Building Measurement Practices in the U.S.: Lessons Learned

For

US–India Dialogue: NITI Aayog, MOSPI, PNNL, U.S. EIA

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By

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# EIA conducts two complex, periodic studies of energy consumers against a relatively flat budget profile

Budget of the US Energy Information Administration

mil dols US
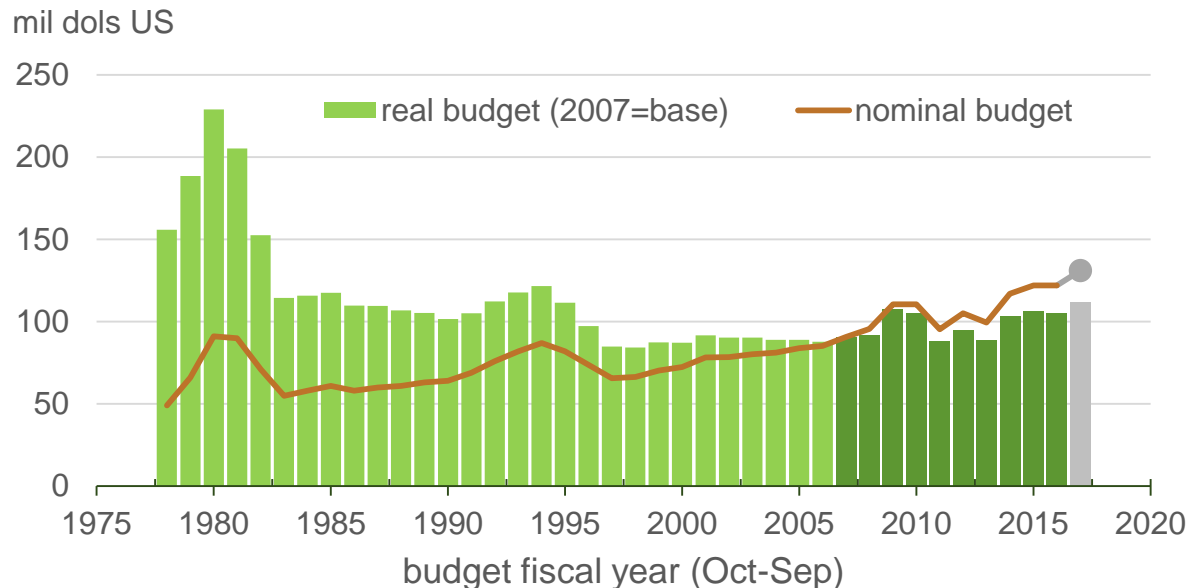
- It costs more to achieve the same or less success
- Survey costs are rising faster than budgets
- Budgets are declining in *real* economic terms

*Source: OMB, Statistical Programs of the United States Government*

Over time, rising costs have reduced the sample size and frequency of the surveys

sample size

● RECS   ● CBECS

survey reference year

| 11 surveys | 8 surveys | 5-6 surveys |
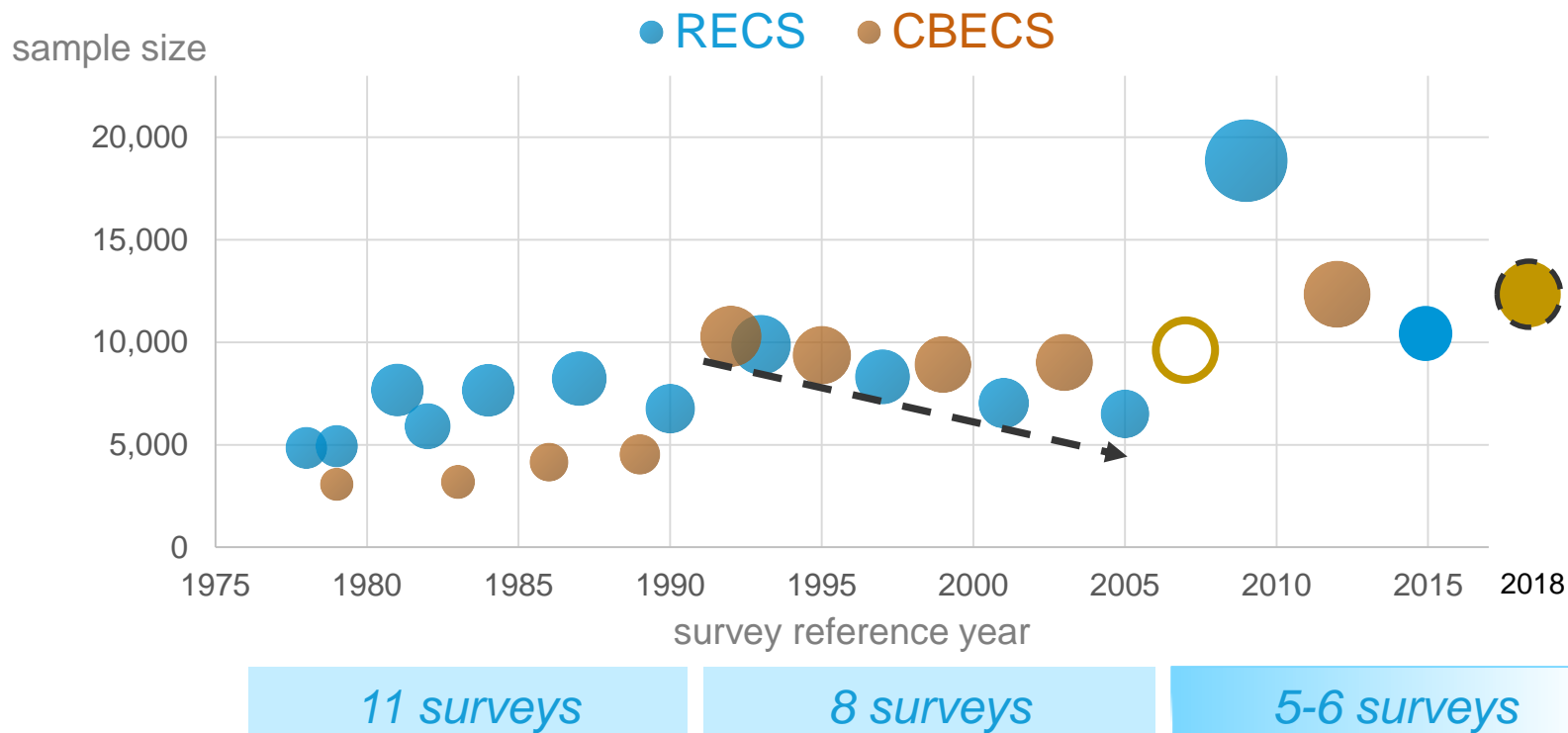
Consumption surveys are widely used in energy performance management, policy and planning goals

Domestic energy consumption remains relatively flat in the Reference case—

Energy consumption (Reference case)
quadrillion British thermal units
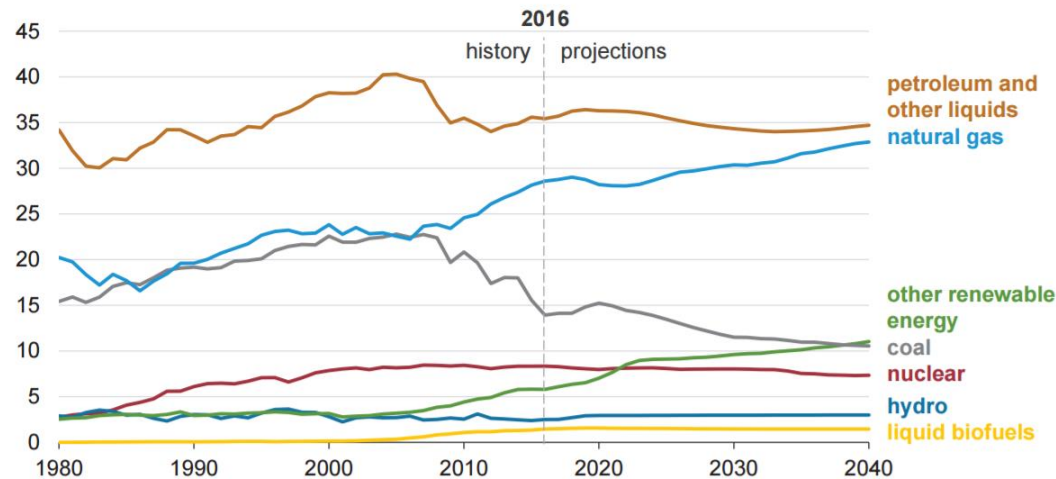
Consumption surveys are the basis for –

- long term energy demand projections

- building energy performance ratings systems

- appliance efficiency standards

Source: US EIA Annual Energy Outlook 2017, https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf

Some lessons learned over 40 years of consumption studies

- Start with good sample frames

- Consider the value of covering the 'whole' population; define subpopulations sensibly—taxonomies matter

- Run pilots before programs; innovate frequently but cautiously, i.e. measure and adjust a strategy

- Have respondents report what they can well; augment, impute, model everything else

- Evaluate your results against related surveys and benchmarks

Start with good sample frames

Commercial

- Multi-stage area probability sampling design

- In-person listing of selected areas and characterization of all buildings in selected block/group of blocks

- Supplement with lists of large, unique, and/or energy-intensive buildings

Residential

- (same)

- Recently reliant on postal lists; augment where 'coverage' is poor with in-person listings

- Special methods for "missed units"

Covering the population

- EIA has two views of demand: microeconomic studies of consumers and macroeconomic studies of supplier data disaggregated by sector

- The consumption surveys do NOT cover the entire demand sector; it is not practical or desirable to do so

  - Residential: occupied housing <u>units</u>

  - Commercial: buildings over 1000 square feet (about 92 m^2)

  - Industrial: manufacturing

- Data gaps can be hard and expensive to fill; monitor boundaries that shift or swell over time, e.g., the growth of "mixed use" buildings (part residential, commercial)

Sequential versus concurrent piloting of new collections and methods

- The first residential survey was conducted in 1978/1979 and annually through 1983. "By 1983, we knew what we were doing."

- The commercial survey was inherently more difficult to launch. We've conducted fewer CBECS; they're more challenging to manage, the cost variance is higher.

- It is better to innovate in a controlled manner, evaluate results, than to take large risks on in the survey cycle itself.

- Concurrent, controlled experiments can provide timely project mitigations.

Collect, impute, model or augment data? Consider the source.

Commercial

- Respondents vary in the expertise of building energy characteristics and system

- Respondent roles vary widely within and between building types; this affects response quality

- About half of respondents can self-report energy consumption data

Residential

- Particular items are hard for householders: age of home, square footage of home

- Tenure at address, own/rent, and awareness affects ability to answer more technical questions

- Householders are largely unaware of their energy bills; we don't try

Stage 1: Start small. Be strategic. Succeed quickly.

- Begin by studying what's easiest to sample and has good coverage

- Identify an early policy win

- Consider critical buildings

Large office buildings

Elementary schools

Hospitals

Large buildings (over 100,000 square feet) are just 2% of the building stock but about 35% of the total floorspace and 41% of consumption

Size of buildings in square feet

- Over 500,000
- 200,001 to 500,000
- 100,001 to 200,000
- 50,001 to 100,000
- 25,001 to 50,000
- 10,001 to 25,000
- 5,001 to 10,000
- 1,001 to 5,000

Buildings:
- 0.1%
- 0.7%
- 1.6%
- 3.6%
- 6.0%
- 15.9%
- 22.1%
- 50.0%

Floorspace:
- 8.1%
- 12.3%
- 14.3%
- 16.0%
- 13.7%
- 16.2%
- 10.2%
- 9.2%

Energy consumption:
- 11.0%
- 14.7%
- 14.9%
- 15.3%
- 11.8%
- 12.6%
- 9.3%
- 10.4%

(Percent of total commercial)

eia
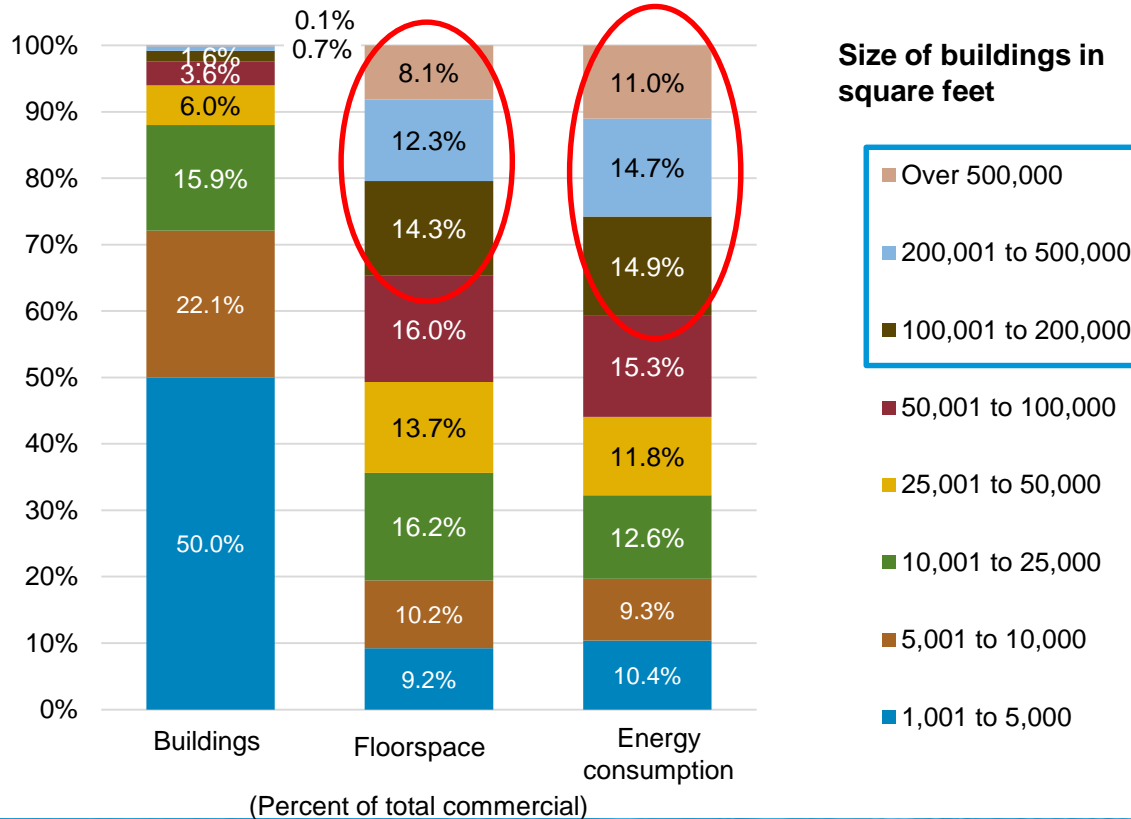
Taxonomies matter. With good building classifications (principal building activities), it's easier to --

- Achieve sharper metrics for policy goals. (Note: CBECS' has a large, varied 'other' category; don't bury what's important in 'other'.)

- Target goals within similar groups, tailor messages and engage a homogenous group (schools, hospitals, etc.)

- Make the taxonomy relevant to India.
  - Example: US versus Britain on principal building activities
  - Lumpers and splitters; let statistics and practical considerations be your guide

Decrease in total energy intensity driven by office and education buildings

Left chart — Total energy use per square foot (thousand Btu), by building type, 2003 and 2012:

- Food service
- Inpatient health care
- Food sales
- Other
- Enclosed and strip malls
- Lodging
- Outpatient health care
- Public order and safety
- Public assembly
- **All commercial bldgs (*)**
- Office (*)
- Education (*)
- Retail (other than mall)
- Service
- Religious worship
- Warehouse and storage
- Vacant

Legend: 2003, 2012

Total energy use per square foot (thousand Btu)

Right chart — Percent, % total energy (2012) and % total floorspace (2012):

- Food service
- Inpatient health care
- Food sales
- Other
- Enclosed and strip malls
- Lodging
- Outpatient health care
- Public order and safety
- Public assembly
- Office
- Education
- Retail (other than mall)
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- Religious worship
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- Vacant

Legend: % total energy (2012), % total floorspace (2012)

Percent

(*) Office, education, and commercial buildings overall
showed statistically significant decreases from 2003 to 2012

Department for
Business, Energy
& Industrial Strategy
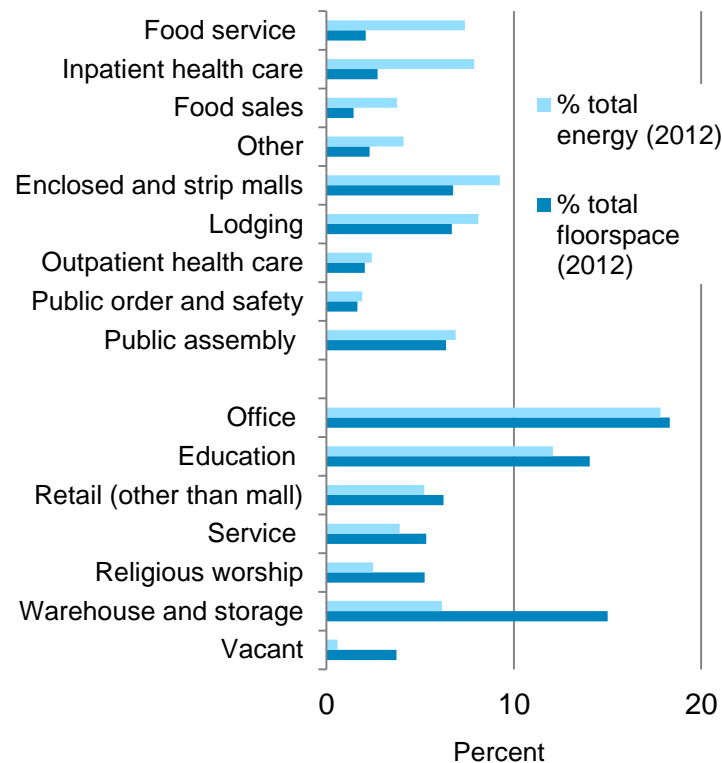
Sectors and sub-sectors surveyed

Education	Nursery	**Offices**	Offices (private sector)
	State primary		Offices (public sector)
	State secondary	**Retail**	Hairdressing/ beauty salon
	University Non-residential		Large food shop (> 750 m2)
	University Residential		Large non-food shop (> 1850 m2)
Emergency Services	Fire + Ambulance station		Retail warehouse
	Law court		Showrooms
	Police station		Small shop
	Prison	**Community, arts & leisure**	Clubs & community centres
Health	Health centre		Leisure centre
	Hospital		Museum, Gallery, Library
	Nursing home		Place of worship
Hospitality	Cafe		Theatre, Concert hall, Cinema
	Hotel	**Industrial**	Factory
	Pub		Workshop
	Restaurant and Takeaway	**Storage**	Cold store
Military	MOD Accomodation		Large distribution warehouse
	MOD Offices		Store
	MOD Storage		Warehouse

The 38 sub-sectors shown are used in the final reports. Some were surveyed and modelled based on more granular sub-sectors with tailored questionnaires.

In a perfect world, we'd have…

- A national <u>building</u> registry

- Mandatory reporting for large buildings

- Common data standards

- National building codes

- Better metering and for more utilities: electricity, gas, water