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March 18, 2022

Transmitted to:
Massachusetts Department of
Energy Resources
(Via email)

The National Propane Gas Association asks that you consider the information contained herein to represent the position of the NPGA with respect to *Building Energy Code Straw Proposal: Updated Stretch Code & Specialized Opt-In Code* dated February 2022.

The National Propane Gas Association (NPGA) is the national trade association of the propane industry with a membership of about 2,500 companies, and 38 state and regional associations that represent members in all 50 states. Membership in NPGA includes retail marketers of propane gas who deliver the fuel to the end user, propane producers, transporters and wholesalers, and manufacturers and distributors of equipment, containers, and appliances. Propane gas fuels millions of installations nationwide for home and commercial heating and cooking, in agriculture, industrial processing, and is a clean air alternative engine fuel for both over-the-road vehicles and industrial lift trucks.

Questions the Straw Proposal Raises

The Straw Proposal represents an "aspirational" code proposal at best, and without code proposal text, the Proposal cannot be reviewed in detail as proposed building code language. Much of the presentation material is vague as to how it would be implemented in code language. Eventual code language proposed could easily be insufficient or contradictory to the Proposal slide presentation. Most importantly, the Proposal raises many questions of interpretation and technical support, incentivizing public comments that reflect uncertainties and specific questions that DOER ought to answer. Questions elicited by the presentation include the following:

- How does DOER account for emissions (slide #7) from buildings (i.e., new buildings as to be covered by the proposal and existing buildings)? Does this accounting take into account the heating energy-related emissions of carbon dioxide and other greenhouse gases (GHGs) upstream of the building (i.e., "source energy" based or "full fuel cycle" energy based) as it should in order to account for the total contribution to the

Commonwealth of Massachusetts's GHG emissions and attainment of the targets placed by the 2021 Climate Act?

- How does DOER define "net zero" as called for under the 2021 Climate Act (slide #7 and discussed in more detail below)?

- The "Base Energy Code" as promulgated and discussed in the Proposal (slide #8) is based on the International Energy Conservation Code (IECC), which includes potential consideration of source energy measurement for building energy efficiency. How are municipalities taking this option for building design into consideration, and should not DOER include at least source energy performance, which more closely aligns with Commonwealth carbon emissions and goals?

- According to the Proposal (slide #11), draft code language for both the "Updated Stretch Code" and the "New Specialized Opt-in Code" will be made available for public comment in "spring 2022" but has not yet been provided. When will this language be made available, and is it not premature to solicit public comments on the Proposal until the draft code language is available?

- Discussion of DOER analysis supporting the Proposal (slide #12) lists that it "analyzed up-front costs, operational costs, and total cost of ownership," but it has not provided its analysis or referenced analytical studies used. Does not conscientious public review require DOER transparency of its analytical basis for the Proposal?

- Emissions comparisons between electric heating and gas heating in residential and commercial buildings (slide #14) appears to be based upon simplistic comparisons of heating systems (discussed below) and application of emission factors. What was the process used by DOER to arrive at this simplistic description of heating systems?

- What quantitative justification can DOER provide for the disproportionate HERS rating performance requirements between fossil fuel heated residential low-rise buildings and electric heated buildings (slide #17)?

- Where has DOER documented and made available the "detailed analysis" of "representative homes" (slide #18)? This information, and the "detailed cost-benefit building case studies," are needed by the public to evaluate both the analysis approach and the selection of "representative homes." This relative lack of transparency stands in stark contrast to stakeholder availability of supporting analysis provided under other standards development processes, notably development of federal appliance and equipment minimum standards and availability of analysis through publication and public review of technical support documents (TSDs).

- Claims regarding results of the residential analysis made on slide #19 and elaborated on in slide #20 regarding the HERS 42 rating, "most homes choose electric heat," comparative construction costs, lower ownership costs, and "significant" GHG reductions from electric heating, including the reduction associated with "switching" are undocumented. How are these claims justified since no technical analysis justification is provided? Since "homes" do not "choose" heating systems, the claim applies to builders and design professionals who have multiple criteria for developing specifications. Such decisions do not manifest themselves as "switches" in specifications in new construction.

- Is there a quantitative basis for the proposed financial incentives for all-electric homes and passively heated homes (slide #21) while providing no incentives for requiring gas heated homes to meet a HERS rating of 42? Without a quantitative justification, the financial incentives in the case of an all-electric home meeting the HERS 45 threshold appears to be nothing more than a subside to electricity generators and distributors to boost grid electricity throughput. Similarly, do not the requirements for "pre-wiring [homes] for future electrification" (slide 27) provide a subsidy to electric utility interests?

The Straw Proposal and "Net Zero"

The Proposal and DOER more generally has not met the statutory requirement for DOER to define "net zero buildings" either in terms of net zero energy or net zero emissions. Contrary to the literal interpretation of the 2021 Climate Act[1] for defining "net zero," DOER staff has claimed that "net zero" does not necessarily apply to individual buildings meeting "net zero" design performance, but then how does the Commonwealth meet a "net zero" requirement? The language in the Act appears to call for defining "net zero" in terms of buildings and for use in developing code requirements consistent with that definition:

> *"*[DOER shall] *develop and promulgate, in consultation with the state board of building regulations and standards, a municipal opt-in specialized stretch energy code that includes, but is not limited to, net-zero building performance standards and* ***a definition of net-zero building****,* [emphasis added] *designed to achieve compliance with the commonwealth's statewide greenhouse gas emission limits and sublimits established pursuant to chapter 21N."*[2]

Additionally, the Proposal skips around the "net zero" criterion in the slide presentation as applying alternately to energy or emissions, although it can be reasoned that it ultimately

[1]2021 Climate Act, Session Law – Acts of 2021, Chapter 8.
[2]2021 Climate Act, Chapter 8, Section 14.

applies to emissions. One must ask how the Proposal's requirements specifically and quantitatively relate to achieving the Commonwealth's objective, however it is defined.

The organizations presenting these comments have provided a candidate "net zero energy" proposal to DOER staff in advance of publication of the Proposal and seek to have that definition more fully vetted in terms of relevance to the rulemaking. Standard emission factors presented in the eGRID data base and other sources, plus some reasonable adjustments over time out to 2050, could be used to estimate "net zero emissions." The following "net zero energy" definition and a companion definition for the metric energy use intensity (EUI) were developed in consultation with members of the ASHRAE Standards 90.1, 105, 189.1, and ASHRAE 228 Special Project Committee (SPC) who recognized that even these source documents do not currently present succinct definitions:

> ***Net zero energy building***: A building that demonstrates calculated design performance in annual source energy use intensity (EUI_{source}) of zero or less as calculated from total annual energy delivered to the building, including source energy losses, minus total annual on-site renewable energy exported from the building.
>
> ***Energy use intensity (EUI):*** An expression of building energy use per year in terms of net energy divided by gross floor area.

The following are considerations leading to and supporting these definitions:

- Definitions of 'net zero energy' across numerous literature sources lack formal reference, and where definitions are discussed, they tend to get conflated with other terminology such as 'zero energy,' which itself is associated with no energy crossing building or property boundaries, therefore lacking the 'net energy' concept. For our purposes, 'net zero energy' and 'zero net energy' are equivalent. However, key sources addressing these definitions are inconsistent and in one prominent case are internally inconsistent:

  > *"A **net zero-energy building (ZEB)** is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. Despite the excitement over the phrase "**zero energy**," **we lack a common definition, or even a common understanding, of what it means.** In this paper, **we use a sample of current generation low-energy buildings to explore the concept of zero energy**: what it means, why a clear and measurable definition is needed, and how we have progressed **toward the ZEB goal**."*[3] [emphasis added]

- Use of energy use intensity (EUI) in the definition:

[3] P. Torcellini, et al. "Zero Energy Buildings: A Critical Look at the Definition," Conference Paper NREL/CP-550-39833, June 2006.

- Among the various building energy performance metrics that can be applied to describe a "net zero energy building," use of energy use intensity (EUI) has perhaps the broadest usage and the most straight-forward description to employ in building energy performance benchmarking, comparisons of building designs based on energy performance, and setting of energy efficiency performance thresholds. EUI methodologies are documented in the International Energy Conservation Code (IECC), EPA Energy Star for Commercial Buildings' Portfolio Manager, and other broadly used energy performance ratings and comparison approaches. Its cousin, the zero energy performance index (zEPI), is easily derived from quantitative results for EUI performance. General descriptions of EUI applications and comparisons to other metrics are referenced in Attachment A of these comments.

- EUI metrics are defined by two general measurement differences, EUI_{site} and EUI_{source}. EUI_{site} is calculated for the building energy flows alone while EUI_{source} uses EUI_{site} energy consumption, categorizes this consumption by fuel type, and includes upstream energy losses in delivering energy to the building by fuel type. A critically important benefit of using EUI_{source} is that only it (and not EUI_{site} without ad hoc adjustments) can be used to calculate building carbon emissions across the energy value chain because many of these emission sources are upstream and external to the building. In practice, conversion of the EUI_{site} building energy performance to EUI_{source} only requires multiplying the EUI_{site} consumption number times energy conversion factors that account for upstream energy losses. The sources referenced in Attachment A have more complete discussions of these two versions of EUI, pros and cons of each approach, and recommendations that tend to favor EUI_{source} provided consensus on the appropriate conversion factors are identified and applied.

- Use of EUI is gaining growth in development of state and local "building energy performance standards" (BEPS). Several city and county jurisdictions have promulgated or are in the process of promulgating BEPS for new construction in their jurisdictions.[4] Both EUI_{site} and EUI_{source} approaches are being applied in BEPS benchmarking and rating approaches; however, in jurisdictions using EPA Portfolio Manager, the default choice of these approaches is EUI_{source} since Portfolio Manager rates commercial buildings on source energy efficiency. Heterogeneity can exist across jurisdictions, such as in the District of Columbia proposed BEPS program, EUI_{source} is used while in neighboring Montgomery County, MD, EUI_{site} is used. It is unclear how Montgomery County would account

[4] "Building Energy Performance Standards – Coming to A City, County or State Near You?" JD Supra, July 15, 2021. https://www.jdsupra.com/legalnews/building-energy-performance-standards-3870779/.

for building carbon emission contributions under its BEPS program since source energy consumption is needed as a starting point.

- Treatment of onsite renewable energy in the definition:

    - A key feature of using EUI_{source} in the definition is accounting for building energy movement across the building boundary, net of and including energy "exported" across the building boundary and on the energy (electric) grid. Onsite use of onsite generated renewable energy does not enter into the net calculation and therefore neither boosts or penalizes EUI performance results.

    - Subsidiary issues such as renewable energy received at the building boundary may be addressed elsewhere in requirements but should not alter the definition itself. A similar situation confronts a building's use of renewable energy credits and other "paper" energy accounting. The objective here is to preserve the role of the definition to account for actual net energy balances presented by a given building design to assist in evaluation of energy efficiency measures and their effect on net energy performance in terms of kWhs and MMBtus. Adding quantitative consideration of these subsidiary issues makes net zero energy performance less transparent and obscures the direct impact of potential building efficiency measures.

Regulatory and Equity Considerations

Furthermore, and with respect to the Climate Act's objectives, DOER must explain why the Proposal only applies to new construction, its requirements only affect those buildings and consumers such as new home buyers. In this respect, the burdens of "net zero" requirements are disproportionately borne by this class of Massachusetts residences. DOER comments in the Straw Proposal that promulgation of requirements for new construction only because "new buildings are the easiest and cheapest to make 2050-compliant" (slide #3), but such regulatory expediency does not address disproportionate burdens. Also, the focus on new construction is likely to place the burden of meeting a state-wide "net zero" target on economically-disadvantaged first-time home buyers such as low- to middle-income new home buyers, and DOER should address such unintended consequences in justifying the Straw Proposal.

Some Realities of GHG Emissions and the Commonwealth's Efforts to Address Them

Although potentially outside the scope of the Proposal development effort, the Commonwealth's targets for grid electricity emissions reduction targets are unrealistic and arguably unattainable. Grid electricity supply (in-state and imported) will not meet this target

based on generation capacity development in the region. The following factors impose constraints on the Commonwealth's ability and likelihood of meeting its 2030 and 2050 targets, especially with respect to trends in natural gas:

- In 2019, Massachusetts consumed 423.9 billion cubic feet (Bcf) of natural gas, of which 118,394 Bcf was consumed generating electricity in the commonwealth.[5] This commitment to natural gas in the Commonwealth represents an extremely strong commitment to natural gas and the carbon emissions associated with consumption of natural gas for power generation over direct use in applications such as residential space heating.

- Natural gas electricity generation capacity rose from 18% of total capacity to 50% between 2000 and 2020, suggesting that the Commonwealth's commitment to gas-fired generation will continue to be significant out to 2030 and beyond.[6] It is not reasonable to expect that power generators serving Massachusetts will abandon this capacity or use it at suboptimal levels, hence preserving the role of gas-fired generation and related carbon emissions.

- Implications of this commitment to natural gas-generated electricity serving space heating (i.e., for "electrified residential buildings) include energy consumption approaching three times the delivered energy available for space heating for gas-fired heating services from gas consumed at the residential property.

- Conservatively, natural gas energy delivered to the Commonwealth had the equivalent of 4% or over 471 million gallons of commercial propane removed prior to entering Massachusetts.[7]

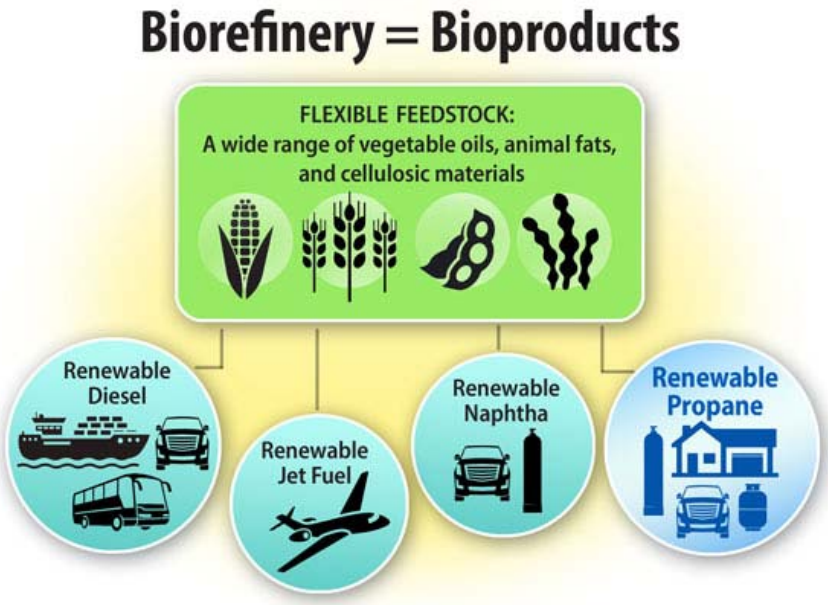
- In contrast to natural gas and gas-fired generation versus direct use, eliminating direct use of propane from residential construction would simply redirect carbon emissions from propane stripped from natural gas already used for electricity generation. That propane would be consumed in other jurisdictions, generate equivalent carbon emissions, and on net would not provide climate benefits to Commonwealth consumers.

[5] 2019 EIA data for Massachusetts for in-state natural gas consumption.

[6] 2021 ISO New England, "Regional Energy Outlook" for Massachusetts, 2000 to 2020 electric generation capacity.

[7] This calculation is based on 2019 EIA national data for total natural gas production liquids (NGPL), dry natural gas fraction from subtracted liquids extraction, and an estimated LPG fraction based upon a 39% proportion of heavy gas liquid (HGL). Total liquids extraction includes production and "straddle" extraction plant removal of C_5 and heavier fractions. Four percent (4%) is "conservative," based upon low estimation of extraction and could be as high as 6%, but with use of national average data and conversion factors, higher removal percentages are difficult to justify. Data conversion to LP gallons based on standard conversion factors for MMCF of propane gas.

- In fact, since delivered energy from electricity generation using natural gas requires over twice the fuel energy of direct use of propane, net carbon emissions for space heating will approximately double relative to energy delivered to consumers.[8]
- The Proposal also does not take into account recent large investments by the propane industry into developing "renewable" propane. The C_3H_8 molecule remains the same, but the source of its production is a variety of renewable feedstocks, such as soybean oil, used cooking oil, and camelina plant oil that is grown under the sun and itself has absorbed carbon dioxide from the atmosphere. The California propane industry anticipates that by 2025, 50% of the propane used will be generated through the renewable process. There is great potential to satisfy propane demand using multiple paths to renewable propane such that by 2050, the vast majority of propane produced in the United States and worldwide would be renewable. Renewable propane has been shown to have a reduced carbon intensity up to 80% less than conventionally produced

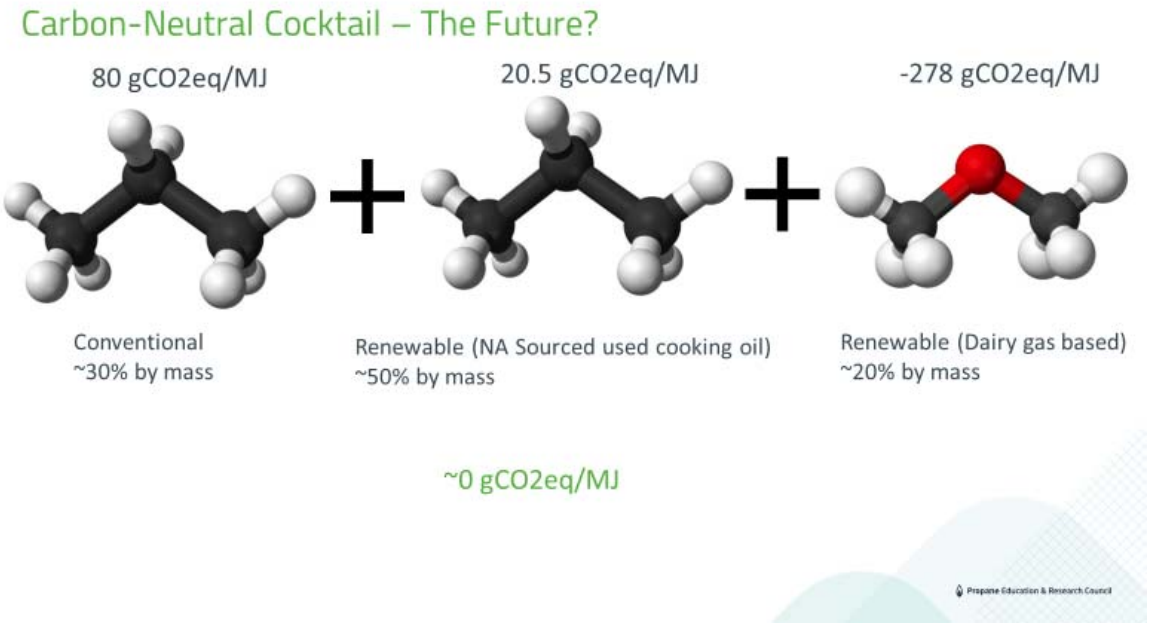


propane.

- The Proposal does not consider the reduction in carbon emissions that will occur in the propane sector due to the addition of renewable propane. Indeed, the chart on page 12 of the slide proposal compares conventional propane emissions to an electric grid as it is projected to be in the future if the emission goals of the Commonwealth are met. If the Proposal projects that it will meet the future electricity goals for carbon, it must also project the future carbon goals for propane. Such a comparison will demonstrate the reductions that can be obtained by including renewable and conventional propane in

[8] Delivered energy comparisons are based upon GTI EPAT conversion factors for Massachusetts and its use of 2010 eGRID data, showing grid electricity conversion of 2.49 for energy delivered to consumers versus its national propane conversion factor of 1.15. Reductions in this grid electricity conversion factor to any measurable degree by 2030 is highly unlike, and any change by that date would reset the trend in the conversion factor out to 2050.

the Proposal. The figure below illustrates the potential benefits available to the citizens of the Commonwealth of Massachusetts, as the combination of renewable propane with renewable dimethyl ether and conventional propane actually results in a negative carbon intensity (-21 gCO_2eq/MJ).



- As per the NETL Grid Mix Explorer tool, NE-ISO's GHG footprint from a lifecycle basis is ~881.8 lb./MWh delivered including imports/exports.[9] However, the chart on page 14 of the proposal uses only half this rate. It is essential that the proposal include lifecycle analysis for all energy sources.

In the end, direct use of gas fuels is likely to continue and in fact grow with continuing conversions of oil heat to gas fuels in existing housing. As a consequence, depending upon new construction reductions of fossil fuels generally in the Commonwealth's relatively mature building stock is unlikely to contribute to meeting the declared objectives. DOER ought to provide projections of how its Proposal would affect demand and sourced electricity for the Commonwealth and propose a comparison of these projections to projections without the Proposal being enacted.

A Focus on Residential Design Implications

As discussed above, the Proposal's analysis supporting differential treatment of fossil fuel-supplied housing and all-electric housing is opaque and biasedly narrow. Stakeholders deserve

- [9] Reference: https://www.netl.doe.gov/energy-analysis/details?id=f0f94954-3627-4e9b-a5c0-c29cfe419d1c

the right to review the "detailed analysis" conducted of residential buildings by DOER, including treatment of source energy impacts associate with the requirements including but not limited to modeling software calculations of source energy consumption across the designs covered. It is noted that even the REM/*Rate*™ software used in "detailed analysis" calculations provides a source energy report for each residential design analyzed. The natural gas industry worked with the REM/*Rate*™ developers in the early 2000s to add this functionality to the software. Of particular interest is how these source energy calculations for the cases analyzed compare across gas and electricity heated designs and with respect to consistency with the differential HERS score requirements. Applying these source energy calculations, or more granular calculations that could be performed using source energy and emissions factors from sources such ASHRAE Standard 105[10] could provide a more reasonable assessment of the potential GHG emissions impacts from DOER proposed standards requirements especially across heating energy types.

Review of the cases discussed in the Proposal reveals that the gas-fired alternatives for heating services (i.e., space heating) are artificially narrow in covering gas boiler as the default design technology. The analysis does not cover the other types of gas-fired heating systems but instead uses a static and unrealistic comparison and should include the following systems and associated costs at a minimum:

- "Add-on" or hybrid heat pump equipment (using gas as the supplemental heat source). These systems have been in commercial production and residential installation for decades.

- Gas-fired heat pump water heating technology for hot water domestic boilers and other advanced technologies that will come into production in the near-term years ahead. An analysis of gas-fired heat pump water heating performance conducted for GTI has shown that source energy COPs and emissions for gas water heating designs range from 1.24 to 1.29 and with emission of 5.6 to 5.1 pounds of CO_2 equivalent (CO_2e) for a 100 gallon unit installed in California compared to electric heat pump water heater COP ranging from 4.3 to 8.2 and with CO_2e emissions.[11] Comparisons to a modern "cold climate" air-source heat pump would be better basis for comparison (provided it is done on a source energy basis) and is an analysis that DOER should perform for Massachusetts climatic conditions.

- Incentivizing home design changes toward forced air heating systems instead of gas-fired hydronic heating systems. Home designers would likely exploit associated installation cost advantages of heat distribution changes beyond those apparently

[10] ANSI/*ASHRAE* Standard 105: "Standard Methods of Determining, Expressing and. Comparing Building Energy Performance and Greenhouse Gas Emissions," 2014.

[11] Glanville, P. "Gas Heat Pump Water Heaters in California: Field and Laboratory Results," Slide #5 and footnotes, GTI presentation, 2019 ACEEE Hot Water Forum Nashville, Tennessee, March 13th, 2019.

analyzed by DOER, from hydronic loops to force air systems for fossil fuel heating buildings. As DOER staff have informally commented, builder cost savings from having to install both a hydronic heating system for gas heating and an air distribution system for air conditioning provides an installation cost penalty for gas boiler hydronic heating. The logical course of designers, then, is to focus on forced air space conditioning systems where this redundancy in space conditioning systems would be avoided. DOER has not explained that it has taken into consideration how the Proposal would likely result in residential change of space heating systems for gas-fired space heating systems.

We thank you for your efforts to draft a net zero energy code and strongly encourage you to consider the information we've presented in our letter to the Massachusetts Department of Energy Resources.

Sincerely,

Bruce Hamilton

ATTACHMENT A
SOURCES SUPPORTING THE PROPOSED "NET ZERO ENERGY" PROPOSAL

"Calculating EUI: Behind the Numbers," from Sustainable Jersey Schools, https://www.sustainablejerseyschools.com/fileadmin/media/Actions_and_Certification/Actions/Building_Efficiency_Measures/Calculating_a_Projected_EUI.pdf

"Energy Use Intensity (UEI): What is Energy and How Does it Affect EUI?," from American Institute of Architects California (AIA California)," https://aiacalifornia.org/energy-use-intensity-eui/

"Energy Use Intensity in Simple Terms: Site EUI or Source EUI?" from Browning Day, https://browningday.com/news/energy-use-intensity-eui-in-simple-terms/

"Getting to Zero Database Frequently Asked Question (FAQs): Do you use site or source EUI?" from New Buildings Institute., https://newbuildings.org/wp-content/uploads/2016/06/ZNE_Tracker_FAQ.pdf

"Guide to the 2021 Building Energy Performance Standards, Version 1.0, January 5, 2021," from the District of Columbia Government, https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/1_Guide%20to%20the%202021%20BEPS%281%29.pdf.

"How is the '% Difference from National Median Site/Source EUI' Calculated?," from Energy Star, https://energystar-mesa.force.com/PortfolioManager/s/article/How-is-the-Difference-from-National-Median-Site-Source-EUI-calculated

"Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals," from ACEEE and describing pros and cons of metrics, including EUI and $EU_{Isource}$, in Building Energy Performance Standards (BEPS) and used in various jurisdictions to advance these approaches, https://www.aceee.org/sites/default/files/pdfs/buildings_standards_6.22.2020_0.pdf