What you see is Watt you Get: An NNSA Utility Cost Deep Dive

Annie Meenan, Daniel Puentes, Patrick Shelton, Matt Siiro

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BLUF

We developed **CERs to estimate future utility costs** at the NNSA sites

HOWEVER

We found substantial shortcomings and **inconsistencies across data sources** and are **recommending improvements and standardization** of the data collection and reporting process

Why are we doing this?

- PA&E conducts AoAs and other analysis for capital acquisition projects
  - ***Increasing interest in Total Lifecycle Cost rather than just TPC***
    - **Task**: Develop methods to defensibly estimate O&S costs
      - LCCE = TPC + O&S
    - ***Step 1:*** *Assess the O&S data that the DOE already collects*

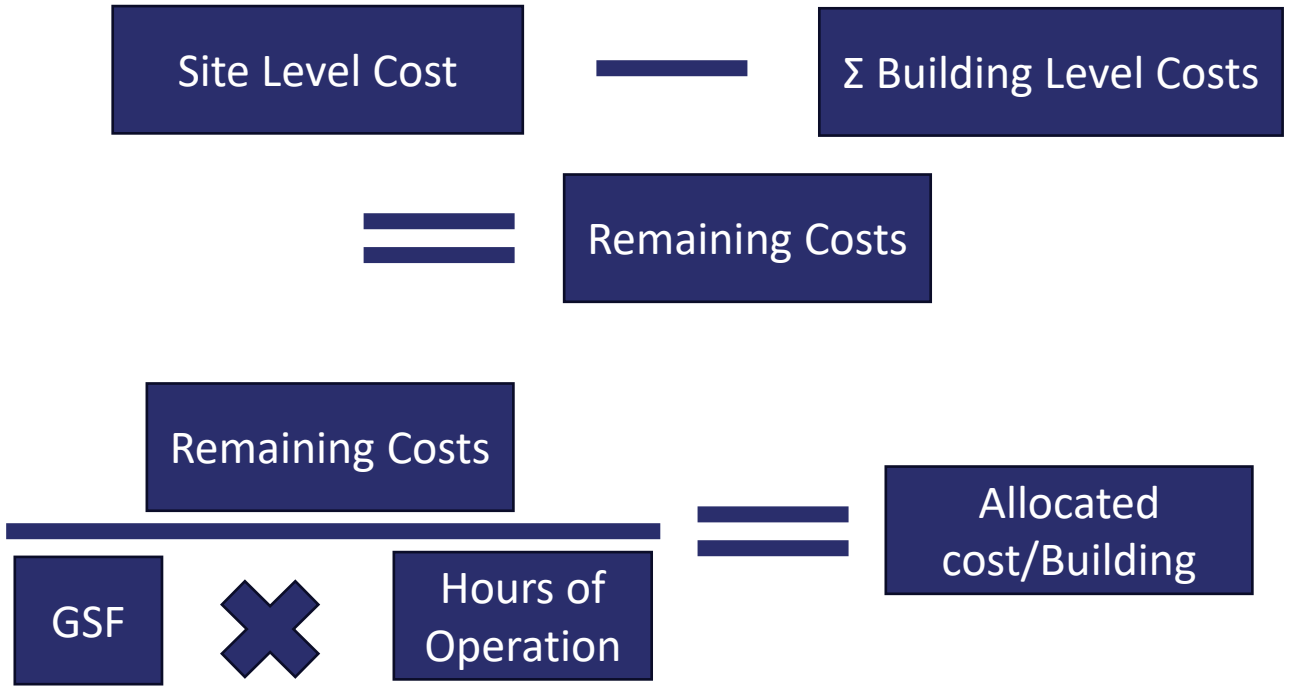
Introducing – The Data

Introducing - FIMS

- Facilities Information Management System (**FIMS**) utilized by DOE to manage buildings across the agency
  - Mandated by DOE Order 430.1C
- FIMS Website: "Complete and accurate information on real property assets is critical to the Department for managing facilities and satisfying several external reporting requirements which includes … and the taxpayers."

FIMS Definitions

- In **FIMS**, each Utility is a component of Operating Cost:
  - **Electricity – *analysis focus***
  - Water
  - Gas
  - Heating
  - Cooling
- **Responsibility of FIMS Representative at each site**
- **Definitions:**
  - "Each component of Operating Cost MUST be entered at the site level (total cost at the site for each component)."
- **Allocation:**
  - "At fiscal year-end for each Operating Cost component,

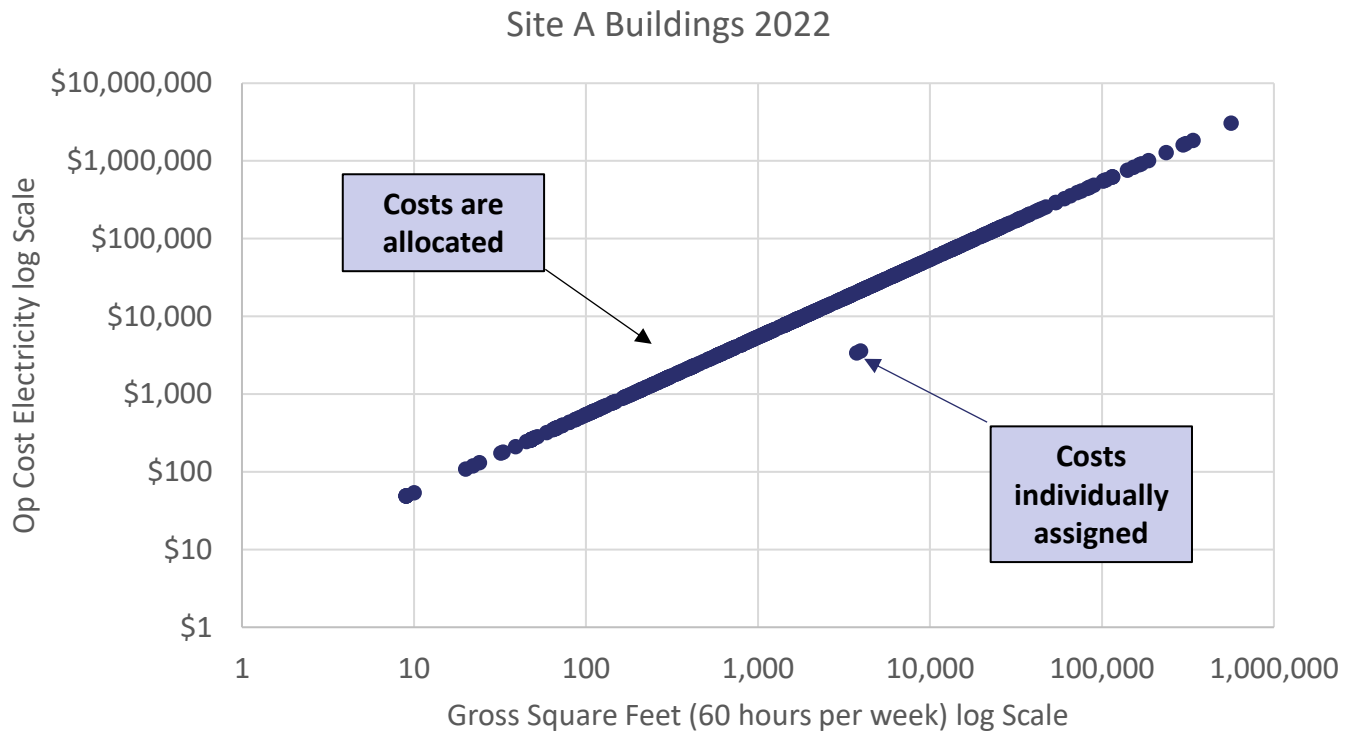


FIMS User Guide. (2024, February 29). Appendix A. FIMS data element dictionary.

Finding 1: FIMS Allocation Methods Insufficient

Finding 1: Allocations Not Actuals

- FIMS utility costs are allocated to buildings based on gross square footage (GSF) and operating hours per week.
- For this site in 2022, all but two buildings have the exact same electricity cost per square foot at standard operation hours.
- The FIMS allocation method ignores other characteristics that drive electricity costs



In FIMS, nearly all buildings are allocated the same electricity cost rate regardless of function or building type.

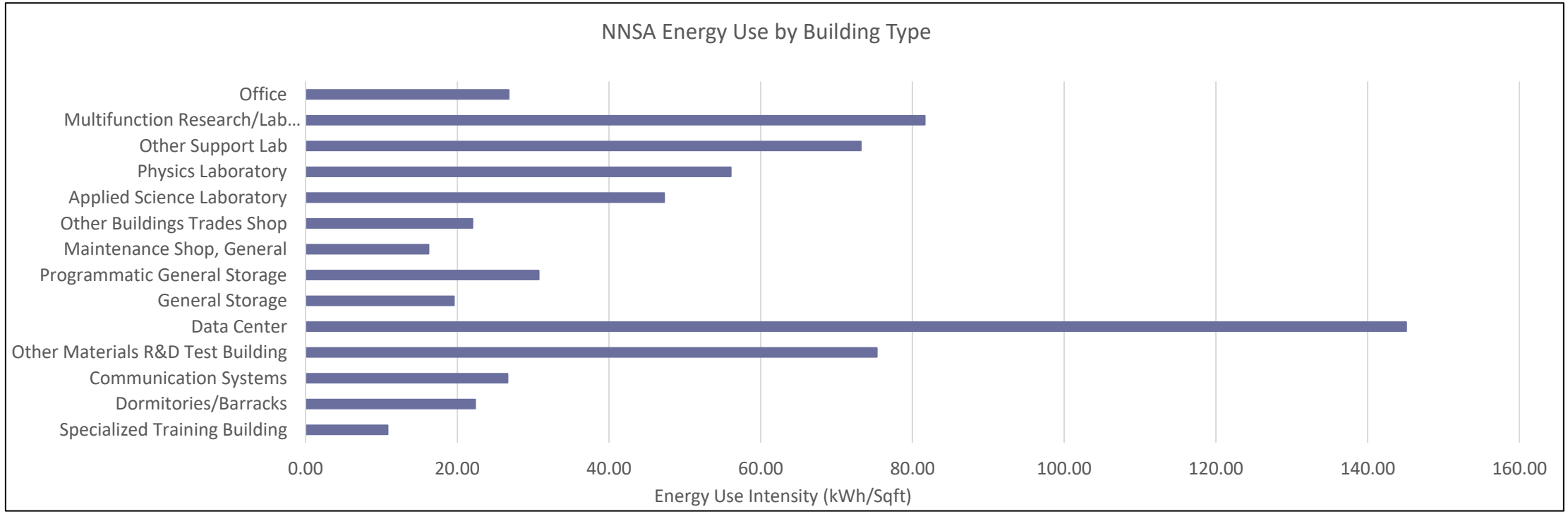
FIMS – Pulling the Thread

- Are there any other data sources out there that capture *actual* electricity costs at the building level?
- If not, is there any data or analysis that could help us to better *estimate* utility costs at the building level?
- What other parameters can we utilize in our CER?

Usage Code	Core Capability	Facility Age
Building Type	Number of Occupants	Hazard Category

Introducing - FEMP

- The Federal Energy Management Program (**FEMP**) generates building level energy **usage** *(kWh)* benchmarks.



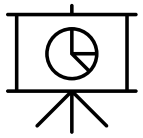
There is a clear indication that different types of facilities use different amounts of energy

PA&E Environmental Impact Team

Separate PA&E effort

- Goal: Estimate energy usage at each NNSA site *(but not cost)*

- Methodology: Use FEMP data to establish Environmental Impact Estimating Relationships (**EIER**)'s

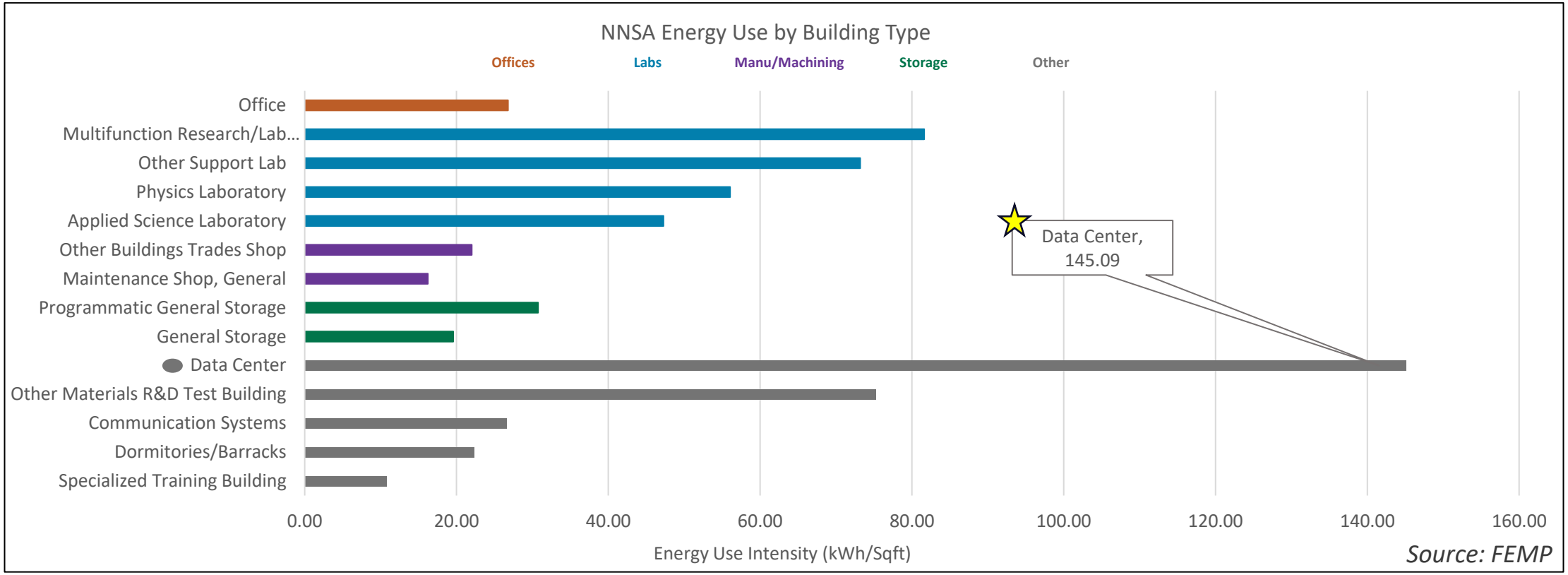


- Result: Developed **energy usage equations** for NNSA buildings as part of their environmental impact process

NNSA Result for EIERs:

$$y_{\log(energy)} = a + bx_{\log(\boldsymbol{gsf})} + cx_{\boldsymbol{operating\ hours}} + [Z] * [x_{\boldsymbol{facility\ type}}] + [W] * [x_{\boldsymbol{location}}] + error$$

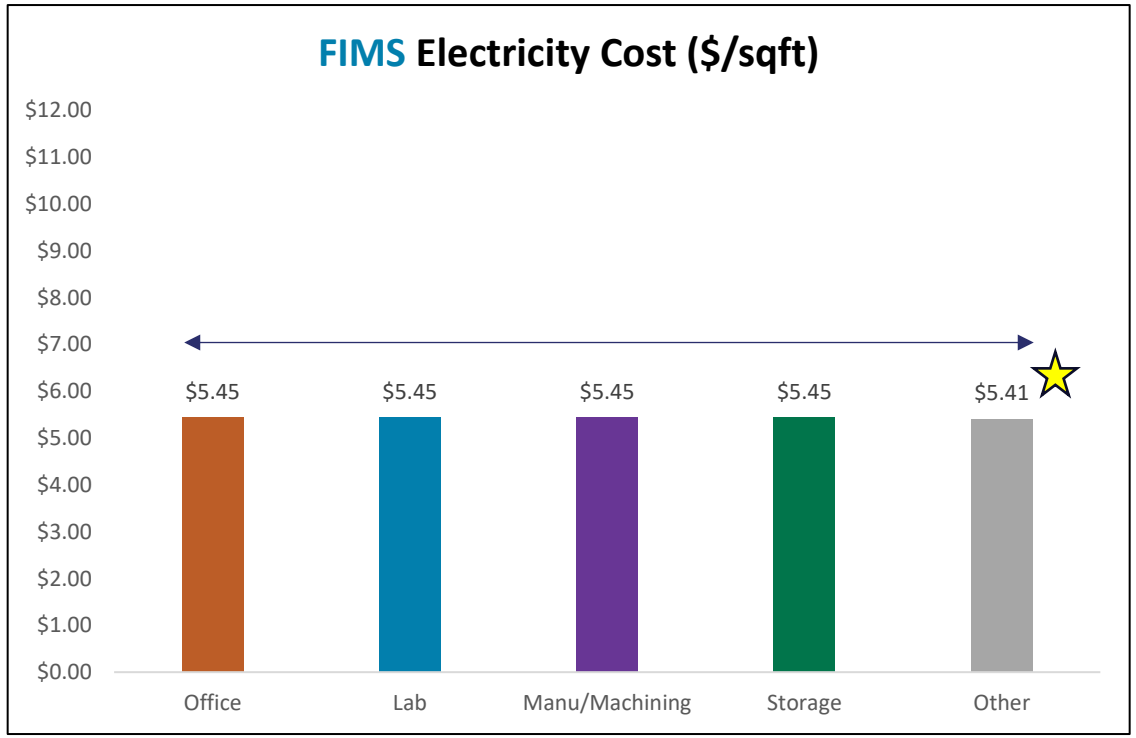
FEMP: Benchmarked Energy Rates

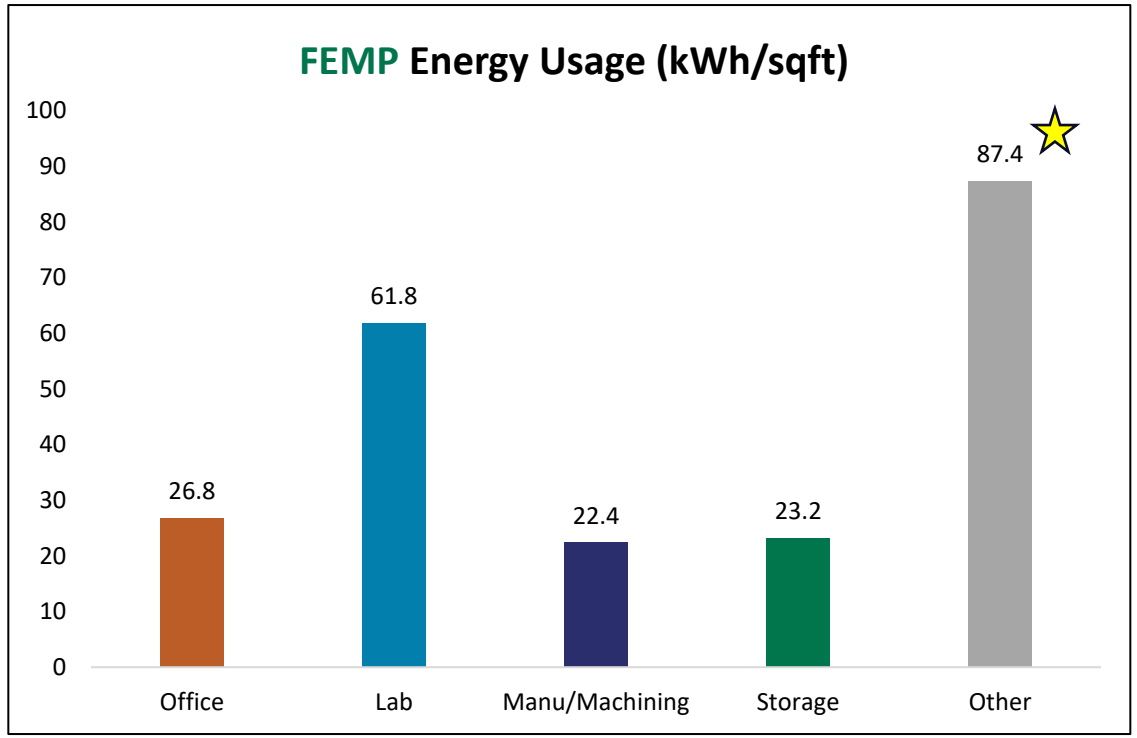


Usage codes are grouped by Facility Type category

FIMS Cost vs Energy Benchmarks

Allocated **FIMS** Electricity cost and **FEMP** energy usage, broken out by building type for a particular site.





The FIMS allocation method doesn't account for differences in energy usage

Backtracking – FIMS Easter Egg

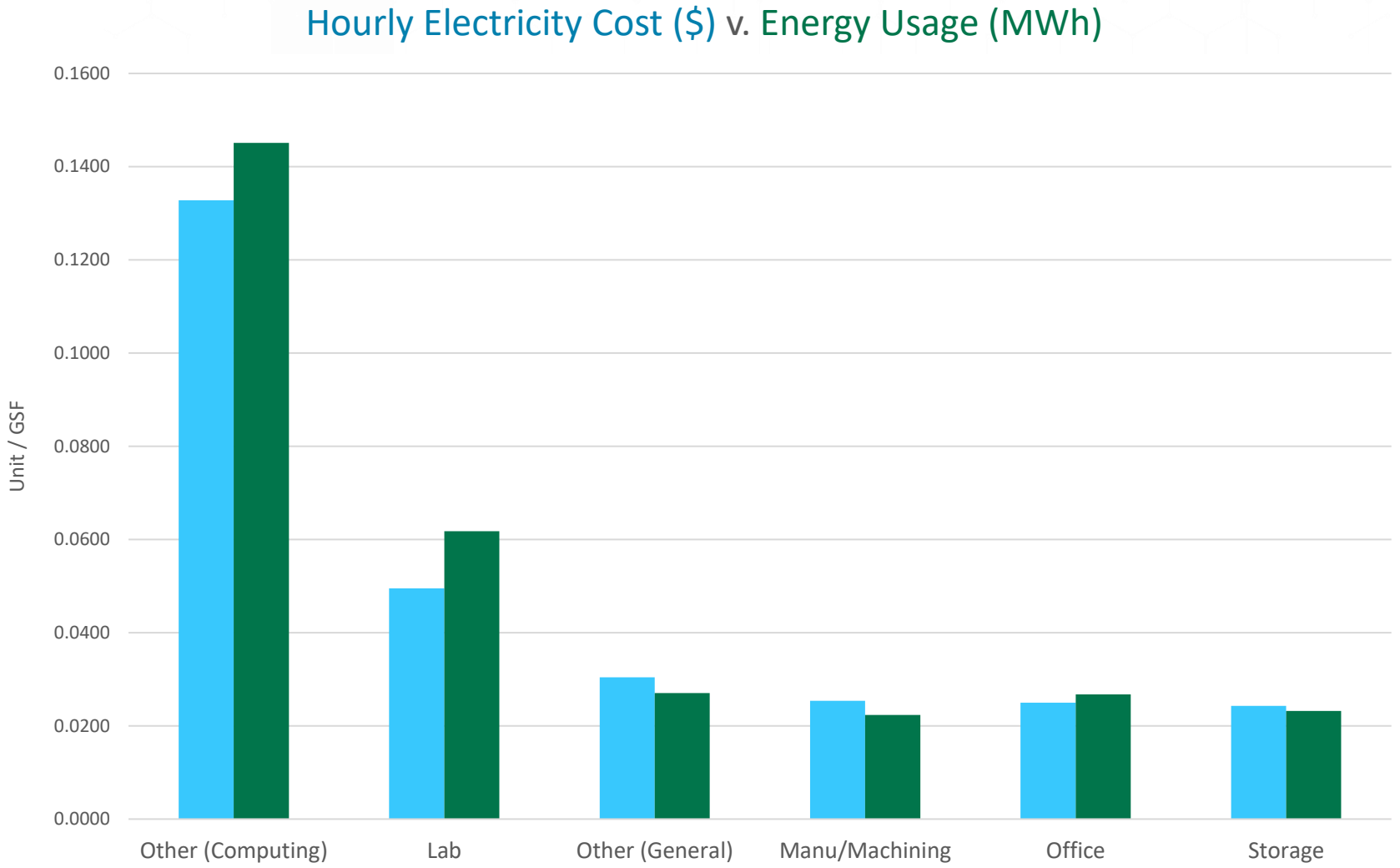
- Within the **FIMS** dataset there is a subset of building utility costs that were not allocated *exclusively* by gross square feet and operating hours
  - Site A from 2014 to 2018
  - Site B from 2014 to 2017
- The exact methodology during this period is unknown, as is why it only took place for a few of years.
- These unallocated, building level electric utility costs from **FIMS** were compared to the benchmarked electricity usage amounts from **FEMP**

FIMS Unallocated vs. FEMP

- **FEMP** Energy Usage directly correlates with **FIMS** Unallocated Costs (2014 – 2018)
- Building Level Costs align with FEMP data

Actual Costs Validate:

- ✓ **FEMP** as a data source
- ✓ **EIER** binning of facility types



Finding 2: Estimate Electricity Cost Using PA&E EIER Equations

Finding 2: Energy Usage as a Parameter

- Rather than use **FIMS** to directly estimate utility costs, use EIER equations to estimate usage, and then apply a cost/unit to each utility
- EIER Energy Usage Drivers:
  - GSF
  - Operating Hours
  - ✓ **Facility Type**
  - ✓ **Location**

FIMS Allocation

NNSA EIERs (Energy Usage Equation)

- Methodology:

Usage ✓

Site Rate?

$$\textbf{\textit{Electricity Cost}}\ (\$) = EIER\ Electricity\ Usage\ (kWh) * \left(\frac{\$}{kWh}\right)$$

Deriving Cost per kWh

- Three proposed methods of determining electricity cost per unit
  1. Total site electrical cost from FIMS and best available usage data
     - *$/kWh = Site Electricity Utility Cost ($) / Site Electricity Usage Estimate (kWh)*
  2. Values reported directly to the **DOE Sustainability Dashboard**
  3. Publicly available rates

More data to introduce!

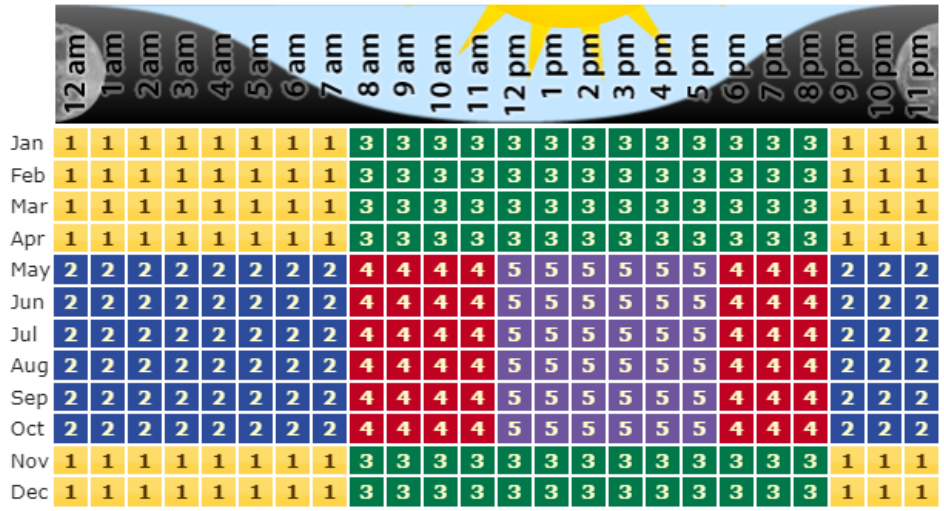
Note on Cost per kWh

Pacific Gas and Electric Co: Industrial Electricity Rates

Tiered Energy Usage Charge Structure

Period	Tier	Max Usage	Max Usage Units	Rate $/kWh	A
1	1		kWh	0.07734	
2	1		kWh	0.07361	
3	1		kWh	0.093	
4	1		kWh	0.09765	
5	1		kWh	0.13875	

Weekday Schedule

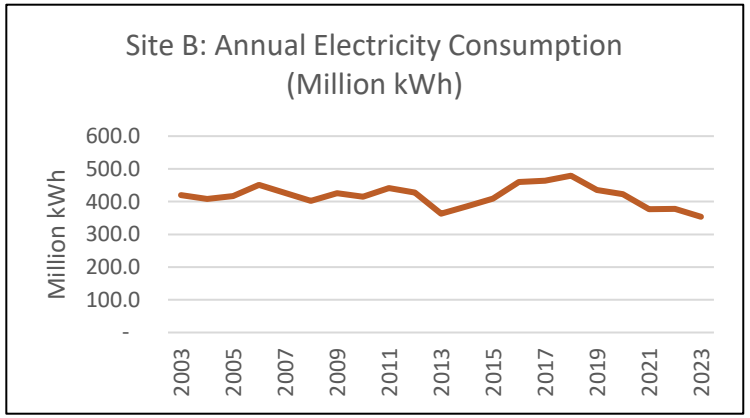


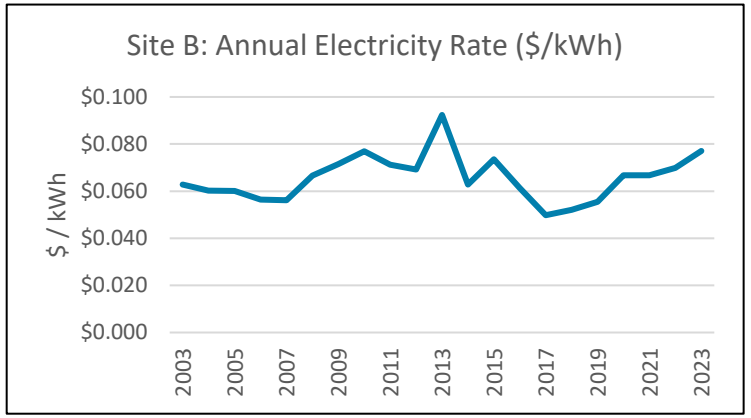
Source: OpenEI.org

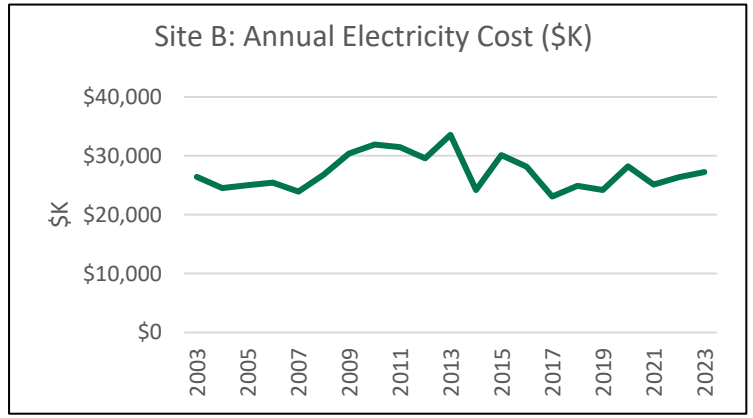
- **We are looking for yearly average rates, not a complex rate structure**
  - For our purposes in early-stage lifecycle cost estimating these tables are too complex.
  - All we need is the **average annual rate** (*annual cost / annual usage*)

Introducing - DOE Sustainability Dashboard

- Energy Usage and cost totals are reported at the site level to **DOE Sustainability Dashboard**
- The costs reported to the **DOE Sustainability Dashboard** claim to be directly linked to **FIMS**







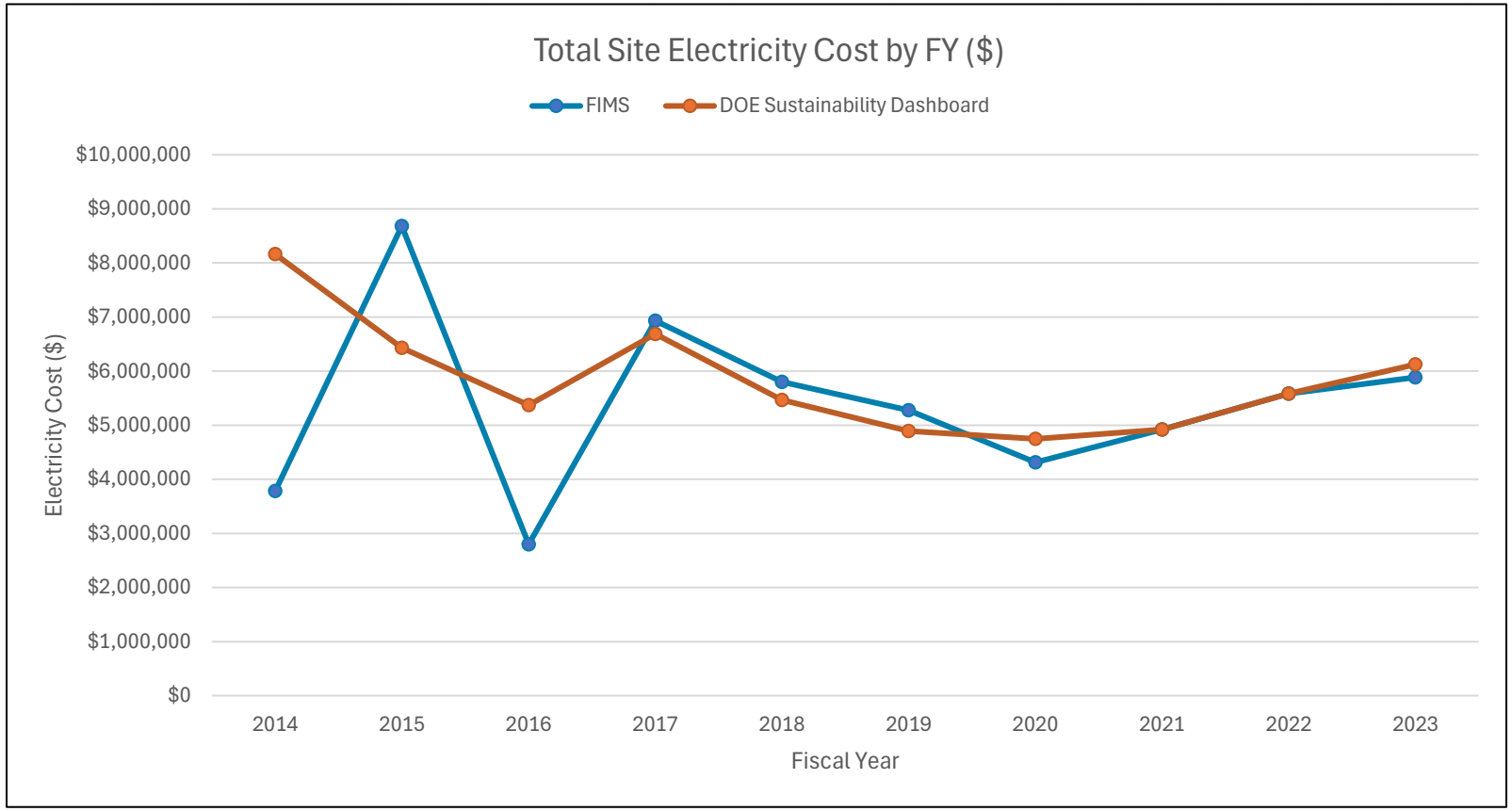
Source: DOE Sustainability Dashboard

Having the cost *and* usage metrics in the same data set allows us to convert EIER energy usage metrics (kWh) to energy costs.

Finding 3: Cost data is not consistent across reporting sources

Discrepancies Between Reporting Sources

- There is a discrepancy of “Op Cost Electricity” in **FIMS** and the electric utility costs reported to the **DOE Sustainability Dashboard**.
- If these sources are linked, what is driving the differences we see?

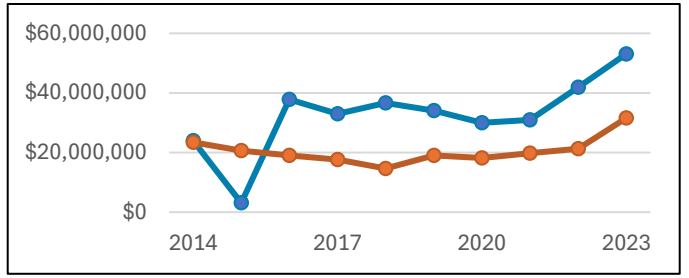


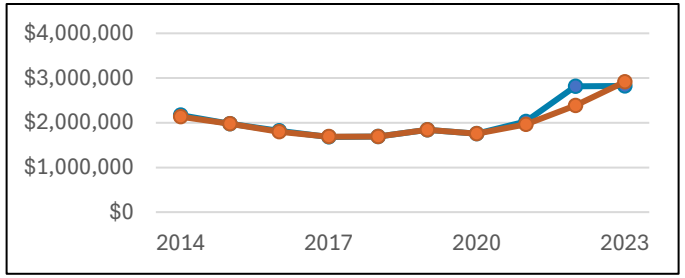
What is the relationship like for the other sites?

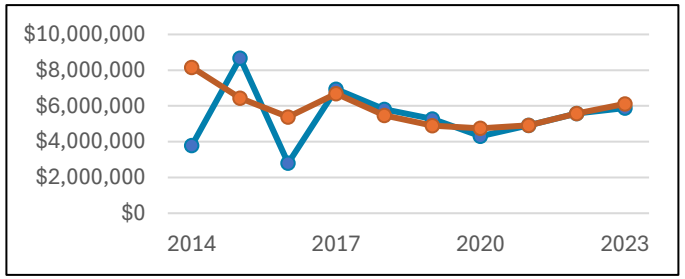
Discrepancies Between Reporting Sources

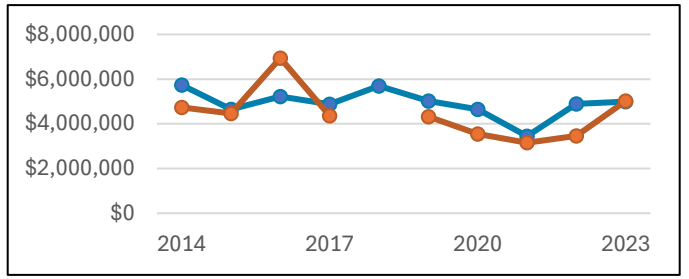
Site electricity cost totals 2014 – 2023.

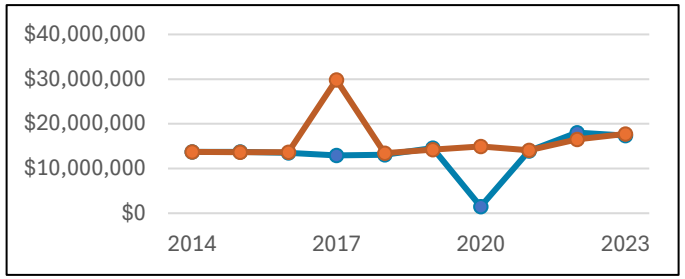
Values reported to **FIMS** and the **DOE Sustainability Dashboard** by various sites.

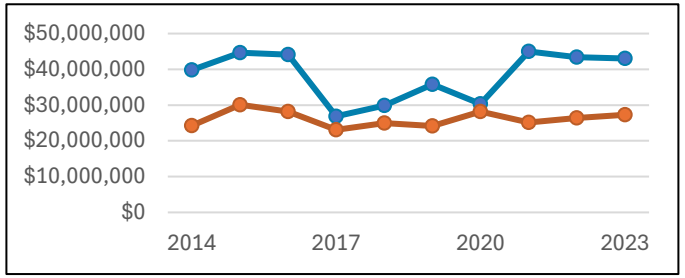


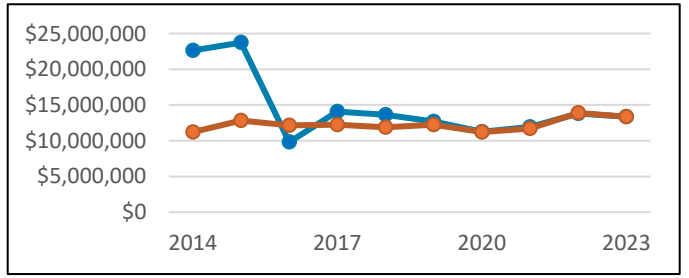


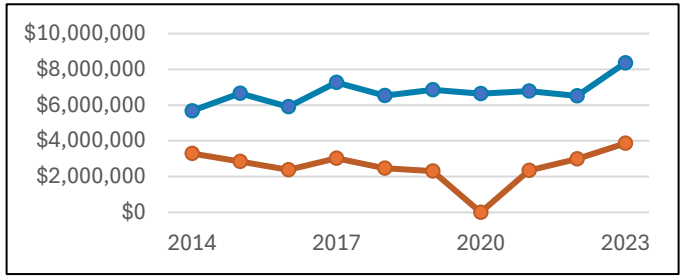












There is no consistent relationship between FIMS electricity costs and DOE Reported utility costs across sites

Pulling the Thread – DOE Sustainability

- The Sustainability Dashboard claims to be directly linked to FIMS
  - Meaning: the site level costs in DOE Sustainability should exactly match the site level costs in FIMS
    - Is that the case?
- We would like to know what is being calculated in the FIMS Operation Cost – Electricity variable, and why it deviates from reported values of electricity purchases to the DOE Sustainability Dashboard.

Introducing – Publicly Available Rates

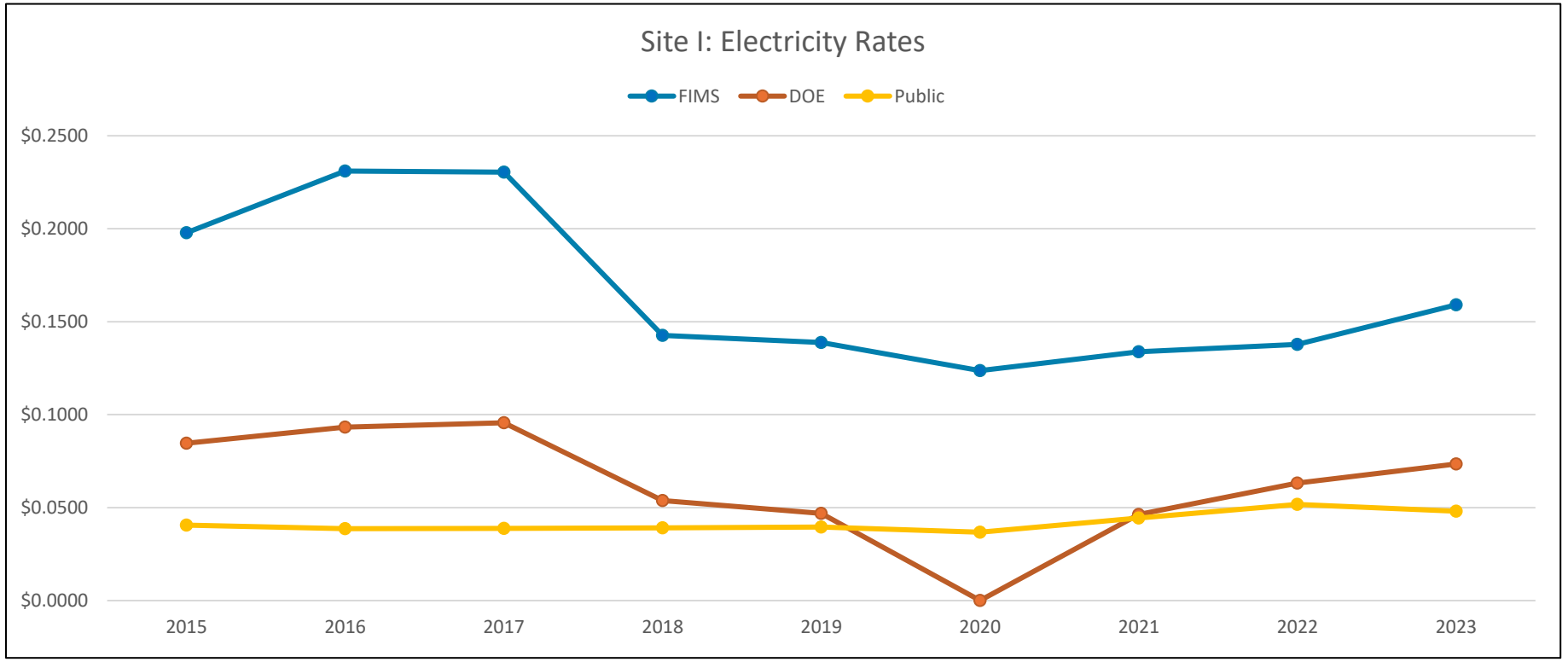
- The Energy Information Administration (EIA) and the National Renewable Energy Laboratory (NREL) have compiled substantial information on electricity prices.
- Both sources aggregate electricity rates published by utility providers.
- We can attempt to use this publicly available data to validate FIMS and/or the DOE Sustainability Dashboard.

Public Data Sources

Data Source	Description	Pros	Cons
OpenEI (EIA)	Utility Rate Database, full rate structures of all utility providers	2024 rates for all utility providers available at each site	Utility rate structures are complex and beyond the scope of our estimating needs
EIA State Averages	Historic state average electricity rates	Time series data (2001 – 2023)	Limited to state level
NREL	2020 Average industrial $/kWh for all utility providers in all zip codes	Point estimates for industrial utility rates at a more granular level	Only one year of data available Aggregation methods not well defined
Historic EIA Averages + NREL locality factor	Average $/kWh for a state (EIA), adjusted for locality (NREL)	Time series data (2001 – 2023) Lower level of granularity	Assumptions on locality factors over time

Public Rates: How do they compare?

Published electricity rates compared to rates reported to the DOE Sustainability Dashboard and FIMS.

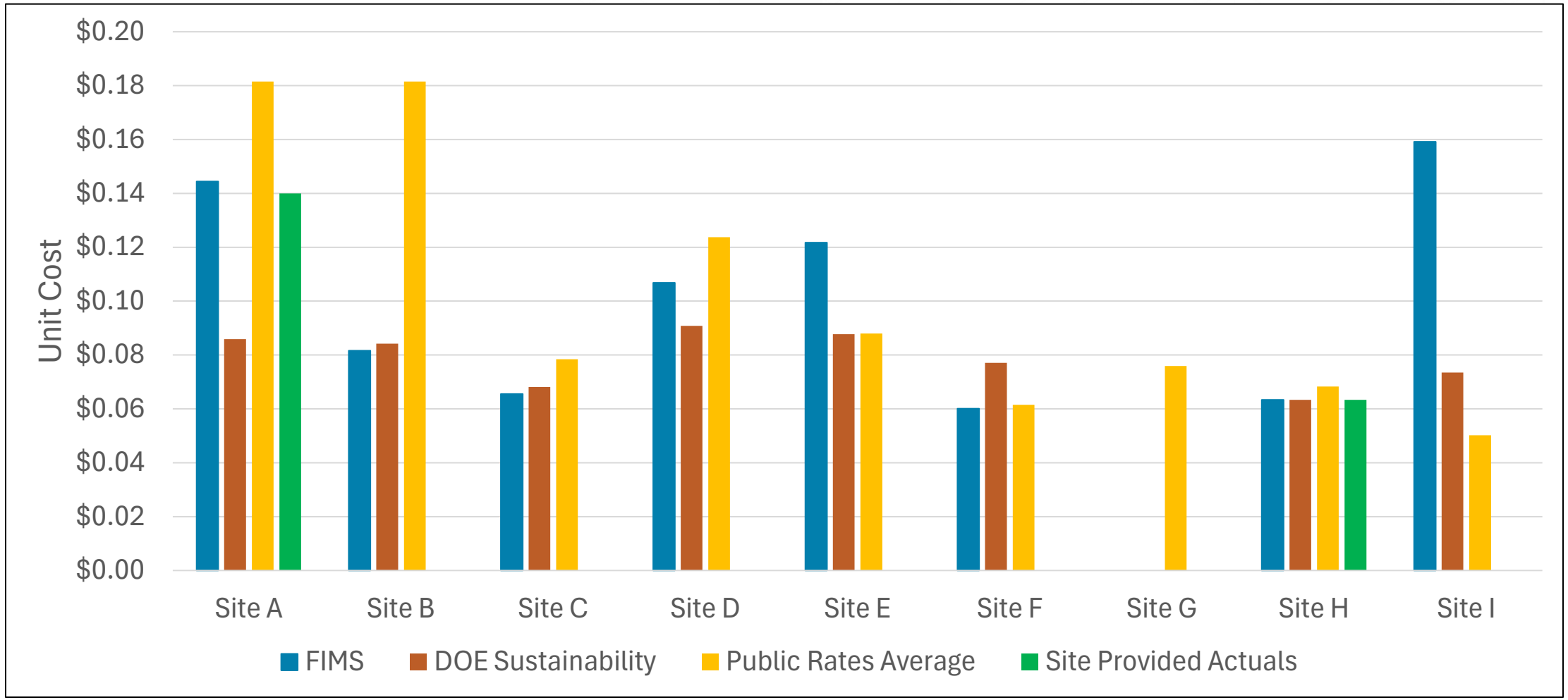


Which rate is correct?

Finally – Just Ask the Sites!

- Primary sources >>> Secondary Sources
  - Sites will know best which data source is correct and explain why there are differences between sources
- Asked each site for their actual electricity usage and total cost
  - One site aligned perfectly with DOE Sustainability in 2023, but fell out of alignment for prior years
  - Three sites reported conflicting information to different sources
    - Site reps disagreed on what/how to report usage and cost
    - Some responses did not confirm the usage

2023 Rate Comparison by Site and Source



Summary – The Data Environment

Source	Site Level		Building Level	
	Cost	*Usage*	*Cost*	*Usage*
FIMS	*Actuals*	*X*	*Allocations / A Few Actuals?*	*X*
FEMP/EIER	*X*	*X*	*X*	*Estimates*
DOE Sustainability	*Actuals*	*Actuals*	*X*	*X*
Site Data	*Actuals*	*Actuals*	*?*	*?*

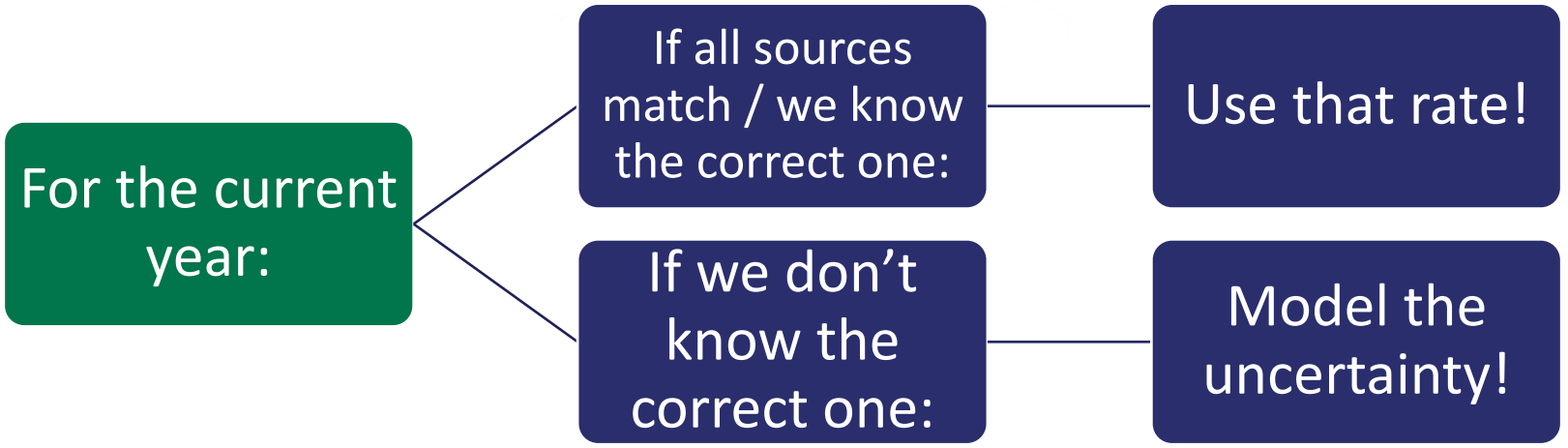
Cost and usage actuals should be identical across data sources

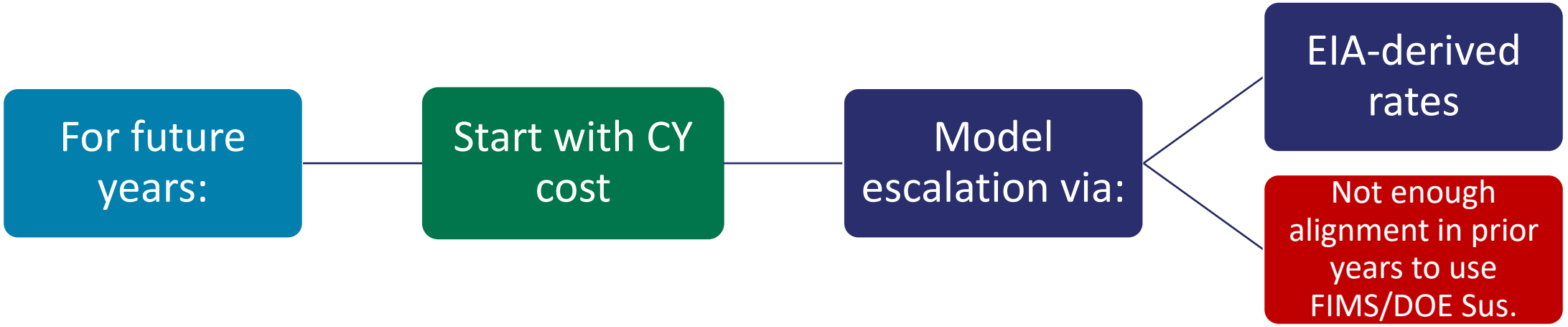
Takeaways – The Data Environment

- There is **no clear indication** that the **DOE Sustainability Dashboard** has been **consistently linked** to **FIMS**
  - **This casts doubt on which (if either) of the two sources is correct**
- Data directly from sites should be the most accurate, but need to understand why that data may differ from other sources

So…Which Cost per kWh Should We Use??

Our Solution – For Now





Our Solution – For the Future

Work with POCs at each site to:

Ideally – bring FIMS and DOE Sustainability into **full alignment** across all years

At minimum – understand and **document why there are discrepancies** between data sources, and make a clear determination of the best source to use for cost modeling

Reach – create a **database of each site's utility bills** and any additional costs that are burdened into each site's reported total

Once all data is validated and aligned:

- **Re-allocate site utility costs** to the asset level in FIMS using the same variables as the EIER

CERs – Present and Future

The CERs We *Have* to Use:

$$\textbf{\textit{Current Year Electricity Cost}}\ (\$) = Dist\{Total\ Electricity\ (kWh)\} * Dist\{\left(\frac{\$}{kWh}\right)\}$$

$$\textbf{\textit{Future Year Electricity Cost}}\ (\$) = Dist\{CYEC\} * Dist\{EIA\ Escalation\}$$

The CERs We *Want* to Use:

$$\textbf{\textit{Current Year Electricity Cost}}\ (\$) = Dist\{Total\ Electricity\ (kWh)\} * \left(\frac{\$}{kWh}\right)$$

$$\textbf{\textit{Future Year Electricity Cost}}\ (\$) = Dist\{CYEC\} * Dist\{Site - Specific\ Escalation\}$$

Conclusion & The Bigger Picture

We believe that **data errors** and **inconsistencies** in **FIMS** could be **pervasive** across all data categories, not just the electricity cost data

Conclusion for future analysis:

- **Be very cautious** when using **FIMS** data for any analytical methods
- **Best practice:** attempt to **validate FIMS data with site primary source data** or other credible sources

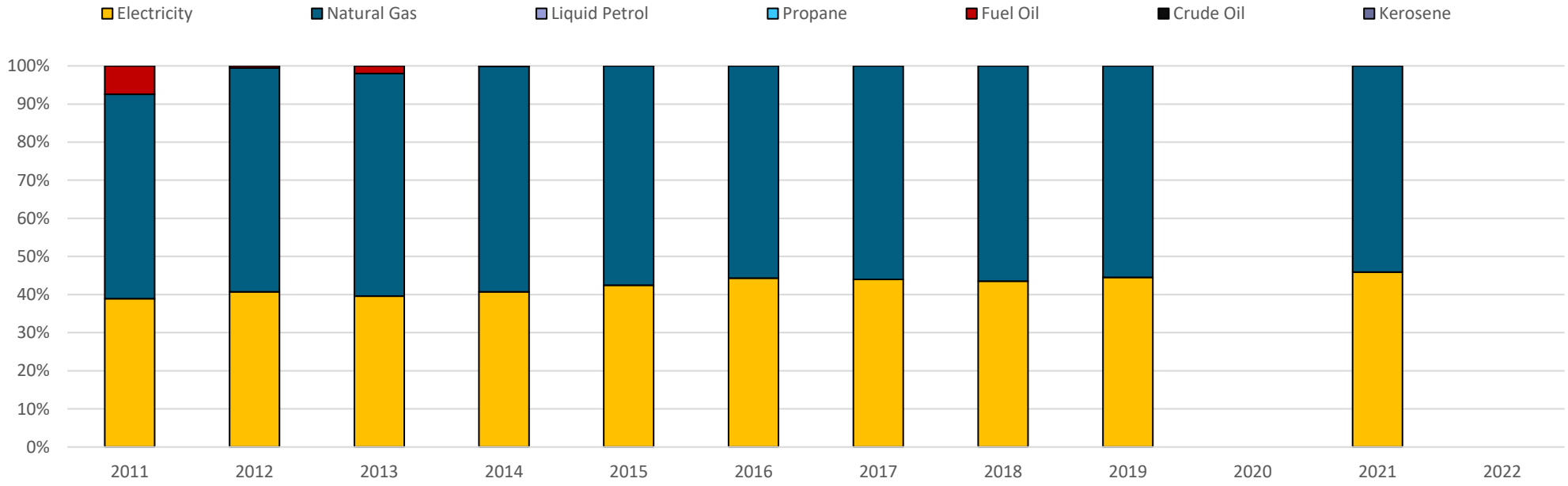
Creating a robust suite of O&S estimating tools will require a *substantial* data collection and validation effort throughout the DOE enterprise

Questions?

Backup

NNSA Energy Estimating Equation

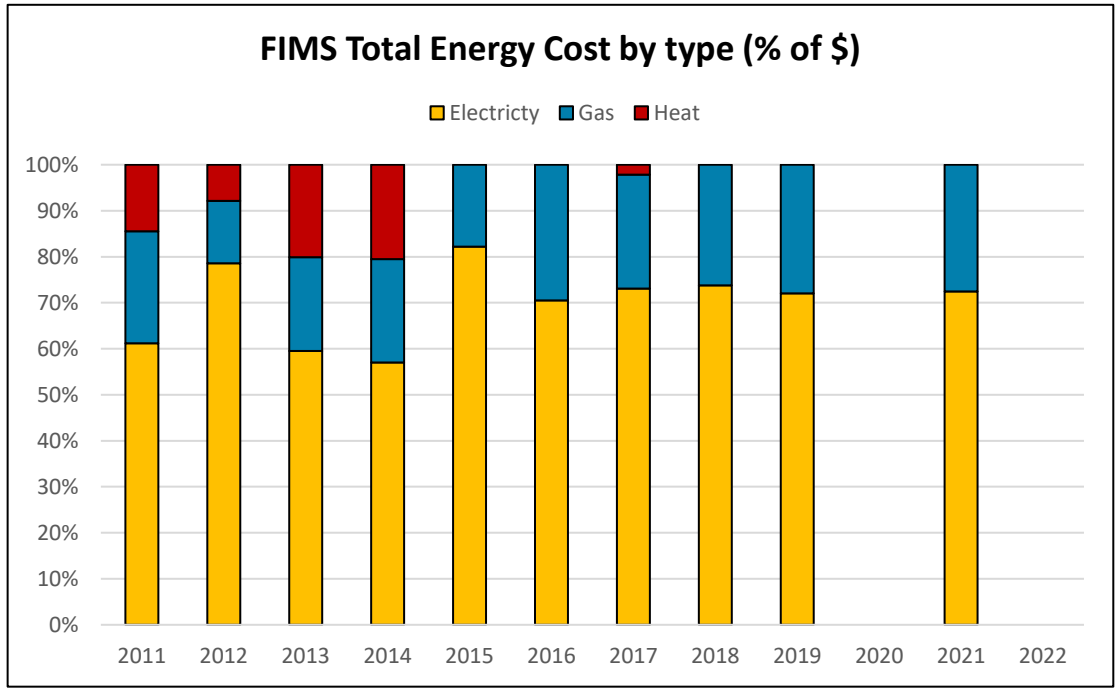
Electricity usage is derived from total energy using site level distributions from the DOE Sustainability Dashboard.

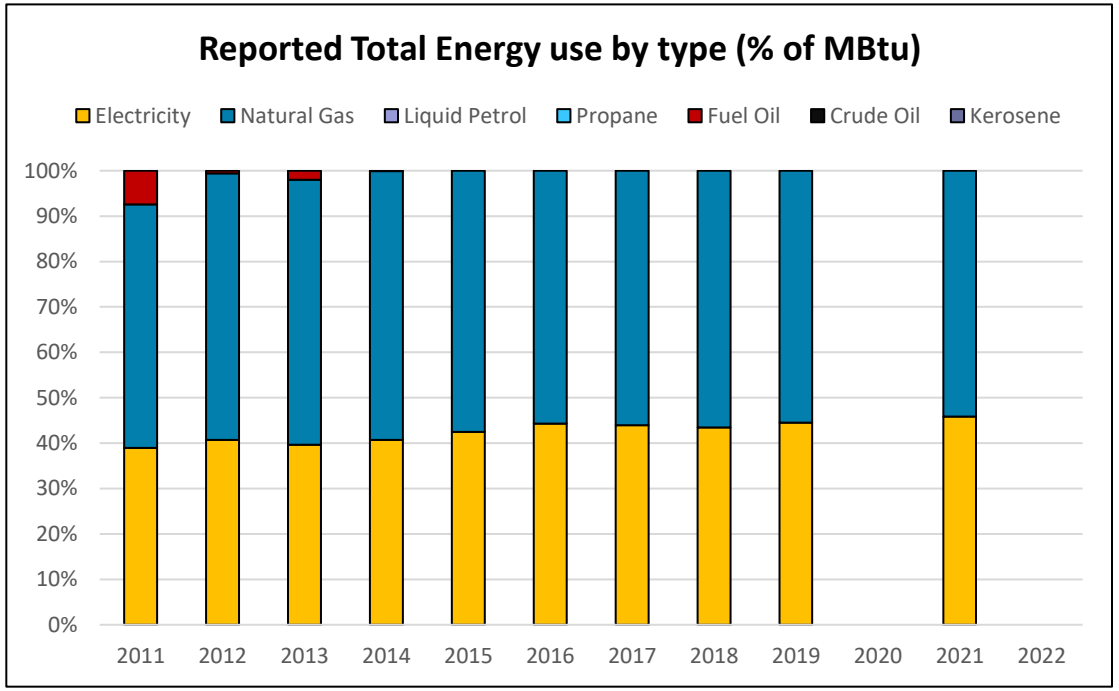


Source: DOE Sustainability Dashboard

A Bunch of Slides on Deriving Rates

- Energy usage and cost do not always align





Backup – Usage Groups

- The Federal Energy Management Program (**FEMP**) generates building level energy ***usage*** *(kWh)* benchmarks.
- Buildings are grouped into five categories based on usage code

Group	Offices	Labs	Manu/Machining	Storage	Other
# of Buildings	414	385	366	866	1078
Total Sqft	9,695,132	8,405,399	5,534,911	3,353,992	6,685,080
Average Energy Use Intensity	26.8	61.8	22.4	23.2	87.4

Our Solution – For the Future

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  - **Ideally** – bring FIMS and DOE Sustainability into **full alignment** across all years
  - **Reach** – create a **database of each site's utility bills** and any additional costs that are burdened into each site's reported total

- **Once all data is validated and aligned:**
  - **Re-allocate site utility costs** to the asset level in FIMS using the same variables as the EIER