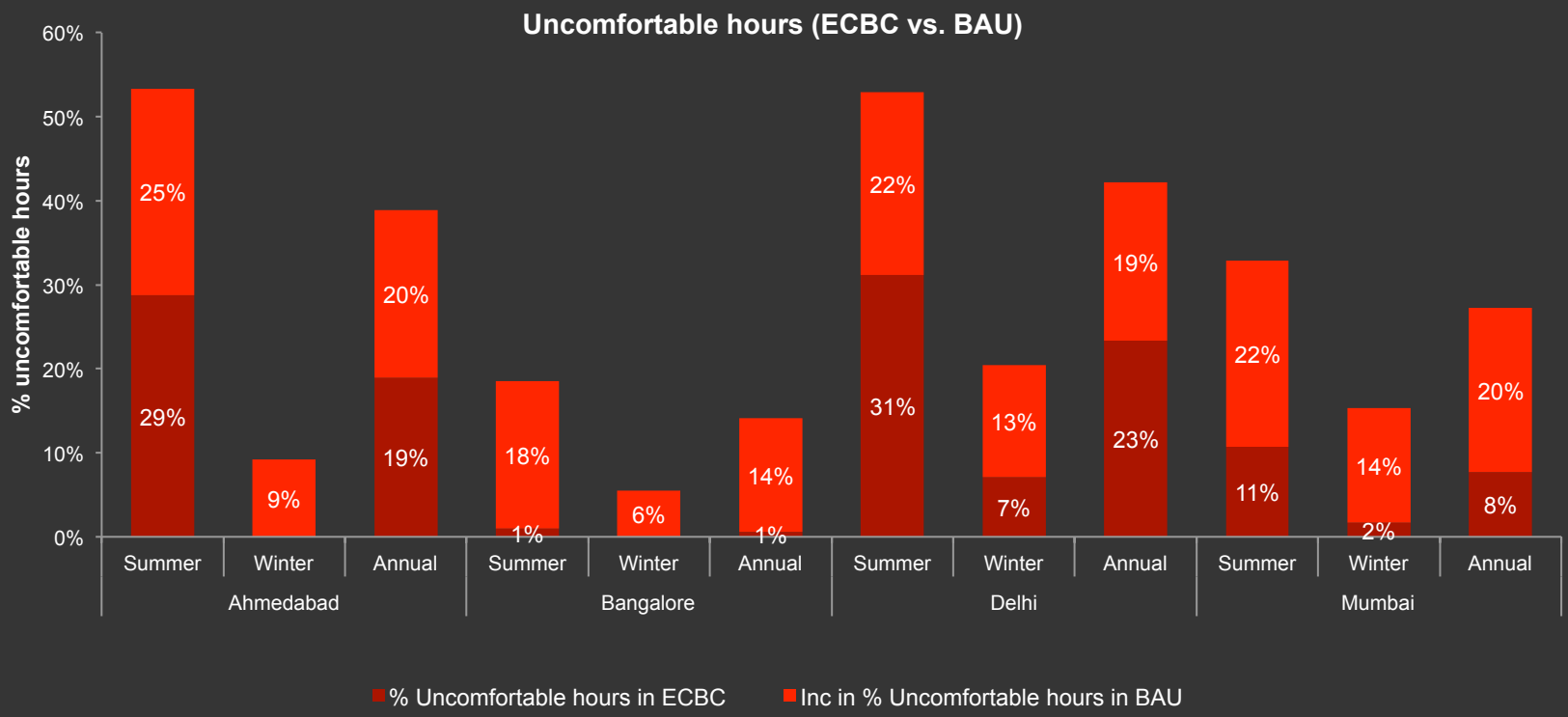


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# Projections

- **Electricity use projection till 2050**
  - Field survey, Energy modelling analysis, and secondary data sources
- **Household projections and Urbanization rate**
  - UNEP Study, National Statistics Organization, Planning Commission, UN
- **Appliance penetrations, efficiency, and saturation**
  - Existing: Field survey, National Statistics Organization, Planning Commission, USAID ECOIII project, Census Survey, Swiss Agency for Development and Cooperation, National Housing Board
  - Future: Dhar et al, Chaturvedi et al, Planning Commission, USAID ECOIII project, World Bank, Lawrence Berkeley National Laboratory, Prayas

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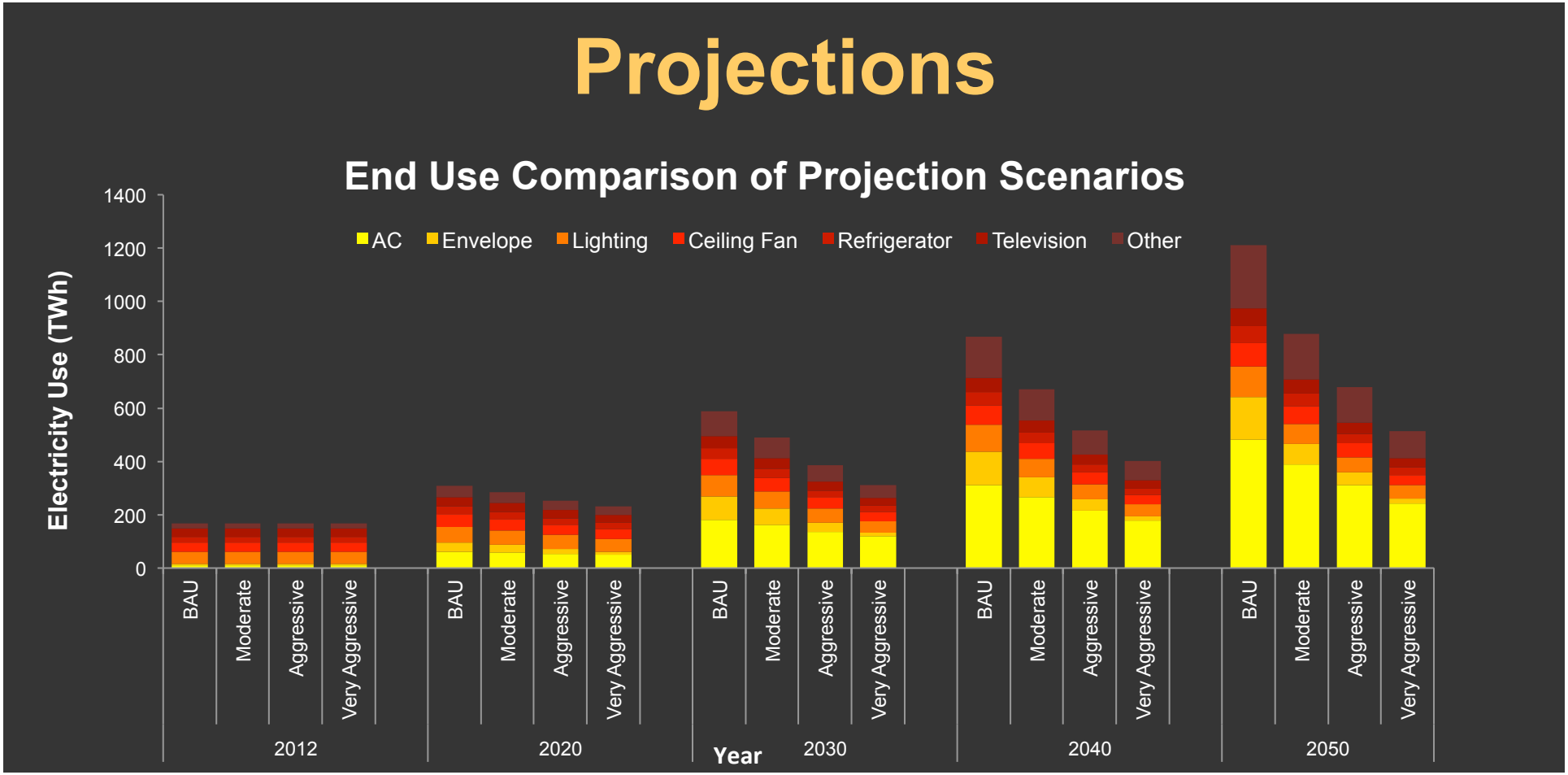
# Projections

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# Conclusions

**Field Study**

- Energy consumption and connected load steadily increases with number of air conditioners
  - Stabilizes after three units
  - Possibly due to unused air conditioners (future research)
- Larger dwellings have higher comfort expectations
- Observed increasing appliance penetration rates
- Occupant behaviour plays major role
- Temporal mixed mode operation of air conditioners

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# Conclusions

## Energy Modelling and Projections

- Prudent operation of air conditioners
- Significant benefits of efficient envelope
  - 15-20% reduction in Uncomfortable hours in NV residences
  - 40% reduction in energy consumptions in residences with AC
- Electricity consumption to increase more than six times under BAU
- Electricity savings can be reduced by 27%, 44%, and 57% under modest, aggressive, and very aggressive scenarios

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# Recommendations

**Policy and Future Studies**

- Specific code for building envelop efficiency in residences
- Common residential energy use database for the country
- Detailed floor and usage projections for major cities
- Important to monitor environment and operation of residences along with energy data
- Larger survey sample for better predictions and to reduce reliance on secondary data

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