Cal TF Modeling Charrette

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MAY 30, 2019

GOALS FOR TODAY

- Morning: Level Set and Identify the Current State in California
- Afternoon:
  - Identify future opportunities
  - Identify **Actionable Solutions**
    - Short term (< 1 year)
    - Medium term (1 – 5 years)
    - Long term (> 5 years)

*Our focus is on **California** needs and solutions !!!*

Agenda

- Introductions
- Morning: Level-Set
  - Goals and a Desired “Future State”
  - A Brief History (and prior attempts at “reform”)
  - The Current State (in CA)
  - Current Challenges
- Afternoon: Future State and Discuss Path Forward
  - Case Study: Innovative Use of Modeling Tools (LADWP)
  - Team Exercise #1: Harmonizing Current Use Cases (Engines, Interfaces/Rulesets, etc.)
  - Team Exercise #2: Developing Current State, Future Solutions, and Opportunities
  - End Product: A Cal TF TPP
  - Closing & Next Steps

INTRODUCTIONS

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VARIOUS

The California Technical Forum (Cal TF)

What is the Technical Forum?

A group of in-state and out-of-state technical experts that work in a collaborative and transparent way to review new and updated energy efficiency measures and other technical information related to California's integrated demand-side management portfolio.

Cal TF: A Broad Collaborative

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CPUC Office of Ratepayer Advocates

Participating Organizations Today

Regulatory
CEC
CPUC

Utilities
LADWP
SCE
PG&E
SDG&E
SoCalGas

DOE/Labs
DOE
NREL
PNNL

Cal TF
Cal TF

Trade Organizations
IBPSA-USA

Non-Profit
The Energy Coalition
Elevate Energy

Implementation
Energy Solutions
Onsite Energy
AESC, Inc.
Lockheed Martin
CLEAResult
Synergy
NORESCO
San Francisco Office of the Environment
Sustainable Returns

EM&V
SBW Consulting
DNV GL
ERS
SKEE

Engine Developers
IES Ltd.
SAC Software Solutions
Red Car Analytics
Big Ladder Software
Bruce Wilcox
NORESCO
Model Efficiency

Engineering/Implementation Support
Solaris-Technical
RMS Energy Consulting
Maddox Energy Consulting
2050 Partners
Resource Refocus
TRC

University
UC Davis - WECC

Goals for “Future State” of CA Modeling Ecosystem

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ANNETTE BEITEL
MARTHA BROOK
MANISHA LAKHANPHAL
STEVE KROMER

Cal TF Business Plan Goal

Develop High-Level Proposed Approach for Achieving Statewide Consistent Approach To Building Simulation Modeling in California.

"Consistent" is not intended to mean "the same" or "identical" modeling

Identify common goals and **propose approaches** to harmonize modeling to:

- **Reduce inefficiencies** – leverage taxpayer/ratepayer investments, encourage collaboration
- Maintain or improve **modeling rigor**
- Identify what constitutes **sufficient evidence** such that results of a new model are **reliable for savings calculations**
- Achieve **consistent documentation** so results are **transparent** and can be **reproduced** and **peer reviewed**

CPUC Staff Comments

DEER 2021 Draft Scoping Memo explores use of other building simulation tools beyond DOE2:

> *"This is another issue that has been raised in many venues, especially with the increased use of the EnergyPlus™ building simulation tool for other state-sponsored work (e.g. California Energy Commission Title 24 compliance tools) and custom projects."*

Staff is seeking stakeholder input:

- Why do we (CPUC) need to change from status quo?
- How do we get to the desired outcome?
- How to fund transition effectively, particularly do we create new prototypes or convert existing DEER prototypes?
- How can staff gain confidence with use of other building simulation tools?

Assessment should lay out **questions, issues, needs, concerns** and establish a **systematic plan** for deciding **whether new tools and prototypes should be developed** and **establish a timeline for the development and execution**.

Also . . ."*What is necessary for us (CPUC) to feel comfortable that alternate modeling engines are producing accurate results and not over-inflating savings?"*

Martha Brook (CEC) Comments

- Need to establish sustainable, effective roles for state government
  - Better to reference industry standards than for governments to establish, maintain and update all standards, including model tool sets
  - Govs should only fund the application layers needed for policy development & implementation
  - Govs could help launch but then collaborate with others to support model test stds, MAP database (see below)
- Leverage past investments in CA and US
  - We have already paid multiple times to model every building in CA, for example
    - MAP == Model Amnesty Program ➔ statewide model database: inputs & outputs
- Use all approved model results: distributions are better than singular estimates for decision making

Statutory and Regulatory Requirements
re: Modeling

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10.3. (Rule 10.3 of Commission's Rules of Practice and Procedure) - Computer Model Documentation.

(a) Any party who sponsors testimony or exhibits which are based in whole, or in part, on a computer model shall provide to any party upon request, the following information:

(1) A description of the **source of all input data**;

(2) The complete **set of input data** (input file) as used in the sponsoring party's computer run(s);

(3) **Documentation** sufficient for an experienced professional to understand the basic logical processes **linking the input data to the output**, including but not limited to **a manual** which includes:

(A) A complete list of variables (input record types), input record formats, and a description of how input files are created and data entered as used in the sponsoring party's computer model(s).

(B) A complete description of how the model operates and its logic. This description may make use of equations, algorithms, flow charts, or other descriptive techniques.

(C) A description of a diagnostics and output report formats as necessary to understand the model's operation.

(4) A complete set of output files relied on to prepare or support the testimony or exhibits; and

(5) A description of post-processing requirements of the model output.

See also Public Utilities Code section on computer modeling (Secs. 1821 and 1822.)

Other Stakeholder Goals

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- **Level Set**: Build common understanding of "current state"
  - Current use cases
  - Current building simulation models, rulesets
  - Identify broad areas of agreement
- **Improve Tracking and Coordination**: How can CA better track and coordinate existing efforts to improve modeling (transparency, usability, etc.) while reducing costs?
- **Anticipate and Plan for Future Needs and Opportunities**: How can modeling be used to meet future needs (such as analysis for grid, electrification, GHG reduction)?
  - Advanced modeling capabilities
  - New opportunities for modeling
- **Emerging Trends**: Identify emerging technical and policy trends that can benefit from modeling
- Other (Participant Input)?

Desired Future State (Starting Point)

- A variety of building simulation models are available and accepted for range of uses
- Ability to easily create well-documented new measures and prototypes
- Ability to use modeling for new uses and opportunities (such as large-scale parametric analysis)

EnergyPlus
DOE2
CSE
IES
Others

Common Rulesets (with sources)

Prototype Library (with sources)

Variety of Interfaces

Calibrated/Validated

Results (Can clearly trace how outputs produced)

Code development & compliance
Demand forecast
CEUS
Deemed & Custom Measure
EM&V, Potential Studies
Benchmarking
Load Impact Forecasting
GHG Reduction Targets
Integrated Grid Modeling

A Brief History

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STEVE KROMER
ROGER BAKER

Overview

- History of model development
- History of modeling in California
- Prior CA collaboratives seeking reform/improvements to CA modeling ecosystem
  - How this charette is different from prior efforts
  - How could this charette produce actionable outcomes that prior efforts have been unable to achieve … that will lead to improvements in the CA modeling ecosystem

Simulation Engines Used Across the State

- The California Energy Commission and the California Public Utility Commission (and LADWP) have built or supported development of simulation engines for a range of energy analysis needs
- The CEC currently utilizes **EnergyPlus, CSE, IES** and other simulation engines to assist in Title 24 code compliance (CBECC)
- The CPUC uses **DOE2/eQUEST** in the **MASControl** tool used to develop DEER database values
- Innovative programs – BRICR (EnergyPlus) and The Energy Coalition (**Open Studio**)
- LADWP – we'll hear from them later today…

Prior Collaborative Efforts to Understand / Improve Modeling

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- **Rocky Mountain Institute** (2011)
  - Not CA-specific.
  - Voluminous materials produced; information on specific models out-of-date but good section on history of modeling.
- **CPUC Energy Modeling Tools Workshop** (2015)
  - To exchange information on the predominant whole building energy modeling simulation tools in the market to understand what's out there, how it's used, and how we understand the strengths and weaknesses of each tool.
  - Did not produce specific action items or "next steps."
- **Cal TF Technical Position Paper** (January 2016 Cal TF affirmed)
  - Compared DOE 2.2/EQuest and EnergyPlus/Open Studio for developing deemed measures for eTRM.
- **SCE Software Symposium** (2017, 2018)
  - Focus on improving code compliance software tools.
- **Participant Input**: Any Others?

Recent Documents on CA Modeling

TRC, SCE Modeling “Roadmap” (2016)

California Technical Position Paper #3: Case for Using EnergyPlus as “Default” for Modeling Engine for eTRM (2016)

Kromer, Status of Energy Modeling and Data Resources in California EE Programs (2019)

Any others? Goal is to have Cal TF Modeling “TPP” incorporate prior work and extend current knowledge.

Current State

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Handout #1: Use Cases

Use Cases: CA uses for building simulation modeling.

- Engines used
- “Rulesets” used
- Caveats/Limitations
- Calibration/Documentation

Use Case Examples

CEC	CPUC	Other	Future
Code development Code compliance Demand forecast CEUS Policy analysis & Implementation (e.g. SB 350, SB 1477)	Deemed measures Custom measures/projects Project analysis (SBD) EM&V (i.e., potential studies?)	Forecast load impacts Benchmarking Local ordinances GHG targets	LA Project Large-scale regional models to identify where interventions will be most cost-effective

Handout #2: Current State

Review

- **Engines**
  - Have we identified key CA engines?
  - What metrics should be used to evaluate?
- **Interfaces**
  - Have we identified key CA interfaces?
  - What metrics should be used to evaluate?
- **Rulesets and Building Prototypes**
  - Have we captured key rulesets and prototypes?
  - Should a repository be created of building prototypes?
  - Should systematic effort be undertaken to document inputs and calibration for rulesets and prototypes?

Metrics

What metrics should be used to evaluate models, wrappers, rulesets?

Can the metrics be “general” across all use cases, or

Should they be tailored to the use case?

Should there be a “test” that models must pass before they can be used (the “CEC approach”)

Metrics: Examples To Consider

Policy	Functionality	Technical Rigor & Breadth	User Experience	Cost	Administrative
Meets State policy directives	Transparent Reproducible	Meets industry standards Model validated Model capabilities	Ease of user interface(s) Learning curve	Cost to use model	Funding for updates, bug fixes & new features

Challenges
(Issues, needs, concerns)

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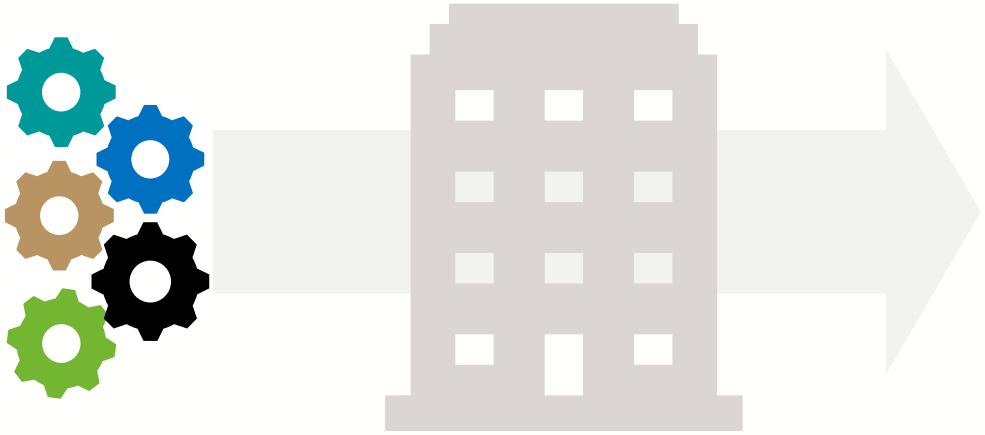
STEVE KROMER
AYAD AL-SHAIKH

Challenge #1:
Multiple Models, One Building

UC Merced 2020 Project

- 5 different models for different use cases required for each building



CBECC compliance

LEED compliance

Title 24 minus 20%

Savings by Design

Contractually set energy targets

Example courtesy of Steve Kromer

Challenge #2: Documentation and Reproducibility

- **MASControl Documentation**
  - Documentation holes
  - Hard to address errors when they occurred
- **Measure Definition**
  - Some measures no longer exist, so need to be developed or retired
  - For measures that do still exist, hard to know how the measure case is defined (i.e., what are keyword changes from base case to measure case)
- **Building Prototype Definition**
  - No documentation on the source of the values in in building prototypes
  - No documentation on the procedure used for calibration of models
  - Unclear what the process is for defining the customer average ("CAv") and measure average ("MAv") values
- **Thermostat Options Definition**
  - No documentation on the source of the value for thermostat options
- **Weighting Data**
  - Data source is not clear
    - Building stock data seems to come from 2014
    - HVAC type seems to come from 2013

Participant Input

Examples of other challenges?

Case Study: EE Potential for LADWP and SoCalGas

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ARMEN SAIYAN
ANDREW PARKER
CHAN PAEK

Intention/Motivation

- EE potentials and goals
  - satisfy AB2021 requirements
  - Internal Integrated Resource Planning
- Comprehensive DSM planning
  - Available potential modeling tools fall short
  - Want to provide accurate: hourly load, GHG, & geographical impacts
- NREL to develop a tool
  - Determine DSM potentials primarily for DSM program planning
  - also has capabilities to expand to other applications

Current State of Potential Modeling

- Difficult and tedious to follow
- Applied simplistically with territory building stock based on past surveys
- No consideration for interactive effects
- Use of outdated and incomplete hourly load shapes
- No visibility on distribution of savings impacts across geographies, building types, vintages, grid infrastructure etc…

Project Summary

1. Energy models of the commercial & residential building stock in LADWP service territory
2. Calibrate building energy models to real electricity & gas data
3. Apply Energy Conservation Measures to models. Calculate technical savings potential by building type, age, etc.
4. Put savings + costs into economics-driven technology adoption model
5. Calculate realistic EE savings potential (gas & electric) based on measure cost, incentive assumptions, etc.

*Today's focus

Building Stock Models

Extract inputs from DEER models

- Sched Shapes
- LPDs
- EPDs
- HVAC Effs
- Const. Props
- Spc Type %
- Etc.
- ~~Geometry~~
- ~~ScaleFactors~~

+

Sample from conditional probability distributions of LA bldg. characteristics

- Building Age
- Building Type
- Area
- Shape
- Num Stories
- Neighbors
- Hrs of Operation
- HVAC Type

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OpenStudio model generation

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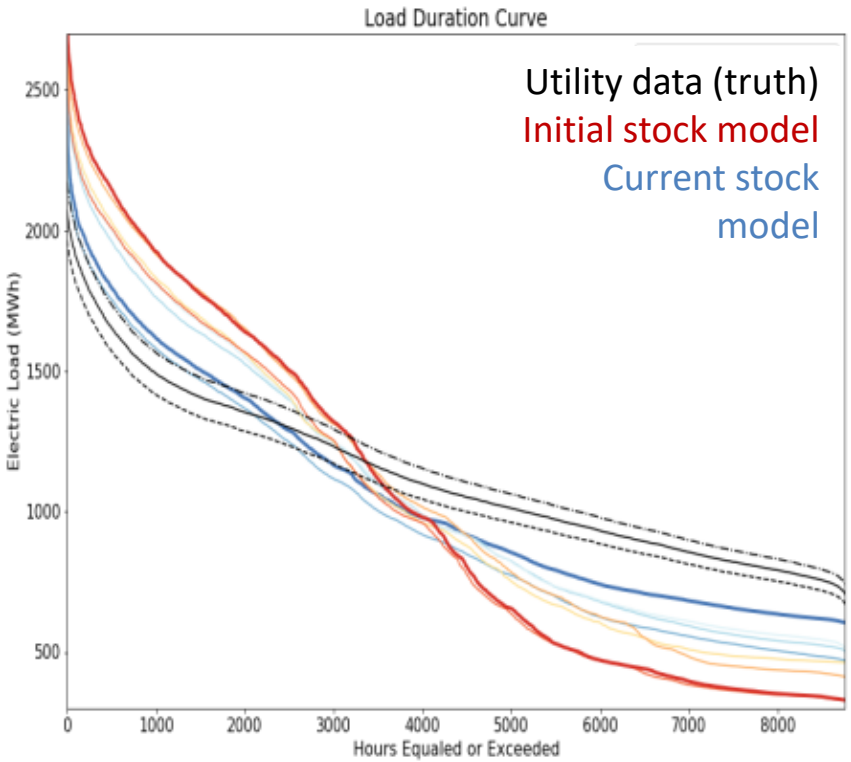
Suite of models representing LA building stock (including diversity)

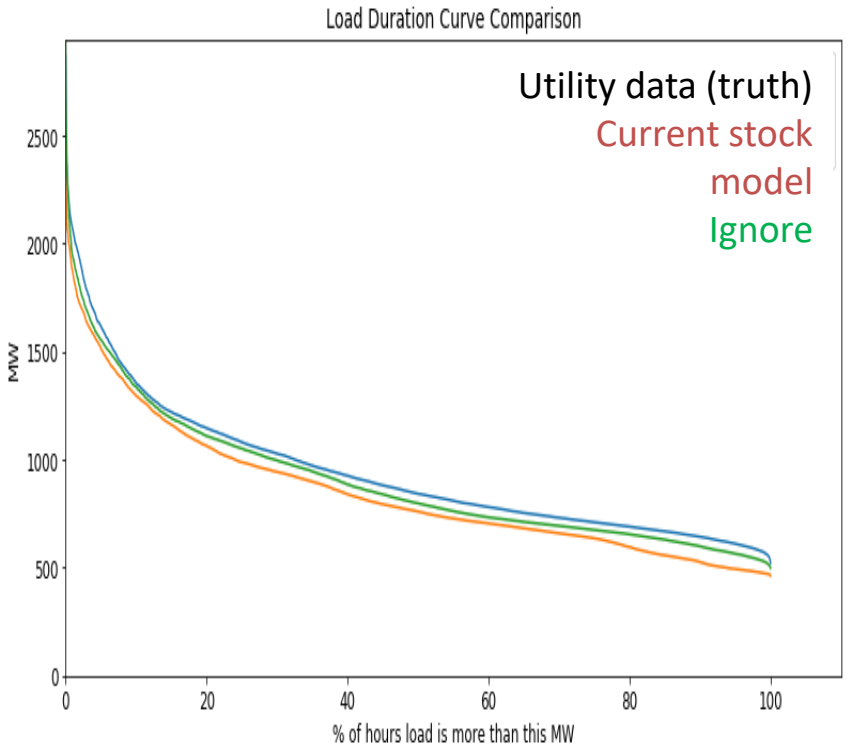
- 25,000 unique commercial models
- 75,000 unique residential models

Calibration (in progress)

Commercial



Residential



Also comparing results against monthly customer-level utility data (all customers) and 15-minute data (subset of customers). Working on access to gas data.

Calibration Changes (partial list)

Commercial

- Removed night setbacks
- Lowered office & retail EPDs
- Plug loads higher @ night
- Lighting schedules less blocky
- Lower LPDs across stock
- Change multifamily schedules
- Added blinds
- Diversity in schedules
- Neighboring building shading

Residential

- Use RASS for many appliance saturation levels
- Add diversity to clothes dryers
- Add diversity to refrigerators
- Add diversity to # bedrooms
- Adjust plug load schedules
- Add holiday lighting

Motto: no changes without supporting data justification!

Energy Conservation Measures

Suite of models representing LA building stock (including diversity)

25,000 unique commercial models

75,000 unique residential models

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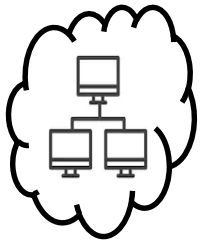
OpenStudio Measures

- Lighting
- HVAC
- Refrig
- Envelope
- Water Htg

(actually much more detailed than this)

\+

Cloud Computing



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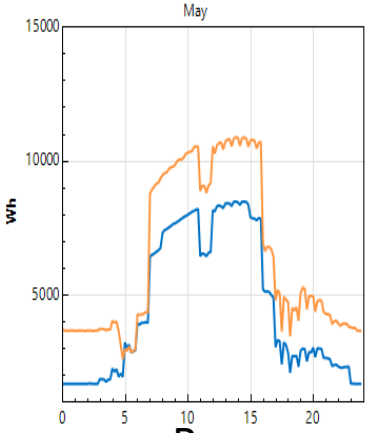
Annual & Hourly Savings



By:
Building Type,
Vintage,
Climate zone,
Neighborhood,
etc.

Benefits of Methodology

- Transparent
- Well documented references
- No arbitrary basis of model changes
- Defensible
- Granular results

Potential Applications

- Refined Territory specific prototype models
- Robust reference for potential deemed savings of applicable measures
- Determining Technical Potentials for measures by geographic region, building type, sector etc …
- Can be expanded for other DER measures
- DSM,DER Program planning tool

Participant Input

Examples of other “Future State” needs and opportunities?

End Product: Cal TF Technical Position Paper

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ANNETTE BEITEL

Cal TPP – **California Focus!**

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- Goals (needs)
- Background – Prior Collaboratives and Literature Review
- Current State
  - Use cases in CA
  - CA engines, rulesets, building prototypes, interfaces
  - Broad areas of agreement
  - Non-consensus items (significant)
  - Open questions
- Current Challenges (issues, concerns)
- Metrics to evaluate models, interface
- Desired Future State for CA modeling ecosystem
- Future uses of and opportunities for modeling
- Path forward
  - Broadly socialized and recommended “action items” and proposed implementation path.

Exercise #1
Harmonizing/Standardizing Modeling Approaches Across IDSM Programs/Use Cases

Exercise #1: Objective

Identify opportunities to align use cases and the specific points of alignment.

- Congregate around a single, primary use case
- Identify related use cases that can be harmonized through the alignment of prototypes, rulesets or common inputs.

Use Cases	Elements
Code compliance	Prototypes
Building design	Rulesets
New construction programs	Interfaces
New construction evaluation	Common inputs
NMEC pre-metering data estimation	Weather data
Deemed savings for measures	Calibration to actual energy use
Custom measure savings estimates	Parametric analysis

Break (15 minutes)

→ Visit each station and identify path forward on topics of interest across the following areas:

- Goal/Metrics
- Desired Future State for CA modeling ecosystem
- Future Uses of Modeling and Emerging Needs

This will inform the discussions in Exercise #2.

Exercise #2
Additional Feedback on Key Issues for TPP

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Exercise #2: Objective

Identify the path forward (both near- and long-term) in the following areas:

- Goal/Metrics
- Desired Future State for CA Modeling Ecosystem
- Future Uses of Modeling and Emerging Needs

Closing & Next Steps

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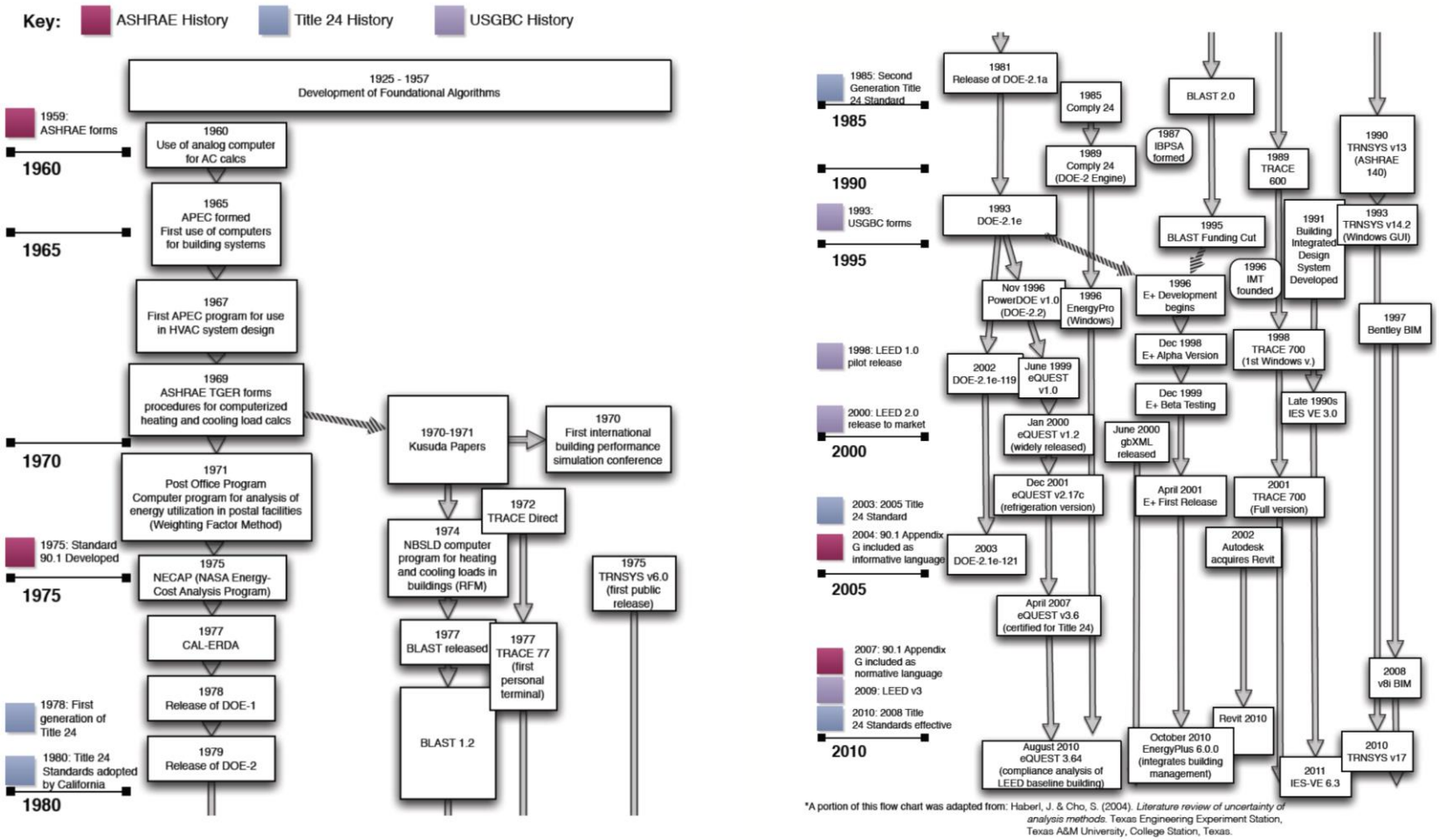
Appendix:
History of Modeling in CA (Steve Kromer)

Generally Accepted Timeline

(credit Haberl, J. & Cho, S., Texas A&M)



*A portion of this flow chart was adapted from: Haberl, J. & Cho, S. (2004). *Literature review of uncertainty of analysis methods*. Texas Engineering Experiment Station, Texas A&M University, College Station, Texas.

Very Brief History of DEER

- Database for Energy Efficiency Resources (DEER) provides approved ex-ante savings estimates for use in prescriptive (deemed) programs.
  - Also used across the US
- DEER started as a California Energy Commission (CEC) project called the California Conservation Inventory Group (CCIG) in the early 1980s.
- The CCIG coined the name Database for Energy Efficiency Resources (DEER) and agreed upon the initial contents of the database.
- The original intended uses for DEER were to estimate and measure program cost-effectiveness for regulatory filings and to forecast DSM program demand reduction and energy savings potential in specific market segments and utility service territories.

DEER from CEC to IOUS to CPUC/Group A

- The key purpose of DEER ***has evolved*** into providing a common set of ex ante savings values (i.e., deemed unit energy savings, net-to-gross values, effective useful life values, and full and incremental measure cost data)
- The 2001 and 2004-05 DEER updates were managed by the investor-owned utilities.
- In **2005**, Commission Decision D.05-01-055 directed the CPUC Energy Division to manage DEER updates as part of its research and analysis in support of policy oversight.
- Next update under CPUC ”Group A” contract

2013 - CEC moves to EnergyPlus

- **Ruleset-Based Software for Compliance Modeling**
- Although CA has a long history of performance- based compliance modelling, the building industry has not been able to benefit from this approach as much as it could.
- This is (primarily) because energy models used for code compliance lag behind technological advances in the energy efficiency sector.