Consumption and End Uses Data in the U.S. Energy Information Administration: program update

For

MINEM – IEA– ADEME

February 2018 | Buenos Aires

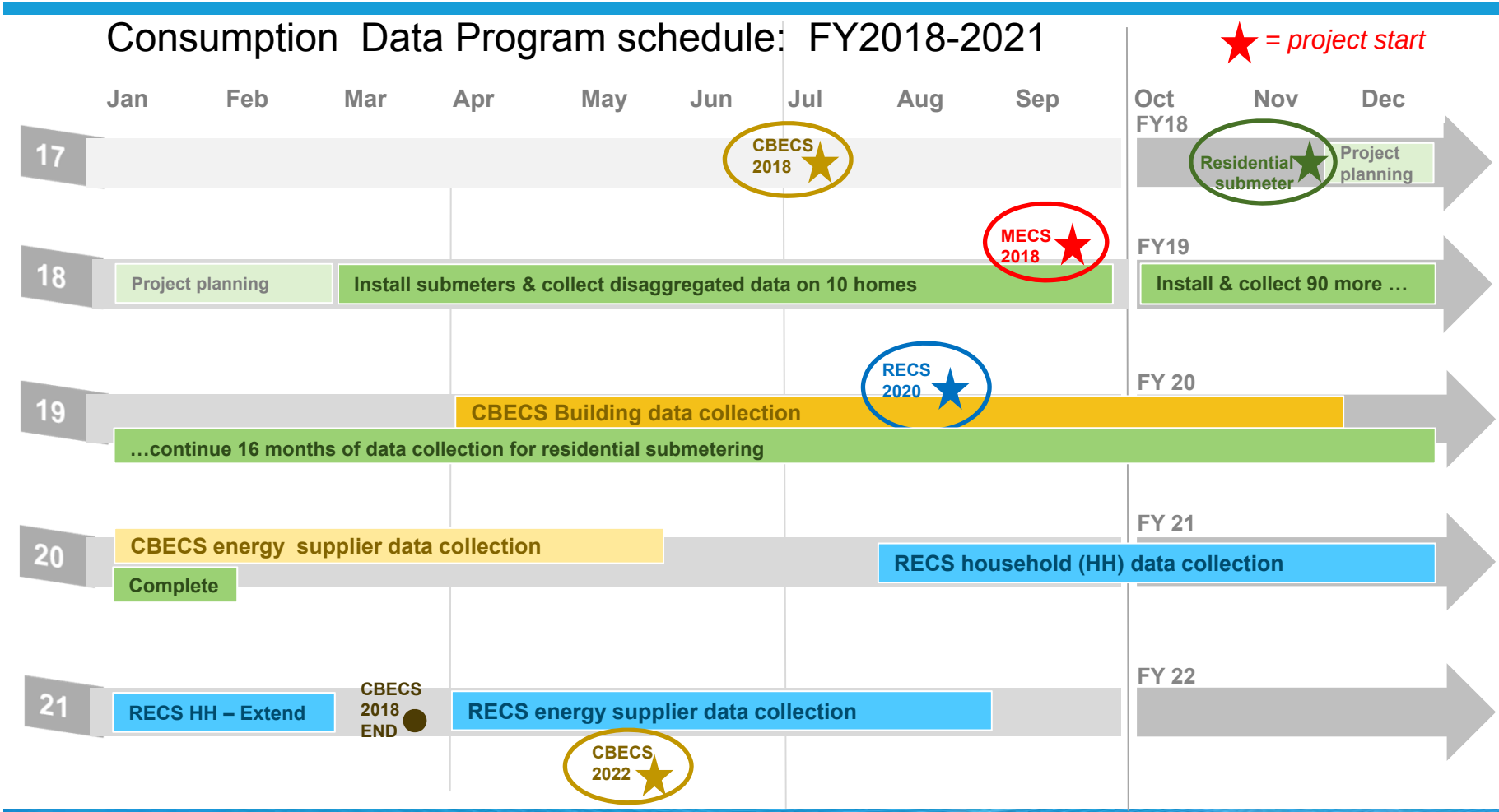
By

Eileen O'Brien, Lead, Buildings Surveys Statistics Team, U.S. EIA

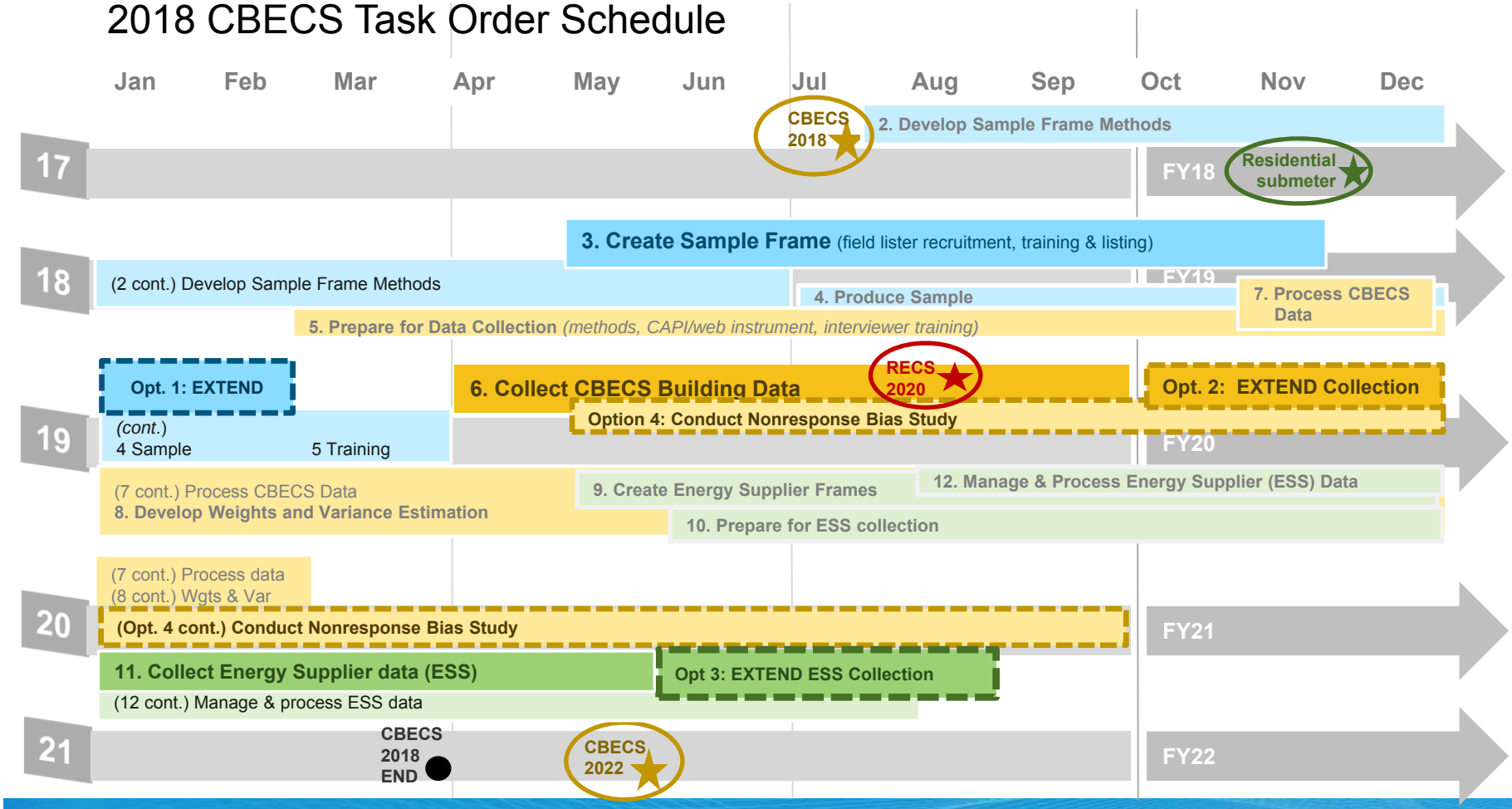
U.S. EIA's energy consumption data program is undergoing major improvements in the following areas:

- How we sample, design, collect and estimate energy consumption
- How we model demand for total, building-level and end uses
- The nature of the data itself: its granularity, velocity, and sources

Consumption Data Program schedule: FY2018-2021



2018 CBECS Task Order Schedule



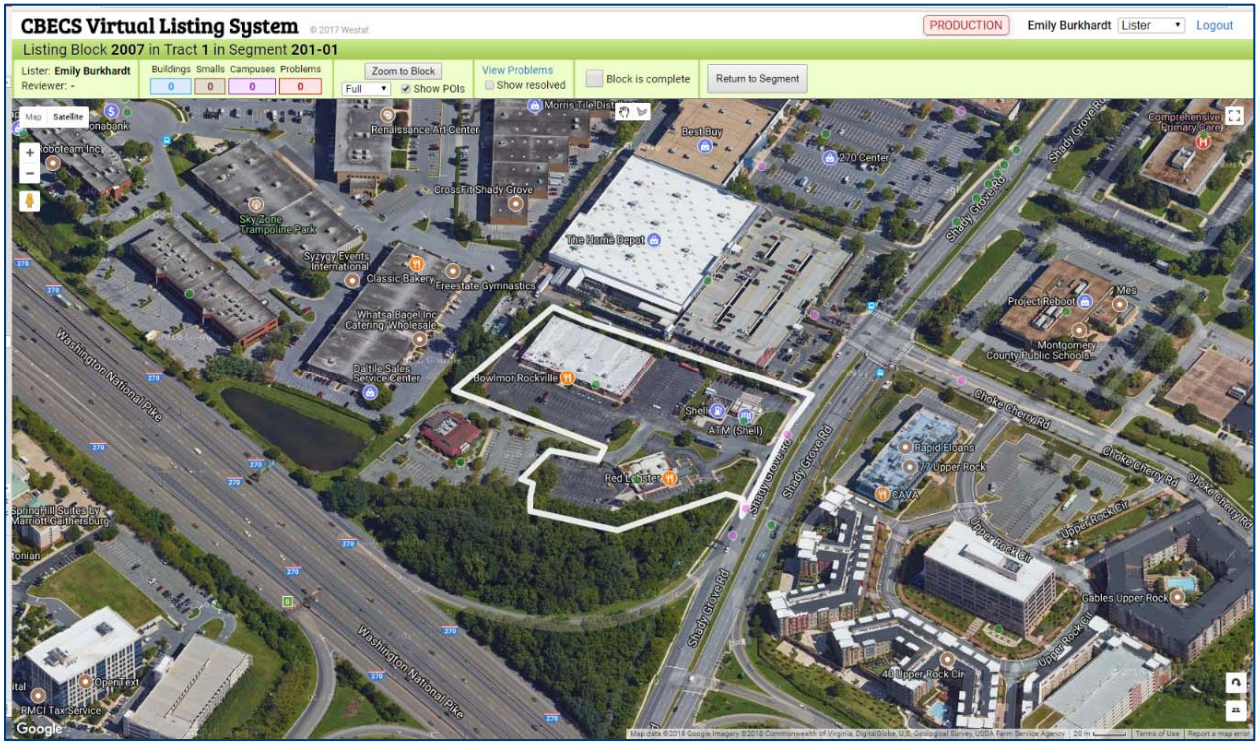
What's new in the consumption data program?

Recent improvements have reduced the labor and costs of building a sample frame, selecting a sample, and collecting data

Sector	Unit of analysis	Sample frame, new methods	Mode of data collection	End use methods
Residential	Primary home	Since 2005, only field-list units in area segments with 'bad' coverage on U.S. postal address frame. Use augmented postal list for most of sample frame.	Since 1997, CAPI/CATI. In 2015, mix of modes: CAPI, mail, and web.	With 2015 RECS, engineering-based models were used to calibrate energy bills to end uses
Commercial	Buildings	PLANNED 2018: only field-list area segments with poor coverage relative to traditional, field-list methods: use GIS methods for most of frame.	Since 1995, CAPI and/or CATI. In 2018, will allow self-completion by secure web form.	Since 2003 CBECS, engineering-based models calibrated to annualized energy bills.
Industry	Manufacturing establishments	Business registry of the U.S. Census Bureau	Since 2006, majority by web.	Direct response or derived form.

CAPI = computer assisted personal interview; CATI=Computer Assisted Telephone Interview; and web is a standardized online version of the survey questionnaire offered to a respondent via a mail or in-person invitation

For the 2018 CBECS, we are also testing "virtual listing" methods to construct our area sample frame, which changes effort, costs and quality.



More information about CBECS sampling methods can be found here: https://www.eia.gov/consumption/commercial/2012-cbecs-building-sampling.php

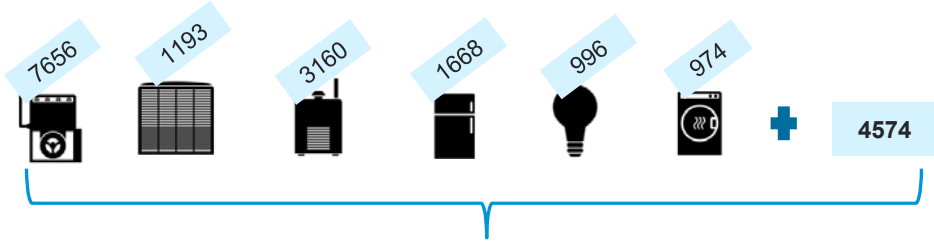
End-Use Modeling methods used in CBECS have been adapted to the 2015 RECS data; results are expected this spring.

Stage 1: Household respondents report housing characteristics and usage behavior (voluntary)

Stage 2: Energy Suppliers provide consumption data for sampled units (response is mandatory)

Stage 3: Produce individual end-use estimates using engineering-based models

Stage 4: To obtain the final end-use estimates for each housing unit, calibrate the engineering result to agree with the annualized energy supplier amount



X_i: engineering model estimate of an i end use

$\Delta Y = 6863 = \sum \Delta X_i$

Total Engineering Estimate
Y_{eng} = **20221**

Billing Data Total
Y_{truth} = **27084**

Beyond models, EIA has begun testing new technologies to objectively measure end use demand. Recent research shows:

- So-called “NILMs” (Non-Intrusive Load Monitoring) are definitely *the* hot topic, and shared by different interests:
  - Energy Efficiency, Demand Response, Measurement & Verification, Energy Audits, Appliance Diagnostics, Cost of Service, etc.
- NILMs are being pursued by Consultants, Non-Profits, Academics, and a few Utilities
  - Almost all extant work has been circuit-level metering, and not NILM methods
  - Whole-Premise monitoring considered to be NILM by some but still requires Home Visit as well as a Disaggregation Algorithm
- Residential sub-metering can be challenging logistically
  - Complex stages: Planning, Design, Recruitment, Installation, Data Collection
  - It’s expensive; several thousand dollars per housing unit to be metered

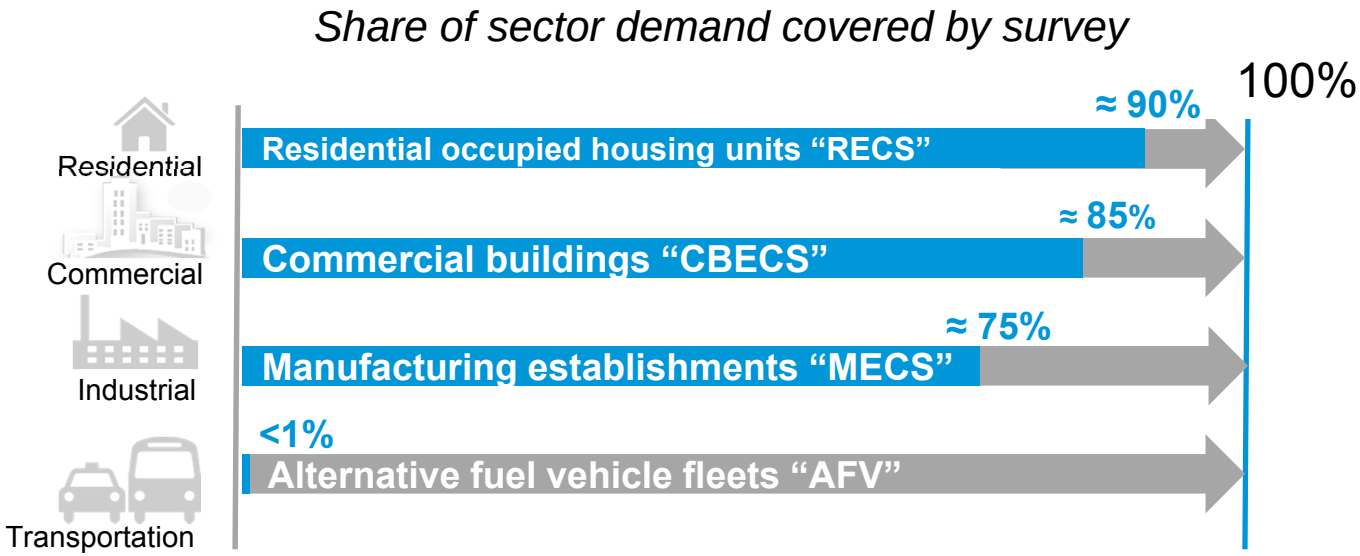
In this initial pilot study of NILM technologies, EIA will conduct analyses to…

- Compare usage patterns between NILM device and respondent, (e.g., number of clothes washer cycles
- Compare usage characteristics (e.g., self-reported versus observed water temperature for a clothes washer or heated drying for a dishwasher)
- Compare actual consumption by end use to the RECS 2015 model results

We'll prioritize the research in three tiers in preparation for the 2020 RECS:

Priority	Products
Tier 1	Refrigerators, Dishwashers, Clothes Washers, Dryers, Cooking, Air Conditioning, Heating
Tier 2	Computers, Televisions, Home Entertainment
Tier 3	Lighting, Rare End Uses, Residual

One challenges that remains for EIA is consumption coverage by sector. EIA will consider "blended" data approaches to fill them.



**These are approximations of site energy for major fuels consumed estimated by the consumption surveys, over primary energy plus electricity retail sales (MER Tables 2.2-2.5), referred to as 'net energy'. This does not account for energy losses in commercial and industrial CHP and electricity-only plants and energy losses from fuel ethanol production.*

A few references

Recent modeling efforts

- Comparisons of Calibration Methods for the RECS Engineering End-Use Estimates — Shaofen Grace Deng, U.S. Energy Information Administration ; Greg Lawson , U.S. Energy Information Administration ; Chrishelle Lawrence, U.S. Energy Information Administration. Presented at the Joint Statistical Meetings, Baltimore (2017, July 31).

- Deriving Estimates for the Energy Consumption of U.S. Residential Space Conditioning Using Seasonal Datasets —William Lawson, U.S. Energy Information Administration (EIA). Presented at the Joint Statistical Meetings, Baltimore (2017, Aug 3).

Related technical documentation of CBECS and RECS

- Residential Energy Consumption Survey (RECS) 2015 Technical Documentation Summary, U.S. EIA, May 2017.

- 2015 RECS Square Footage Documentation Summary, U.S. EIA, October 2017.

- 2012 CBECS Methodology

- Lewis, Katie, “Exploratory Research on the Use of Google Earth to Create a Sampling Frame of Buildings,” U.S. Energy Information Administration, 2013 Federal Committee on Statistical Methodology (FCSM) Research Conference, Washington D.C. November 4-6, 2013.