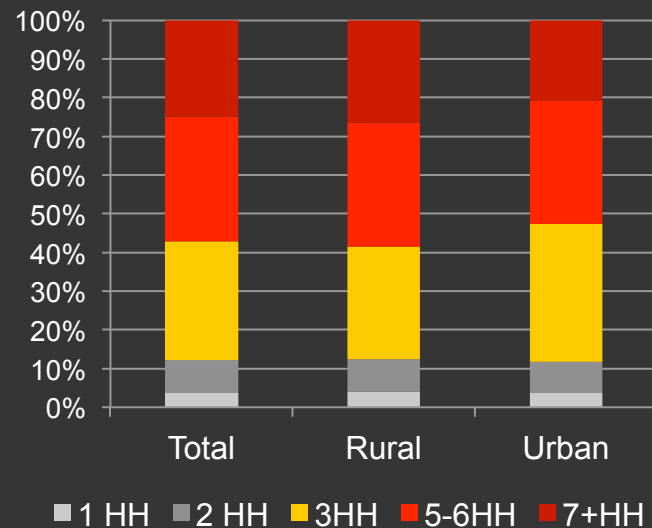


Residential Buildings in India: Energy Use Projections and Savings Potentials

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

Context



Population: 1237 Million (313.9)

Households: 220 Million (120.7)

Avg. Household size: 5.3 (2.6)

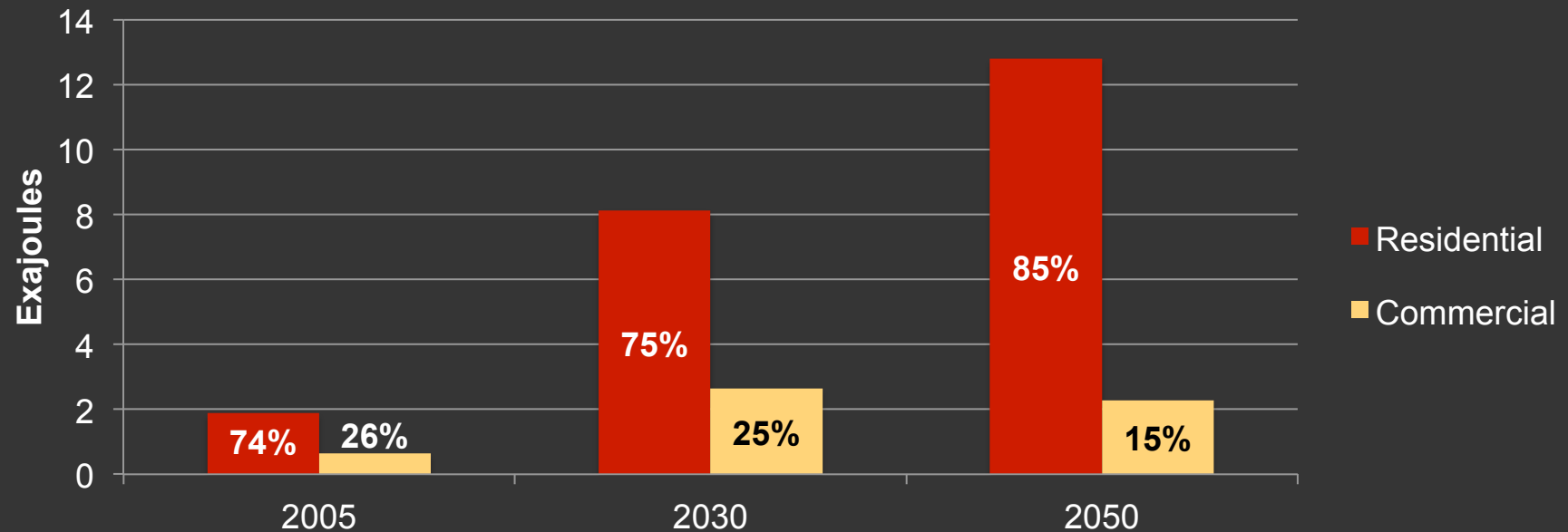
8000 Towns and 6,00,000 Villages

Avg. household energy consumption per year 900 kWh/year

833M (69%) in Rural India

377M (31%) in Urban India

Context



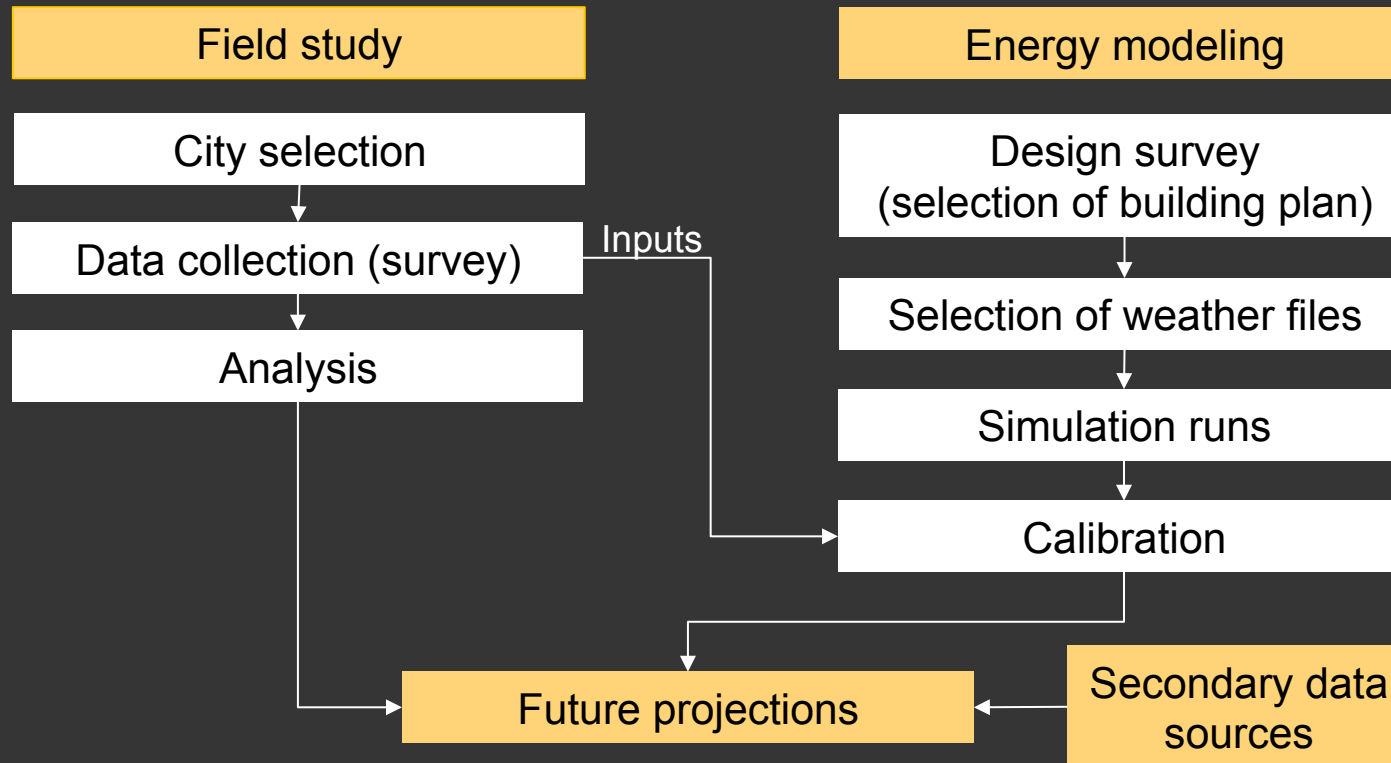
Moderate efficiency scenario projected energy consumption of India's buildings in 2030 and 2050; percentages represent the ratio of residential and commercial buildings floor space

Context: Power Cuts, Summer 2014

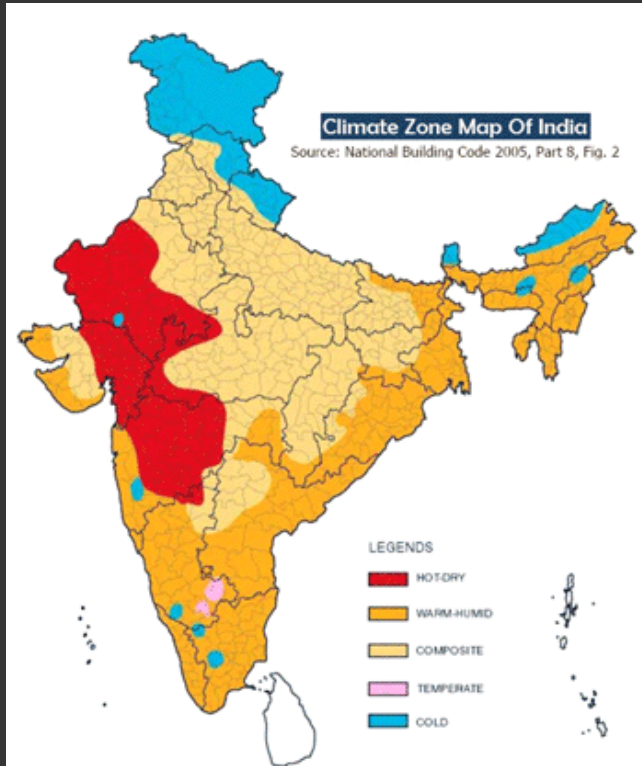
City	Avg. Temp (°C)	Peak Demand (MW)	Peak Supply (MW)	Power cut (hrs)
Srinagar	28	822	750	10
Raipur	41	410 (375)	410	14-16
Kolkata	35	1986 (1865)	1986	Unscheduled
Patna	40	2400 (2200)	1900	3-5
Bhopal	45	330 (280)	330	Unscheduled
Mumbai	32	3365 (3212)	As per Demand	No
Ahmedabad	39	1534 (1372)	As per Demand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

Source: Indian Express, Sunday , June 1, 2014

Methodology



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

Methodology: Field Study



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

Methodology: Field Study

તમારું વીજળી બિલ સમજો.

07550341

B. L. PATEL,
HOUSE NO. 1
GOODLIFE STREET,
WIS CANTON,
SURAT.

YOUR ELECTRICITY BILL - MAR-2012

Service number / સેવા નંબર
500229773

Particulars / શ્રેણી

Particulars / શ્રેણી	Amount / રકમ
Total energy charges (અંતિમ-વિદ્યુત) / જા સંચારિત રકમ	1675.25
Energy Payment Charges / ઇન્ડેક્સ ગ્રાન્ટિ રકમ	30.43
Other (કલેક્ટ / અન્ય ફી)	0.00
Govt. duty refund / સરકારી રકમ	564.31
Current bill amount / હાલના બિલ રકમ	1677.21
Previous dues / પાછલા ફી	16206.03
C. F. amount / સરકારી રકમ	0.04
Net Payable amount / જા સંચારિત રકમ	22483.00

METER & BILLING DETAILS / મીટર અને બિલની વિગત

Type / શ્રેણી	Value / મૂલ્ય	Unit / યુનિટ
Meter No. / મીટર નંબર	50000070	50000000
Present reading / હાલના મીટર	419021	34475
Past reading / ગયા મીટર	417517	34374
Multiplying Factor / ગુણક	1.00	1.00
Units consumed / વપરાયેલ યુનિટ	954	701
Govt. duty % / સરકારી દર	70%	10%
at the charges / હાલના રકમ	0.00	210.30
at Energy charges / ઇન્ડેક્સ રકમ	0.00	3665.50
at PFPA charges / પીએફપીઆ રકમ	0.00	1529.75
at Govt. duty / સરકારી દર	0.00	564.31
at Meter charges / મીટર ફી	30.00	0.00

CONSUMPTION INFORMATION / વીજવપરના વિગત

Feb-12 Jan-12 Dec-11 Nov-11 Oct-11 Sep-11 Aug-11 Jul-11 Jun-11 May-11 Apr-11 Mar-11

500.00 361 1207 351 0 0 0 500 1192 1207 1000 1000 000 000

24x7 call center facility, JUST DIAL 150333. Obtain Power, Meter, Bill, New Application information and complaint registration.

Please attach this coupon with cheque for payment and drop box.

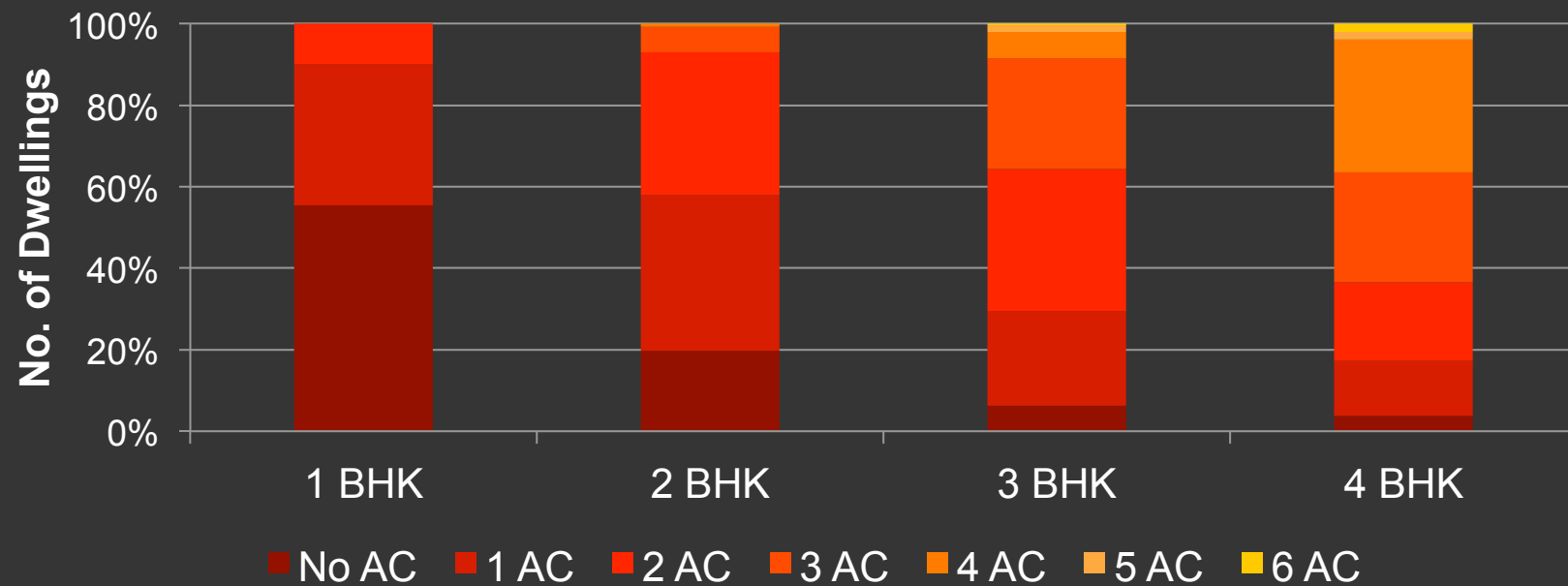
Bill Month: MAR-2012
Current bill no: 07550341
Service No: 500229773
Net Amount: 22483.00

Due Date: 31-03-2012
Security Deposit-Required Amt: 2790.00

- 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

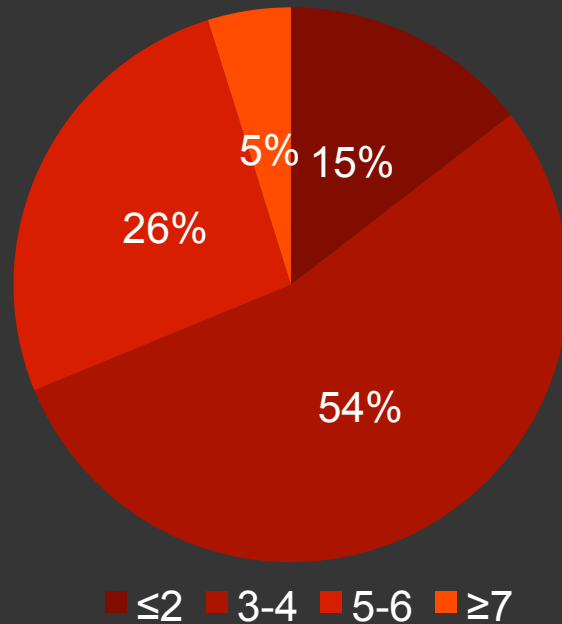
Observations and Analysis

Air Conditioners and Bedroom Distribution

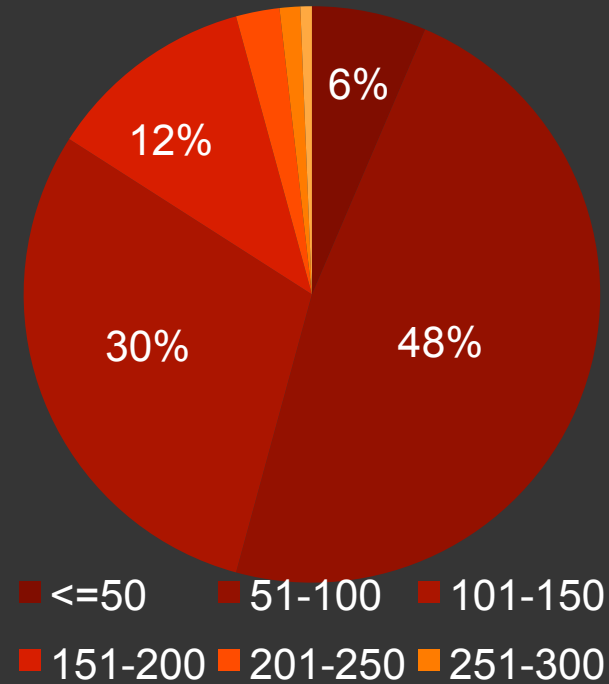


Observations and Analysis

Distribution of no. of Occupants

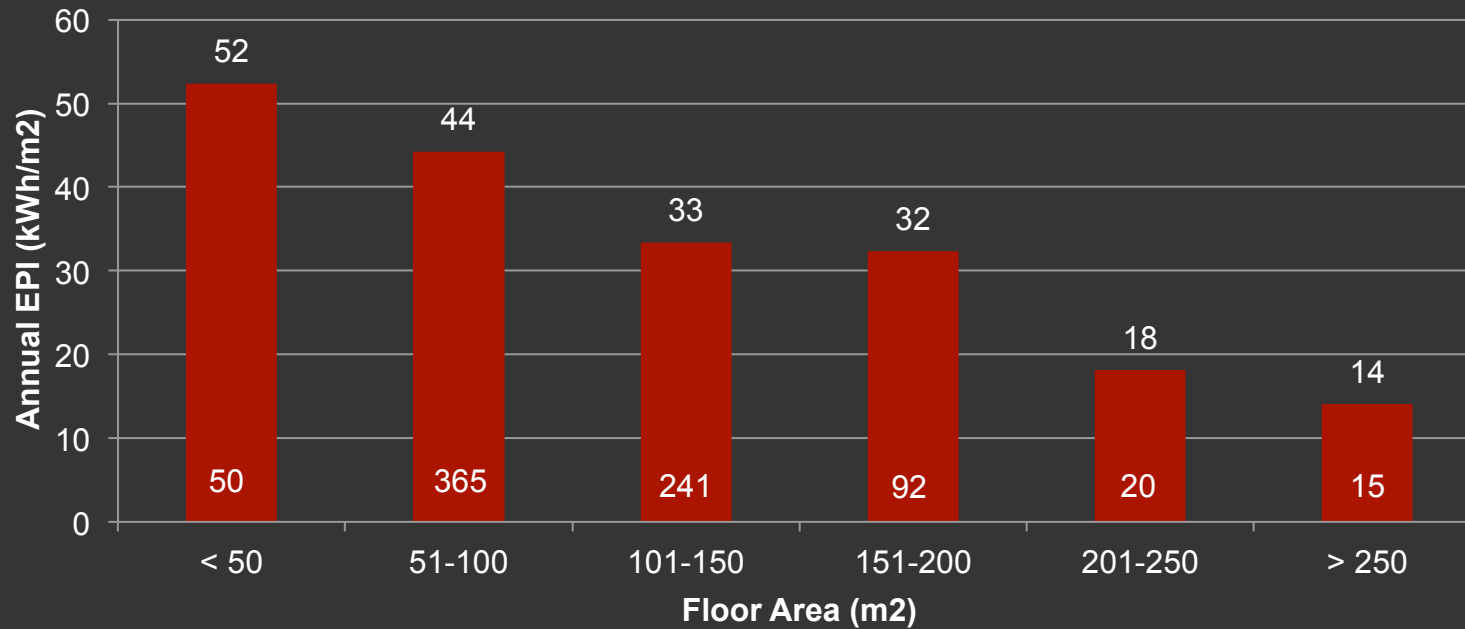


Distribution of Floor area

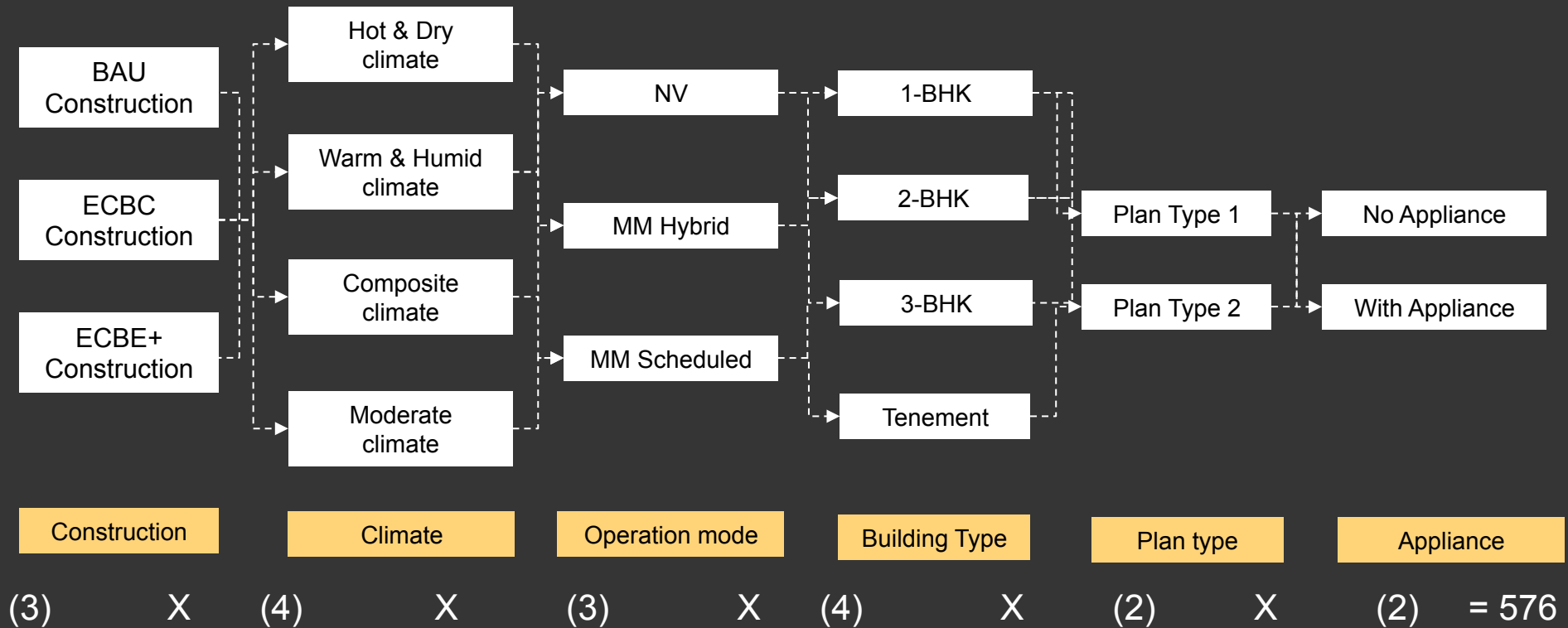


Observations and Analysis

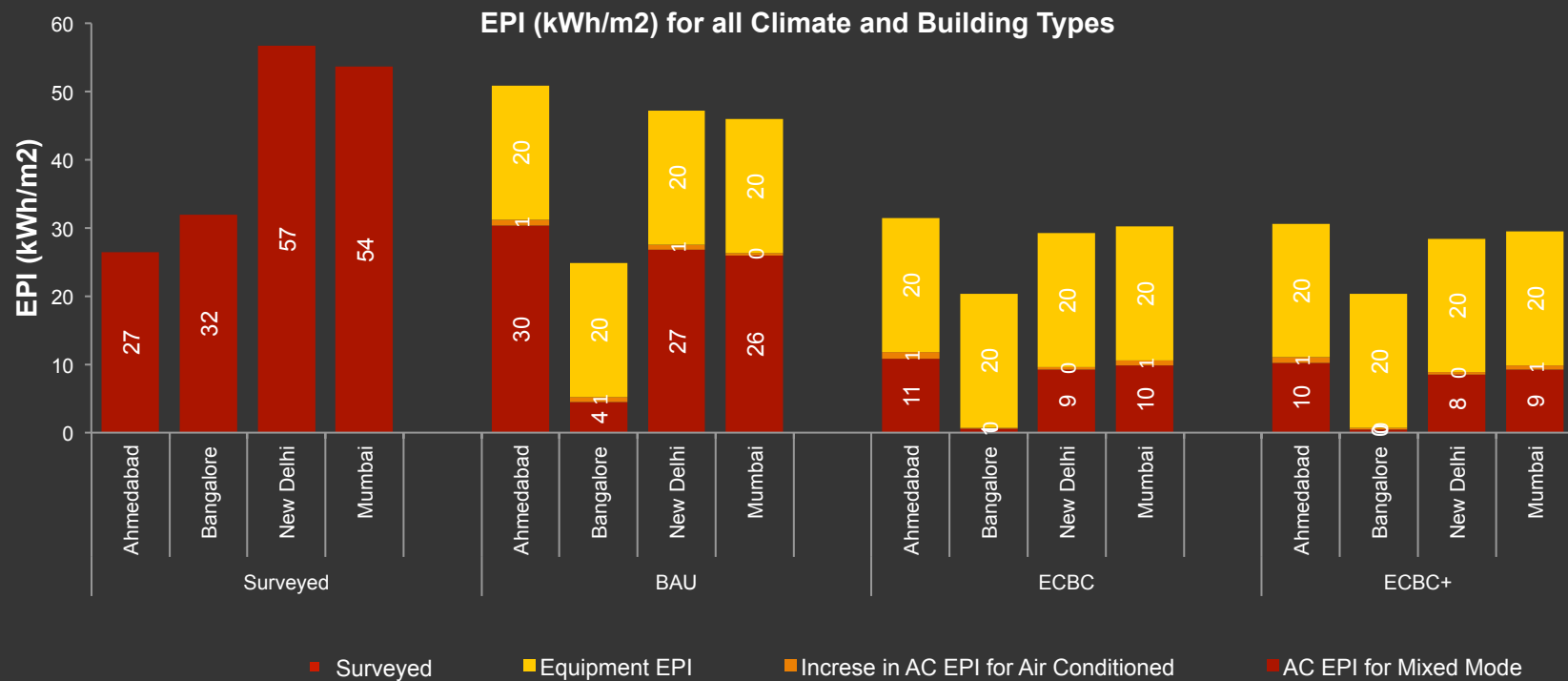
Annual mean EPI v/s Floor Area



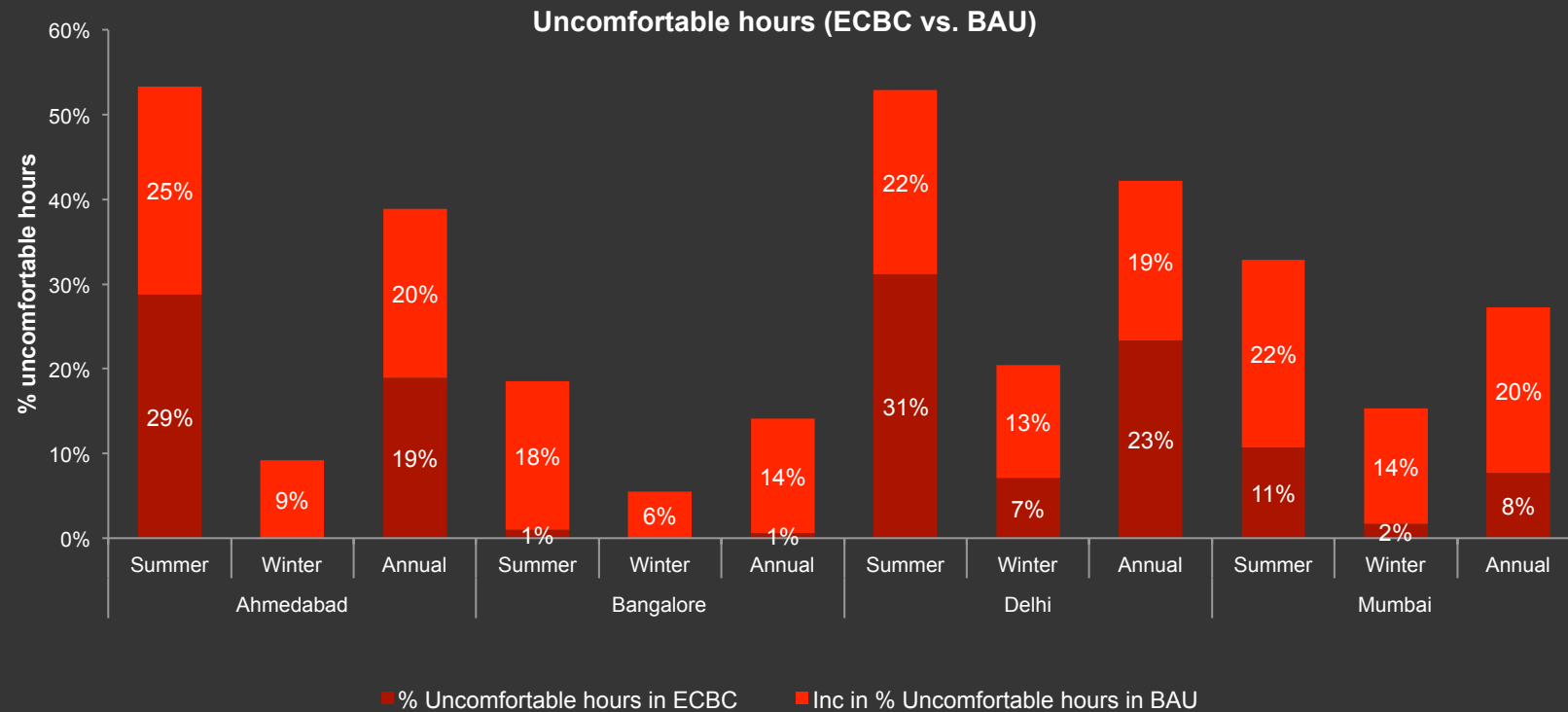
Methodology: Energy Modelling Run Chart



Observations and Analysis



Observations and Analysis

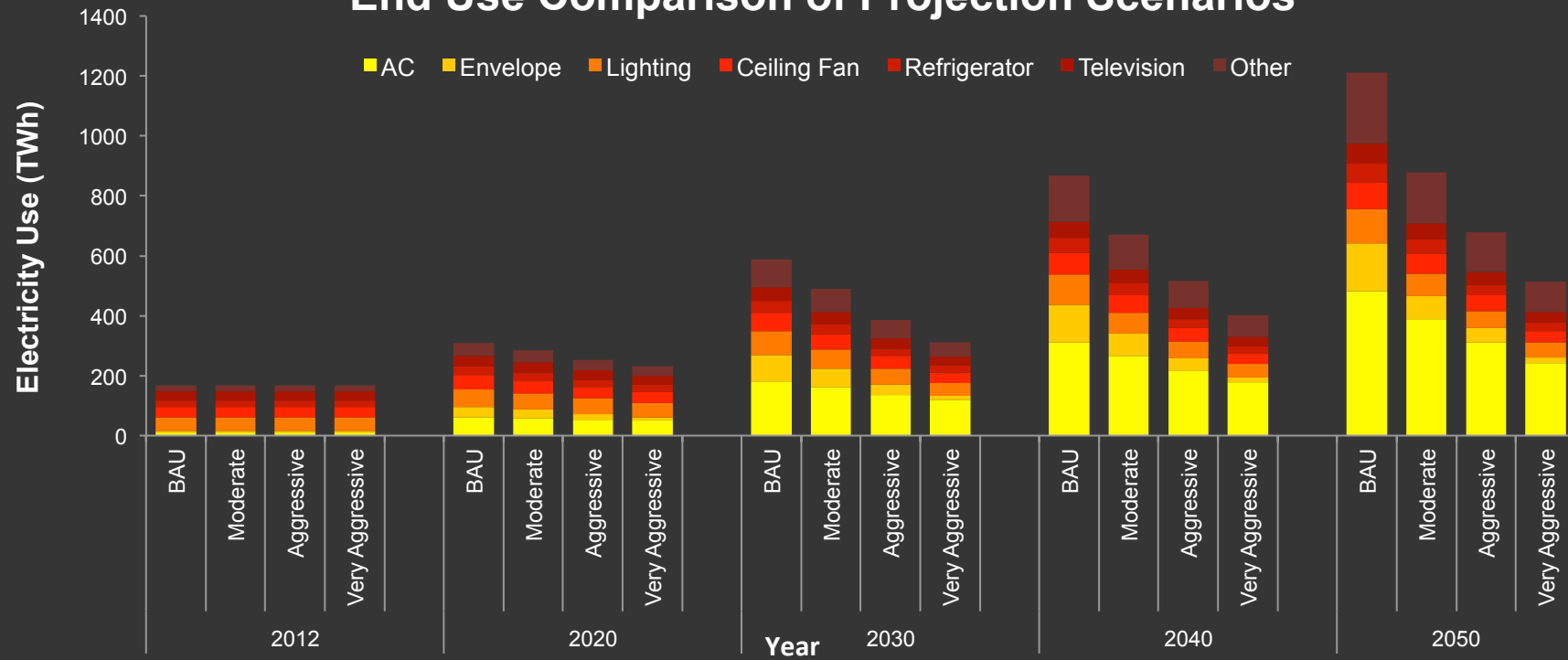


Projections

- **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

Projections

End Use Comparison of Projection Scenarios



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

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

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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