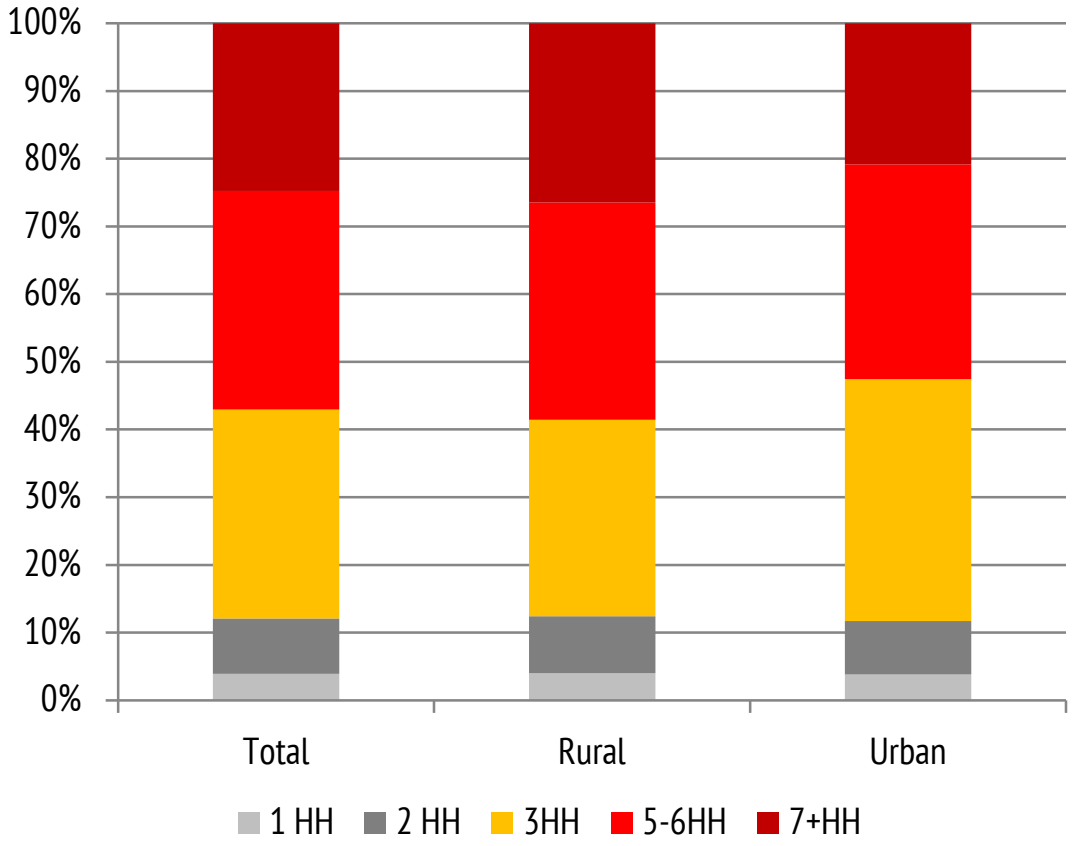
Housing: Comfort: Energy

Context



Source: Census India 2011

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

8k Towns and 600k Villages

Avg. house hold energy consumption per year
900 kWh/year

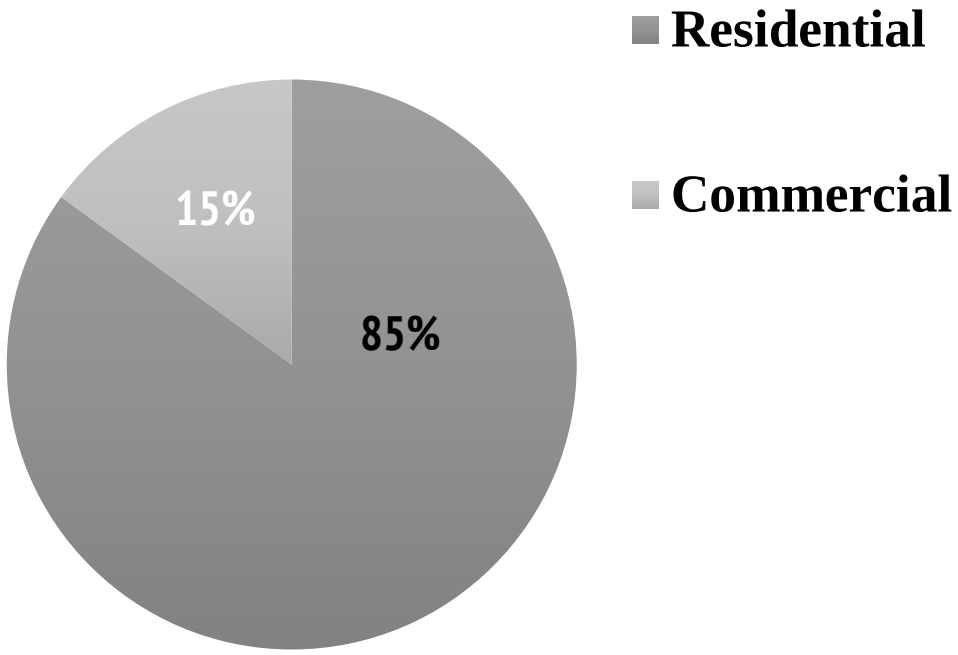
833M (69%) in Rural India
377M (31%) in Urban India

Context: Power cuts summer 2016

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

Source: Indian Express, Sunday , June 1, 2016

Context



Sector-wise Floor Space Area by 2050

Residential Energy Consumption

34% Fans

28% Lighting

7% Air Conditioning

4% Evaporative Cooler

73%

13% Refrigerator

4% Television

10% others

27%

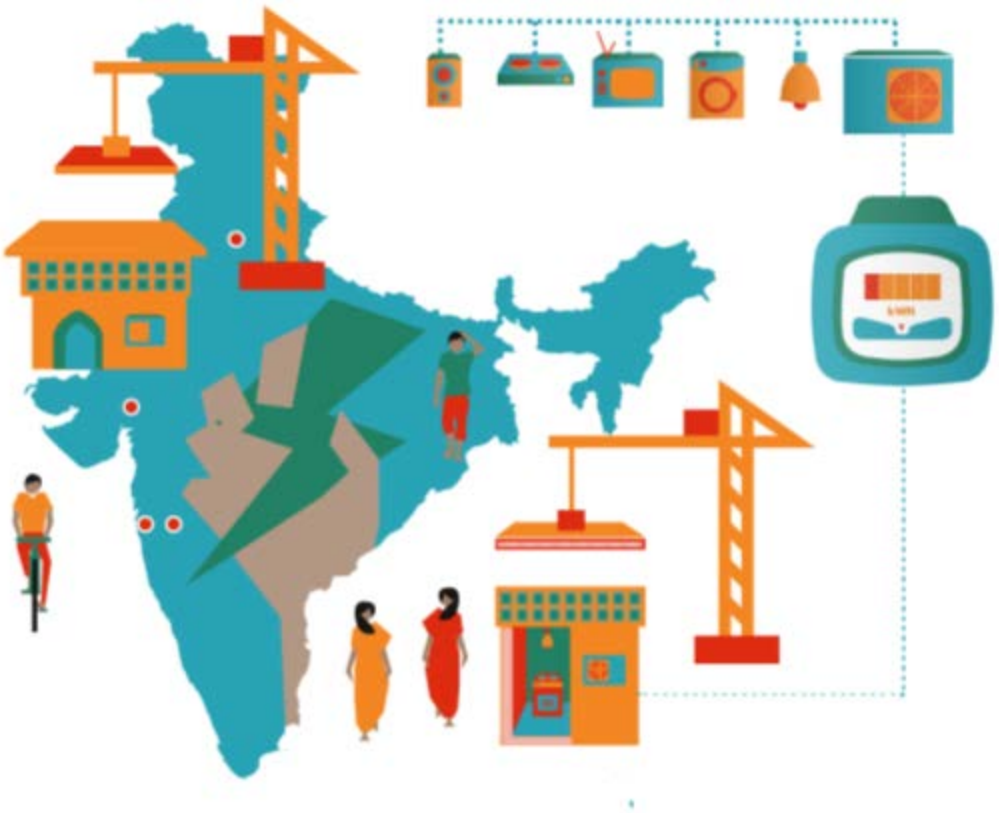
Source: GBPN / Planning Commission of India 2015

Context

- Building Codes for Commercial Buildings: ECBC and For Residential ECBC – R
- “Housing for All” – GoI
- Residential Energy can be managed by S & L program
- ‘Lock In” period of new residential construction

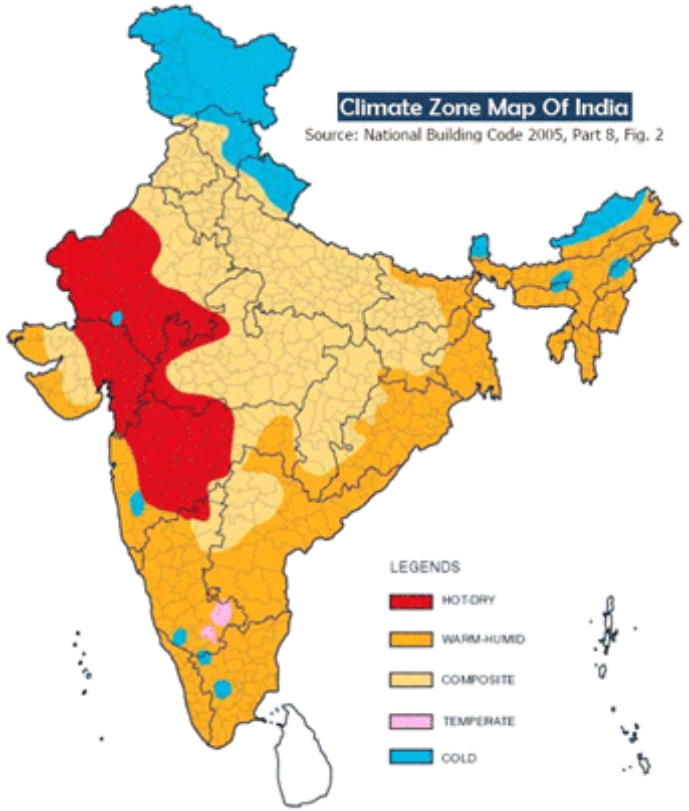
Source: Sangath

GBPN – CEPT Study



- How much Energy India's residential sector consume
- What should we focus on
  - Buildings or
  - Appliances or
  - Behaviour or
  - Everything?
- Should we rely on Market or Codes

Methodology: Field Study



- Four Cities – in Four Climate Zone
- 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)

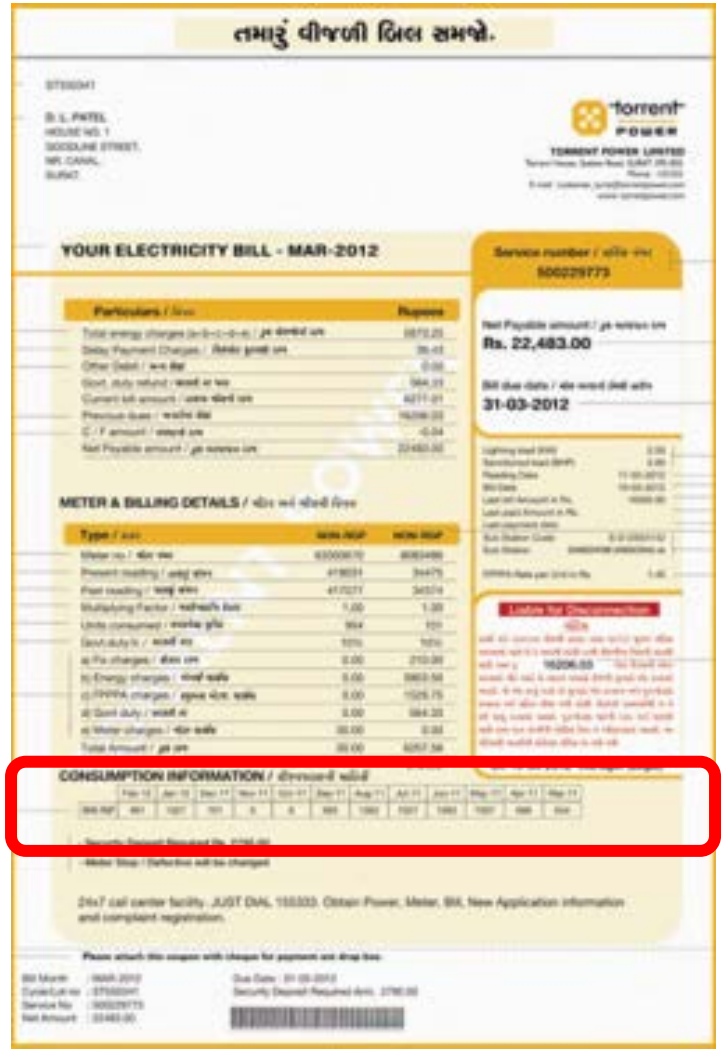
About 1000 households – 250 per Climate Zone

Source of Map : BEE

Methodology: Field Study

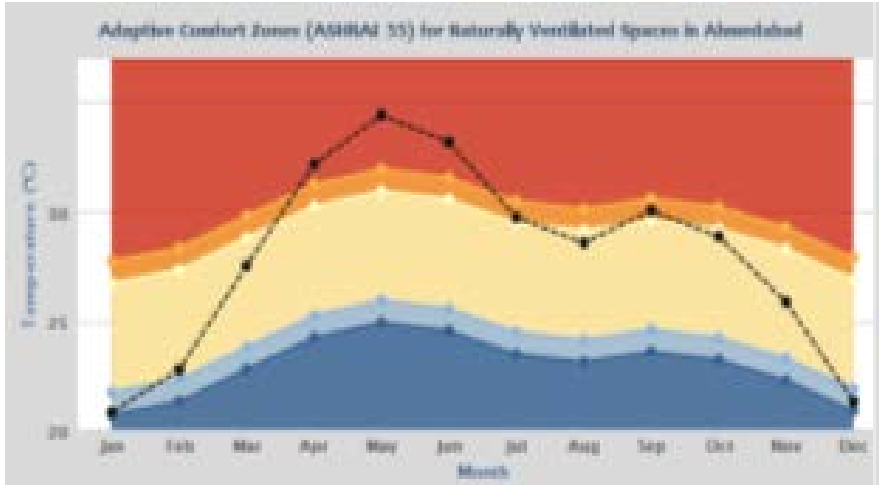
- Housing Typology
  - Ground + 3
  - Ground + 12
  - Row houses – Tenements
  - Independent Bungalows
- Family of 2 to 7
- Various neighborhoods

Methodology: Field Study

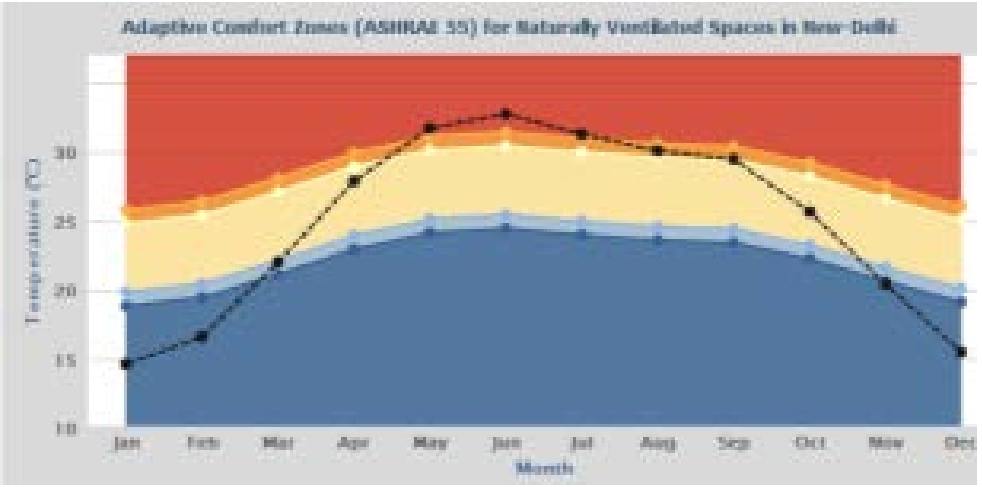


- Built-up / carpet / super built - up area
- Construction characteristics
- Building Type - *Common Load*, *Lifts*, *Water Pumps*
- Floor Plans – Number of bed rooms
- Family profile
- Location, Number and rating of appliances
  - Appliances operation pattern
- Connected Load & Bills of One / Two years

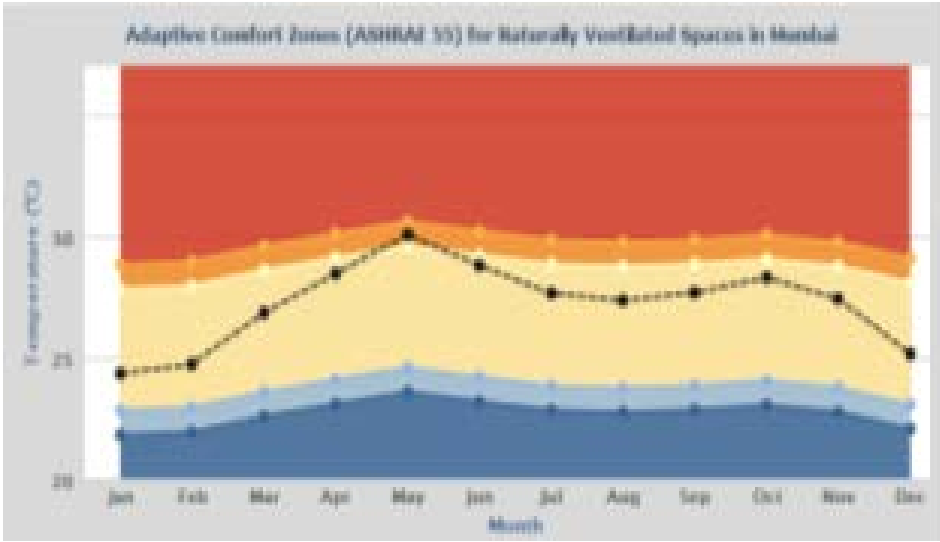
Methodology: Comfort Hours (ASHRAE 2010 Adaptive Model)



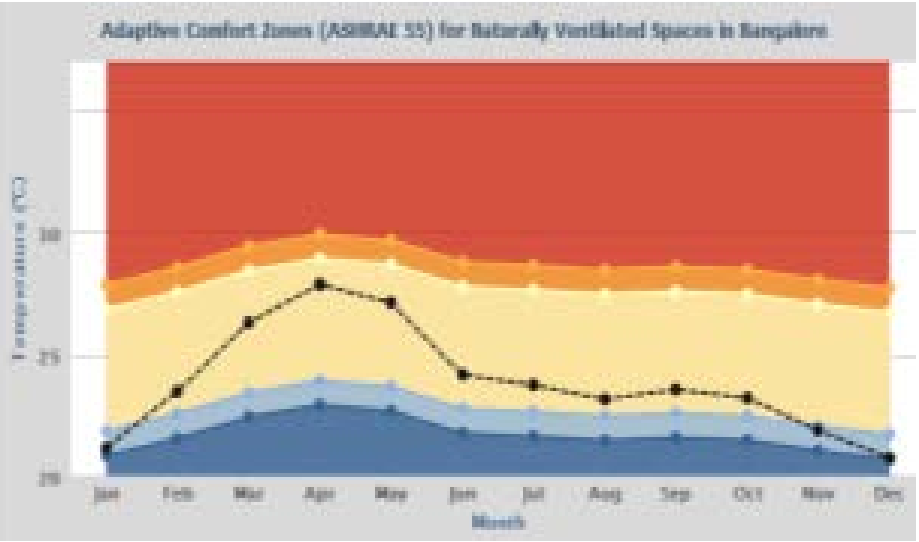
Ahmedabad



New Delhi



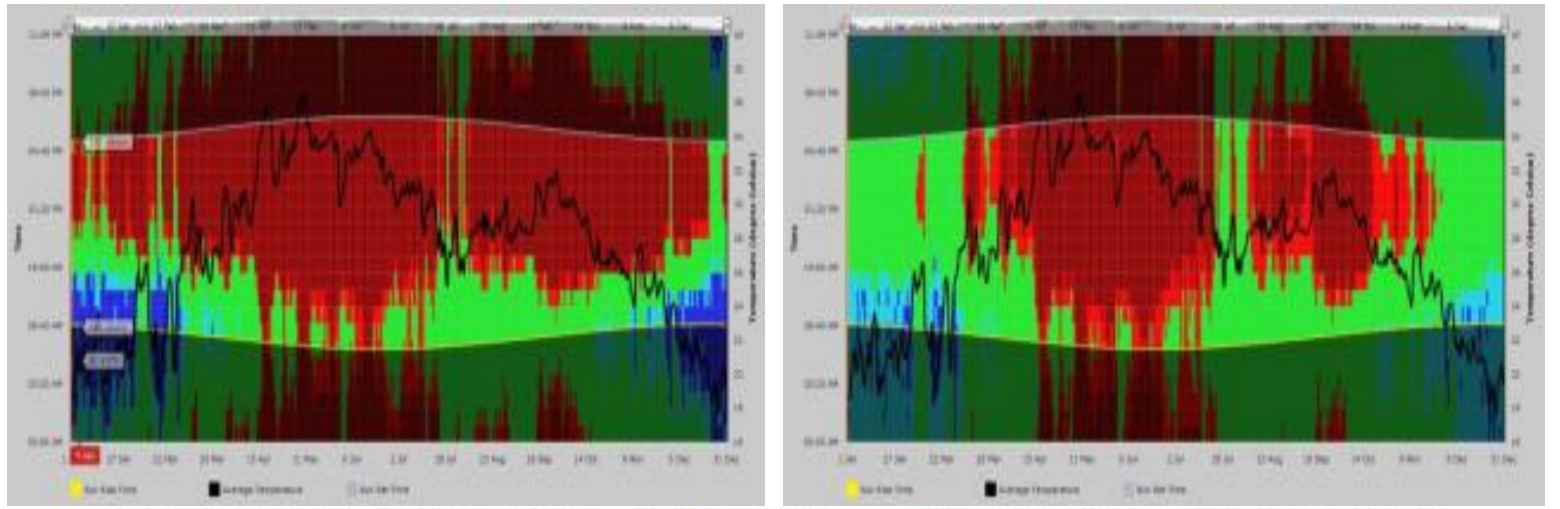
Mumbai



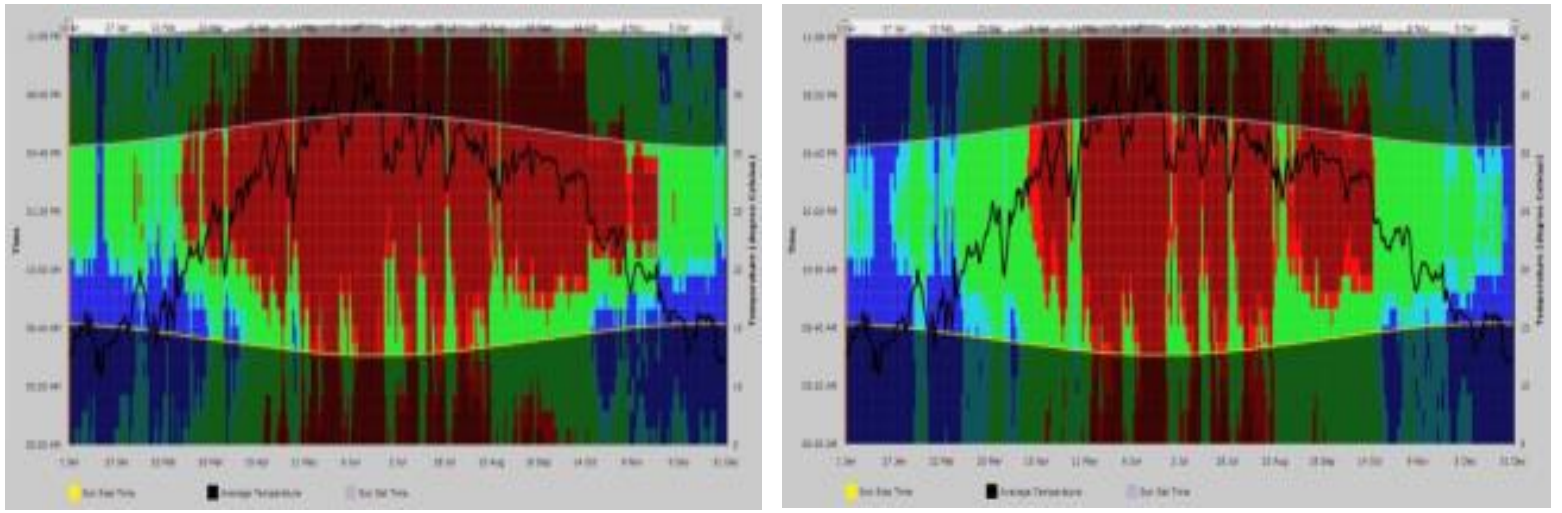
Pune

Source: CARBSE Tool

Methodology: Comfort Hours: Indoors



Ahmedabad

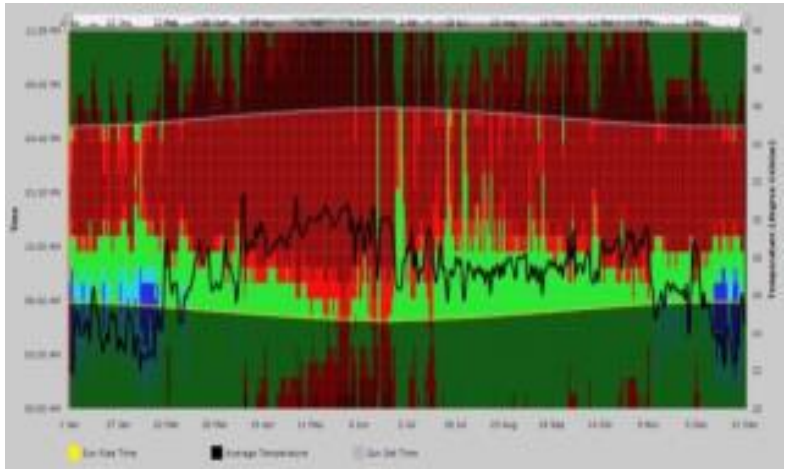


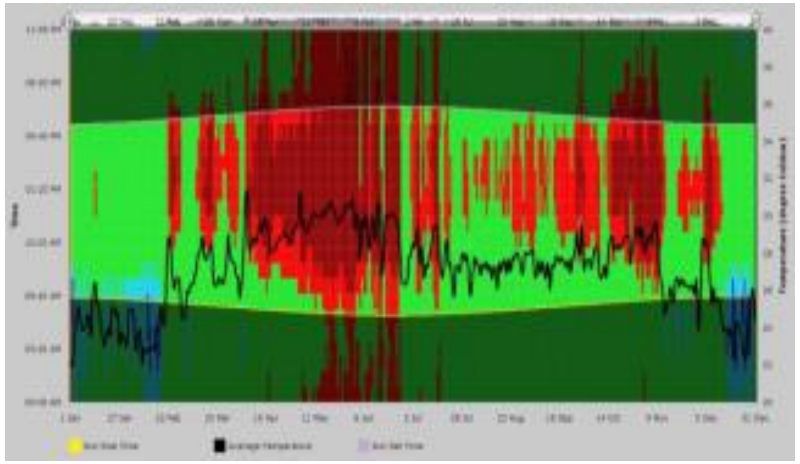
BAU - Residence

ECBC - Residence

New Delhi

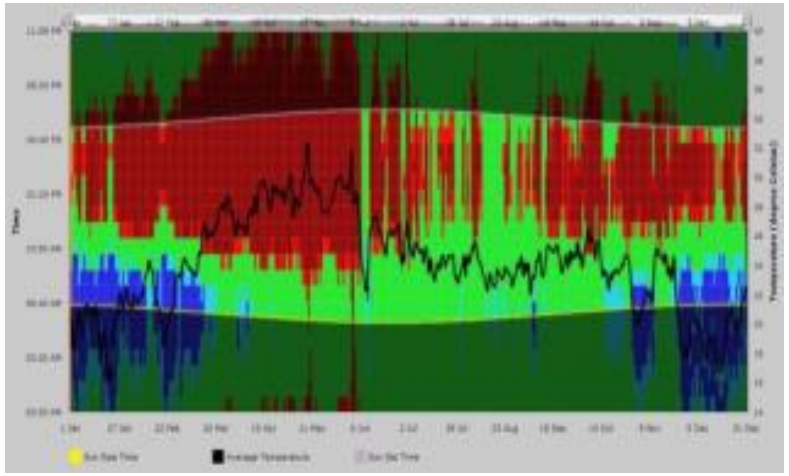
Methodology: Comfort Hours: Indoors

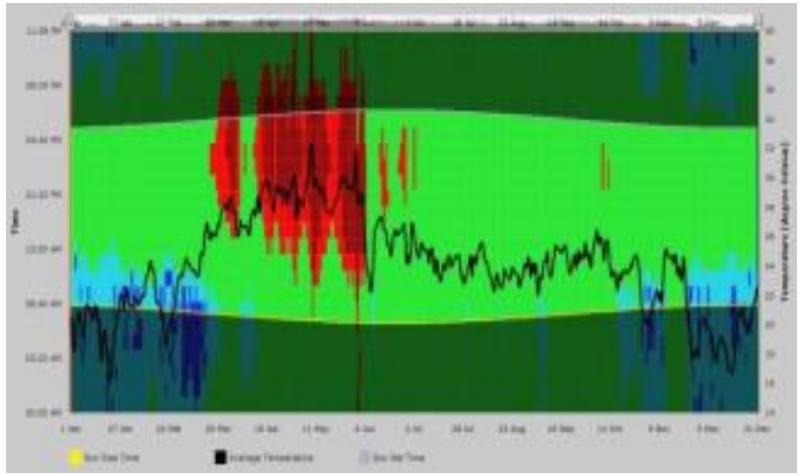




Mumbai

Uncomfortable cold | 80% adaptive low | 90% adaptive | 90% adaptive high | Uncomfortable high



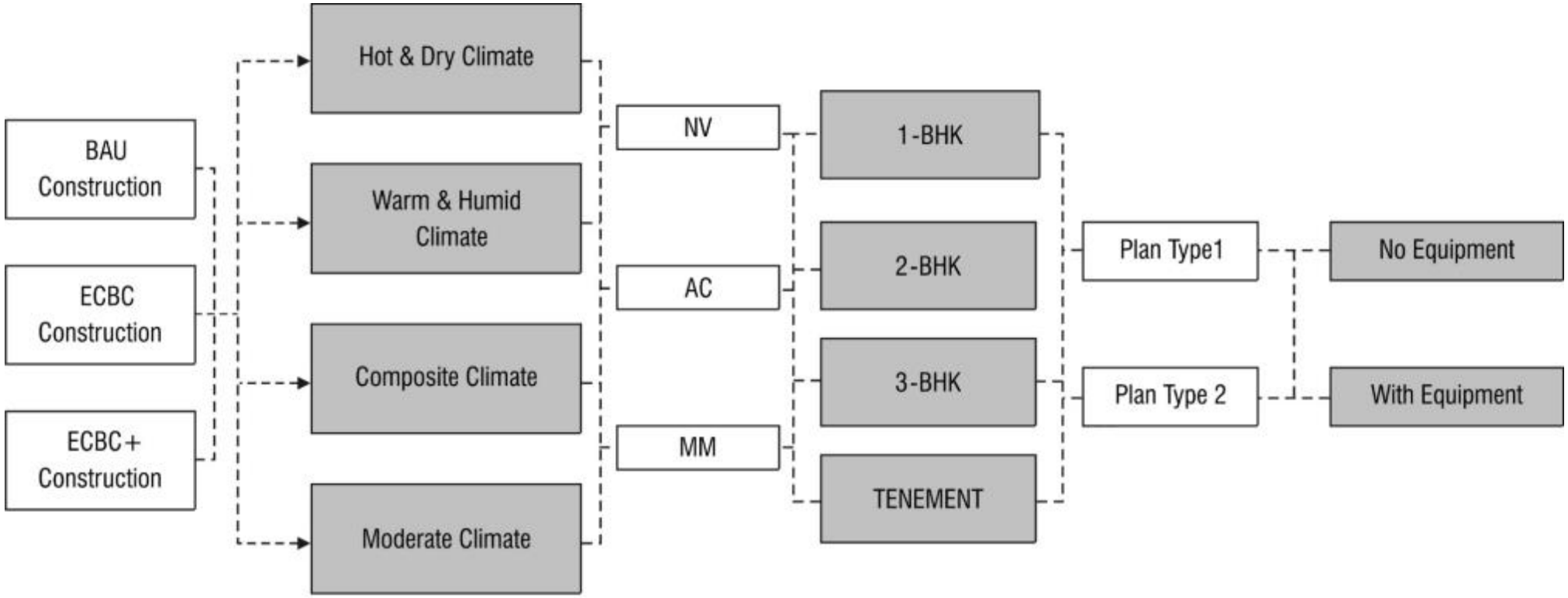


Pune

BAU - Residence

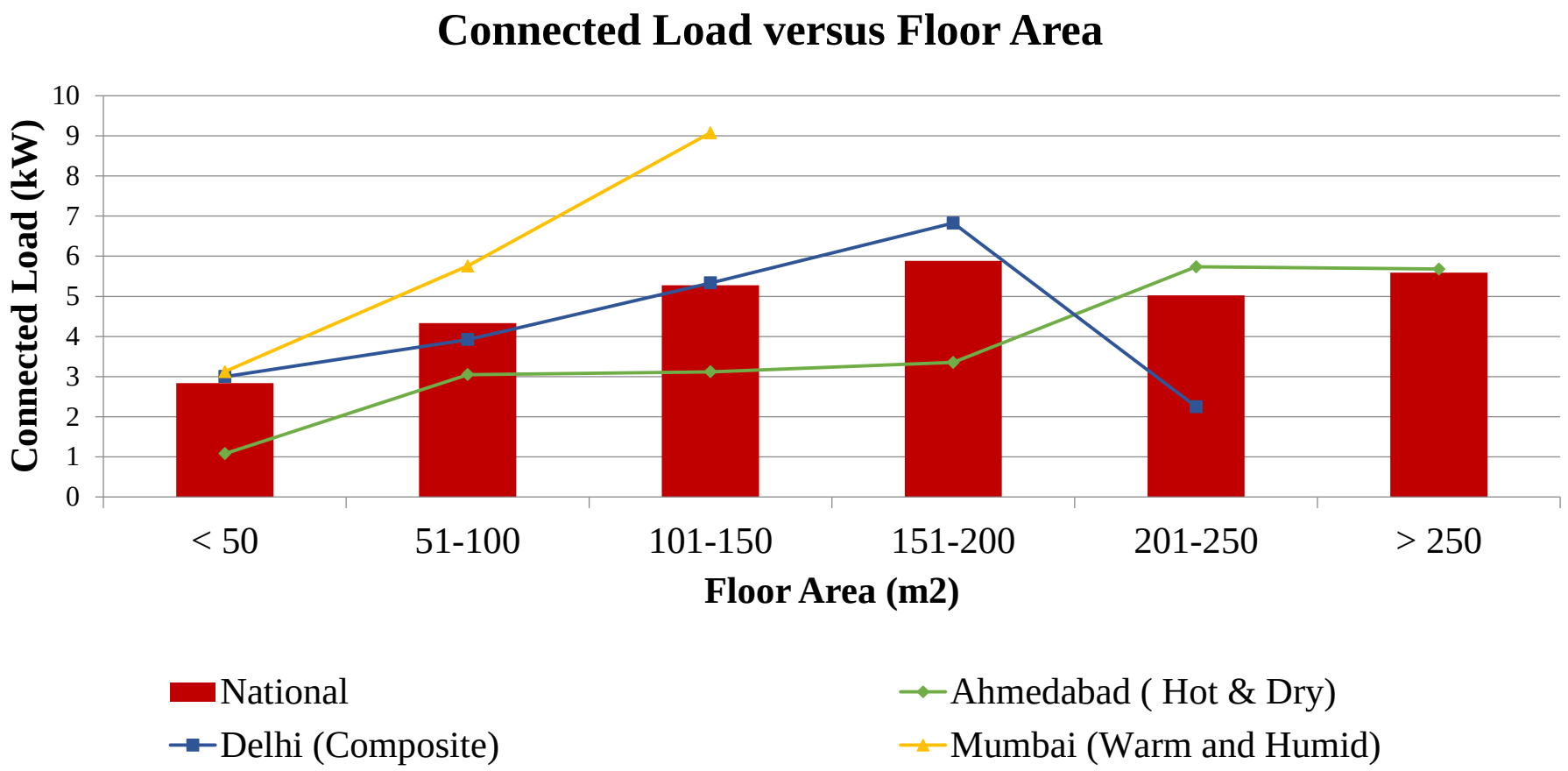
ECBC - Residence

Methodology: Simulation Run Chart



Source: GBPN Report

Observations and Analysis



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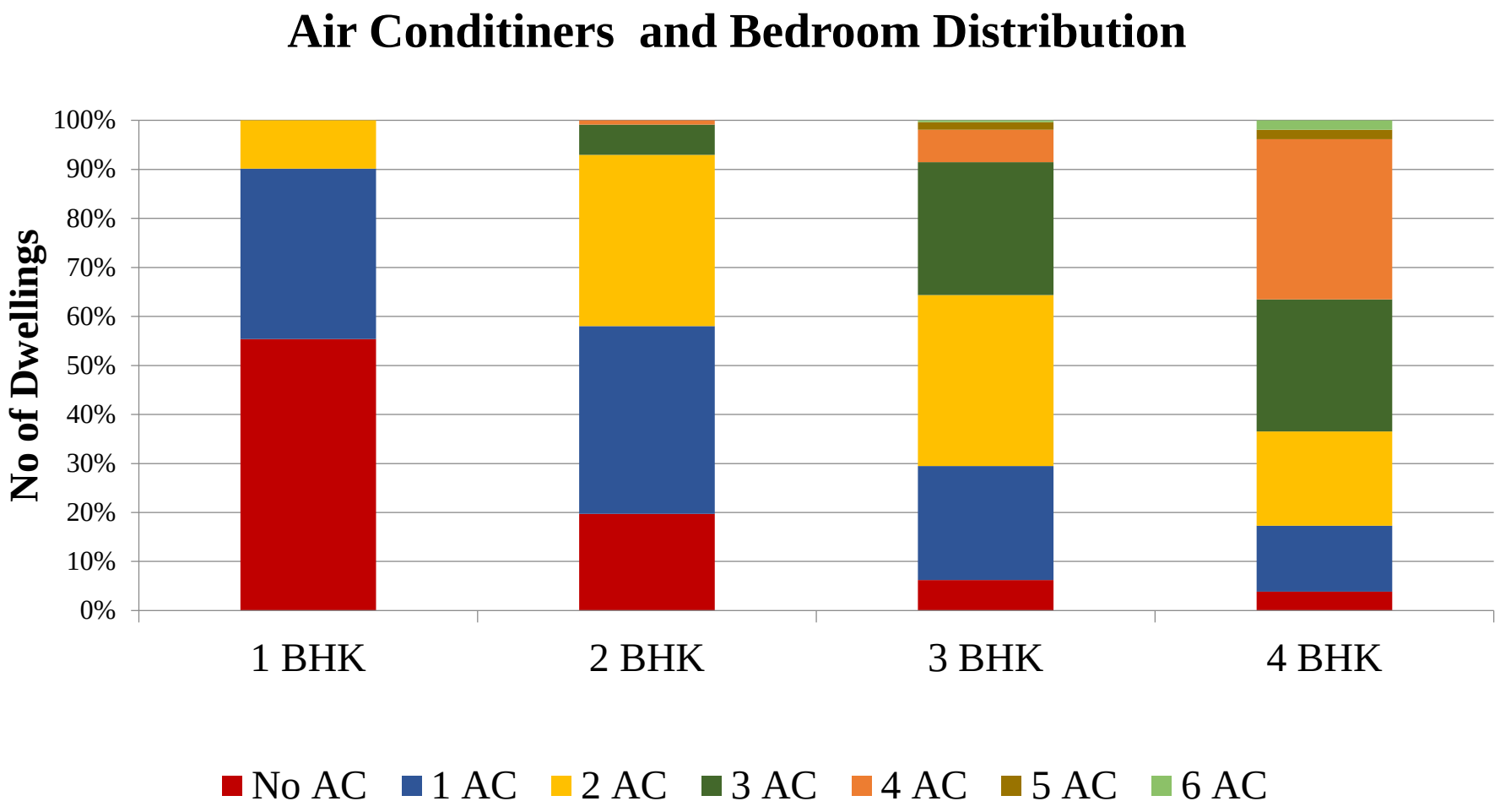

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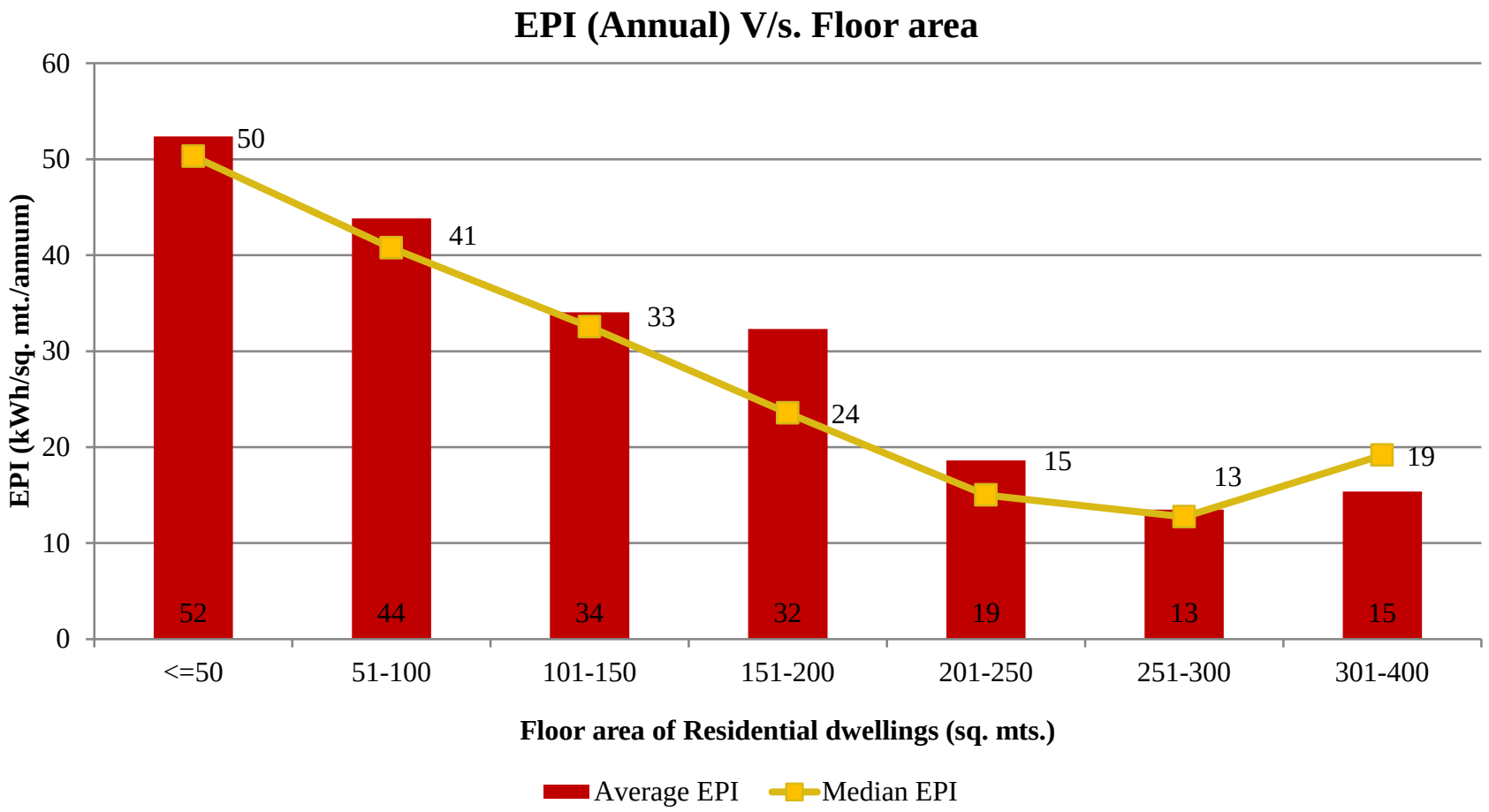

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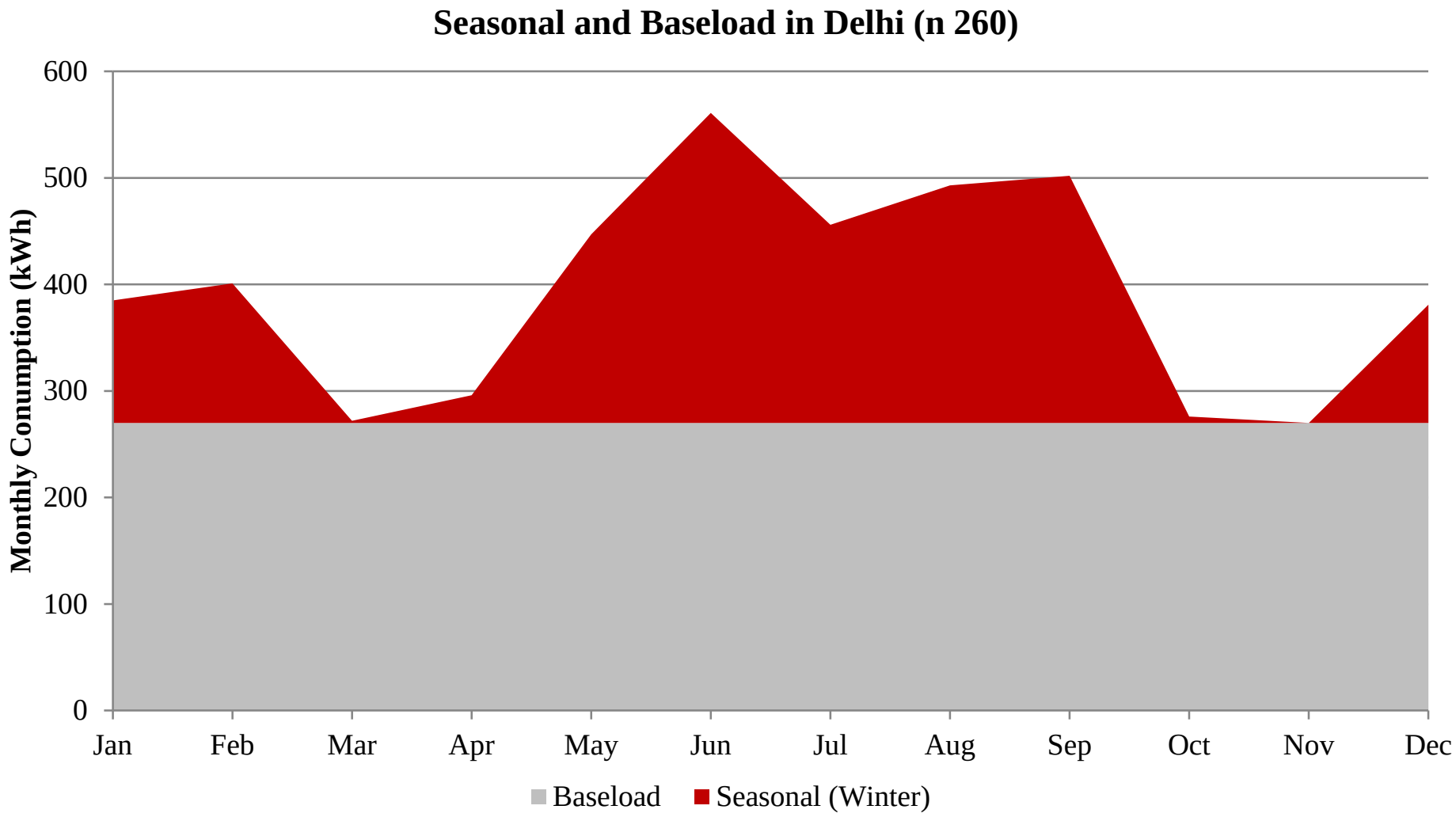

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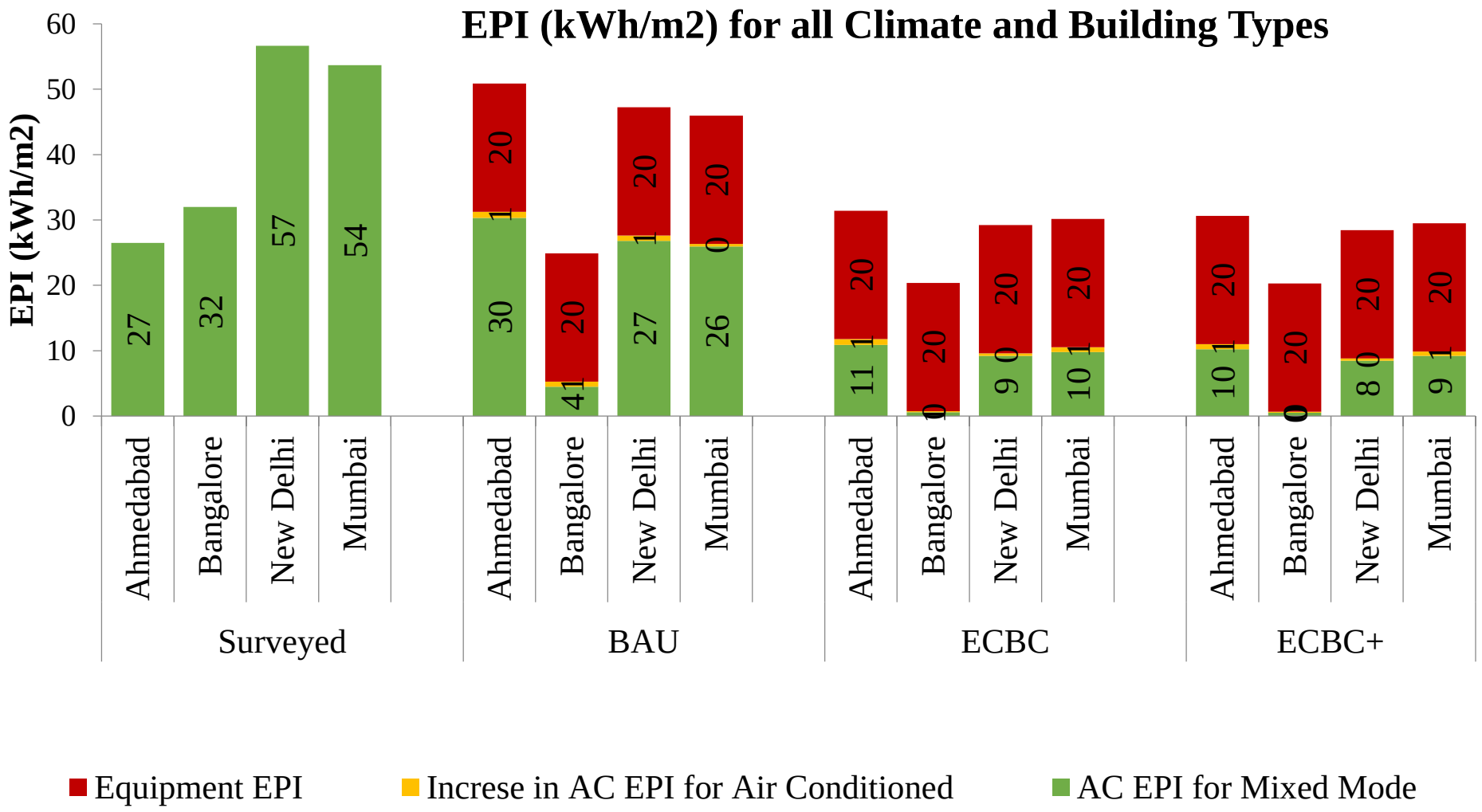
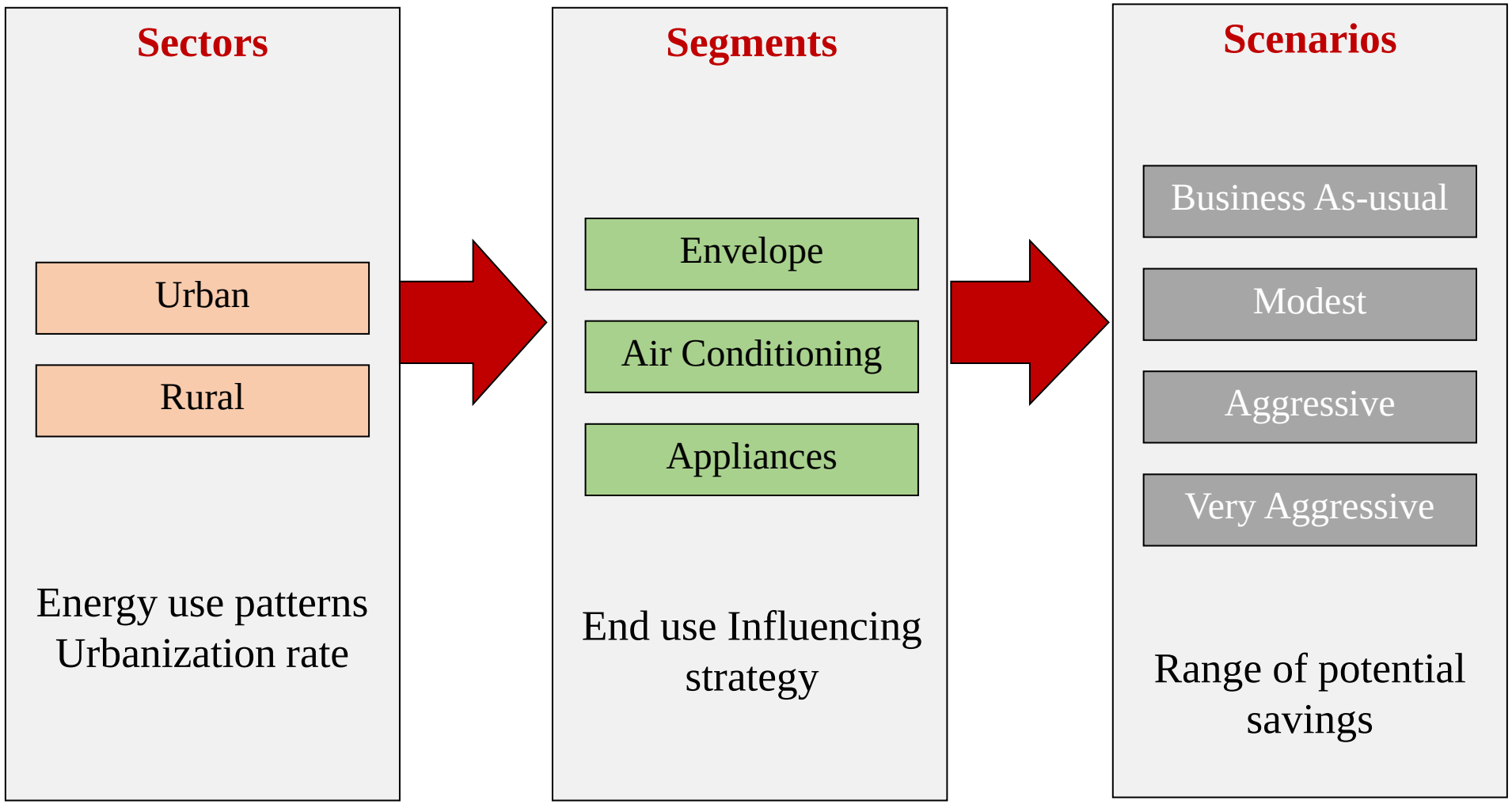


Projections



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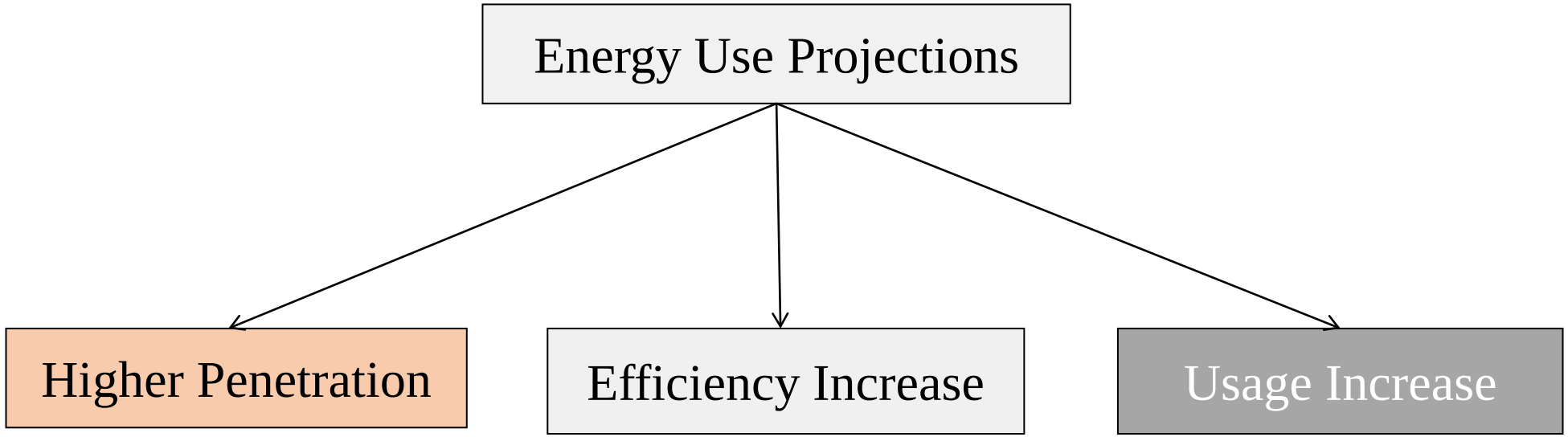
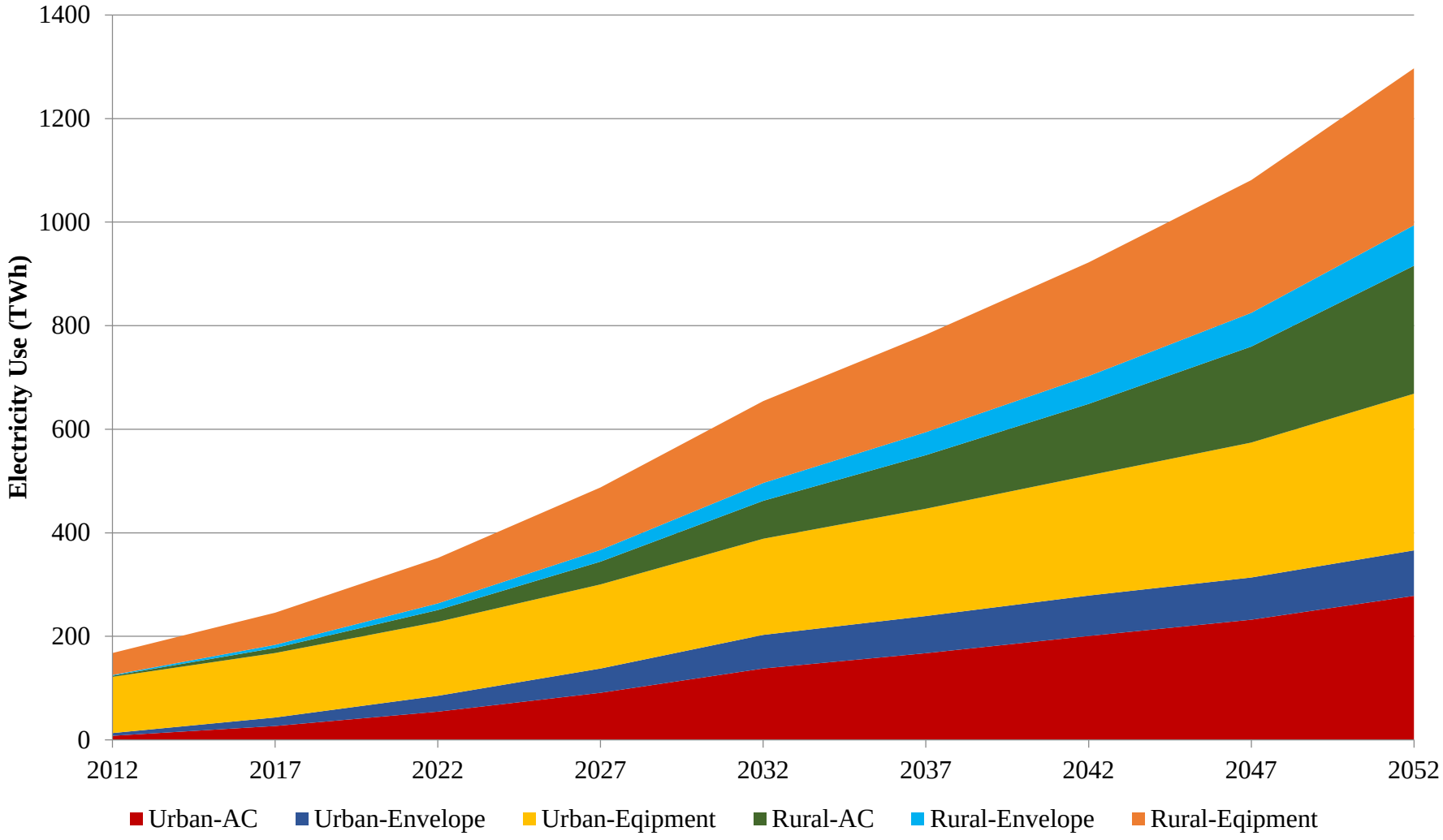


- Population
- Electrification
- Income

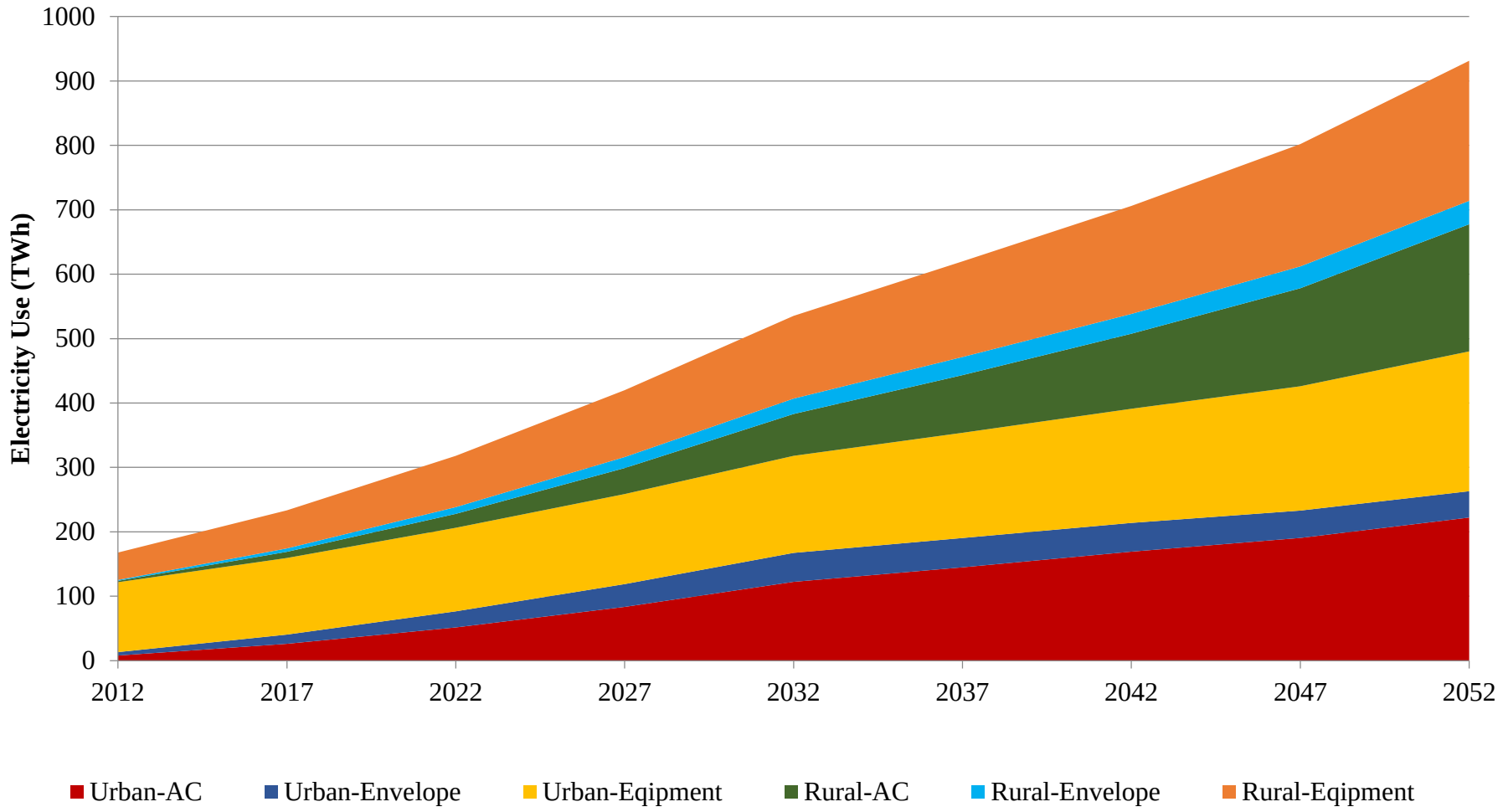
- Technology
- Policy
- Globalization

- Income
- Expectation
- Lifestyle

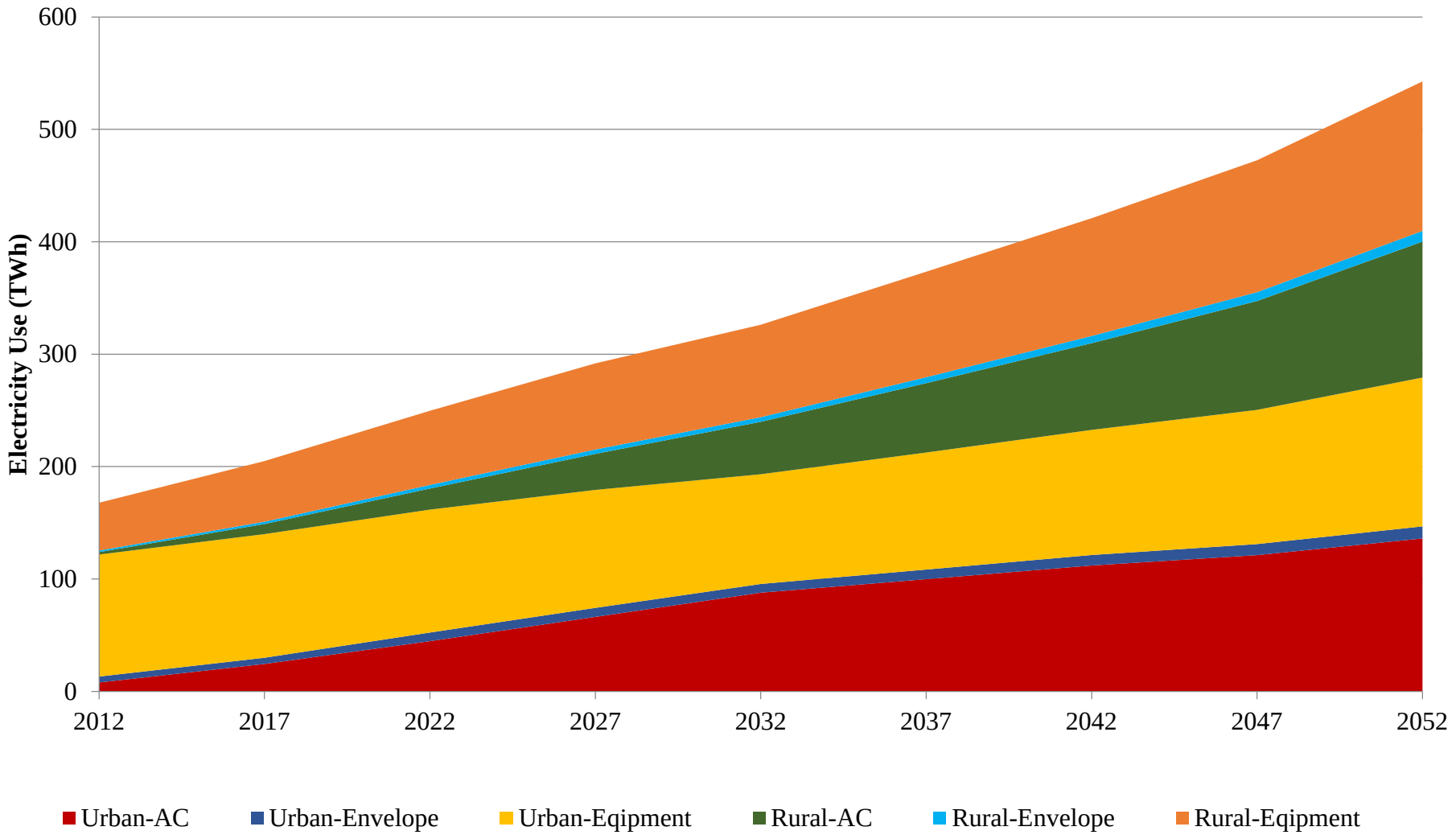
Projections: BAU Scenarios



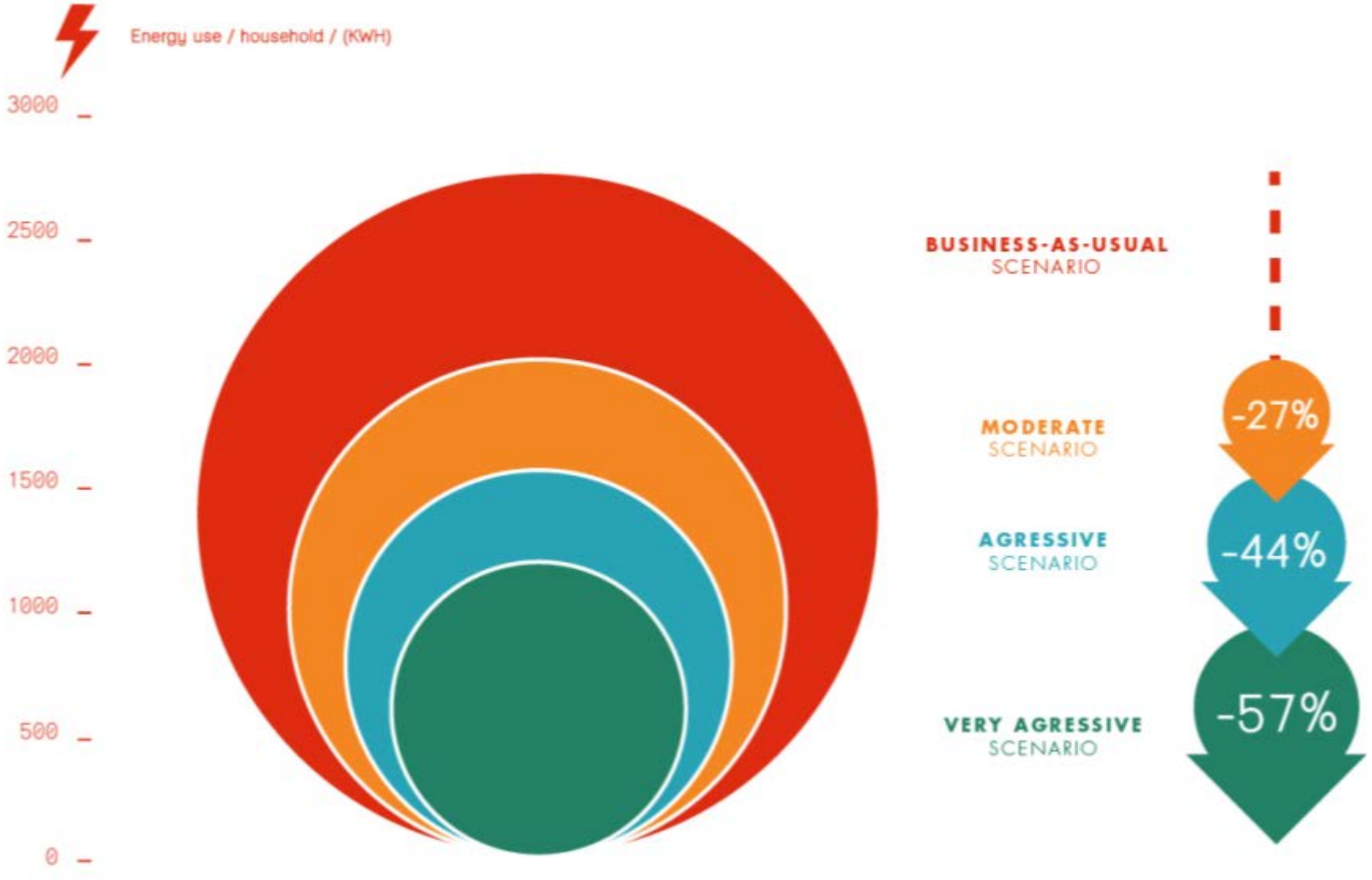
Projections: Moderate scenario



Projections: Very aggressive scenario



Four Possible Scenarios



THANK YOU