TRC
Results you can rely on

436 14th Street, Suite 1020, Oakland, CA 94612
Phone: (916) 962-7001
Email: APande@trcsolutions.com

ZNE Building Design and Performance Verification Methodologies

Final Report

September 26, 2016

CALMAC Report # PGE0387.01

PG&E

Submitted To:

Pacific Gas and Electric Company
Rachel Allen
Strategic Analyst
Evaluation, Measurement and Verification

TABLE OF CONTENTS

TABLE OF FIGURES

1. ACKNOWLEDGEMENTS

The California Investor Owned Utilities (IOUs) funded and supported the development of the Study. The Study has been carefully guided by Rachel Allen, the Pacific Gas & Electric (PG&E) project manager who provided oversight on this project. Dr. Carrie Brown and Anna LaRue of Resource Refocus LLC provided research guidance as contractors to PG&E. Corinne Sierzant, Rob Rubin, Darrell Brand, Adam Manke and Carlo Gavina from Sempra Utilities and Jesse Emge, Piotr Urbanski from Southern California Edison also provided study inputs and feedback. The study research plan and draft report was posted on CPUC's basecamp site and several reviewers including Ralph Prahl and Nikhil Gandhi provided comments and recommendations on study design. Peter Turnbull from PG&E provided key context with current CA and non-CA efforts on ZNE.

Edward Dean from Bernheim + Dean Associates provided data and insights on California commercial buildings that have targeted ZNE status, including summaries of monitored and modeled energy use. These example projects were crucial in developing the verification methodologies and the study team would like to express our sincere thanks for Ed for his enthusiastic cooperation.

The project study plans and draft findings were reviewed by numerous stakeholders through a CPUC-led public review process. Written comments and follow-up conversations that followed from that process assisted the study teams in their efforts. While not all comments were incorporated into the study, these comments nevertheless helped broaden the purview of the study which strengthened the study findings and recommendations.

Heather Flint-Chatto, Mark Lyles and Ralph DiNola from New Buildings Institute (NBI) shared their work on the California ZNE Watchlist as well as the proposed California ZNE Recognition program technical criteria.

The Study benefited from the diligent work of all of our subcontractors. Amber Mahone and Snuller Price from Energy and Environmental Economics, Inc. (E3) provided research and recommendations on the verification issues around the Time Dependent Valuation metric. Bill Dakin, Alea German and others at Davis Energy Group, Inc. (DEG) provided data and insights into residential ZNE projects that DEG has been involved with the design, modeling or monitoring of energy use.

The study team was led by Abhijeet Pande who provided research oversight and management to the project and is the primary author of this report. Dr. Marian Goebes, Cathy Chappell and Vasudha Lathey provided key research, analysis and reporting support. Cathy Chappell was the supervising Officer-in-charge from the study team on this project.

2. EXECUTIVE SUMMARY

2.1 Study Objectives and Application Scenarios

Pacific Gas & Electric Company (PG&E), on behalf of the joint California Investor Owned Utilities (IOUs), contracted with a team led by TRC Energy Services (TRC) to develop verification methodologies for validating predicted energy performance of Zero Net Energy (ZNE) buildings in California. **It is important to note that this project is not intended to develop evaluation protocols specific to individual ZNE programs or initiatives nor is it intended to address all aspects of program evaluation (e.g. free-ridership, Net-to-Gross etc.). Rather it is intended to address how gross energy savings at the unit level (ZNE Building) are to be verified at the design stage as well as once the building is constructed and under operation.**

This study builds upon protocols currently being used to specify and track ZNE building design and performance by early adopters across the country and specifically on efforts within California to develop a unified ZNE recognition effort and the stated policy of ZNE Code buildings currently under development. This study also builds upon verification methodologies currently being used for evaluation of IOU Codes and Standards and IOU Nonresidential New Construction programs.

This study has three main objectives, as listed below. These objectives are interrelated in their intent and scope and together guided the study process.

- Objective I: Develop Draft Verification Methodologies for ZNE Buildings in California based on literature review and review of ZNE building data availability.
- Objective II: Test Verification Methodologies on Sample ZNE Projects. The verification methodologies developed in Objective I will be applied to a small subset of ZNE buildings in California where post-construction monitoring data is available showing actual performance of these buildings.
- Objective III: Propose Final Verification Methodologies based on findings from Objective II.

This project does not develop any ZNE metrics or definitions of its own. Rather, this study develops verification protocols that are applicable and appropriate for the ZNE definitions already in use in California through utility programs and voluntary efforts.

There are currently several utility efforts to promote ZNE buildings, from ZNE pilot programs for residential, commercial and school buildings, new construction programs such as California Advanced Homes Program (CAHP) and Nonresidential New Construction program, Codes and Standards Enhancement (CASE) initiatives and training, outreach and education. Additionally, there are non-utility efforts such as those run by third party program implementers and rating entities (e.g. Build it Green) that promote ZNE. Lastly, the early adopters in the ZNE design and construction community (e.g. residential builders) are constructing ZNE buildings on a voluntary basis and need a common language for promoting ZNE to their customers/clients. All of these efforts need to address or at least be cognizant of the regulatory definition of ZNE included in the 2015 Integrated Energy Policy Report (IEPR)[1] that uses the Time Dependent Valuation (TDV) metric as its basis.

[1] 2015 Integrated Energy Policy Report, California Energy Commission, 2015. (http://www.energy.ca.gov/2015_energypolicy)

With all these efforts addressing ZNE, there is a need to establish some common protocols for what constitutes a ZNE building, especially when there is a mismatch between the regulatory definition (ZNE Code, using TDV) and those used by early adopters (ZNE Site, ZNE Source). Without a common set of data, analysis and verification protocols, it is impossible to know whether everyone is talking about the same ZNE metric and whether they have indeed achieved ZNE.

With this background in mind, this study aims to develop verification methodologies to address ZNE verification challenges for the following programmatic and voluntary efforts:

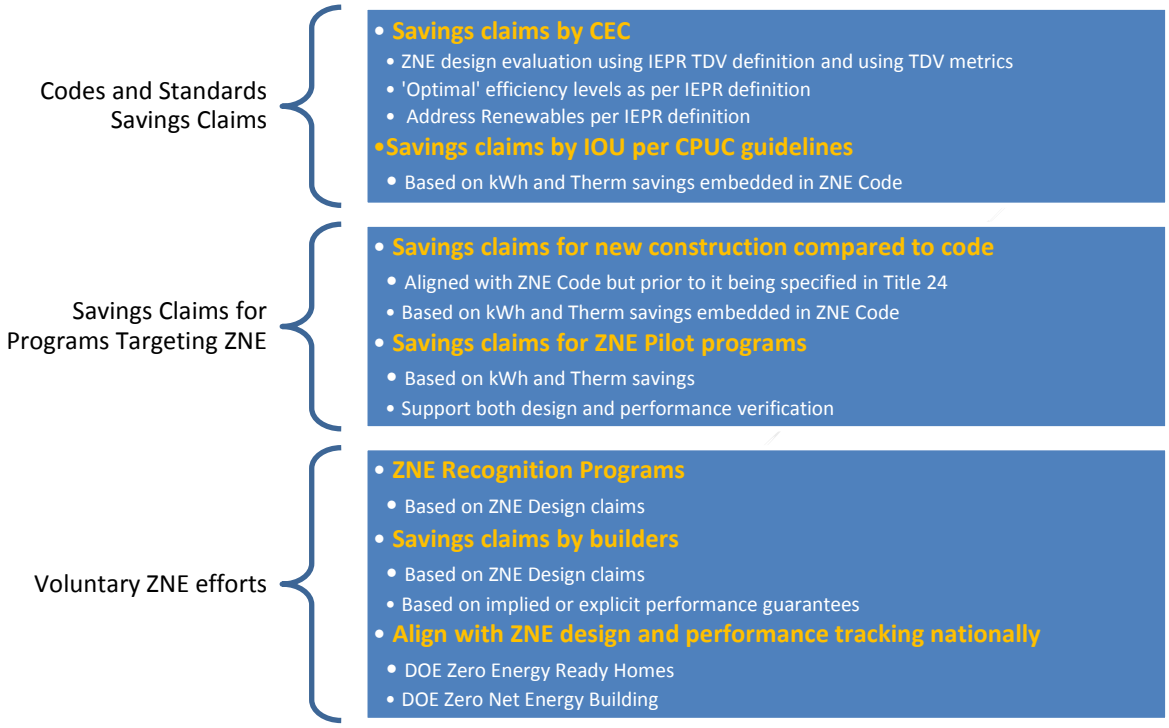

Figure 1: Programs and Voluntary Efforts that Require Evaluation of ZNE Design or Performance

2.2 Key ZNE Terminology

There are several key terms introduced or referenced in this document that have a specific definition and often multiple definitions based on the entity using the term. To avoid confusion to the reader, this section outlines the definitions and explanations for the key terms as they apply to this document:

- **Zero Net Energy (ZNE)** Building – A ZNE building is one where the annual energy use of the building is offset by the energy production onsite through renewable energy means. ZNE includes all energy end uses within the building (including process loads) but does not include electric vehicle charging or other end uses not within the confines of the building itself. There are several definitions for ZNE based on how the energy use accounting is done – site energy, source energy, energy cost, carbon emissions or in the case of California the Time Dependent Valuation (TDV) metric.
- **ZNE Design** – A ZNE Design designation for a ZNE building denotes that the building is designed to be ZNE based on the assumed energy end uses and operation schedules. It is not necessary that a building that achieves ZNE Design also performs as a ZNE building.
- **ZNE Performance** – A ZNE Performance designation denotes that the building is performing as a ZNE building based on actual building operation.

- **ZNE Site** – A building that is designated as ZNE Site is a building that offsets its annual energy use expressed in terms of site kBtu (site energy) with renewable energy generated on site also expressed in terms of site kBtu (site energy). A ZNE Site building could be designated ZNE Site - Design if the designation is based on predicted performance or ZNE Site - Performance if based on actual observed building energy use and renewable generation.
- **ZNE Source** – This definition is similar to the ZNE Site definition, except the metric used is a source kBtu (source energy) that accounts for energy required to extract and transport the raw fuel and losses associated with conversion, transmission and distribution to the point of use (building).This is typically achieved by multiplying site energy values with a multiplier that then generates the source values. These site-to-source conversion factors vary by fuel (electricity, natural gas, propane) as well as the electricity generation mix for a particular utility or region. This report uses national average values for site-to-source energy as used by the US Department of Energy (DOE) for the EnergyStar and Portfolio Manager initiatives. This enables the values to be comparable across the various states and utility territories across the country.
- **ZNE Code** – this definition of ZNE is specific to California and is unlike the definitions of ZNE used elsewhere. As described in detail in Section 4.3, a ZNE Code building is one that achieves ZNE based on the Time Dependent Valuation (TDV) of energy use and generation onsite. ZNE Code is a design rating since it is based on predicted energy performance. It uses the Energy Design Rating (EDR) to express whether a building is ZNE.
- **Time Dependent Valuation (TDV)** – TDV has been used to evaluate cost-effectiveness of energy efficiency and demand response measures for Title 24 since the 2005 Title 24 update. Prior to 2005, a flat value of source energy cost was used to evaluate the value of measures. Under TDV, energy is valued instead on an hourly basis that better reflects the actual cost of energy to the customers, to the utility system and to society. TDV values are calculated separately for the three primarily fuels used in buildings – electricity, natural gas and propane – as well as for the 16 California climate zones. Electricity values change by hour for each hour of the year while natural gas and propane values change by month.

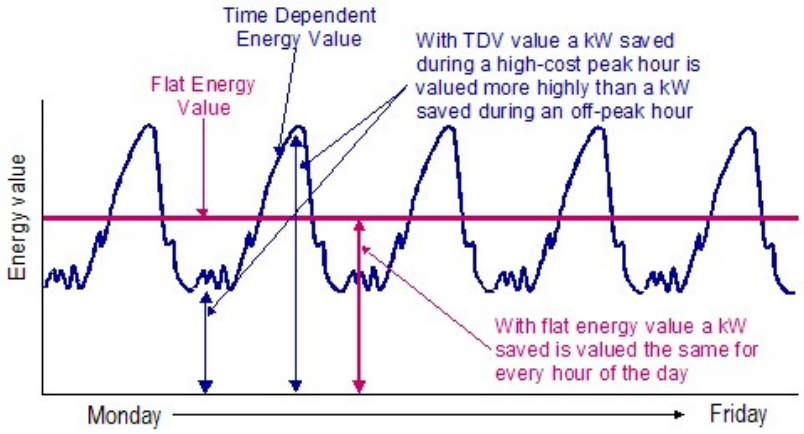

Figure 2: TDV Concept – "Flat" Valuation versus TDV for Electricity Use

The TDV value of electricity is highest during summer peak periods when the overall grid is stressed to full capacity and there is need for additional generation resources. Thus energy saved on peak carries a higher value than energy saved off-peak. As a result, residential HVAC energy savings get higher benefit under TDV (since HVAC usage coincides currently with system peak) and lighting savings get lesser benefits since they occur at night.

- **Energy Design Rating (EDR)** - The EDR is a separate calculation from code compliance calculation and is akin to an energy use intensity, except that it is based on TDV as envisioned in the 2015 IEPR. The EDR is calculated using CEC approved calculations and assumptions in the Title 24 Part 6 (building energy code). Unlike code compliance which is based on regulated loads, EDR includes all energy uses within the building such as space heating, space cooling, water heating, lighting, plug and appliance energy use. The EDR calculation uses a reference home compliant with the 2006 International Energy Conservation Code (IECC), to better align EDR with RESNET calculations for Energy Rating Index (ERI). The reference home gets an EDR score of 100 and the building is considered ZNE Code - Design if the EDR = Zero (0). This is in line with and a direct implementation of the ZNE Code definition outlined in the 2015 IEPR. Note that there is currently no CEC-approved method for calculating EDR for Nonresidential Buildings.
- **Energy Rating Index (ERI)** - The ANSI/RESNET/ICC 301-2014 Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index was republished in January 2016 with some modifications to outline how a ZNE Design building should be evaluated. The methodology compares the energy performance of an actual home with the energy performance of a reference home of the same geometry, resulting in a relative energy rating called the Energy Rating Index (ERI). Where the energy performance of the actual home and the reference home are equal, the ERI is 100 and where the actual home requires no net purchased energy annually, the ERI is 0 (zero).
- **Energy Use Intensity (EUI)** - The EUI is expressed as kBtu/sf/yr and is a commonly used metric of a building's energy use or performance. It also allows benchmarking and comparisons of buildings. In order to normalize the various fuels in a building, all the energy forms for both use and production/generation are converted to thousands (k) of British Thermal Units (Btu) and then divided by the square feet (sf) of the building with 'yr' representing the 12 month period of data.

2.3 Study Recommendations

The report proposes verification methodologies for the following ZNE metrics: ZNE Design versus ZNE Performance. Within each, the methodologies are further refined based on whether the design is based on ZNE Code that uses the California Integrated Energy Policy Report (IEPR) definition using Time Dependent Valuation (TDV) or using ZNE Site or ZNE Source energy metrics. The methodologies are also separated by whether they are for residential or nonresidential buildings. Section 5 presents the proposed ZNE Evaluation methodologies. Based on the review of data from case study buildings summarized in Section 6, here are the key verification requirements:

ZNE Metric to be Verified	Stage	Verification Metric Residential	Evaluation Metric Nonresidential
ZNE Site	Design	ERI = 0 Predicted Net Site kBtu = 0	Predicted Net Site kBtu = 0
	Performance	Actual Net Site kBtu = 0	
ZNE Source	Design	Predicted Net Source kBtu = 0	
	Performance	Actual Net Source kBtu = 0	
ZNE Code (TDV)	Design	EDR = 0	
	Performance	Calibrated Predicted Net kBtu = Actual Net kBtu	

Figure 3: Key ZNE Verification Metrics by ZNE Criteria

ZNE Metric to be Verified	Stage	Modeled Energy Performance – Annual total of hourly analysis	Utility Net Meter Data – Annual	Separate Energy Use and Renewable Meter Data - Annual	End Use Monitoring – Annual Total and/or Hourly
ZNE Site	Design	Sufficient	Not Required	Not Required	Not Required
	Performance	Not Required	Sufficient	Sufficient	Not Required
ZNE Source	Design	Sufficient with Source Factors	Not Required	Not Required	Not Required
	Performance	Not Required	Sufficient with Source Factors	Sufficient with Source Factors	Not Required
ZNE Code (TDV)	Design	Sufficient with TDV Factors	Not Required	Not Required	Not Required
	Performance	Required but not sufficient by itself	Required along with building details necessary for a calibrated post-construction energy model (see § 5.5.2)		Not Required

Figure 4: Required Data to Verify that a Building Meets the ZNE Criteria by Type of ZNE Criteria

Each of the proposed verification methodologies presented in this document represents a particular type of ZNE building and it is not necessary that a building that is ZNE under one metric (say ZNE Code) is ZNE under another metric (say ZNE Site). Further, a building designed to be ZNE may or may not have ZNE Performance. Thus it is important that ZNE buildings be qualified as ZNE Design or ZNE Performance as well as specify the metric being used (Site/Source/Code). ZNE Verified – a term used by New Buildings Institute (NBI) – may be a good substitute for ZNE Performance.

2.3.1 Establish Standard Documentation Requirements

Based on review of the ZNE case study buildings and specifically the gaps in data availability to conduct verification activities on various ZNE metrics, this section outlines documentation requirements for each of the ZNE metrics of concern. Since most of the required documentation is similar across the ZNE metrics, the report presents the full list of documentation for ZNE Code - Design but for the subsequent metrics, the report presents only those data and results that are unique to those metrics.

ZNE Code – Design: Documentation Requirements

Topic	Subtopic	Submittal Requirements
Analysis Methodology	Software Used for Predictions	Name and version of software (needs to be CEC approved software).
	Period of Analysis	Annual based on hourly analysis
Net Energy Use Onsite	Energy Design Rating (EDR)	EDR calculated using CEC approved methodologies. EDR must be Zero or Negative to show ZNE Code compliance. NOTE: Currently there is no approved CEC method to calculate EDR for Nonresidential Buildings.

Topic	Subtopic	Submittal Requirements
Annual Energy Consumption Onsite	Predicted Electricity Use (kWh)	Total kWh/sf for a 12-month period
	Predicted Fuel Use (Therm)	Total Therm/sf for a 12-month period
	Predicted TDV Use	Total TDV/sf for a 12-month period
	Predicted TDV Use by End Use Category	TDV/sf by end uses for all building end uses for a 12-month period
Annual Renewable Energy Generated Onsite	Predicted Annual Renewable Electricity Produced Onsite Dedicated to Offset Building Energy Use (kWh)	Total kWh/sf for a 12-month period. Note: This feature is not natively available in nonresidential compliance software currently.
	Predicted Onsite Renewable Electricity Generation Dedicated to Offset Building Energy Use (TDV)	Total TDV/sf for a 12-month period. Note: This feature is not natively available in nonresidential compliance software currently.
Background	Project Team	Owner, Developer, Builder, Architect, Mechanical Engineer, Contractor, Energy Consultant, Other Consultants
	Project Goals	ZNE metric targeted; specific goals and targets relevant to ZNE
General Building Information	Project Name	
	Location	City, County, CEC Climate Zone
	Building Type	Type(s) of building occupancies (e.g. Office, Retail, School, Residential Single Family, Residential Multifamily Low-rise, Residential Townhomes)
	Building Size	Conditioned area, # floors, # buildings
	Construction Type	New Construction; Addition/Retrofit
Building Construction	Building Envelope	Framing type, U-factor (wall, roof, floor), U-factor and SHGC (windows), air leakage
	HVAC System	System type, capacity, efficiency, # of systems
	DHW System	System type, capacity, efficiency, # of systems
	Lighting	Lighting efficacy (lumens/watt)
Building Occupancy	Number of Occupants	Default per CEC Residential/Nonresidential ACM procedures.
	Occupancy Schedule	
	Equipment Schedule	
	Lighting Schedule	
Building Commissioning	System Commissioning	Commissioning Report outlining key activities performed – for nonresidential buildings only.
	Building Operations	Building Operations Manual or other documentation outlining building operational strategies
Renewable Energy Systems	Photovoltaic (PV) System Generation Capacity (kW)	Total installed rated capacity in kW DC and kW AC

Topic	Subtopic	Submittal Requirements
	Photovoltaic (PV) System Capacity Dedicated to Offset Home Energy Use (kW)	Total installed rated capacity in kW DC and kW AC dedicated to offset home energy use. Renewable capacity dedicated for Electric Vehicle (EV) or Storage needs to be subtracted from the total generation capacity to calculate this number.
	Photovoltaic (PV) Orientation and Tilt	Orientation in degrees from North (0=North, 90 = East); Tilt (angle from horizontal); If multiple panels used, provide orientation and tilt by each panel 'group'
	Photovoltaic (PV) System Location	Specify location of renewable system (e.g. Roof). System must be installed within the bounds of the 'project' site as defined in the 2015 IEPR
	Photovoltaic (PV) Manufacturer and Make	Make, model number, manufacturer name
	Other Renewable Energy Systems	Rated capacity, total annual output, location onsite, manufacturer and make.
Electric Vehicles	If Electric Vehicle Charging is Anticipated	# of Electric Vehicles Predicted to be Charging at Home
Energy Storage	Energy Storage System	Estimated Storage Capacity

Figure 5: Proposed ZNE Code Verification Requirements for Documentation

ZNE Design - Site/Source: Documentation Requirements

Topic	Subtopic	Submittal Requirements
Analysis Methodology	Software Used for Predictions	Name and version of software (needs to be ANSI/RESNET/ICC approved software for residential buildings).
	Period of Analysis	Annual based on hourly analysis
Net Energy Use Onsite	Res: Energy Rating Index (ERI)	ERI calculated using ANSI/RESNET/ICC approved methodologies. ERI must be Zero or negative to show Res ZNE Design.
	Nonresidential: Predicted Net Annual Site Energy Use (site kBtu)	Total Predicted Energy Use (site kBtu/sf) - Total Predicted Renewable Electricity Produced Onsite (site kBtu/sf) = Zero or Negative.
	Res/Nonresidential: Predicted Net Annual Source Energy Use (source kBtu)	Total Predicted Energy Use (source kBtu/sf) - Total Predicted Renewable Electricity Produced Onsite (source kBtu/sf) = Zero or Negative.
Building Occupancy	Number of Occupants	Res: default per ANSI/RESNET/ICC 301-2014 Nonresidential: document assumptions made by modeler
	Occupancy Schedule	
	Equipment Schedule	
	Lighting Schedule	

Figure 6: Proposed ZNE Design - Site/Source: Documentation Requirements (excerpt)

ZNE Site – Performance: Documentation Requirements

Topic	Subtopic	Submittal Requirements
Net Energy Use Onsite	Net Annual Actual Energy Use (site kBtu)	Actual Annual Energy Use (site kBtu/sf) - Actual Annual Renewable Electricity Produced Onsite Dedicated to Offset Home Energy Use (site kBtu/sf) = Zero or Negative.
Building Occupancy	Number of Occupants	Actual average number of occupants
	Operating Hours and Schedule	Actual weekly hours of operation, and typical occupancy schedule (weekday and weekend/holiday)
	Vacancy Rate	Confirm that vacancy was less than 10% on an annual basis
	Building System Operation	Confirm that building systems were installed per manufacturer instructions and operational. Note any discrepancies.
	System Commissioning (nonresidential)	Commissioning Report outlining key activities performed
Billing and Metering Data	Electricity Bills	Monthly electricity bills for at least 12 months post-occupancy
	Natural Gas/Fuel Bills	Monthly natural gas/fuel bills for at least 12 months post-occupancy
	Renewable Electricity Metering (Optional)	Monthly renewable electricity production for at least 12 months post-occupancy. If separate PV Meter is not installed onsite, note source of estimate.
Annual Energy Consumption Onsite	Actual Electricity Use (kWh)	Total kWh for a 12-month period post-occupancy
	Actual Fuel Use (Therm)	Total Therm for a 12-month period post-occupancy
	Actual Site Energy Use (site kBtu)	Total site energy use (site kBtu/sf) for a 12-month period post-occupancy
	Actual Energy Use by End Use Category (Optional)	kWh and Therm by end uses - Space Cooling, Space Heating, Ventilation, DHW, Lighting, Appliances and MELs.
Annual Renewable Energy Generated Onsite	Actual Annual Renewable Electricity Produced Onsite dedicated to offset Building Energy Use (kWh)	Total kWh for a 12-month period
	Actual Annual Renewable Electricity Produced Onsite dedicated to offset Building Energy Use (site kBtu)	Total site kBtu/sf for a 12-month period
Weather Data (Optional)	Cooling Degree Days during the period of analysis	Document CDD base 65°F during the period of analysis through review of observed weather from nearest weather station with data availability.

Topic	Subtopic	Submittal Requirements
	Heating Degree Days during the period of analysis	Document HDD base 65°F during the period of analysis through review of observed weather from nearest weather station with data availability.
Significant Operational Variables	Operational Variables compared to Design	Short narrative of incidents or variations that affected the energy use (positive or negative) compared to design stage assumptions.

Figure 7: ZNE Site – Performance: Documentation Requirements

ZNE Source – Performance: Documentation Requirements

Documentation requirements for ZNE Source - Performance are similar to that for ZNE Site - Performance except that for ZNE Source, the analysis is documented in terms of source kBtu per Figure 8. The figure does not repeat documentation requirements outlined in Figure 7 which apply here as well.

Topic	Subtopic	Submittal Requirements
Billing and Metering Data	Electricity Bills	Monthly electricity bills for at least 12 months post-occupancy
	Natural Gas/Fuel Bills	Monthly natural gas/fuel bills for at least 12 months post-occupancy
	Renewable Electricity Metering (Optional)	Monthly renewable electricity production for at least 12 months post-occupancy. If separate PV Meter is not installed onsite, note source of estimate.
Annual Energy Consumption Onsite	Actual Electricity Use (kWh)	Total kWh for a 12-month period post-occupancy
	Actual Fuel Use (Therm)	Total Therm for a 12-month period post-occupancy
	Actual Total Energy Use (kBtu)	Total energy use in Source kBtu for a 12-month period post-occupancy
	Actual Total Energy Use Intensity	Source kBtu/sf for a 12-month period post-occupancy
	Actual Energy Use by End Use Category (Optional)	kWh and Therm by end uses - Space Cooling, Space Heating, Ventilation, DHW, Lighting, Appliances and MELs.
Annual Renewable Energy Generated Onsite	Actual Annual Renewable Electricity Produced Onsite dedicated to offset Home Energy Use (kWh)	Total kWh for a 12-month period
	Actual Onsite Renewable Electricity Generation Dedicated to Offset Home Energy Use (kBtu)	Total source kBtu/sf for a 12-month period
Net Energy Use Onsite	Net Annual Actual Energy Use (source kBtu)	Total Actual Energy Use (kBtu) - Total Actual Renewable Energy Produced Onsite dedicated to offset building energy use (kBtu) = Zero or Negative. Note: For this calculation, onsite fuel and electricity usage are converted to source kBtu

Figure 8: ZNE Source Documentation Requirements (Excerpt)

2.3.2 Identify Entities that will be Responsible for ZNE Verification

Currently, there is no central entity within California that is responsible for verification of ZNE. This is likely to change as ZNE becomes a code mandate and ZNE Design claims will be verified by building departments and HERS raters. These entities need to be trained and coordinated so that the ZNE verification is done consistently across the state. But this is in the future, assuming ZNE Code is put in place. Till then, there is currently no entity that oversees ZNE Code and ZNE Design verification.

There is no requirement for ZNE Performance in current regulatory proceedings and utility programs. Thus it is unknown if there will be a central entity or a coordinated effort to ensure that ZNE verification is done on a consistent basis. The ZNE Recognition program being developed by the California Public Utilities Commission (CPUC) appears to be the right venue for this entity but the ZNE recognition program does not have any ongoing scope or budget to do so. Any entity tasked with ZNE verification will require sufficient support, and adequate training to ensure that verification is accurate and consistent throughout the state.

2.3.3 Develop Standardized Registries for ZNE Buildings

Related to above, there is a need to develop a standardized tracking platform that tracks ZNE Design and ZNE Performance across buildings. Currently, there is no one place where this information is tracked.

NBI is tracking commercial buildings nationally through their efforts with various grants and sponsors as well as in greater depth in California through their efforts with the CPUC. On the residential side, the IOUs completed a ZNE Market Characterization study that identified ZNE buildings in the state, but that was a one-time activity. The Net-Zero Energy Coalition[1] as well as RESNET are both tracking ZNE buildings across the country – but they use differing definitions. Note that these efforts are reliant on self-reporting by building owners and operators of their predicted and actual energy use/energy generation onsite.

2.3.4 Develop Rulesets for ZNE Code - Design Nonresidential Modeling

There are several aspects of the ZNE Code - Design Nonresidential analysis, documentation and verification that are currently unknown. There are no procedures within the compliance tools to address onsite renewable generation, no procedures to calculate the Energy Design Rating and no nonresidential HERS Raters or data registries that can verify and track nonresidential building ZNE Code status.

2.3.5 Develop Verification Methodologies for ZNE Retrofits in Existing Buildings

The verification methodologies proposed in this document are applicable to new construction ZNE buildings only. The methodologies for ZNE performance validation may be applicable to retrofit situations but this study has not conducted detailed analysis of the suitability of the proposed verification methodologies for retrofits. The study team therefore recommends a follow-up study to review ZNE retrofit projects and identify retrofit specific verification methodologies.

[1] http://netzeroenergycoalition.com/wp-content/uploads/2015/04/20150105_nzec_zero_energy_homes_report_booklet_fnl_02.pdf