Agenda

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Morning

- Scope and Application
- HERS Reports
- Entities Recognized
- Building Performance Contractors
- Quality Assurance

Afternoon

- Energy Modeling
- Utility Bill Analysis
- Rating Recommendations

Architectural Energy Corporation

Scope and Application

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

HERS Regulations, Section 1672(a)

"A California Whole House Home Energy Rating or a California Home Energy Audit shall be completed for a home only if it is completed as specified by these regulations and the HERS Technical Manual."

Approach

- **Rate the home not the occupants**
- **But, consider utility bills and life-style patterns when developing recommendations and estimating savings**

California HERS Program Objectives

- **Complete implementation of the HERS Program called for in Public Resources Code Section 25942**
  - **Phase I of the HERS Program was adopted in 1999, establishing the general framework for the program**
  - **Phase I focused on field verification and diagnostic testing to confirm implementation of special energy efficiency features under Title 24**
  - **Phase II expands the scope of the program to include the audit or rating of new and existing homes.**
  - **The purpose of the program is to:**
    - **ensure consistent, accurate, and uniform ratings based on a single statewide rating scale;**
    - **ensure reasonable estimates of potential utility bill savings, and reliable recommendations on cost-effective measures to improve energy efficiency; and**
    - **provide training and certification procedures for raters and quality assurance procedures to promote accurate ratings and protect consumers.**

California HERS Program Objectives (continued)

- **Phase II fulfills the goals of Public Resources Code 25942 by:**
  - **Guiding the production of consistent, accurate, and uniform ratings based on a single statewide rating scale**
  - **Ensuring that any audit or rating include reasonable estimates of potential utility bill savings and reliable recommendations on cost-effective measures to improve energy efficiency**
  - **Establishing labeling procedures that will meet the needs of home buyers, homeowners, renters, the real estate industry, and mortgage lenders with an interest in home energy ratings**
  - **Proposing a technique for determining energy efficiency measure cost-effectiveness**
  - **Proposing a technique to develop recommendations for energy efficiency improvements, including cross checking against utility bills**

Background Documents

- The CEC report "Options for Energy Efficiency in Existing Buildings" developed pursuant to AB 549
- The Phase I regulations for HERS
- Title 24 Standards, Residential Alternative Calculation Method (ACM) Manual, and Commission-adopted field verification and diagnostic testing procedures
- RESNET's "2006 Mortgage Industry National Home Energy Rating Systems Standards"

Existing Home Opportunities

- California has over 12 million residential dwelling units.
- Many of the existing homes were built before 1978, when California adopted its first energy code. These homes often have limited energy efficiency measures.
- Even homes built after 1978 will have significant opportunities for improving the energy efficiency of the structure.
- Many energy efficiency measures are highly cost-effective.
- Alerting homeowners to cost-effective measures can result in reducing their energy bills and achieving California energy and climate change goals.

HERS Topic Report

- **The Topic Report informed the production of the Draft HERS regulations and HERS Technical Manual**
- **The details of the topic report will be discussed throughout the presentation**
- **The content of the HERS Topic Report**
  - The appropriate structure of a rating scale
  - Modeling assumptions used to estimate home energy use
  - The means by which reliable recommendations of energy efficiency improvements should be made
  - The appropriate role for providers, raters, auditors, and other entities in the delivery of ratings and audits
  - Potential HERS provider and rater accreditation and quality assurance procedures

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

HERS Reports

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Rating Report Elements

- The Rating Certificate
- A statement of recommended improvements
- An analysis of projected and historic energy consumption
- A detailed listing of the features of the home that were used in the analysis

Sample Rating Certificate

California Home Energy Rating Certificate

Energy Impact

Greenhouse Gas Emissions

Carbon Dioxide tons/year	xxx

Energy Consumption

Electricity (kWh/year)	
Cooling	__
Lights	__
Appliances	__
Total	
Natural Gas (therms/year)	
Space Heating	__
Water Heating	__
Total	__

Operating Cost ($/year)

Electricity	__
Gas	__
Total	__

Renewable Energy Production

None

Information goes here on compliance with other programs

Qualifying Information Goes Here

HERS Provider and/or Sponsor Co-Branding Logos Go Here

HERS Provider

Acme Energy Rated Homes
934 Energy Efficient Way
Power Junction, California
www.AcmeEnergyRatedHomes.com

Rating Information

Rating Number	xxxx-yyyy
Certified Rater	EEH, Inc. Stockton, CA
Rating Date	January dd, yyyy

Official Home Energy Rating in conformance with the requirements of the California Energy Commission www.energy.ca.gov

Site Information

Address

123 Jones Street
Anywhere, California 9410x

General Information

Conditioned Floor Area	2,200 ft²
Conditioned Volume	16,000 ft²
Bedrooms	4
House Type	Single Family
Foundation Type	Slab-on-Grade

Energy Efficiency Features

Insulation

Ceiling	R-38
Wall	R-19
Floor over crawlspace	R-19
Slab Edge	R-7

Windows

Frame	Alum. Clad Wood
Glazing	Double low-e

Heating System

Condensing gas furnace, 0.92 AFUE
Sealed air distribution ducts

Cooling System

None

Ventilation System

None

Water Heating System

Gas storage type, 0.62 EF
ICS solar system

California HERS Index

California Home Energy Rating Certificate

Official Home Energy Rating in conformance with the requirements of the California Energy Commission www.energy.ca.gov

Site Information

Address
123 Jones Street
Anywhere, California 9410x

General Information

Conditioned Floor Area	2,200 ft²
Conditioned Volume	16,000 ft²
Bedrooms	4
House Type	Single Family
Foundation Type	Slab-on-Grade

Energy Efficiency Features

Insulation
Ceiling R-38
Floor over crawlspace R-19
Frame Alum. Clad Wood
Glazing Double low-e
Heating System
Condensing gas furnace, 0.92 AFUE
Sealed air distribution ducts
Cooling System
None
Water Heating System
Storage type, 0.62 EF
ICS solar system

Energy Impact

Greenhouse Gas Emissions
Carbon Dioxide xxx
tons/year

Energy Consumption
Electricity (kWh/year)
Cooling __
Lights __
Appliances __
Total

Natural Gas (therms/year)
Space Heating __
Water Heating __
Total __

Operating Cost ($/year)
Electricity __
Gas __
Total __

Renewable Energy Production
None

Information goes here on compliance with other programs

Qualifying Information Goes Here

Co-Branding Logo Here

HERS Provider
Acme Energy Rating Services
934 Power Junction, California
www.acmeenergy.com

Rating Information
Rating Number
Certificate Number
Rating Date January dd, yyyy

- **HERS Index is ratio of the TDV energy of the rated house to the TDV energy of a reference house**
- **Zero represents a zero energy home**
- **100 represents the reference home (minimum compliance with the 2008 California energy efficiency standards)**
- **Most older homes will have an index greater than 100**

What's Included in the Rating

- **What's Included**
  - Traditional uses of heating, cooling, and water heating are already produced by compliance software
  - Lighting and appliances energy as determined through the recommended model
  - Exterior lighting attached to the building
- **What's not included**
  - Pools
  - Spas
  - Lighted sports courts
  - Well pumps
  - Grinder pumps

Onsite Renewable Generation

- Two ratings are required: one with the building's energy efficiency features and one with those features plus onsite renewable generation (e.g., photovoltaics)
- The California Energy Commission in its 2007 Integrated Energy Policy Report recommends a goal of achieving zero-energy newly constructed homes by 2020
- It is critically important to invest first in energy efficiency
- Onsite renewable generation should be included in the modeling of projected utility bills

Site Information

California Home Energy Rating Certificate

- **Address of the home**
- **Floor area**
- **Conditioned volume**
- **Number of bedrooms**
- **House type**
- **Foundation type**

Energy Impact

Greenhouse Gas Emissions
Carbon Dioxide xxx
tons/year

Energy Consumption
Electricity (kWh/year)
Cooling ___
Lights ___
Appliances ___
Total ___

Natural Gas (therms/year)
Space Heating ___
Water Heating ___
Total ___

Operating Cost ($/year)
Electricity ___
Gas ___
Total ___

Renewable Energy Production
None

Information goes here on compliance with other programs

Qualifying Information Goes Here

HERS Provider and/or Sponsor Co-Branding Logos Go Here

HERS Provider
Acme Energy Rated Homes
934 Energy Efficient Way
Power Junction, California
www.AcmeEnergyRatedHomes.com

Rating Information
Rating Number xxxx-yyyy
Certified Rater EEH, Inc.
Stockton, CA
Rating Date January dd, yyyy

Official Home Energy Rating in conformance with the requirements of the California Energy Commission www.energy.ca.gov

Site Information

Address
123 Jones Street
Anywhere, California 9410x

General Information

Conditioned Floor Area	2,200 ft²
Conditioned Volume	16,000 ft²
Bedrooms	4
House Type	Single Family
Foundation Type	Slab-on-Grade

Energy Efficiency Features

Insulation

Ceiling	R-38
Wall	R-19
Floor over crawlspace	R-19
Slab Edge	R-7

Windows

Frame	Alum. Clad Wood
Glazing	Double low-e

Heating System
Condensing gas furnace, 0.92 AFUE
Sealed air distribution ducts

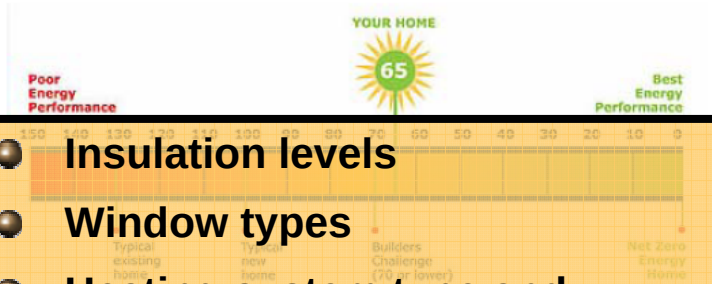
Cooling System
None

Ventilation System
None

Water Heating System
Gas storage type, 0.62 EF
ICS solar system

Energy Efficient Features

California Home Energy Rating Certificate



- **Insulation levels**
- **Window types**
- **Heating system type and efficiency**
- **Cooling system type and efficiency**
- **Ventilation System**
- **Water heating System**

Energy Impact

Greenhouse Gas Emissions
Carbon Dioxide xxx
tons/year

Energy Consumption
Electricity (kWh/year)
Cooling
Lights
Appliances
Total

Natural Gas (therms/year)
Space Heating
Water Heating
Total

Operating Cost ($/year)
Electricity
Gas
Total

Renewable Energy Production
None

Information on Other Programs

HERS Provider and/or Sponsor Co-Branding Logos Go Here

Qualifying Information Goes Here

HERS Provider
Acme Energy Rated Homes
934 Energy Efficient Way
Power Junction, California
www.AcmeEnergyRatedHomes.com

Rating Information

Rating Number	xxxx-yyyy
Certified Rater	EEH, Inc. Stockton, CA
Rating Date	January dd, yyyy

Official Home Energy Rating in conformance with the requirements of the California Energy Commission www.energy.ca.gov

Site Information

Address
123 Jones Street
Anywhere, California 9410x

General Information

Conditioned Floor Area	2,200 ft²
Conditioned Volume	16,000 ft²
Bedrooms	4
House Type	Single Family
Foundation Type	Slab-on-Grade

Energy Efficiency Features

Insulation

Ceiling	R-38
Wall	R-19
Floor over crawlspace	R-19
Slab Edge	R-7

Windows

Frame	Alum. Clad Wood
Glazing	Double low-e

Heating System
Condensing gas furnace, 0.92 AFUE
Sealed air distribution ducts

Cooling System
None

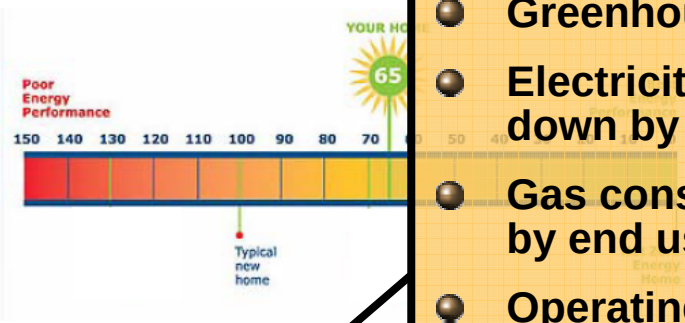
Ventilation System
None

Water Heating System
Gas storage type, 0.62 EF
ICS solar system

Scope and Application
HERS Reports
Recognized Entities
Building Performance Contractors
Quality Assurance
Energy Modeling
Utility Bill Analysis
Rating Recommendations
California Home Energy Rating System Program
Phase II Regulations Development
Public Workshop May 2, 2008

Estimated Energy Impact of the Home

California Home Energy Rating Certificate



- **Greenhouse gas emissions**
- **Electricity consumption (broken down by end uses)**
- **Gas consumption (broken down by end uses)**
- **Operating costs**
- **Renewable energy production**

Official Home Energy Rating in conformance with the requirements of the California Energy Commission www.energy.ca.gov

Address
123 Jones Street
Anywhere, California 9410

General Information
Conditioned Floor Area 2,000 ft²
Conditioned Volume 18,000 ft²
Bedrooms 4
House Type Single Family
Foundation Type Slab-on-Grade

Energy Efficiency Features

Insulation
Ceiling R-38
Wall R-19
Floor over crawlspace R-19
Slab Edge R-7

Windows
Frame Alum. Clad Wood
Glazing Double low-e

Heating System
Condensing gas furnace, 0.92 AFUE
Sealed air distribution ducts

Cooling System
None

Ventilation System
None

Water Heating System
Gas storage type, 0.62 EF
ICS solar system

Energy Impact

Greenhouse Gas Emissions
Carbon Dioxide xxx
tons/year

Energy Consumption
Electricity (kWh/year)
Cooling __
Lights __
Appliances __
Total

Natural Gas (therms/year)
Space Heating __
Water Heating __
Total __

Operating Cost ($/year)
Electricity __
Gas __
Total __

Renewable Energy Production
None

Information goes here on compliance with other programs

HERS Provider and/or Sponsor

Co-Branding Logos Go Here

Qualifying Information Goes Here

HERS Provider
Acme Energy Rated Homes
934 Energy Efficient Way
Power Junction, California
www.AcmeEnergyRatedHomes.com

Rating Information
Rating Number xxxx-yyyy
Certified Rater EEH, Inc.
Stockton, CA
Rating Date January dd, yyyy

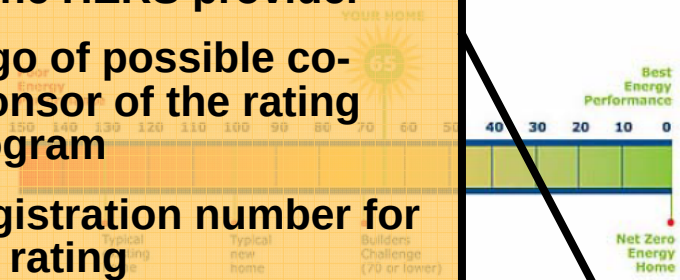
Energy Impact Summary

- **The Rating Certificate *energy impact summary* is based on the modeled energy use of the home, using the same inputs as are used for the rating**
- **The *summary* does not consider the historical energy use of the home**
- **The *summary* is not adjusted for the particular energy usage patterns of the home's current occupants**
- **The *summary*, and the overall rating, should be roughly identical regardless of the rater that produces the certificate**

HERS Provider and Rater Information

California Home Energy Rating Certificate

- **Logo and identification of the HERS provider**
- **Logo of possible co-sponsor of the rating program**
- **Registration number for the rating**
- **Date of the rating**
- **Name and certification number of the rater**



Energy Impact

Greenhouse Gas Emissions
Carbon Dioxide xxx
tons/year

Energy Consumption
Electricity (kWh/year)
Cooling __
Lights __
Appliances __
Total

Natural Gas (therms/year)
Space Heating __
Water Heating __
Total __

Operating Cost ($/year)
Electricity __
Gas __
Total __

Renewable Energy Production
None

Information goes here on compliance with other programs

HERS Provider and/or Sponsor Co-Branding Logos Go Here

Qualifying Information Goes Here

HERS Provider
Acme Energy Rated Homes
934 Energy Efficient Way
Power Junction, California
www.AcmeEnergyRatedHomes.com

Rating Information
Rating Number xxxx-yyyy
Certified Rater EEH, Inc.
Stockton, CA
Rating Date January dd, yyyy

Official Home Energy Rating in conformance with the requirements of the California Energy Commission www.energy.ca.gov

Site Information

Address
123 Jones Street
Anywhere, California 9410x

General Information

Conditioned Floor Area	2,200 ft²
Conditioned Volume	16,000 ft²
Bedrooms	4
House Type	Single Family
Foundation Type	Slab-on-Grade

Energy Efficiency Features

Insulation

Ceiling	R-38
Wall	R-19
Floor over crawlspace	R-19
Slab Edge	R-7

Windows

Frame	Alum. Clad Wood
Glazing	Double low-e

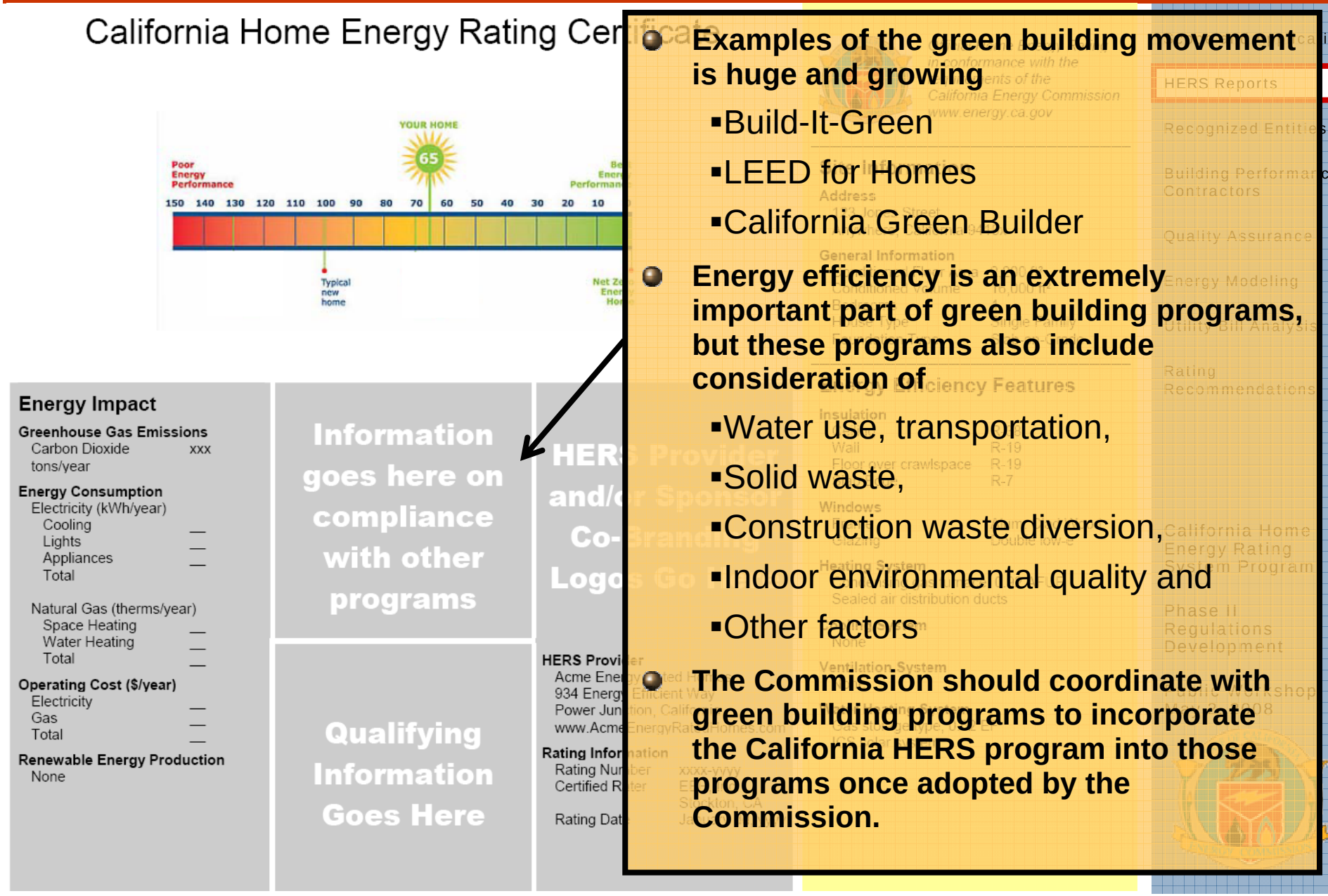
Heating System
Condensing gas furnace, 0.92 AFUE
Sealed air distribution ducts

Cooling System
None

Ventilation System
None

Water Heating System
Gas storage type, 0.62 EF
ICS solar system

Compliance with other Programs



- **Examples of the green building movement is huge and growing**
  - Build-It-Green
  - LEED for Homes
  - California Green Builder
- **Energy efficiency is an extremely important part of green building programs, but these programs also include consideration of**
  - Water use, transportation,
  - Solid waste,
  - Construction waste diversion,
  - Indoor environmental quality and
  - Other factors
- **The Commission should coordinate with green building programs to incorporate the California HERS program into those programs once adopted by the Commission.**

Caveats and Qualifying Information

California Home Energy Rating Certificate

Energy Impact

Greenhouse Gas Emissions
Carbon Dioxide xxx
tons/year

Energy Consumption
Electricity (kWh/year)
Cooling __
Lights __
Appliances __
Total

Natural Gas (therms/year)
Space Heating __
Water Heating __
Total __

Operating Cost ($/year)
Electricity __
Gas __
Total __

Renewable Energy Production
None

Information goes here on compliance with other programs

Qualifying Information Goes Here

HERS Provi and/or Spon Co-Brandi Logos Go H

HERS Provider
Acme Energy Rated Homes
934 Energy Efficient Way
Power Junction, California
www.AcmeEnergyRatedHomes.com

Rating Information
Rating Number xxxx-yyyy
Certified Rater EEH, Inc.
Stockton, CA
Rating Date January dd, yyyy

Official Home Energy Rating in conformance with the requirements of the California Energy Commission www.energy.ca.gov

Site Information

Address
123 Jones Street
Anywhere, California 9410x

General Information

Conditioned Floor Area	2,200 ft²
Conditioned Volume	16,000 ft²
Bedrooms	4
House Type	Single Family
Foundation Type	Slab-on-Grade

Energy Efficiency Features

Ceiling	R-38
Wall	R-19
Slab Edge	R-7
Windows	
Frame	Alum. Clad Wood
Glazing	Double low-e

Heating System
Condensing gas furnace, 0.92 AFUE
Sealed air distribution ducts

Cooling System
None

Ventilation System
None

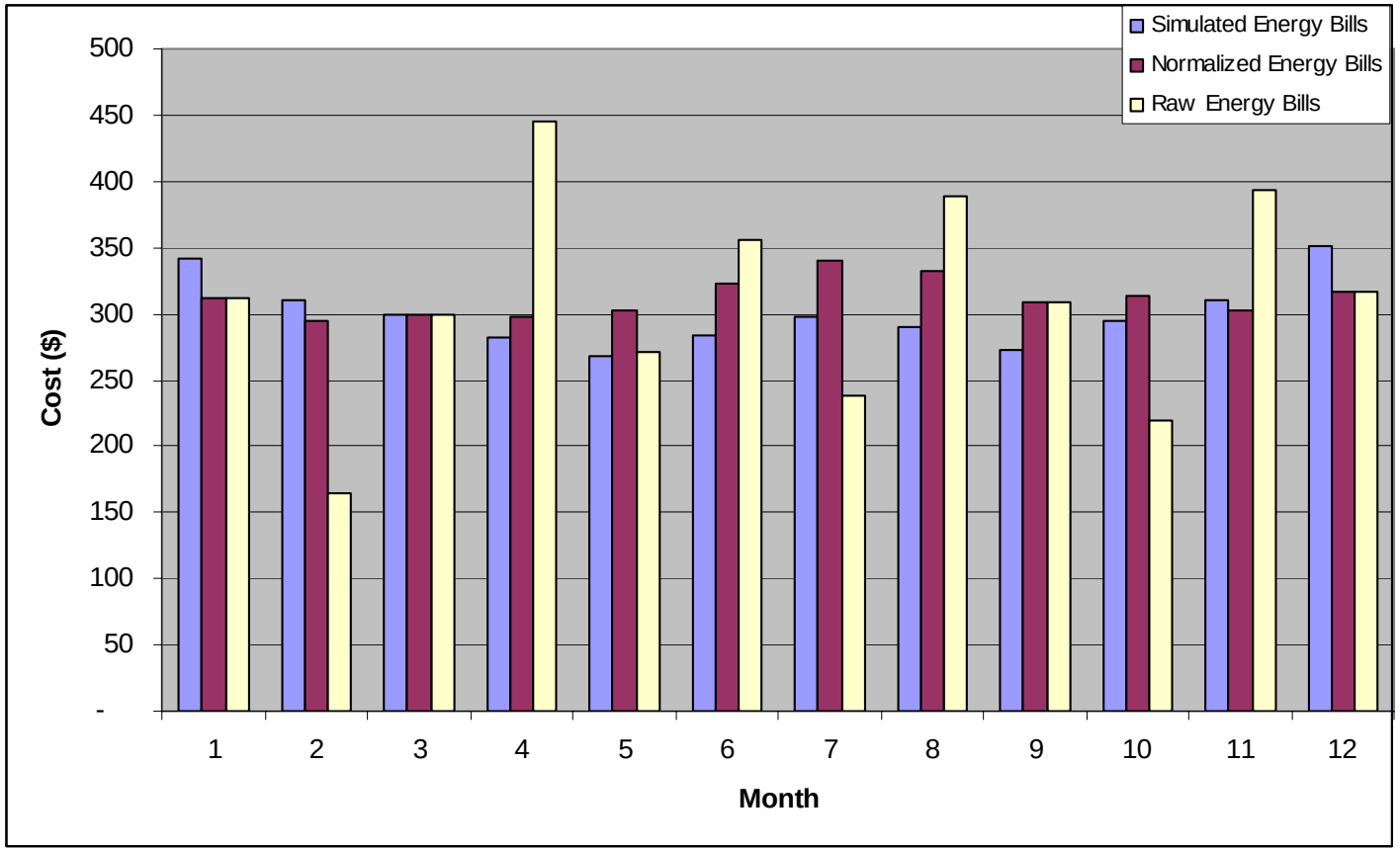
Water Heating System
Gas storage type, 0.62 EF
ICS solar system

Energy impact and rating are based on typical home occupancy patterns (your mileage will vary)

Energy Consumption Analysis

- **The second component of the overall rating report will be a graphical representation of energy consumption in the home. It will be comprised of three graphs:**
  - One representing the monthly cost of energy use in the home
  - One representing the kWh of electricity used monthly in the home
  - One representing the Btu's of gas used monthly in the home
- **All three reports will compare, where possible:**
  - Simulated energy use for the home
  - Actual "raw" energy use for the home over the last 12 months of normal occupancy
  - Actual energy use for the home normalized to the same weather profile as was used to determine the simulated energy use

Energy Costs



California Home Energy Rating System Program

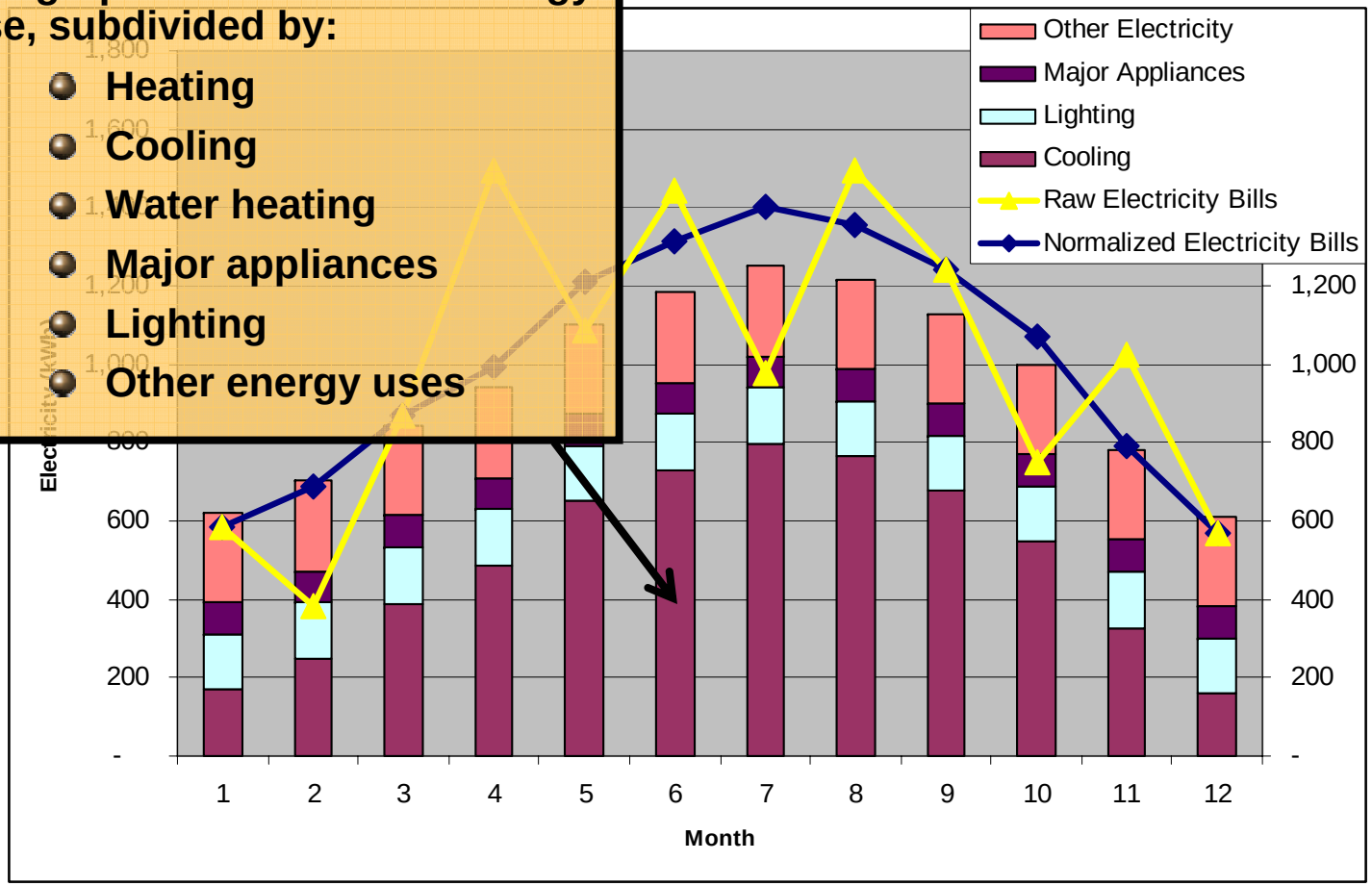
Phase II Regulations Development

Public Workshop May 2, 2008

Electricity Usage

Bar graphs are simulated energy use, subdivided by:

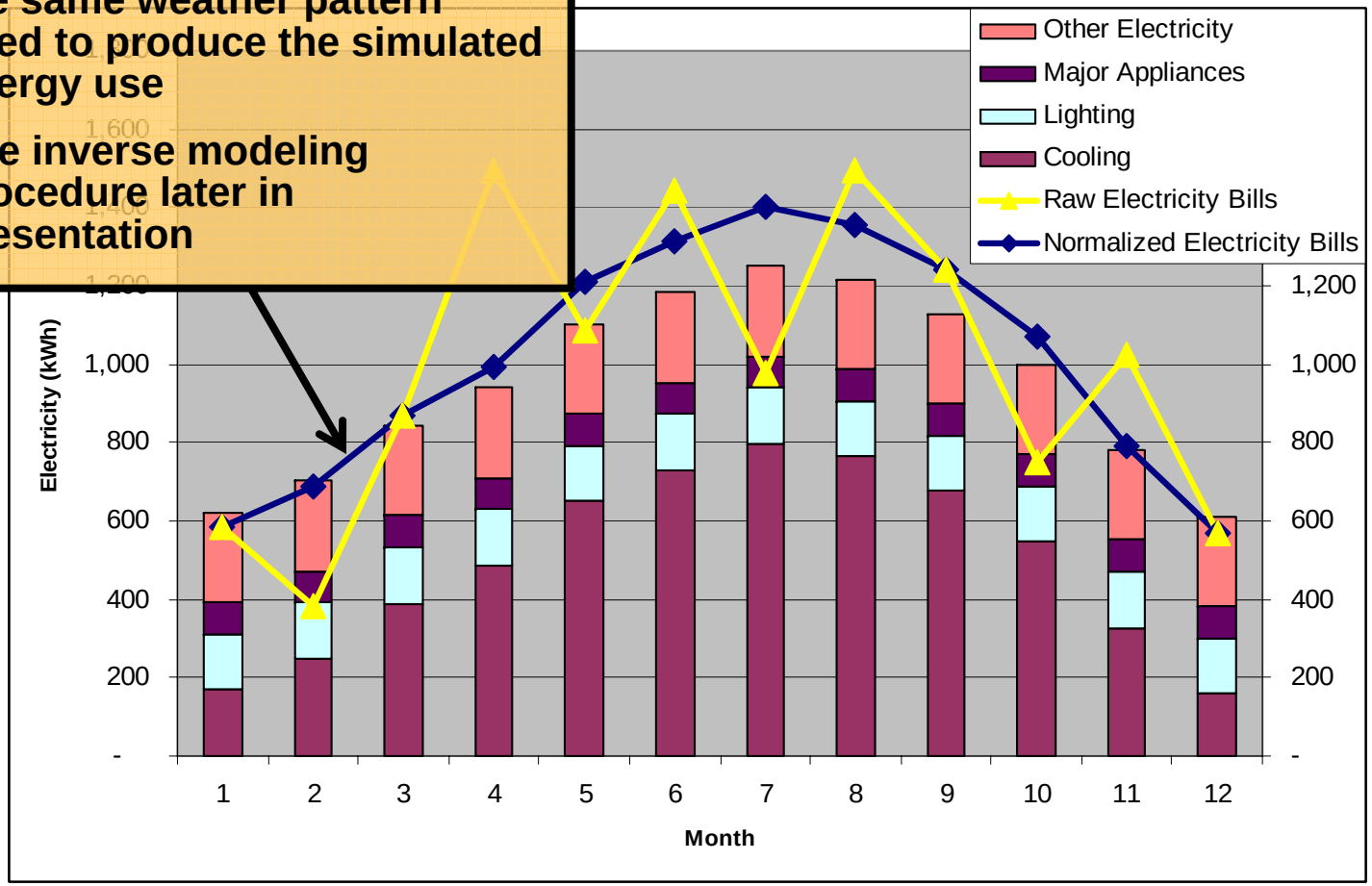
- **Heating**
- **Cooling**
- **Water heating**
- **Major appliances**
- **Lighting**
- **Other energy uses**



Electricity Usage

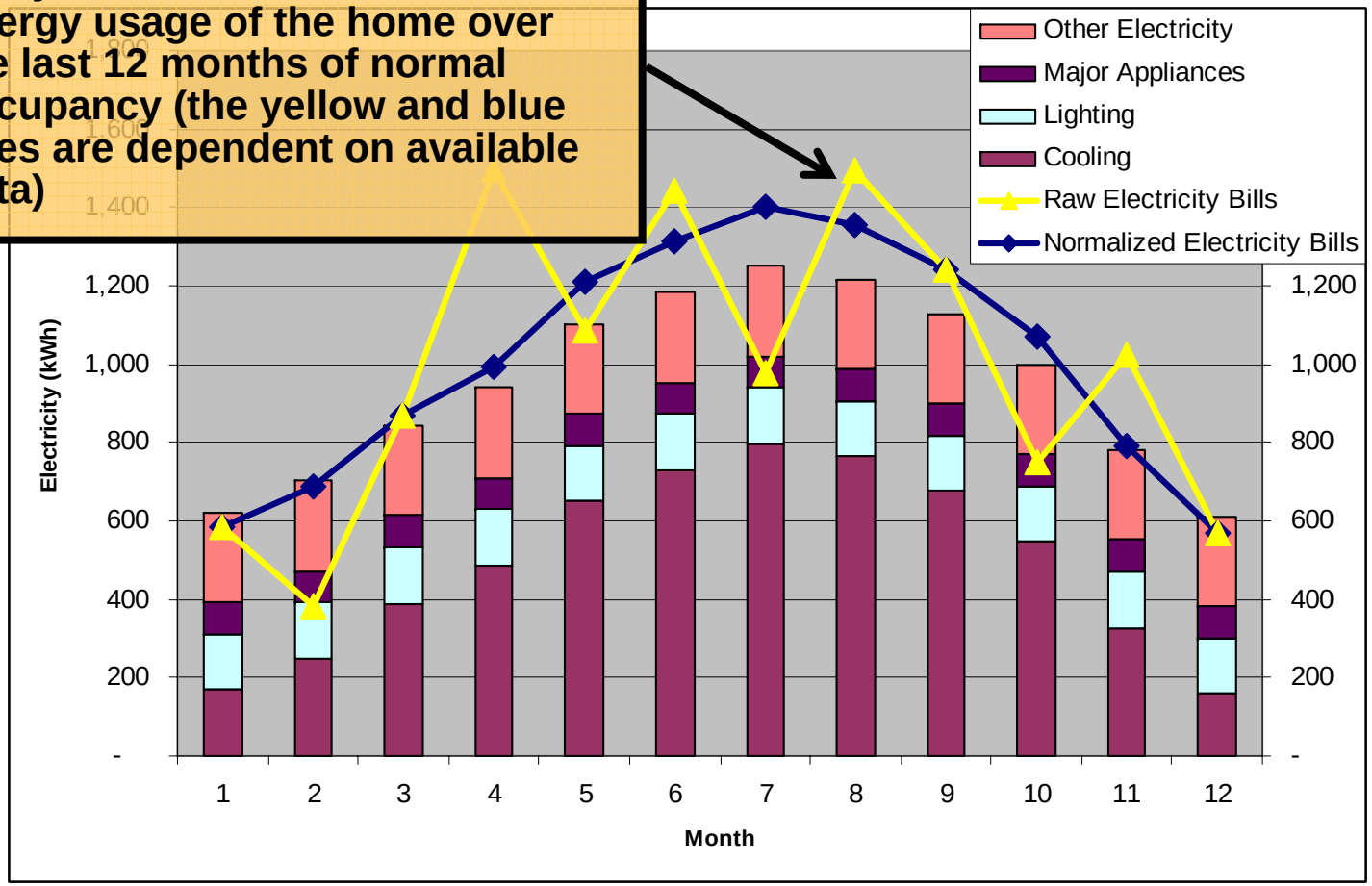
The blue line demonstrates the actual historic energy use of the home, but normalized to the same weather pattern used to produce the simulated energy use

See inverse modeling procedure later in presentation

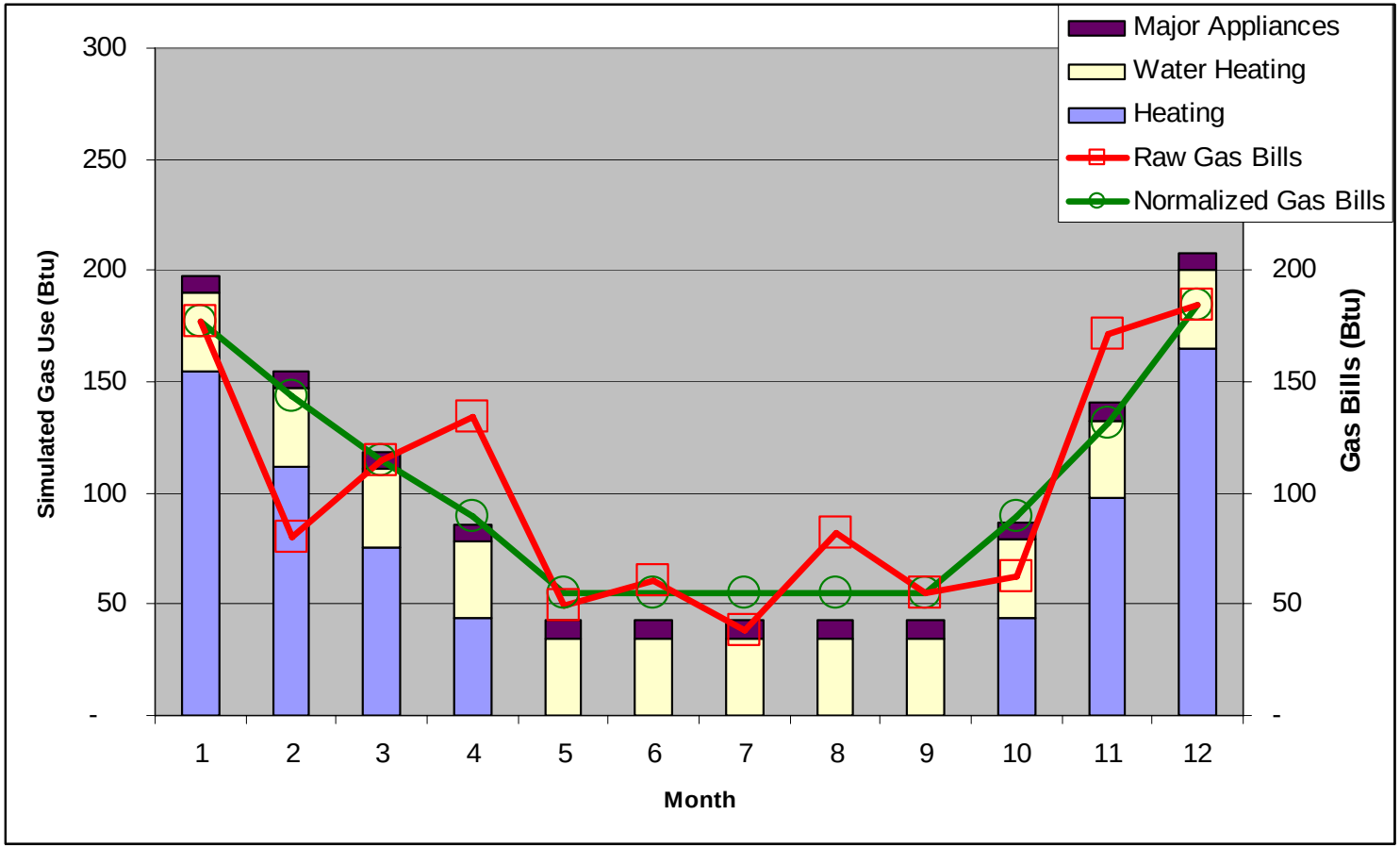


Electricity Usage

The yellow line tracks the actual energy usage of the home over the last 12 months of normal occupancy (the yellow and blue lines are dependent on available data)



Gas Usage



California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop May 2, 2008

The Standard and Custom Approaches

- The HERS system shall have the capability to generate recommendations using both a Standard Approach and a Custom Approach.
- Approved HERS systems shall be able to accommodate both approaches. However, the Standard Approach is mandatory for every rating and the Custom Approach is optional.
- The Standard Approach will result in the same set of recommendations, no matter who does the rating or which HERS system is used.
- The Custom Approach allows for consideration of unique homeowner circumstances, such as operating practices and available financing.

Recommendation Report Shall Include:

- **A descriptive list of the cost-effective recommendations for energy efficiency improvements.**
- **The cumulative projected annual energy bill savings of implementing each successive component of the recommended energy efficiency improvements.**
- **Expected California HERS Index reduction for each successive energy efficiency improvement.**

Optional Custom Approach Recommendations

- The rater may customize the inputs into the model to fit the particular behavioral patterns of homeowners
- The analysis can also be customized to use cost data for implementing measures more precisely tailored to the home
- The optional recommendations reports shall include details as needed to disclose the non-standard assumptions that are the basis of the recommendations

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Recognized Entities

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

The California Home Energy Rating Process

1. Inspection of the existing conditions of the home's energy-related features
2. Analysis of the energy impact of those features
3. Identification of potential energy efficiency improvements for that home
4. Evaluation of the cost effectiveness of each improvement
5. Recommendations to the homeowner of the cost effective improvements
6. Designation of a rating of the comparative energy efficiency of the home
7. Production of a label that communicates the rating

These steps can be accomplished in whole or in part by different entities covered by the California HERS Program.

Energy Rating Activities

- Field Verification Ratings for Title 24 compliance
- Whole-house Home Energy Ratings that produce a rating score
- Home Energy Audits that assess the efficiency of a house and offer recommended improvements but do not designate a rating score
- A Home Energy Audit is a subset of a Whole-house Home Energy Rating that includes the same first five steps as a HERS Rating but typically may leave out the last two steps
- Building Performance Contracting

The Oversight Role of HERS Providers

- The CEC relies on HERS providers to train, test, and certify raters and to provide quality assurance
- HERS providers must maintain an arms-length relationship with the raters, auditors, and other entities that they certify and oversee to avoid conflicts of interest
- Each provider must assign a Quality Assurance Manager and Quality Assurance Reviewers to oversee the quality assurance processes
- There are presently three CEC certified providers in California: CHEERS, CalCERTS, and CBPCA

Scope and Application

HERS Reports

Recognized Entities

Building Performance Contractors

Quality Assurance

Energy Modeling

Utility Bill Analysis

Rating Recommendations

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop May 2, 2008

Certifications Issued by the HERS Provider

- California Whole-House Home Energy Rater
- California Home Energy Auditor
- California Home Energy Inspector
- California Home Energy Analyst
- California Field Verification and Diagnostic Testing Rater

California Whole-House Home Energy Rater

- The rater is trained to perform both data collection and energy analysis functions
- Whole-House Home Energy Raters may manage Home Energy Inspectors, using the inspectors to perform the data collection portion of the rating process
- Whole-House Home Energy Raters may manage Home Energy Analysts, using the analyst to operate approved HERS compliance software using data provided by the rater
- A Whole-House Home Energy Rater is not certified to perform Field Verification and Diagnostic Testing Ratings for Title 24, Part 6 compliance.

California Home Energy Auditor

- **A California Home Energy Auditor is the baseline certification to become a California Whole-House Home Energy Rater**
- **The certification entails training in:**
  - Gathering data required for a California Whole-House Home Energy Rating
  - Evaluation of all the energy consuming features of a home
  - Estimating the energy consumption of the home
  - Completion of both standard and custom recommendation reports
- **A California Home Energy Auditor must receive authorization from the HERS provider to become a California Whole-House Home Energy Rater**

California Home Energy Inspector

- **The Home Energy Inspector certification is designed for home inspectors seeking to be involved in a program to provide home energy ratings.**
- **A Home Energy Inspector may:**
  - Collect data on the condition of a home and its energy related features
  - Partner with a Whole House Home Energy Rater to complete the rating
- **A Home Energy Inspector may not:**
  - Conduct the modeling and analysis required to produce a rating report and associated recommendations
  - Collect the data from a home derived from the diagnostic testing procedures outlined in Reference Appendix RA3 of the Title 24, Part 6.

California Home Energy Analyst

- **The Home Energy Analyst certification permits only the analysis portion of producing a home energy rating**
- **A Home Energy Analyst may:**
  - Model the energy usage of a home
  - Produce a Rating Report and Rating Certificate
  - Develop a recommendation report entailing standard recommendations, and, if desired, custom recommendations
  - **Produce a California Whole-House Home Energy Rating for new homes based on construction documentation and site verification by the Whole-House Home Energy Rater**
  - Partner with Whole House Home Energy Raters who can collect data on energy efficiency features of existing homes
- **A Home Energy Analyst may not collect data from existing homes**

California Field Verification and Diagnostic Testing Rater

- The role of Field Verification and Diagnostic Testing Raters – developed in the Phase I regulations for the HERS program – remains largely unchanged
- Field Verification and Diagnostic Testing Raters will continue their role of assuring implementation of special energy efficiency features for Title 24, Part 6 compliance
- Field Verification and Diagnostic Testing Raters will not conduct modeling analysis or produce California Home Energy Ratings
- Field verification and diagnostic testing to verify the installer's testing and proper installation for Title 24, Part 6 must be performed by a California Field Verification and Diagnostic Testing Rater

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Building Performance Contractors

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Building Performance Contractors

- **Building Performance Contractors are permitted to both rate homes and perform contracting work on the home to improve its energy efficiency**
- **The Building Performance Contractor must be certified as a California Whole-House Home Energy Rater**
- **The Building Performance Contractor must comply with heightened disclosure and quality assurance procedures to protect consumers**

Scope and Application

HERS Reports

Recognized Entities

Building Performance Contractors

Quality Assurance

Energy Modeling

Utility Bill Analysis

Rating Recommendations

Heightened Quality Assurance Procedures for Building Performance Contractors

- **The Building Performance Contractor shall justify to the consumer and to the provider why measures recommended through the *Standard Approach* were not implemented.**
- **Any work performed on the home that requires field verification and diagnostic testing pursuant to Title 24 regulations shall be field verified and diagnostically tested by a rater and provider that are independent entities from the Building Performance Contractor.**
- **The Building Performance Contractor shall disclose to the consumer:**
  - That the rater of the home has a financial interest in the work being performed
  - When measures are being recommended for reasons other than energy efficiency, such as safety or comfort
  - Why Standard Approach rating recommendations were not implemented

Heightened Quality Assurance Procedures for Building Performance Contractors (continued)

- **Twelve months following implementation of improvements the building performance contractor shall complete a post retrofit utility bill analysis that analyzes the actual energy savings being realized in the home. The analysis shall be shared with the homeowner and HERS provider.**
- **The provider shall conduct quality assurance checks on 5% of all homes using the Building Performance Contractor exception, rather than the standard 1% of quality assurance checks for other ratings.**
- **All improvements to the home carried out by the Building Performance Contractor that can be field verified or diagnostically tested shall be verified or tested following the procedures in Reference Appendix RA3 of Title 24.**

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Quality Assurance

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Primary Quality Assurance Tools

- **Auditors and raters must remain "independent entities" – defined as having no "financial interest" – with the contractors who perform energy efficiency improvements on a home or the builder and contractors of a newly-constructed home.**
- **1% of all ratings received by a provider will be repeated by a provider's Quality Assurance Reviewers to insure that the original rating was performed properly.**
- **In addition, each rater shall have the greater of one or 1% of all of the rater's ratings field checked each year by the provider's quality assurance process.**

Requirements for Quality Assurance Checks

- A home shall not be selected by a provider for a quality assurance check until the rating report is submitted to the consumer or a CF-4R is submitted to the provider
- The quality assurance check shall confirm that the initial rating was accurately completed
- The quality assurance check for homes improved by Building Performance Contractors shall include a review of the rating and recommendations performed both before and after the energy efficiency improvements were implemented
- For untested homes in groups passed through sampling for field verification and diagnostic testing ratings, a minimum of the larger of 1 home or 1% of the untested homes for each rater shall be field verified by the provider through a quality assurance check

Quality Assurance Personnel

- Each provider will designate a Quality Assurance Manager
- Each provider will designate Quality Assurance Reviewers
- The QAM and QARs shall be approved by the Executive Director of the Commission
- The QAM and QARs shall implement a provider's quality assurance requirements

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Modeling Assumptions

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Recommended California HERS Index

$$\text{HERS Index} = \frac{TDV_{Rated} - TDV_{PV}}{TDV_{Reference}} \times 100$$

- **What's Included**
  - Traditional uses of heating, cooling, and water heating are already produced by compliance software
  - Lighting and appliances energy as determined through the recommended model
  - Exterior Lighting attached to the building
- **What's not included (examples)**
  - Pools
  - Spas
  - Lighted sports courts
  - Well pumps
  - Grinder pumps

Adjustments for House Size

- If the conditioned floor area of the rated home is larger than 2,500 ft², the TDV energy of the reference home shall be based on a 2,500 ft² home.
- Energy uses for the reference house shall be calculated by the rules stated below.

$$TDV_{Reference,ScaledBack} = \frac{2{,}500\ ft^2}{Area_{RatedHome}} \times TDV_{Reference,FullSize}$$

Component of Energy Use	*Method of Reference House Adjustment*
Heating	See Equation
Cooling	See Equation
Interior Lighting	Calculate for a 2,500 ft² reference home using the methods in HTM
Refrigerator	No adjustment
Dishwasher	No adjustment
Other Appliances	Calculate for a 2,500 ft² reference home using the methods in HTM
Outdoor/Garage Lighting	Calculate for a 2,500 ft² reference home using the methods in HTM

Greenhouse Gas Emissions Associated with Energy Consumption

- **Emissions shall be calculated hourly based on estimates of electricity and gas consumption.**
- **Emission rates shall be taken from the time dependent valued (TDV) hourly files.**
- **The following table is a summary of average emission rates from the TDV files (not to be used for calculations)**

	CO_2	NO_x	SO_x	PM_{10}
Electricity emissions	579	158	948	74.3
Units	tons/GWh	lb/GWh	lb/GWh	lb/GWh
Gas emissions	5581	9200	6720	1000
Units	tons/Mtherm	lb/Mtherm	lb/Mtherm	lb/Mtherm

ACM Modeling Rules

The modeling rules and assumptions specified in Chapter 3 of the 2008 Residential ACM Approval Manual shall be used to calculate the TDV energy for the rated home and the reference home, except as otherwise stated in the HERS Technical Manual.

Reference Home Definition

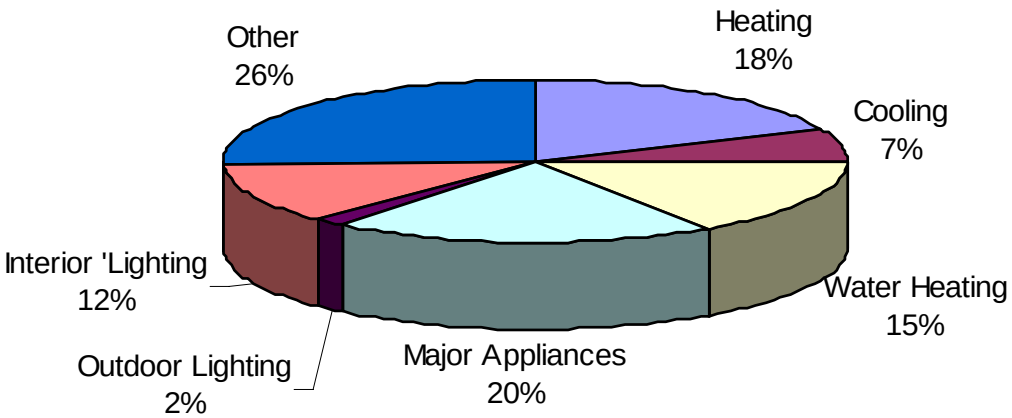
- The reference home is a building similar to the rated home, but one which is modified to just meet the requirements of the 2008 California energy efficiency standards, and other specifications of the HERS Technical Manual.
- The process of reference home generation shall not be accessible to program users for modification when the program is used for rating purposes or when HERS reports are generated.
- The fixed and restricted modeling assumptions apply to both the reference home and to the rated home. The standard fixed and restricted modeling assumptions always apply to the reference home and are the default for the rated home.

Utility Rates Model Minimum Capabilities

- Seasonal variations: a separate rate structure can be defined for at least three periods of the year (summer, winter and shoulder)
- Tiered rates: a different price per unit applies for different blocks of consumption, for example, one price for the first 500 kWh/month of consumption with a different price applying for consumption that exceeds 500 kWh/month.
- Monthly service charge: a fixed or seasonally variable charge that is added to the bill for each month, regardless of consumption.
- Demand charges
- Time-of-use charges.
- Ratcheted rates

Lighting and Appliance Energy

- **California Standards compliance calculations include only space heating, cooling and water heating energy**
- **Lighting and other appliance energy use is regulated through mandatory requirements, but not included in the performance standards.**
- **For HERS ratings lighting and appliance energy shall be included**



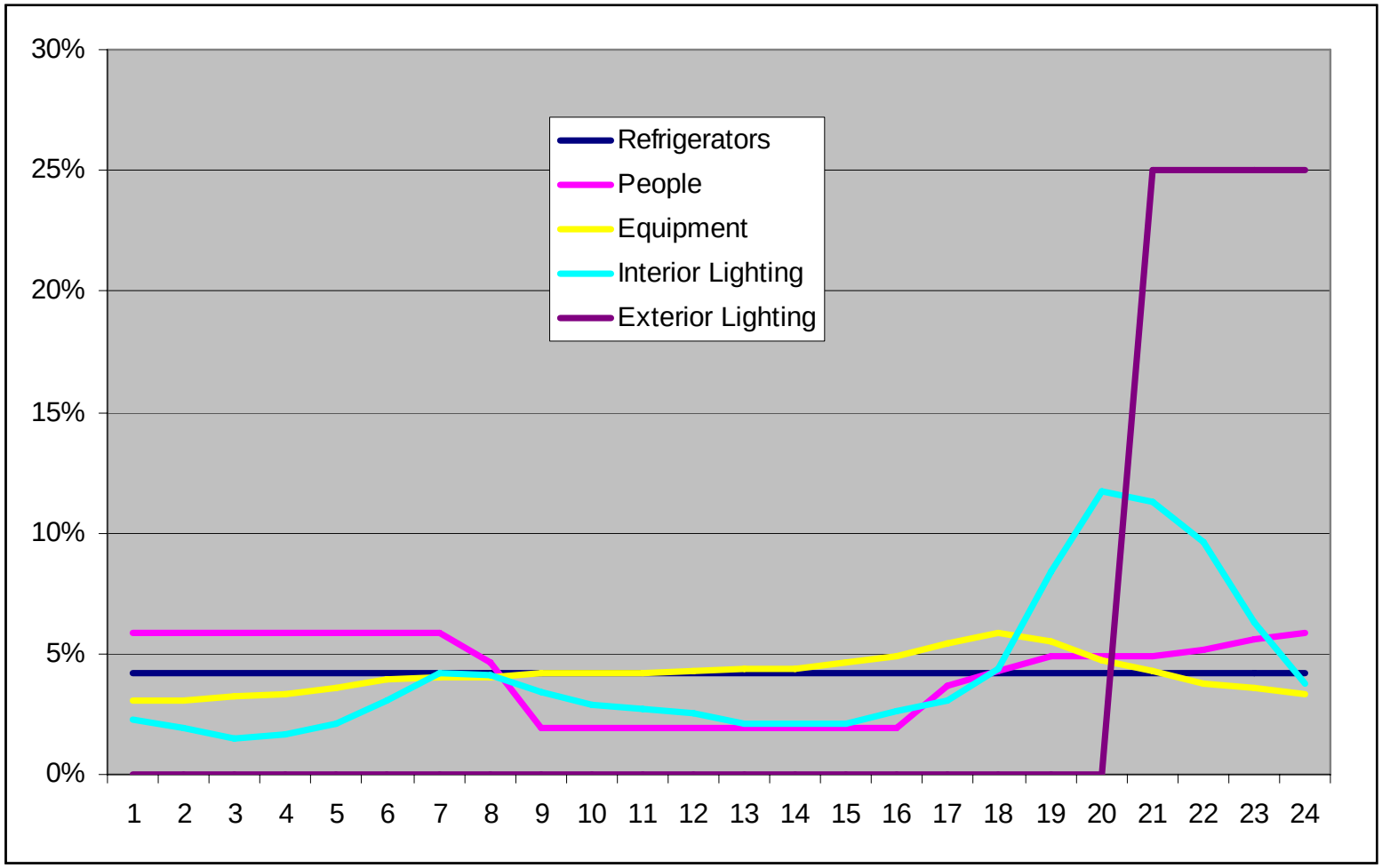
Average Single Family Source Energy Use

Note: These data represent average source energy use for existing homes in California, many of which are near the coast with low cooling loads.

Schedules for Lights, Appliances, People, and Equipment

Time	Refrigerators	People	Equipment	Interior Lighting	Exterior Lighting
1	4.2%	5.9%	3.1%	2.3%	0%
2	4.2%	5.9%	3.1%	1.9%	0%
3	4.2%	5.9%	3.2%	1.5%	0%
4	4.2%	5.9%	3.3%	1.7%	0%
5	4.2%	5.9%	3.6%	2.1%	0%
6	4.2%	5.9%	3.9%	3.1%	0%
7	4.2%	5.9%	4.0%	4.2%	0%
8	4.2%	4.6%	4.0%	4.1%	0%
9	4.2%	1.9%	4.2%	3.4%	0%
10	4.2%	1.9%	4.2%	2.9%	0%
11	4.2%	1.9%	4.2%	2.7%	0%
12	4.2%	1.9%	4.3%	2.5%	0%
13	4.2%	1.9%	4.4%	2.1%	0%
14	4.2%	1.9%	4.4%	2.1%	0%
15	4.2%	1.9%	4.6%	2.1%	0%
16	4.2%	1.9%	4.9%	2.6%	0%
17	4.2%	3.7%	5.4%	3.1%	0%
18	4.2%	4.3%	5.9%	4.4%	0%
19	4.2%	4.9%	5.5%	8.4%	0%
20	4.2%	4.9%	4.7%	11.7%	0%
21	4.2%	4.9%	4.3%	11.3%	25%
22	4.2%	5.2%	3.8%	9.6%	25%
23	4.2%	5.6%	3.6%	6.3%	25%
24	4.2%	5.9%	3.3%	3.8%	25%

Schedules for Lights, Appliances, People, and Equipment

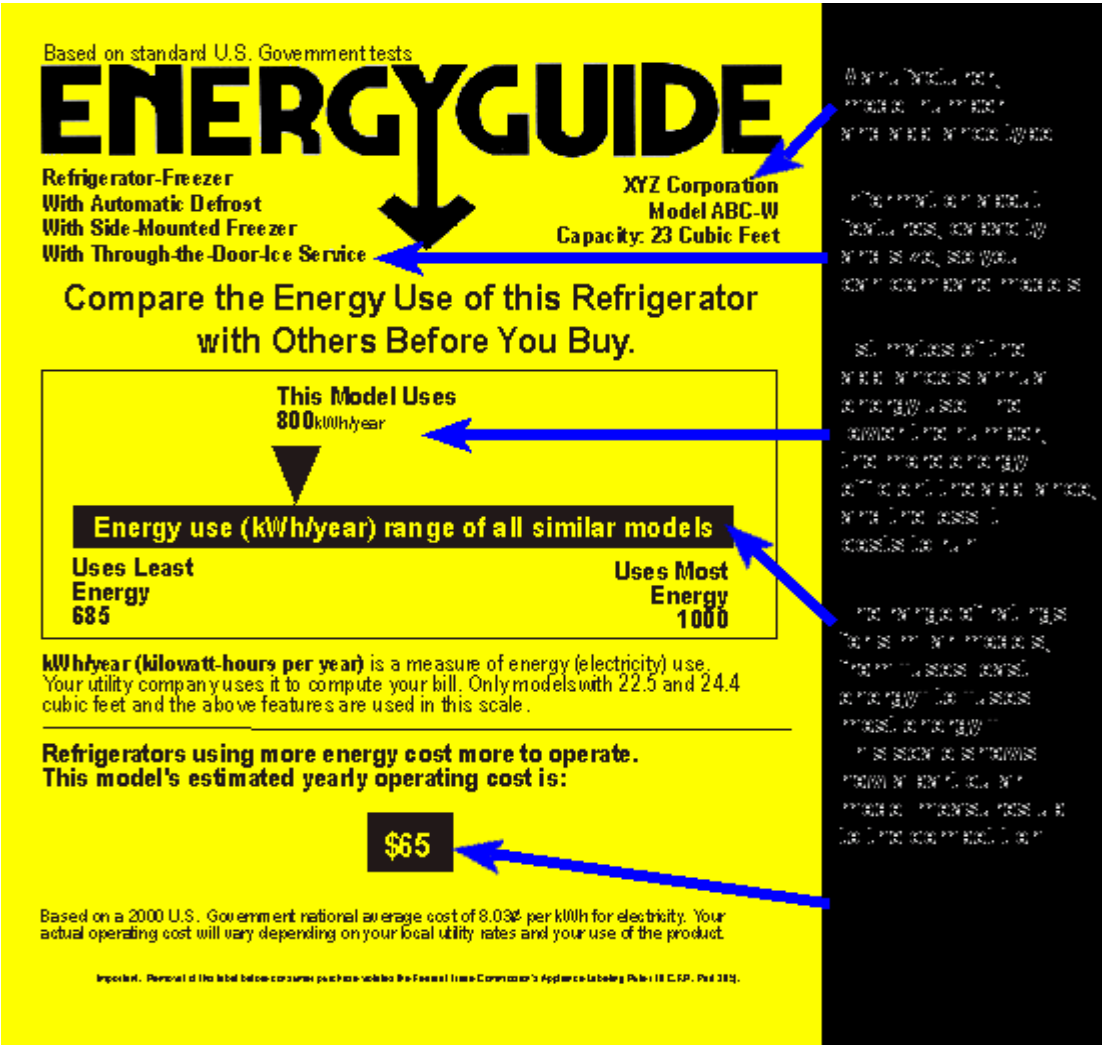


Refrigerator

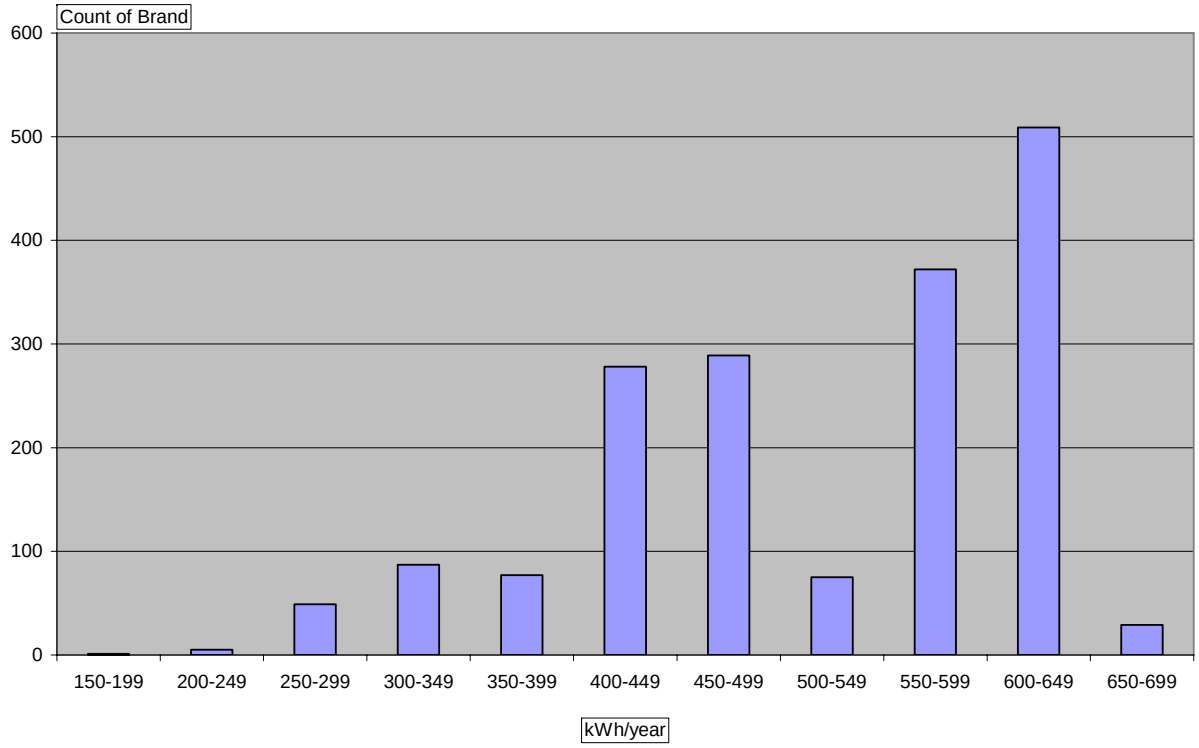
- The refrigerator in the reference home shall use 775 kWh/y.
- If the rated house has a refrigerator and the EnergyGuide data for the refrigerator is known, then this information is used for the rated house.
- In those instances when the rater observes the presence of a second refrigerator in the rated home, the rated home shall include the energy of the second refrigerator using the equation below:
- $\text{Electricity}_{\text{SecondRefrig}} = -50 + 0.717 * \text{CFA}$

Electricity units are kWh/y
Gas units are therms/y

Federal Energy Guide Label



EnergySTAR Refrigerators



Source: EnergySTAR Database December 2006

Dishwasher

- The dishwasher in the reference house shall be modeled with an energy factor (EF) of 0.46.
- The dishwasher in the rated house shall be the same as the reference house, unless the EF can be determined by the rater for the equipment that exists in the house at the time of the rating.
- Dishwasher energy use shall only include the electricity used by the dishwasher, not the hot water delivered by the water heater, since this is accounted for separately.
- Energy use shall be calculated based on the following equation:

$$\text{Electricity}_{\text{Dishwasher}} = 0.27 \times \frac{\text{Cycles / year}}{\text{EnergyFactor}}$$

- The dishwasher in both the rated house and the reference house shall use the *Equipment* schedule.

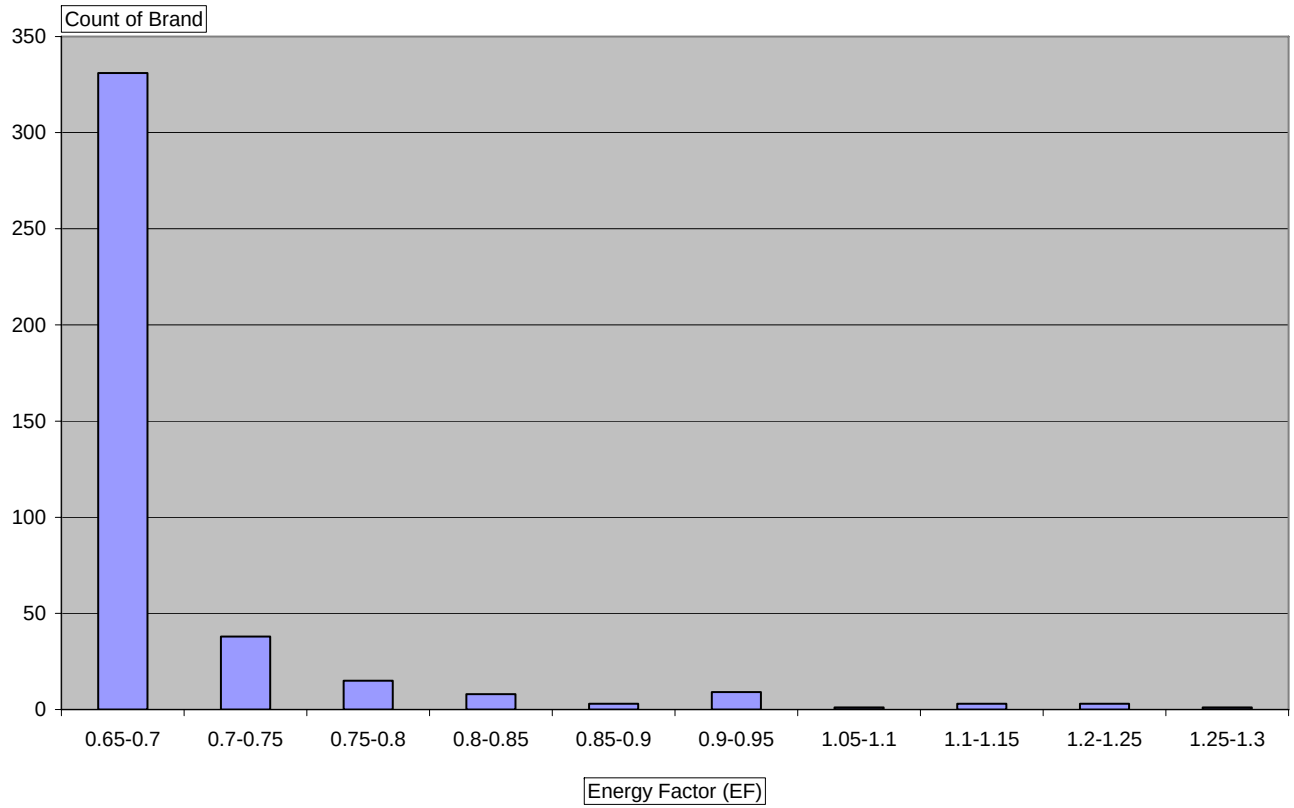
Electricity units are kWh/y
Gas units are therms/y

Dishwasher Use Assumptions

Bedrooms	Cycles/year	Reference Dishwasher kWh/y
1	154	90
2	214	126
3	247	145
4	296	174
5 or more	345	203

EnergySTAR Dishwashers

- **EnergySTAR® dishwashers are required to have an EF of 0.58 or greater, 25% better than federal standard, which is 0.46.**



Source: EnergySTAR.gov, December 2006

Clothes Dryer

- If a clothes dryer is present in the rated house or if there is a space and hookup for a clothes dryer, then the energy use of the clothes dryer shall calculated for both the rated home and the reference home using the following equations.

$$\text{Electricity}_{\text{Dryer}} = 263 + 0.254 \times \text{CFA}$$

$$\text{Gas}_{\text{Dryer}} = 13 + 0.010 \times \text{CFA}$$

Electricity units are kWh/y
Gas units are therms/y

Clothes Washer

- If a clothes washer is present in the rated house or if there is a space and hookup for a clothes washer, then the energy use of the clothes washer shall calculated for both the rated home and the reference home using the following equation:

$$\text{Electricity}_{\text{Washer}} = -64 + 0.108 \times \text{CFA}$$

Electricity units are kWh/y
Gas units are therms/y

Oven/Range

- If the rated home has an electric range and oven or hookups, then electricity use for both the rated home and the reference home shall be calculated as below:

$$\text{Electricity}_{\text{Range/Oven}} = 92 + 0.118 \times \text{CFA}$$

- If the rated home has a gas range and oven or hookups, then gas use for both the rated home and the reference home shall be calculated as below

$$\text{Gas}_{\text{Range/Oven}} = 31 + 0.008 \times \text{CFA}$$

- In the event that the rated home has both an electric and gas range oven, then both shall be used for both the rated home and the reference home.
- Both the rated home and the reference home shall use the *Equipment* schedule.

Electricity units are kWh/y
Gas units are therms/y

Miscellaneous Electricity

- Miscellaneous electricity use for both the rated home and the reference home shall be calculated as below.

$$\text{Electricity}_{\text{Misc}} = 1{,}650 + 0.410 \times \text{CFA}$$

- Both the reference home and the rated home shall use the *Equipment* schedule.

Electricity units are kWh/y
Gas units are therms/y

Interior Lighting

- The electricity for interior lighting is calculated as follows:.

$$\text{Electricity}_{\text{InteriorLights}} = (214 + 0.601 \times \text{CFA}) \times (\text{Fract}_{\text{Portable}} + (1 - \text{Fract}_{\text{Portable}}) \times \text{PAM}_{\text{Interior}})$$

Electricity units are kWh/y
Gas units are therms/y

Fraction of Portable Lighting

- Depends on the number of hardwired fixtures in the rated house (F) and the conditioned floor area of the rated house (CFA), using the following equation.

$$\text{Fract}_{\text{Portable}} = 0.22 \times \frac{28}{F} \times \frac{CFA}{2200}$$

- This fraction is used for both the rated home and the reference home.

Power Adjustment Multiplier (PAM)

- This value is fixed at 0.625 for the reference house.
- The PAM is calculated for the rated house using the following equation

$$PAM_{Interior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

$PAM_{Fixture,i}$

- 0.33 is used for hardwired high efficacy fixtures as defined in §150(k) of the California energy efficiency Standards;
- 0.67 is used for permanently mounted luminaires that are fitted with screw-in compact fluorescent lamps; and
- 1.00 is used for permanently mounted incandescent luminaires.

$$PAM_{Interior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

$PAM_{Control,i}$

- Power adjustment multiplier based on the type of control serving the ith fixture:
- 1.00 is used for a conventional on/off switch;
- 0.90 is used for a dimming control; and
- 0.80 is used for an occupant sensor.

$$PAM_{Interior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

Daily Lighting Hours – Interior

Location	$DailyHours_i$
Small Closet	0.5
Bedroom/WIC	1.4
Hall/Entry/Stairs/Other	2.0
Living	2.6
Utility/Laundry	2.6
Kitchen/Dining/Nook	3.4
Source: HMG 1999 Lighting Efficiency Technology Report, Volume 1, Figure 1-6	

$$PAM_{Interior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

Rules for Determining Luminaire (Lighting Fixture) Count

Luminaire Type	Examples/Description	Method of Counting
Track Lighting	Line-voltage or low-voltage track	Larger of: • One luminaire for each 3' of track length rounded up to 3 foot multiple, or • Actual number of track heads installed.
Linear Fluorescent (see Note 1)	Linear fluorescent luminaire, factory installed ballast	One luminaire per individual factory made luminaire, regardless of number of lamps per luminaire
LED (see Note 2)	Single diodes or clusters of diodes	One luminaire per cluster
	Linear row of diodes	One luminaire for each 3 ft length, rounded up to 3 ft multiple.
All Other	Incandescent luminaires including low voltage or line voltage	Count = 1 for luminaries with one lamp or one socket. Count = 1 luminaire for every two sockets, rounded up to the nearest whole number, for luminaires with multiple lamps or sockets

Note 1: A factory made luminaire is a complete lighting unit consisting of lamps and the parts designed to distribute the light, to position and protect the lamps, and to connect the lamp to the power supply.

Note 2: LED system, no screw bases, includes optics and power supply

$$PAM_{Interior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

Permanently Installed Luminaire Types

Classification	Definition
Permanently installed High efficacy	Meets the requirements of §152(k). Includes luminaires which can accept only linear fluorescent, compact fluorescent, or LED lamps.
Low efficacy	Any luminaire that accepts any type of incandescent lamp, and which has incandescent lamps installed
Screw-in high efficacy	Any luminaire that accepts screw based incandescent lamps, but which has screw based compact fluorescent or screw based LED installed. Any track lighting track that accepts medium screw based incandescent lamps, but which has medium screw-base track head with screw-in CFL, CFL track heads with factory installed ballast, or LED track heads

Exterior Lighting

Exterior Lighting Power is calculated using the following equation:

$$\text{Electricity}_{\text{OutdoorLights}} = (-81 + 0.152 \times \text{CFA}) \times \text{PAM}_{\text{Exterior}}$$

Electricity units are kWh/y
Gas units are therms/y

Power Adjustment Factor (PAM)

- The PAM for the reference home is fixed at 0.49.
- The PAM for the rated home is calculated as follows:

$$PAM_{Exterior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

$PAM_{Fixture,i}$

- 0.33 is used for hardwired high efficacy fixtures as defined in §150(k) of the California energy efficiency Standards;
- 0.67 is used for permanently mounted luminaires that are fitted with screw-in compact fluorescent lamps; and
- 1.00 is used for permanently mounted incandescent luminaires.

$$PAM_{Exterior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

Exterior Lighting Control Power Adjustment Multipliers

Control Type	$PAM_{Control}$
On/Off	1.00
Photocontrol with motion sensor (outdoor lighting only)	0.50
Occupant sensor (interior garage only)	0.80

$$PAM_{Exterior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

Daily Lighting Hours – Exterior

Location	DailyHours
Indoor Garage	2.3
Outdoor – Front entry	6.0
Outdoor - Other (side/back)	2.0
Source: Impact Analysis of the 2005 Title 24 Energy Efficiency Standards, Eley Associates, Table 7.	

$$PAM_{Exterior} = \frac{\sum PAM_{Fixture,i} \times PAM_{Control,i} \times DailyHours_i \times Count_i}{\sum DailyHours_i \times Count_i}$$

Internal Heat Gain

- The total daily internal gains shall be equal to the heat content generated by interior lighting, appliances and miscellaneous electricity, as calculated in the previous sections.
- An additional 4,140 Btu (230 Btu per occupant times 18 hours per day per occupant) shall be included for each bedroom in the rated house and the reference house. The "people" heat gain shall follow the People schedule in .

		Internal Gain Percent
Electricity Uses	Refrigerator	100%
	Dishwasher	100%
	Dryer (Electric)	30%
	Range/Oven (Electric)	90%
	Clothes Washer	100%
	Interior Lighting	100%
	Outdoor Lighting	0%
	Other (Miscellaneous)	100%
Gas Uses	Range/Oven	90%
	Dryer (gas)	30%

U-factors for Uninsulated Construction Assemblies

- U-factors for uninsulated wall and ceiling construction assemblies in existing homes shall be modeled with a U-factor no greater than 0.25.

Infiltration

- The default specific leakage area for new and existing homes shall use the values below
- The values for new homes are identical to the 2008 Residential ACM Approval Manual (RACM).
- Mechanical ventilation is required when credit is taken for infiltration reduction through testing *(a typical solution is a a quiet, continuously operating exhaust fan)*.
- Testing shall be performed according to the procedures specified in Standards Reference Appendix RA3.

Case	New Homes	Existing Homes
Unsealed ducts	4.3	4.9
Sealed ducts	3.8	4.4 (see Note)
No ducts	3.2	3.8
Measured leakage	May be no lower than 1.5	May be no lower than 1.5
Mechanical ventilation	Mandatory Measure	Required as retrofit when leakage is measured
Note: To use the 4.4 SLA value for existing ducts, they shall be tested to a leakage of 6%.		

Mechanical Ventilation

- Mechanical ventilation became a mandatory feature for homes constructed in compliance with the 2008 Title 24 energy efficiency standards.
- For the common situation when the rated home does not have mechanical ventilation, it shall be modeled with mechanical ventilation having the same specification as the reference home.
  - **The ventilation rate of the reference home is determined based on floor area and the number of bedrooms.**
  - **The fan shall be assumed to operate continuously with a power to volume ratio of 0.25 W/cfm.**
- In those cases when the rated home has a mechanical ventilation system, the home inspector shall collect data and these data shall be used calculate the fan energy for the rated home.
  - **The fan volume of the mechanical ventilation system,**
  - **The fan power and the schedule of operation (in those cases when the fan does not operate continuously),**
  - **The mechanical ventilation system in the standard design shall be as specified in the RACM for new homes.**

Ancillary Energy Uses

- Ancillary energy uses are to be excluded from the California HERS Index
- However, they shall be included in the estimate of simulated energy use as defined below

End Use	Features	Electricity (kWh/y)	Gas (therms/y)
Swimming Pool	Gas heated with cover	2671	352
	Gas heated with no cover	2671	703
	Solar heated or not heated	2671	0
	Electric heated with cover	4169	0
	Electric heated with no cover	5667	0
Spa	Gas heated with cover	467	81
	Solar/gas heated with cover	467	20
	Electric heated with cover	2186	0
	Solar/electric heated with cover	897	0
Well Pump	All	862	0
Grinder Pump	All	104	0

Schedules for Ancillary Energy Uses

Time of Day	Pools	Spas	Well Pumps	Grinder Pumps
1	0%	0%	Use *Equipment* schedule	Use *Equipment* schedule
2	0%	0%		
3	0%	0%		
4	0%	0%		
5	0%	0%		
6	0%	0%		
7	3%	0%		
8	5%	0%		
9	6%	0%		
10	10%	0%		
11	10%	0%		
12	10%	0%		
13	10%	0%		
14	10%	0%		
15	10%	0%		
16	10%	0%		
17	8%	0%		
18	6%	0%		
19	3%	25%		
20	0%	25%		
21	0%	25%		
22	0%	25%		
23	0%	0%		
24	0%	0%		

Onsite Photovoltaic (PV) Production

- The benefit of onsite renewable energy generation systems shall be accounted for in the rating.
- Calculations of PV production shall be determined on an hourly basis following the procedures of the 2008 Residential ACM Approval Manual, Appendix B.

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Utility Bill Analysis

California Home Energy Rating System Program

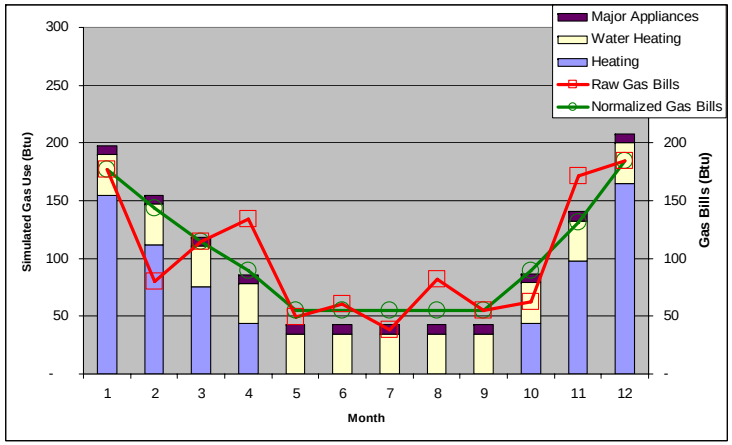
Phase II Regulations Development

Public Workshop
May 2, 2008

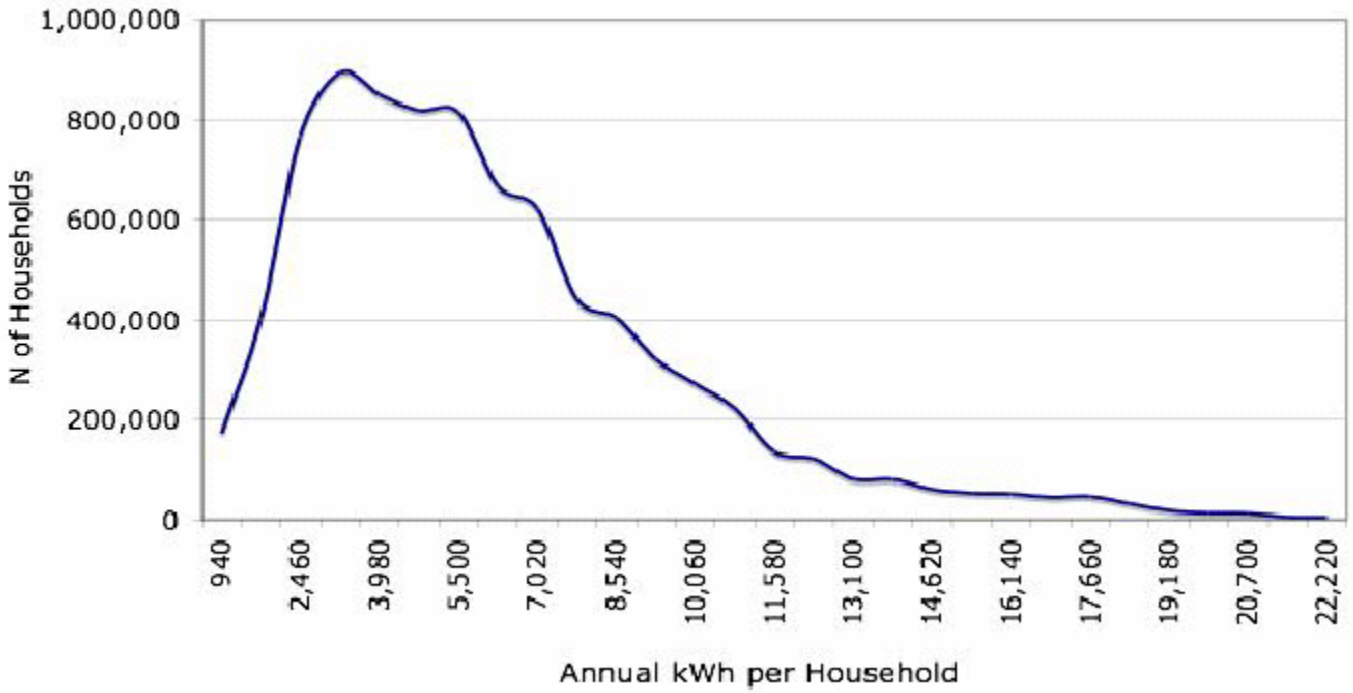
Architectural Energy Corporation

Cross Checking Energy Savings Against Utility Bills

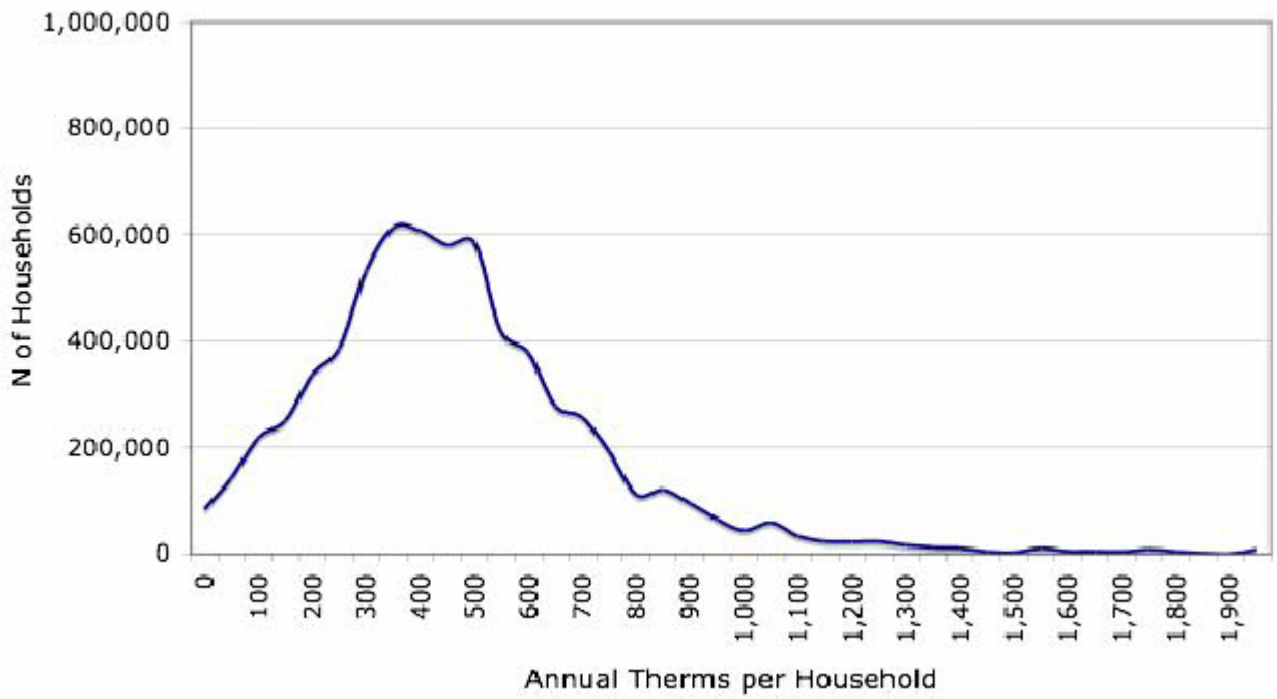
- **Lifestyle and behavioral issues greatly affect energy consumption**
- **Energy consumption predicted by the energy models will often be greater or less than actual energy consumption, as indicated by the utility bills**
- **California HERS tools are required to have the capability of normalizing the utility bills to typical weather data represented by the CEC climate files so that utility data may be compared more reasonably to the models**
- **The overall rating report will include graphical representations of energy consumption in the home. There will be graphs of monthly energy costs, electricity use, and gas use.**



Distribution of California Residential Electricity Consumption



Distribution of California Residential Natural Gas Consumption



Consumption Patterns

Quartile	Electricity Consumption		Natural Gas Consumption	
	Average Usage	Percent of Total	Average Usage	Percent of Total
Mean	6050	n. a.	460	n. a.
First	2350	10	n. a.	10
Second and Third	3200-7500	43	n. a.	50
Fourth	11500	47	n. a.	40

Consumption Levels of Lifestyle Groups

Lifestyle	Type	Income	Ethnicity	kWh	kWh ratio	Therms	Therms Ratio
YY+c	MultFam	$25-50K	Hispanic	3,254	.54	210	.46
S	SnglFam	<$25K	Anglo	4,685	.78	491	1.07
OO	Townhouse	$50-75K	Anglo	5,327	.88	344	.75
MM+c	SnglFam	$100-150K	Asian	5,920	.98	473	1.03
MM+c	SnglFam	$100-150K	Afr Amer	7,936	1.32	792	1.72
OO	SnglFam	$150K+	Anglo	9,725	1.61	522	1.14
Population Averages				6,030		460	

c – child 0-18 years; Y – young adult 19-34 years; M – medium age adult 35-54 years; O – older adult 55-64 years; S – senior 65+ years

Source: Lutzenhiser 2006

Scope and Application

HERS Reports

Recognized Entities

Building Performance Contractors

Quality Assurance

Energy Modeling

Utility Bill Analysis

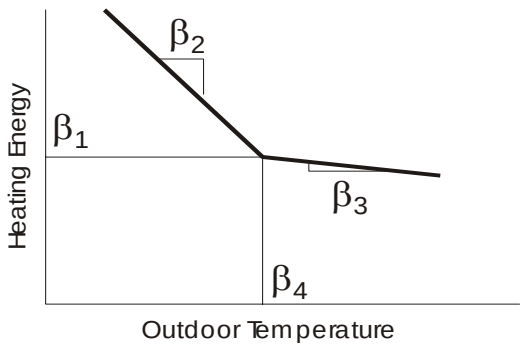
Rating Recommendations

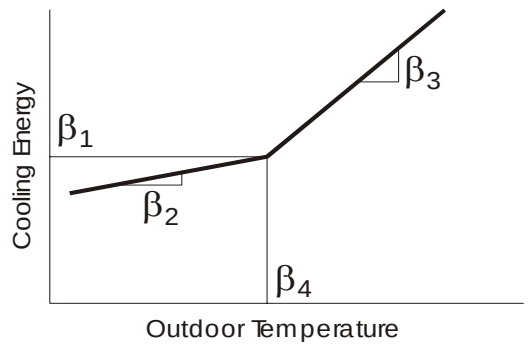
Inverse Modeling

- **The utility bill analysis shall be consistent with ASHRAE Research Paper 1050, "Inverse Modeling Toolkit: Numerical Algorithms".**
- **Support the following modes of operation:**
  - Heating Only
  - Cooling Only
  - Heating and Cooling
- **The four-parameter change-point model shall be used for heating only and cooling only analysis while the five-parameter change-point model shall be used for both heating and cooling analysis.**
- **In all cases, the independent variable shall be outside temperature.**

Four-Parameter Model

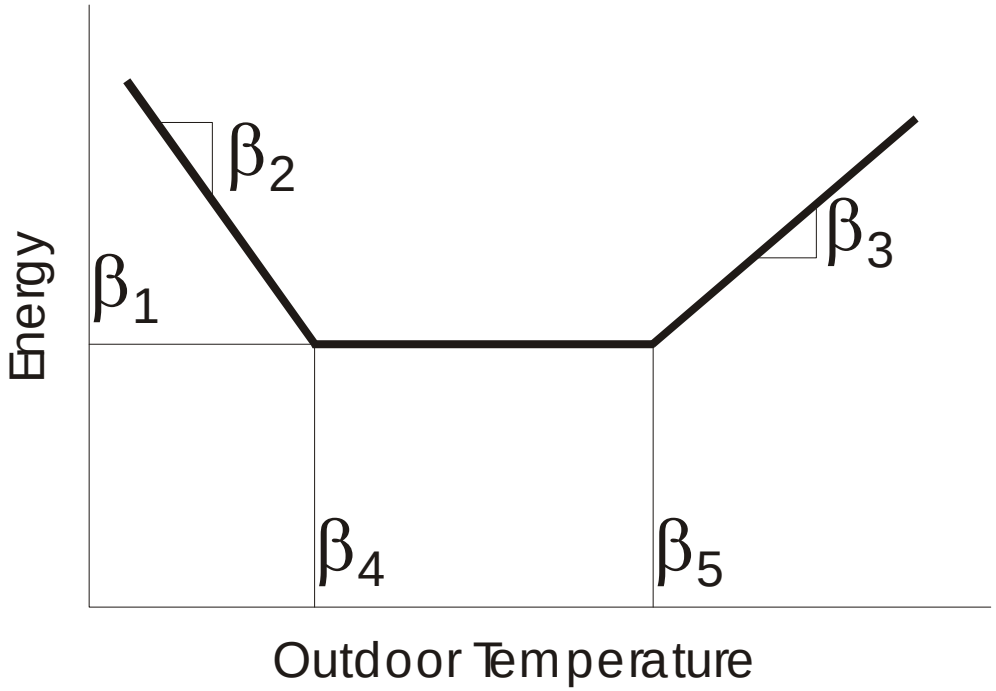
$$E = \beta_1 + \beta_2(T - \beta_4) + \beta_3(T - \beta_4)$$





Five-Parameter Model

$$E = \beta_1 + \beta_2(T - \beta_4) + \beta_3(T - \beta_5)$$



Recommended Text Format for Climate Data

Sample Data

1	1	1995	43.0
1	2	1995	40.6
1	3	1995	47.5
1	4	1995	49.2
1	5	1995	48.6
1	6	1995	48.0
1	7	1995	51.9
1	8	1995	52.9
1	9	1995	58.4
1	10	1995	56.3
1	11	1995	53.5
1	12	1995	53.9
1	13	1995	56.1
1	14	1995	57.5
1	15	1995	50.1
1	16	1995	46.7
1	17	1995	41.2
1	18	1995	46.1
1	19	1995	45.3
1	20	1995	43.9
1	21	1995	48.1
1	22	1995	50.9
1	23	1995	52.4
1	24	1995	52.0
1	25	1995	51.5
1	26	1995	49.3
1	27	1995	49.7

Notes

Columns:

1. Month
2. Day
3. Year
4. Average Daily Temperature

Columns (data fields) shall be separated by tabs, spaces, or commas.

File may contain any amount of data as long as it encompasses the period of time for which utility bill data is provided

Data for several California cities is available at http://www.engr.udayton.edu/weather/.

Text Format for Utility Bill Data

Sample Data

10	31	1990	-99	722	527	1	1
11	30	1990	-99	1409	1126	1	1
12	31	1990	-99	1093	1443	1	1
1	31	1991	-99	809	1301	1	1
2	28	1991	185200	1180	1392	1	1
3	31	1991	187000	1461	1351	1	1
4	30	1991	185700	1690	872	1	1
5	31	1991	172300	2021	914	1	1
6	30	1991	192500	2420	770	1	1
7	31	1991	134700	1747	701	2	2
8	31	1991	99000	1470	577	2	2
9	30	1991	115100	1013	343	2	2
10	31	1991	135400	753	299	2	2
11	30	1991	127400	572	351	2	2
12	31	1991	97700	634	334	2	2
1	31	1992	125700	436	414	2	2
2	28	1992	128000	615	383	2	2
3	31	1992	134500	717	412	2	2
4	30	1992	131500	775	423	2	2
5	31	1992	124500	905	445	2	2
6	30	1992	123500	1271	435	2	2
7	31	1992	123100	1439	437	2	2
8	31	1992	110900	1224	449	2	2

Notes

Columns

1. meter reading month
2. meter reading day
3. meter reading year
4. electricity consumption (kWh/month)
5. peak electrical demand (kW)
6. thermal energy consumption (units/month)
7. pre/post indicator for electricity use
8. pre/post indicator for thermal energy use

Each column should be separated by at least one space, a tab or a comma. If energy use data are missing or unavailable, enter no-data flags “-99” in their place; The “pre/post” indicators in columns 7 and 8 define the pre and post retrofit periods. Enter "1" to represent data from before the retrofit, and "2" to represent data from after the retrofit.

Utility Website Bill Disaggregation Alternative

- **Utilities often offer information about expected utility bills on their website using bill disaggregation methods.**
- **HERS providers may use information from these utility programs when available instead of the inverse modeling procedures.**

Post Retrofit Utility Bill Analysis

- The modeling software will permit providers and raters to analyze the energy consumption of the home following the implementation of efficiency improvements to assess whether actual energy savings have been realized
- This approach standardizes energy consumption patterns before and after the improvements to the same weather period so that a direct "apples to apples" comparison of energy usage can be made.
- Such a report will not be produced as a part of a rating report for a home but can be provided as an optional service by the rater 12 months after a retrofit.
- This process is required for programs using building performance contractors 12 months after a retrofit.

Scope and Application

HERS Reports

Recognized Entities

Building Performance Contractors

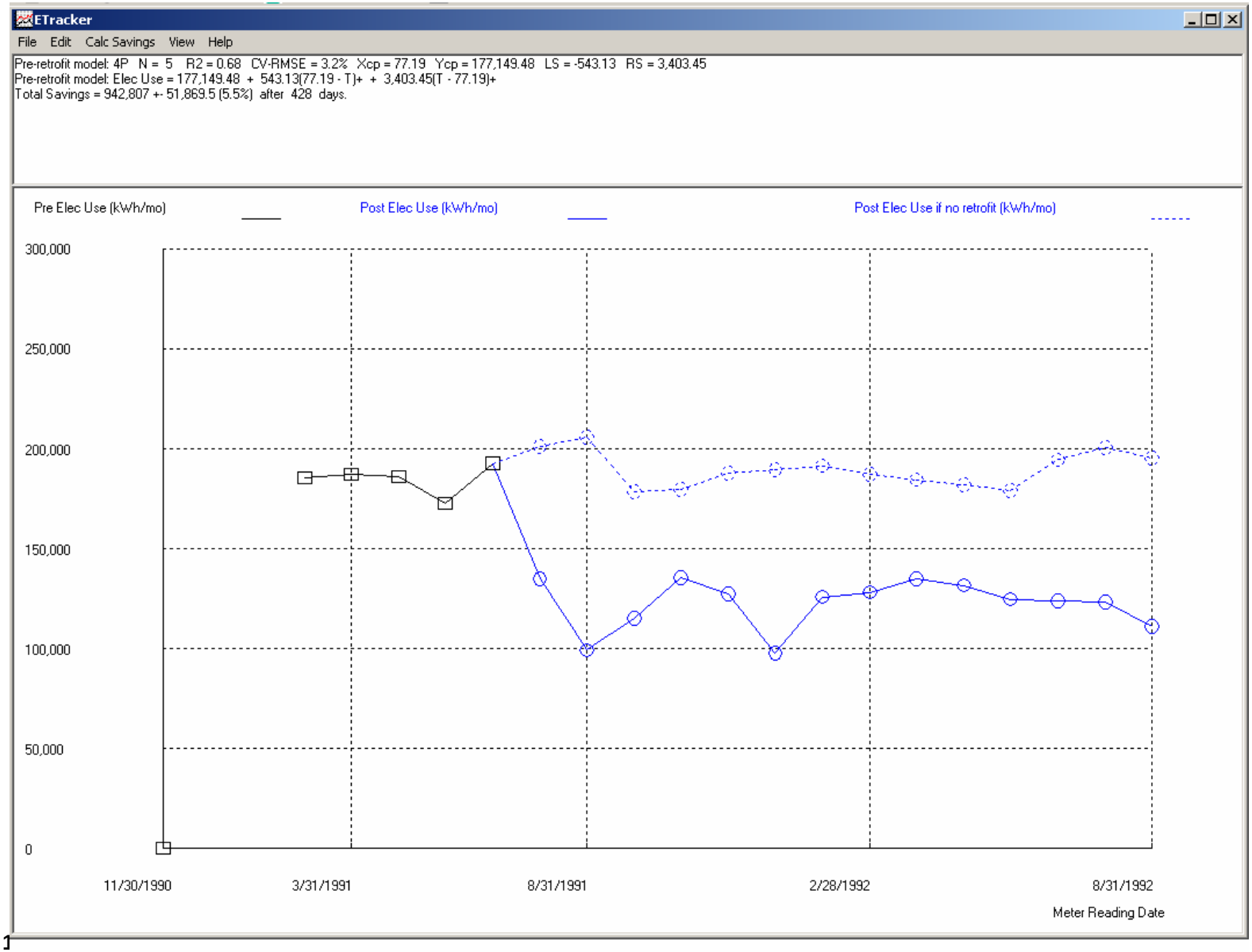
Quality Assurance

Energy Modeling

Utility Bill Analysis

Rating Recommendations

Post Retrofit Utility Bill Analysis



Scope and Application

HERS Reports

Recognized Entities

Building Performance Contractors

Quality Assurance

Energy Modeling

Utility Bill Analysis

Rating Recommendations

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop May 2, 2008

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Rating Recommendations

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Background on Rating Recommendations

The Public Resources Code (§25942) says that statewide home energy rating programs shall include "reasonable estimates of potential utility bill savings and reliable recommendations on cost effective measures to improve energy efficiency."

The Standard and Custom Approaches

- **The HERS system shall have the capability to generate recommendations using both a Standard Approach and a Custom Approach.**
- **Approved HERS systems shall be able to accommodate both approaches, however, the Standard Approach is mandatory for every rating and the Custom Approach is optional.**
- **The Standard Approach will result in the same set of recommendations, no matter who does the rating or which HERS system is used.**

Cost Effectiveness Method

Standard Approach	Custom Approach
The list of recommendations shall include all measures that are cost effective, considering the interactions between the measures.	**The Custom Approach may use any of the following methods:** • ***Fixed Budget*. Achieve the greatest energy savings for a given cost.** • ***Minimum Level of Performance.* Bring the house up to some specified level of energy performance at the least cost.** • ***Customer Identified Measures*. Homeowners may propose one or more measures they prefer in combination with other measures that are determined to be cost-effective as a whole.**

Rolling Basecase Method

- Start with the home in its present condition (the initial basecase)
- Evaluate all possible measures in all categories and rank measures in terms of benefit to cost ratio
- Add the top measure to the home and begin the process anew (this is the new basecase)
- Repeat the process until the remaining measures all have a benefit to cost ratio less than one

Determining Cost Effectiveness of Energy Efficiency Measures

Standard Approach	Custom Approach
Determine cost effectiveness of measures using the method used for the 2008 Title 24 energy efficiency standards.	**Consider cost effectiveness from the perspective of the homeowner or investor, including: conventional mortgage, energy efficient mortgage, green financing programs, utility financing programs, cash outlay by owner, or home equity financing.** **Each homeowner's individual tax bracket and mortgage rate may be considered.** **Non-energy benefits (such as thermal comfort, indoor air quality, and acoustics) may also be considered in making recommendations.**

Utility Rates

Standard Approach	Custom Approach
CEC adopted forecasts of energy costs are incorporated in Title 24 method of determining cost effectiveness.	**Use the utility rates in effect for each home that is rated.**

Modeling Assumptions

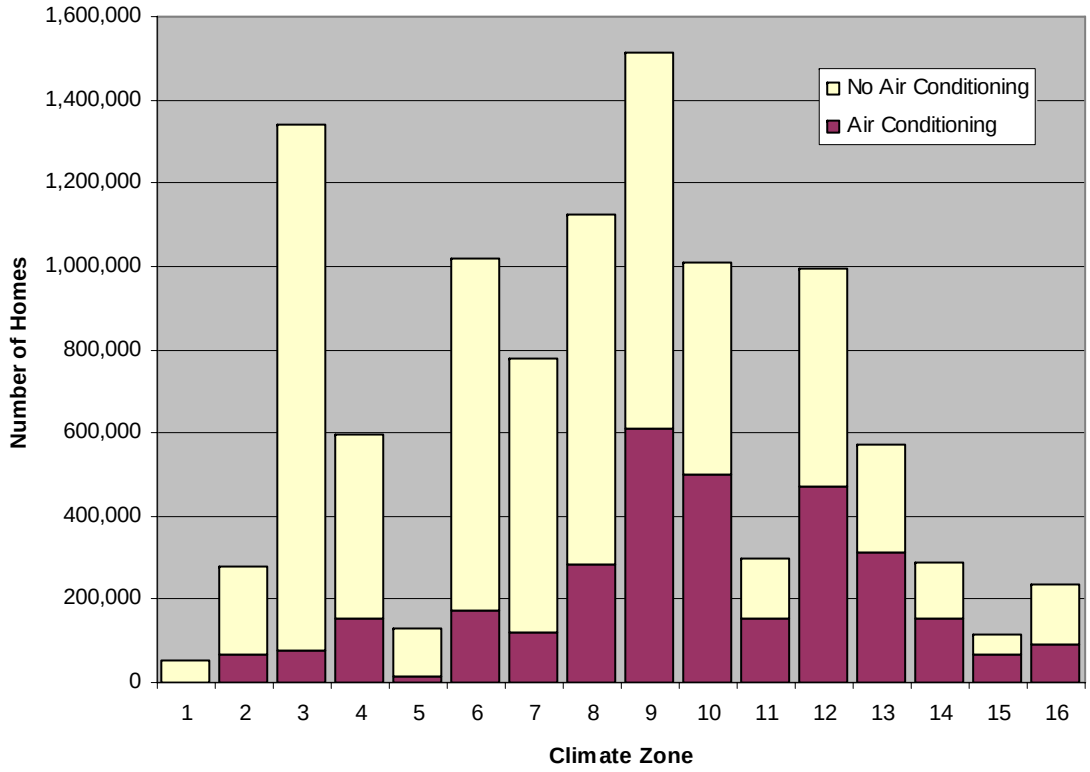
Standard Approach	Custom Approach
Use all modeling assumptions as specified in the HERS Technical Manual (same assumptions used to determine the California HERS Index). **Exception: Do not assume air conditioning for homes that do not have it.**	**The rater may modify certain modeling assumptions to approximate the specific occupant patterns of the rated house, considering factors such as:** • **Thermostat schedules** • **Intermittent occupancy** • **Presence of special energy using equipment.** • **Lifestyle patterns**

Estimating Energy Cost Savings

- **Use the energy models used to determine the rating to determine the savings from measures**
- **Do not assume air conditioning for homes that do not have it**
- **Use the utility rate in effect for the home, or the most common rate for the area if the utility account is not active**

Air Conditioning in Heated-Only Homes

Assume air conditioning as recommended in the residential ACM manual for determining the rating, but do not assume air conditioning for the purpose of generating the recommendations.



Measures and Costs that Affect the Rating Recommendations

Standard Approach	Custom Approach
All raters and HERS providers shall use the same database of energy efficiency measures and costs.	**Raters may modify measure costs and add additional measures to address the field conditions of a particular home.** **Alternate costs and measures shall be reported to the provider. Such costs shall be considered when the standard database is periodically updated in collaboration with the Energy Commission.** **The HERS provider shall approve the use of alternate measures.**

Categories of Measures to be Considered

- **Building Envelope**
  - Attic insulation
  - Wall insulation
  - Window replacement
  - Building envelope sealing
  - Awnings, trellises, or other shading devices
- **Lighting**
  - Energy efficient luminaires
  - Screw in CFLs
  - Automatic controls
- **HVAC**
  - Equipment replacement
  - Verification of charge, air flow and fan watt draw
  - Duct sealing and insulation
- **Water heating**
  - Equipment replacement
  - Controls
  - Solar
- **Appliances**
  - Refrigerator
  - Dishwasher
- **Photovoltaic systems**

Costs from Database for Energy Efficiency Resources (DEER)

- Supported by the CEC and the CPUC.
- DEER has been designated by the CPUC as its source for deemed costs for program planning.
- Most recently updated in 2005.

Requirements for HERS Providers to Maintain Cost Data

- **HERS providers shall have primary responsibility for maintaining and updating the databases.**
- **Data provided by HERS raters using the Custom Approach shall serve as the basis of updating the cost data.**
- **Data would be periodically updated.**
- **The providers shall collaborate with Commission staff to cross review costs for measures from different providers and reconcile differences for updating of the standard database.**

Measures and Costs that do not affect the California HERS Index

Standard Approach	Custom Approach
Standard recommendations shall be provided based on the presence of energy using systems or equipment that are not considered in the California HERS Index, such as pools, spas, well pumps, lighted courts.	**The rater, using methods approved by the provider, may evaluate the cost effectiveness of specific measures to improve the energy efficiency of swimming pools, spas, well pumps, and other energy uses not considered in the California HERS Index.**

Energy Bill History

Standard Approach	Custom Approach
Rater is expected to collect utility bill data and enter it into the tool. If utility bill data is unavailable, then the rater should disclose why it is not available. **When data is available, utility bills shall be analyzed using Inverse Modeling and normalized for the standard CEC weather data. The normalized results shall be compared with the simulated results and presented as one of the HERS reports.** **HERS providers may use information from utility web-based bill disaggregation programs instead of the inverse modeling procedures.**	**Same requirements as the Standard Approach, except that results of the inverse modeling may be used to "calibrate" the model (see Modeling Assumptions above).**

Qualifying the Recommendations

The recommendations in this report are based on the following assumptions:

- **Cost-Effectiveness Method.**
- **Determining Cost-Effectiveness of Energy Efficiency Measures.**
- **Utility Rates.**
- **Modeling Assumptions.**
- **Measures and Costs That Affect the California HERS Index.**
- **Measures and Costs That Do Not Affect the California HERS Index.**

Public Comment

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation

Wrap-up

California Home Energy Rating System Program

Phase II Regulations Development

Public Workshop
May 2, 2008

Architectural Energy Corporation