CALIFORNIA STATEWIDE
UTILITY CODES AND STANDARDS PROGRAM

2016 Title 24 Codes & Standards Enhancement (CASE) Proposal

Residential Instantaneous Water Heaters

CEC Pre-rulemaking Workshop, July 21st, 2014

Heidi Hauenstein
hhauenstein@energy-solution.com
510-482-4420 ext. 261

Sarah Schneider
SSchneider@energy-solution.com
510-482-4420 ext. 202

Bijit Kundu
BKundu@energy-solution.com
510-482-4420 ext. 261

General Structure of Title 24

requirements for all buildings

Mandatory Measures
(required for all buildings)

+

Prescriptive Path
(additional measures)

or

Performance Path
(model building energy performance)

Over 90% of buildings use the performance path

only required for some equipment and building types

Certification and Acceptance Requirements

Types of Code Change

- **Mandatory Requirements**
  - Mandatory requirements must be satisfied whether the prescriptive or performance method is used.
  - Mandatory requirements cannot be traded against other measures.
- **Prescriptive Requirement**
  - Prescriptive requirements become the “base case” energy budget that must be achieved if applicant is using performance method.
- **Performance Credit / Compliance Option**
  - Performance credits / compliance options explain how an applicant achieves the required energy budget an approved whole-building modeling approach.

Current Title 24 Requirements

- Low-rise residential buildings must be designed to accommodate high-efficiency water heaters, including IWHs (**mandatory** requirement).

SUBCHAPTER 7
LOW-RISE RESIDENTIAL BUILDINGS – MANDATORY FEATURES AND DEVICES

SECTION 150.0 – MANDATORY FEATURES AND DEVICES

(n) **Water Heating System.**

1. Systems using gas or propane water heaters to serve individual dwelling units shall include the following components:
   - A. A 120V electrical receptacle that is within 3 feet from the water heater and accessible to the water heater with no obstructions; and
   - B. A Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed; and
   - C. A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance, and
   - D. A gas supply line with a capacity of at least 200,000 Btu/hr.

Current Title 24 Requirements *(continued)*

- If an applicant chooses to comply using the **prescriptive** path:
  - If natural gas service is available: water heater must be gas storage, propane storage, gas IWH, or propane IWH.
  - If natural gas is unavailable, as determined by the gas utility: water heater can be electric storage or IWH, but applicant must also install a solar water heating system that achieves a minimum solar fraction of 0.50.

Current Title 24 Requirements *(continued)*

- If an applicant chooses to comply using the **performance** path, the applicant can install any federally compliant water heater plus other measures that allow the building to achieve the required energy budget.
  - Energy budget is calculated using 50 gallon gas-fired storage water heater that is minimally compliant with federal efficiency standards.

Current Federal Appliance Efficiency Standards

- **Existing Standards**
  - Gas IWH (< 2 gal):
    - $EF \geq 0.62 - 0.0019 * V_s$
  - Gas Storage (20 to 100 gal):
    - $EF \geq 0.67 - 0.0019 * V_s$

50 gal tank: EF = 0.575

- **Future Standards** (*effective April 2015*)
  - Gas IWH (< 2 gal):
    - $EF \geq 0.82 - 0.0019 * V_s$
  - Gas Storage:
    - 20 to 55 gal $EF \geq 0.675 - 0.0015 * V_s$
    - 55 to 100 gal $EF \geq 0.8012 - 0.00072 * V_s$

50 gal tank: EF = 0.60

V_s = Rated Storage Volume (gallons)

Proposed Code Change

Modification of <u>prescriptive</u> requirements for domestic hot water systems

- The proposed code change would update the water heating energy budget:
  - Energy budget would be calculated using a noncondensing gas IWH that is minimally compliant with federal efficiency standards.
    - Gas IWH would become primary prescriptive option.
    - Primary prescriptive requirements are used to establish baseline for performance approach (i.e. establishes energy budget for building).
    - Federal minimum Energy Factor (EF) of 0.82 for gas IWHs (2015).
  - Proposal would include an alternative prescriptive option that would allow the use of a gas storage water heater plus a solar water heating system.

Proposed Code Change *(continued)*

Modification of <u>prescriptive</u> requirements for domestic hot water systems (continued)

- Applicants that use the performance path can install a minimally compliant storage water heater in combination with other measures that will allow the building to meet the energy budget.
  - Most applicants (over 90%) use the performance path.

- The proposed code change would add a prescriptive option to install a heat pump water heater (HPWH) if gas is not available, as determined by the gas utility.

Proposed Code Change *(continued)*

- Proposed code change applies to the following building types:
  - Low-rise residential
  - Multi-family buildings if each unit is served by a dedicated water heater
    - Does not apply to centralized water heating systems
- Additions and Alterations
  - The proposed code change would apply to additions
  - The proposed code change would not apply to alterations (retrofits)

Schematic of Possible Code Compliance Methods

Mandatory Measures
(required for all buildings)

This code change proposal does not recommend changes to the mandatory requirements in Title 24.

+

Prescriptive Path
(additional measures)

Either:

1) Install a gas IWH that complies with minimum federal efficiency standards; OR
2) Install a gas storage water heater that complies with minimum federal efficiency standards + a solar water heating system with a minimal solar savings fraction of 0.55.

OR

Performance Path
(model building energy performance)

Builder can comply using a number of measures, so long as the energy budget is achieved.

Proposed Code Change (continued)

- Natural Gas Availability
  - Statewide CASE Team will be proposing revised definition of natural gas availability.
  - Still developing recommendations on how to define gas availability.
  - Code language that was in previous versions of Title 24:

> "… natural gas is currently not available and extension of natural gas service is impractical, as determined by the natural gas utility…"

Proposed Code Change (continued)

- Still developing alternative prescriptive option:
  - When gas is available
    - Prescriptive option will include use of minimally compliant storage gas water heater.
    - Aiming to develop a package of measures that will result in similar energy performance as IWH option in every climate zone.
    - Possible option: Gas storage 0.62 EF + 0.55 solar fraction.
  - When gas is not available
    - Add a prescriptive option that allows for the installation of minimally compliant HPWH.

Proposed Code Change (continued)

- Performance Approach
  - No proposed changes to the performance approach.
  - Can meet energy budget via other strategies
    - Installation of condensing storage water heater (EF 0.82 or higher).
    - Combination of upgrades that meet the energy budget.

Reasons for Proposed Code Change

- Water heating accounts for 49% of natural gas energy consumption in California homes (RASS 2009)
- IWHs are typically more energy efficient than storage gas water heaters (no standby heat loss)
- IWH market share has expanded; lower unit costs
- This measure builds on the 2013 Title 24 mandatory requirements for domestic hot water systems
- By the time the 2016 Title 24 standards take effect in 2017, builders will be accustomed to designing for higher-efficiency water heaters

Market Analysis

- **Widespread availability of qualifying IWHs**
  - CEC Appliance Database (April 2014)
    - 12 manufacturers
    - 30 unique brands
    - 817 models
  - ENERGY STAR Qualified Products List (April 2014)
    - 1,248 models
- **Drivers**
  - Update of Federal standards
  - ENERGY STAR and rebate programs
  - Title 24 compliance credits
  - Decreasing unit costs
  - Growing interest in other benefits (e.g., lower utility bills)

Energy Analysis Assumptions

- Energy and cost effectiveness analysis still under development, and subject to change.
- Electricity Consumption
  - This version of the analysis does not account for electricity use from IWH. Statewide CASE Team will be updating analysis to add electricity use.
  - Estimated annual electricity use is 29 kWh/yr, we think this estimate may be on the high side.
- Natural gas consumption (2015 Federal minimum)
  - Base case: 50 gallon storage water heater (0.60 EF)
  - Standards case: IWH (0. 82 EF)
- Prototype Building: 2,500 square feet, two-story
- Daily hot water usage per household (56.5 gallons)
- Distribution loss multipliers (in accordance to Res ACM)
- Used new construction forecasts that CEC developed to estimate statewide savings.

Energy Analysis Assumptions

- Hot water draw schedule
  - EF ratings for IWHs are slightly higher than they should be due to inaccurate draw schedule used in the federal water heater test procedure.
  - Statewide CASE Team discounted the rated EF by 8% to adjust for inflation in rated EF for IWHs
    - Discounting the rated EF addresses concerns that savings from IWH are overstated in the performance approach
    - Discounting methodology is consistent with the rule set forth in the 2013 Residential ACM (Appendix E)
    - Field testing indicates that the 8% discount used in Title 24 results in reasonable energy impacts estimates (Schoenbauer, Hewett, and Bohac 2011; Hoeschele, M., and E. Weitzel 2013)
  - DOE recently released revised test procedure.
  - CEC could consider revising the discounting assumptions used in the ACM ruleset to respond to the adjustment in DOE's test procedure.

Energy Analysis Results – Per Unit

Climate Zone	Per Unit First Year Savings	
	Natural Gas Savings (Therms/yr)	2013 TDV Natural Gas Savings (kBTU)
Climate Zone 1	55	8,796
Climate Zone 2	53	8,423
Climate Zone 3	52	8,392
Climate Zone 4	52	8,245
Climate Zone 5	52	8,363
Climate Zone 6	50	8,021
Climate Zone 7	49	7,763
Climate Zone 8	49	7,871
Climate Zone 9	48	7,787
Climate Zone 10	48	7,795
Climate Zone 11	50	8,059
Climate Zone 12	51	8,198
Climate Zone 13	48	7,739
Climate Zone 14	50	8,066
Climate Zone 15	42	6,747
Climate Zone 16	57	9,249

Energy Analysis Results – Statewide

	Total First Year Savings	
	Natural Gas Savings (MMtherms)	TDV Natural Gas Savings (Million kBTU)
Statewide	5.4	862

Cost Analysis: Assumptions and Results

- Incremental cost difference between storage WH and IWH: $446
- IWH have lower replacement cost than storage WH
- Equipment lifetimes: 20 years (IWH), 13 (storage)
- Number of replacements over 30 years: 1 (IWH), 2 (storage)
- Number of installations over 30 years: 2 (IWH), 3 (storage)

Condition	Initial Equipment Cost		Incremental Present Value of Maintenance Cost	Total Cost
	Current	Post Adoption		
Existing Conditions	$1,279	$1,279	$2,087	$3,366
Proposed Conditions	$1,725	$1,725	$1,135	$2,860
Incremental	$446	$446	-$952	-$506

Cost-effectiveness Analysis Results

Climate Zone	Benefit: TDV Energy Cost Savings + Other Cost Savings (2013 PV $)	Cost: Total Incremental Cost (2013 PV $)	Change in Lifecycle Cost[4] (2013 PV $)	Benefit to Cost Ratio
Climate Zone 1	$2,475	$446	-$2,029	5.6
Climate Zone 2	$2,411	$446	-$1,965	5.4
Climate Zone 3	$2,405	$446	-$1,959	5.4
Climate Zone 4	$2,380	$446	-$1,934	5.3
Climate Zone 5	$2,400	$446	-$1,954	5.4
Climate Zone 6	$2,341	$446	-$1,895	5.3
Climate Zone 7	$2,296	$446	-$1,850	5.1
Climate Zone 8	$2,315	$446	-$1,869	5.2
Climate Zone 9	$2,301	$446	-$1,854	5.2
Climate Zone 10	$2,302	$446	-$1,856	5.2
Climate Zone 11	$2,348	$446	-$1,902	5.3
Climate Zone 12	$2,372	$446	-$1,926	5.3
Climate Zone 13	$2,292	$446	-$1,846	5.1
Climate Zone 14	$2,349	$446	-$1,903	5.3
Climate Zone 15	$2,120	$446	-$1,674	4.8
Climate Zone 16	$2,554	$446	-$2,108	5.7

Heat Pump Water Heater Option

1. The current prescriptive water heating requirement for locations where natural gas is not available is electric resistance with 0.5 solar fraction.

2. For climate zone 1-15, a typical minimum efficiency heat pump water heater (2.0EF) is more efficient than option 1 above. Propose to offer HPWH as another prescriptive alternative in addition to option 1.

TDV Comparison

Climate Zone	Electric Resistance 0.94EF + 0.5SF (kTDV/sf)		Heat Pump Water Heater 2.0EF (kTDV/sf)	
Square Feet	2100	2700	2100	2700
Climate Zone 1	22.84	19.78	19.43	16.16
Climate Zone 2	20.99	18.17	17.37	14.43
Climate Zone 3	21.09	18.26	17.43	14.48
Climate Zone 4	20.32	17.59	18.34	15.23
Climate Zone 5	21.61	18.71	19.22	15.97
Climate Zone 6	19.07	16.51	14.94	12.4
Climate Zone 7	19.74	17.09	15.52	12.88
Climate Zone 8	18.63	16.13	14.72	12.21
Climate Zone 9	18.23	15.78	14.41	11.96
Climate Zone 10	18.04	15.62	14.28	11.85
Climate Zone 11	19.03	16.47	15.0	12.45
Climate Zone 12	19.89	17.22	18.06	14.99
Climate Zone 13	18.79	16.26	14.87	12.34
Climate Zone 14	18.28	15.83	16.26	13.49
Climate Zone 15	14.77	12.79	12.43	10.28
Climate Zone 16	21.23	18.38	26.09	21.69

Proposed Code Language – New Construction

SECTION 150.1 – PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR NEWLY CONSTRUCTED RESIDENTIAL BUILDINGS

(c) Prescriptive Standards/Component Package.

8. **Domestic Water-Heating Systems.** Water-heating systems shall meet the requirements of either A, B, or C~~, or D~~.

~~A. For systems serving individual dwelling units, a single gas or propane storage type water heater with an input of 75,000 Btu per hour or less, and that meets the tank insulation requirements of Section 150.0(j) and the requirements of Sections 110.1 and 110.3 shall be installed. For recirculation distribution systems, only Demand Recirculation Systems with manual control pumps shall be used.~~

A. ~~B.~~ For systems serving individual dwelling units, the water-heating system shall meet the requirements of either i or ii:

i. ~~a~~ A single gas or propane instantaneous water heater with an input of 200,000 Btu per hour or less and no storage tank, and that meets the requirements of Sections 110.1 and 110.3 shall be installed. For recirculation distribution systems, only Demand Recirculation Systems with manual control pumps shall be used.

ii. A single gas or propane storage type water heater with an input of 75,000 Btu per hour or less, and that meets the tank insulation requirements of Section 150.0(j) and the requirements of Sections 110.1 and 110.3 may be installed as the main water heating source only if the water heater is located within the building envelope, and a solar water-heating system meeting the installation criteria specified in the Reference Residential Appendix RA4 and with a minimum solar savings fraction of 0.55 is installed. For recirculation distribution systems, only Demand Recirculation Systems with manual control pumps shall be used.

Proposed Code Language – New Construction *(continued)*

B. ~~C~~. For systems serving multiple dwelling units, a central water-heating system that includes the following components shall be installed:

i. Gas or propane water heaters, boilers or other water heating equipment that meet the minimum efficiency requirements of Sections 110.1 and 110.3; and

ii. A water heating recirculation loop that meets the requirements of Sections 110.3(c)2 and 110.3(c)5 and is equipped with an automatic control system that controls the recirculation pump operation based on measurement of hot water demand and hot water return temperature and has two recirculation loops each serving half of the building; and

EXCEPTION to Section 150.1(c)8Cii: Buildings with eight or fewer dwelling units are exempt from the requirement for two recirculation loops.

iii. A solar water-heating system meeting the installation criteria specified in Reference Residential Appendix RA4 and with a minimum solar savings fraction of 0.20 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.35 in Climate Zones 10 through 16. The solar savings fraction shall be determined using a calculation method approved by the Commission.

Proposed Code Language – New Construction *(continued)*

C. ~~D. For systems serving individual dwelling units, an electric-resistance storage or instantaneous water heater may be installed as the main water heating source only if natural gas is unavailable, the water heater is located within the building envelope, and a solar water-heating system meeting the installation criteria specified in the Reference Residential Appendix RA4 and with a minimum solar savings fraction of 0.50 is installed. The solar savings fraction shall be determined using a calculation method approved by the Commission. Recirculation pumps shall not be used.~~

For systems serving single dwelling units in area where natural gas is not currently available, as determined by the natural gas utility, the water-heating system shall meet the requirements of either i or ii:

i. An electric-resistance storage or instantaneous water heater with a minimum solar savings fraction of 0.5 shall be installed. The solar water-heating system shall meet the installation criteria specified in the Reference Residential Appendix RA4. The solar savings fraction shall be determined using a calculation method approved by the Commission. For recirculation distribution systems, only Demand Recirculation Systems with manual control pumps shall be used.

ii. In Climate Zones 1 through 15, a heat pump water heater that meets the requirements of Sections 110.1 and 110.3 shall be installed. For recirculation distribution systems, only Demand Recirculation Systems with manual control pumps shall be used.

Proposed Code Language – Additions

No proposed changes to relevant language code language for additions

SECTION 150.2 – ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS IN EXISTING BUILDINGS THAT WILL BE LOW-RISE RESIDENTIAL OCCUPANCIES

(a) Additions …

1. **Prescriptive approach.** …

D. **Water Heater**. When a second water heater is installed as part of the addition, one of the following types of water heaters shall be installed and assumed to comply:

i. A natural gas or propane water-heating system that meets the requirements of 150.1(c)8; or

ii. If no natural gas is connected to the building, an electric water heater that has an energy factor equal to or greater than required under the Appliance Efficiency Regulations. Recirculation pumps shall not be used; or

iii. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item 1 above; or if no natural gas is connected to the building, a water-heating system determined by the Executive Director to use no more energy than the one specified in Item 2 above; or.

iv. Using the existing building plus addition compliance or addition alone compliance as defined in Section 150.2(a)2 demonstrate that the proposed water heating system uses no more energy than the system defined in item 1 above regardless of the type or number of water heaters installed.

Proposed Code Language – Alterations

SECTION 150.2 – ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS IN EXISTING BUILDINGS THAT WILL BE LOW-RISE RESIDENTIAL OCCUPANCIES

(b) Alterations

1. **Prescriptive approach.** …

G. Water-Heating System. Replacement service water-heating systems or components shall:

Meet the requirements of Section 150.0(j)2 and either be:

i. If natural gas is connected to the building, a natural gas heater that has an energy factor equal to or greater than required under the Appliance Efficiency Regulations. For storage type water heaters the capacity shall not exceed 60 gallons. ~~A natural gas or propane water-heating system that meets the requirements of 150.1(c)8.~~ No recirculation system shall be installed; or

ii. If no natural gas is connected to the building, an electric water heater that has an energy factor equal to or greater than required under the Appliance Efficiency Regulations. For storage type water heaters the capacity shall not exceed 60 gallons. No recirculation system shall be installed; or

iii. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item 1 above; or if no natural gas is connected to the building, a water-heating system determined by the Executive Director to use no more energy than the one specified in Item 2 above; or

iv. Using the existing building plus addition compliance approach as defined in Section 150.2(b)2 demonstrate that the proposed water heating system uses no more energy than the system defined in item 1 above regardless of the type or number of water heaters installed

EXCEPTION to Section 150.2(b): Existing inaccessible piping shall not require insulation as defined under 150.0(j)2A iii.

Proposed Changes to ACM Reference Manual

Residential Alternative Calculation Method Reference Manual

Section 2.10 Domestic Hot Water (DHW)

STANDARD DESIGN

Individual dwelling units: The standard design is based on §150.1(c)8. For single family dwelling or dwelling units served by a dedicated water heating system, each dwelling unit has ~~one small storage (<75,000 Btu), 50 gallon gas storage~~ gas instantaneous water heater, meeting minimum federal Energy Factor standard ~~(0.575 in 2014, 0.60 in 2015).~~ (0.82).

Section 2.2.10 Natural Gas Availability

The natural gas utility is responsible for determining if natural gas is available at the site. If the natural gas utility has determined that extension of natural gas service is impractical and that natural gas is not available at the site, ~~T~~the user can specify~~ies~~ whether that natural gas is not available at the site. This is used to establish the TDV values from Reference Appendices JA3 used by the compliance software in determining standard and proposed design energy use.

PROPOSED DESIGN

The user specifies whether natural gas is available at the site. User can only specify that natural gas is not available if the natural gas utility has determined so.

STANDARD DESIGN

The standard design has natural gas space and water heating if natural gas is available at the site; otherwise it is propane.

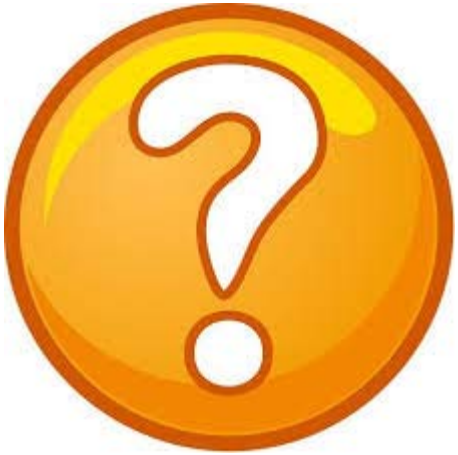
VERIFICATION AND REPORTING

Whether natural gas is or is not available is reported on the CF1R.

Feedback From Statewide CASE Team Stakeholder Meeting

- Stakeholder meeting held May 20, 2014
  - Notes and presentations from stakeholder meeting available at Title24Stakeholders.com

- Key comments
  - Implications of federal water heater test procedure update (e.g., hot water draw patterns; energy factor ratings)
    - *Response*: CASE Team has been following the rulemaking and is currently investigating the impact to the proposed measure.
  - Consideration of heat pump water heaters
    - *Response:* CEC is currently exploring HPWHs as an alternative prescriptive option for the electric-only scenario.



Questions?

Sarah Schneider
SSchneider@energy-solution.com
510-482-4420 ext. 202

Bijit Kundu
Bkundu@energy-solution.com
510-482-4420 ext. 261