A Top-Down Framework for Managing Energy Code Development

Randall Higa, Southern California Edison
Abhijeet Pande and Cathy Chappell, TRC Energy Services
Jonathan McHugh, McHugh Energy Consultants
Chad Worth, Energy Solutions
Dan Suyeyasu, Arup
Jim Edelson, New Buildings Institute
Patrick Eilert, Pacific Gas and Electric

ABSTRACT

Public policy demands continual improvements and increased stringency of appliance standards and building codes. Typically energy code improvements have been a bottom-up aggregation of measures. This approach is typically incremental and progress is subject to the relative level of pressure from opponents and proponents. It is also reactive to the current pace of market transformation as the code development process usually passively waits for measures to be "code ready." However, occasionally significant jumps in code stringency are realized; these discontinuous leaps are usually in response to policy initiatives from the highest levels of government. This paper describes a top-down approach which sets energy savings targets for code updates based upon policy goals. The top-down approach may provide focus for strategies and tactics to accelerate market transformation to fast-track code readiness. When key policymakers translate and embrace these goals, progress can be achieved relatively quickly. This was the case for the 2001 California Title 24 emergency rulemaking (AB 970) in response to the California electricity crisis, and the ASHRAE 90.1-2010 in response to a memorandum of understanding with USDOE. This paper discusses how a top-down strategy can be instrumental in accelerating the stringency of efficiency codes. Applying this construct to California's strategic plan for all newly constructed low rise residences to be Zero Net Energy (ZNE) by 2020 we describe a short and medium term tactical plan for implementing the ZNE goal.

Introduction

Energy code updates have traditionally followed a linear progression where measures or technologies become adopted into codes after they advance through various phases of the market transformation from research labs to mainstream use. This progression can be characterized as a "bottom-up" approach to code development.

However, in light of various energy and non-energy policy goals, the traditional bottom-up approach to updating codes and standards cannot progress at sufficient speed to meet accelerated energy efficiency and global warming goals including:

- 30% increase in stringency in ASHRAE 90.1 between the 2004 and the 2010 versions - MOU between ASHRAE and US DOE. (PNNL, 2011)
- 30% increase in stringency in International Energy Conservation Code (IECC) Residential between the 2006 and the 2009 versions
- 50% reduction in residential lighting and 25% reduction in commercial and outdoor lighting by 2018 California AB 1109 (Huffman)

- New buildings to be carbon neutral by 2030 – endorsed by the American Institute of Architects (Architecture 2030)
- Limit California Greenhouse Gas (GHG) emissions to 1990 levels by 2020 – (AB 32, 2006)
- California's ZNE goal for all new homes by 2020 and for all new commercial buildings by 2030 (CPUC 2008).

The first goal on this list was mostly achieved after USDOE took the position that unless ASHRAE delivered on the goal, that USDOE would write their own national commercial energy code. If California maintains its course on the 45 lumens per watt efficacy requirement for most general service lamps by 2018, the second goal will be mostly achieved because general service lamps make up the vast majority of residential lighting energy consumption and the new lamp standard will cut the power draw by these lamps by two thirds. Similarly if California takes this same approach for small diameter directional lamps, significant reductions are expected for retail occupancies. The rest of the goals are extremely aggressive and, if history is a guide, require broad based societal support with leadership from the highest levels of government for these goals to be realized.

The Traditional 'Bottom-up' Approach

Market transformation theories embraced by many in the efficiency community envisions a technology diffusion model that progresses from research, to commercial introduction, to commercial growth, and then into commercial maturity (see Figure 1). Under this traditional market transformation model some implementers see Codes & Standards as an "exit strategy" to remove public support of efficient technologies during the latter part of the commercial maturity phase. Once energy efficient technologies are broadly accepted (low net to gross ratio) and cost effective they are determined to be "code ready" and should be adopted into energy codes.

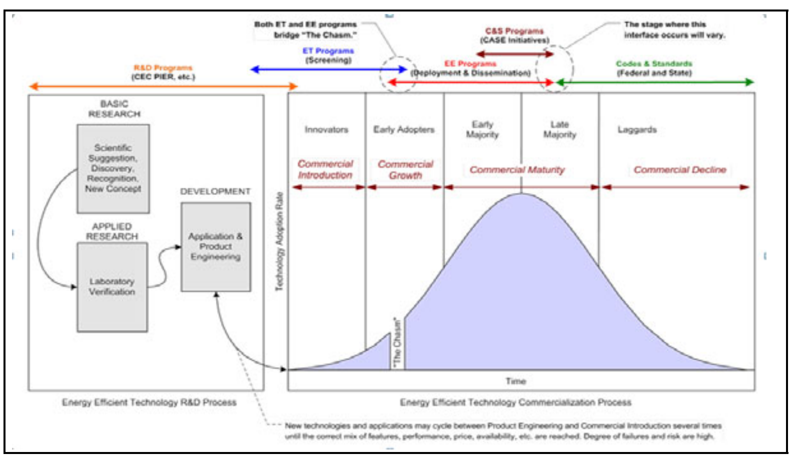

Figure 1. Technology diffusion of innovation curve (Campoy 2006).

This traditional bottom-up approach to code updates assumes that measures become 'code ready' due to incremental improvements technologies or building practices over time. Thus, code readiness is passively dependent on the success of other efforts by the regulatory, programmatic and market forces. If there is no apparent demand for an increase in efficiency for that measure, or if an increase in efficiency is not necessary for differentiation in the marketplace, a manufacturer of that technology has no incentive to improve their product. Some products, such as high efficiency consumer electronic power supplies and battery chargers, though ubiquitous and able to save a significant fraction of energy are so inexpensive and save so little energy per device that these devices are not well suited for traditional EE program market intervention.

The bottom -up approach to code improvement results in a piecewise approach to energy efficiency; each successive code cycle starts with a smaller energy budget to impact. If the cost-effectiveness methodology disallows packages of measures, synergies between measures are missed and showing cost-effectiveness is more difficult. However staging building code requirements has a flip side: it is recognized that building markets can absorb only so much change (and incremental cost) at a time and the costs of new building methods promoted by market forces (and performance method credits) can drop as these new methods enter the mainstream.

Without a strategic vision of the end goal for codes, code developers can whip-saw the building market with incremental changes are not aligned with the direction of future codes. An example of this is transforming the markets for HVAC ducts. The long-term vision for ZNE homes is that duct losses are eliminated by bringing ducts inside the conditioned space or eliminating ducts altogether. However some proposals for intermediate code cycles would develop very stringent duct sealing and insulation requirements and build up a significant amount of effort and infrastructure around ducts in unconditioned attics. Is this approach desirable, when it is expected that this effort would be jettisoned in future code cycles?

The limitations of the 'bottom-up' approach becomes more evident when faced with a specific energy savings goal in mind such as what California envisions with its 2020 Zero Net Energy (ZNE) target for all residential new construction. Achieving a policy driven goal by an aggressive deadline does not allow the leisure of incrementally increasing the stringency of codes in response to long-term market transformation cycles. However a top-down efficiency policy cannot be implemented in isolation from markets and technology development; thus a top-down policy is by necessity broader than consideration of codes and standards alone and is key subject of the tactical plan discussed below.

A Top-Down Approach to Code Development

The top-down approach offers a management method to accelerate codes and standards and associated programmatic efforts to achieve the end goals. The top-down approach adds four critical planning and implementation components to the code development process missing in the bottom-up strategy:

- defining an end-goal target,
- consolidating top management support,
- developing a well-coordinated tactical plan and
- implementing the plan

Developing an End Goal Target

"First start with the end in mind." This commonly repeated business strategy motto is repeated to remind leaders and planners that in the running a company or running an energy policy division, that the mechanics of running these organizations can result in distraction from providing direction towards key policy goals. (Covey 1989) By developing goals and target dates, this provides both direction and an expectations of the speed at which progress is made. For a major reorientation of buildings and appliances a long-term vision is needed and an achievable time line is required.

Breaking the End-Goal into Intermediate Sub-Goals

When the California Global Warming Solutions Act of 2006(AB 32) was passed, the legislators gave the California State agencies 14 years to implement a plan that would reduce greenhouse gas emissions to 1990 levels. To move this legislation from an aspirational goal to an actionable plan, the state agencies developed the Climate Change Scoping Plan which broke this goal down into subgoals that were assigned to various departments. GHG emissions associated with regulated energy utilities were assigned to the California Public Utility Commission (CPUC) and they responded with a number of initiatives including the California Long Term Energy Efficiency Strategic Plan. (CPUC, 2008). Most notable in this plan is the 2020 ZNE goal for new residences and the 2030 ZNE goal for new commercial buildings. Since these goals apply to all new buildings it is reasonable to expect that this goal includes an energy code requirement to compel all or most builders to redesign buildings to achieve this goal.

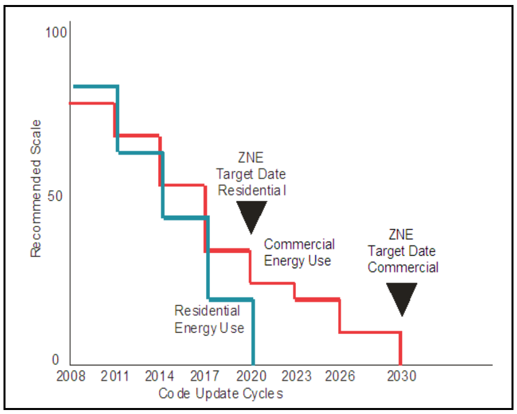

Figure 2. Code cycles to ZNE. *Source:* SCE & AEC, 2009.

In the case of building codes, the updates are generally done in three-year cycles. To reach a goal by a certain date, the trajectory has to accommodate these cycles in a "stair step" progression. An example of such a progression is depicted in Figure 2. Common wisdom would expect that the law of diminishing returns would apply and thus the steps closer to the ultimate ZNE goal would be harder to achieve and that as a result, at the very least, the progression towards ZNE should be at least in even steps as shown in Figure 2. The importance of smaller intermediate steps helps organize progress and to signal to all market participants that the goal is "real" with timeline of policy actions and not merely an "aspirational goal" with no impact on government actions and regulations. These intermediate steps provide feedback on progress towards goals so that policy directors can take steps to get the policy initiatives back on track and/or re-evaluate timelines and goals.

Though Architecture 2030 has a goal of all buildings being carbon neutral by 2030, a step change from the status quo to this very aggressive goal was too much to accomplish in a single step. Thus similar to the stair steps towards ZNE codes in Figure 2, Architecture 2030 as depicted in Figure 3 also has a phased set of goals which can be evaluated every 5 years on the path towards the 2030 goal. As a voluntary standard, Architecture 2030 does not have the force of government regulation behind it, however this path to carbon neutrality has been referenced by a number of governments and was said to have influenced the California ZNE policy.

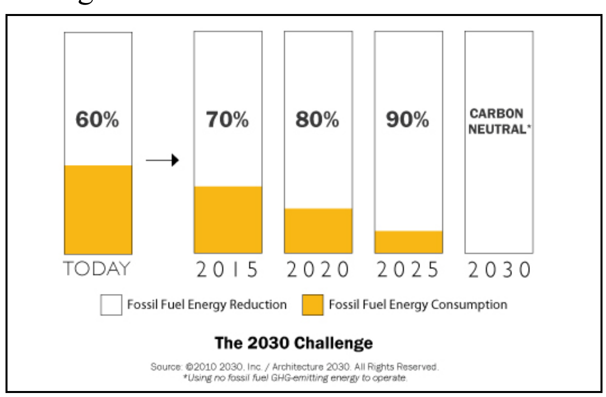

Figure 3. The 2030 Challenge: progressive steps to carbon neutral.

Likewise, Oregon SB 79 (2009) set a minimum improvement of 15% savings for the next energy code development cycle for the Oregon Specialty Code – and this became the top-down target for the 2010 energy code on average. SB 79 referenced the Architecture 2030 goals, and earlier Oregon legislation (HB 3543; 2007) established a state greenhouse gas reduction target of 80% below 1990 levels by 2050. At the end of 2013, the City of Boulder enacted by ordinance a top-down goal for new construction in the city to exceed the energy savings in 2012 IECC by 30%. Boulder policy of increasing levels of stringency over time is clearly stated so that stakeholders in the building market can prepare. "As the city works toward a net zero energy goal by 2031, continuing the pattern of reducing the HERS index by 10 points per code update cycle will align residential and commercial energy requirements."[1]

In these examples the intermediate savings targets are normalized relative to the specific energy use intensity or overall energy use that varies by building type and climate zone. A similar approach is also taken for the 2015 IECC where one can comply by having an Energy Rating Index (ERI) around 55 - 51 or less (varies by climate zone) where an ERI of 100 reflects the energy consumption of the same home minimally complying with the 2006 IECC. A similar proposal has been proposed for the ASHRAE 90.1 Standard, relative to the 2004 version.

Validating Technical Feasibility of Goals

Table 1. Residential efficiency measures ranked by TDV energy savings to achieve ZNE

Simulation order	2,112 sf Home Climate Zone 12 (Sacramento) Strategy Description	Site kBtu/sf	TDV PV$/sf	TDV kBtu/sf
7	High eff LED lighting and vacancy controls	-1.32	-$2.20	-12.70
1	2x6 walls 24" OC, R-21 w/ R-4 rigid ext. sheathing.	-1.94	-$1.15	-6.64
9	Reduced Plug Loads & Plug Load Control 20%**	-0.71	-$1.09	-6.29
14	Condensing Gas Water Heater*	-2.53	-$0.85	-4.91
12	High Eff 2-speed AC, SEER 21 w/ Int Ventilation Cooling	-0.23	-$0.55	-3.18
11	Ducts in Conditioned Space	-0.86	-$0.54	-3.12
8	High Eff White Goods: Clothes washer, Dishwasher, Refrigerator**	-1.12	-$0.52	-3.00
10	Low-Flow Shower & Sinks	-1.84	-$0.49	-2.83
3	Reduced Infiltration: 1.8 SLA / 3.15 ACH50	-0.91	-$0.24	-1.39
2	R-60 blown-in insulation w/ raised heel trusses	-0.43	-$0.23	-1.33
13	Condensing Gas Space Heating*	-0.78	-$0.22	-1.27
6	Added Thermal Mass	-0.15	-$0.20	-1.15
4	Windows: U-Factor=0.25 / SHGC=0.20	-0.78	-$0.16	-0.92
5	Cool Roof: Reflectivity=0.40 / Emissivity=0.85	0.06	-$0.14	-0.81
15	Compact DHW distribution, Insulated HW Pipes	-0.18	-$0.06	-0.35
16	Rooftop PV (3.3 kW)	-16.65	-$9.77	-56.41
	Totals	**-30.37**	**-$18.41**	**-106.30**

*May violate federal preemption. **Added after Certificate of Occupancy

For goals to be accepted by the broader market, policy makers must show that they are not engaging in magical thinking. Thus the technical feasibility of the future code goals must be demonstrated. It is not necessary to show that all technologies are cost-effective today as code requirements can lead to the commoditization of some building practices and technologies that currently are sold as a boutique add-on with considerable transactional costs and a steep learning curve. Examples of declining costs after code adoption and commoditization are documented by (Goldstein 2010, Synapse 2011, USDOE 2011) and expand upon the more general observations of declining costs associated with cumulative sales i.e. the "experience curve." (Hossain 2013, Bass 1980).

During the creation of the 2020 residential ZNE goal, the CPUC was likely aware of off-grid and on-grid homes that were able to provide all of their energy needs on site. In California's predominantly sunny and mild climate, very efficient homes have enough roof area to produce

[1] City of Boulder, CO. Building Code Updates. Accessed 5/11/14. https://bouldercolorado.gov/plandevelop/proposed-changes-to-the-international-building-code-ibc-and-international-residential-code-irc

all of the energy they need with roof-mounted photovoltaics (albeit with the electrical grid used as a perfect battery under the current net metering and ZNE definition regime). This finding was supported by the ZNE Technical Potential Study (Arup, 2012) that not only found ZNE homes were technically feasible by 2020, but also with a code mandated roll-out that these homes were very cost-effective (an incremental first cost of $9.25/sf yielding a benefit/cost ratio of 2 to 1 in 2020) as compared to a home that is minimally compliant to the 2013 Title 24 standards. Table 1 illustrates the measures that are required to achieve zero net energy status in Sacramento (California climate zone 12).

One simulation study does not prove the concept, thus developing a portfolio of studies and demonstration projects are required to build confidence in the concept. No one state has to do this alone as there are a number of programs, industry groups, independent builders and designers that are adding to the accumulated industry expertise of building ZNE homes and buildings. Organizations include but are not limited to: USDOE's Building America program, the Net-Zero Energy Coalition, etc.

Earlier efforts were focused on "one-off" demonstrations of Zero Net Energy homes. More recently as California approaches the implementation deadline of the residential ZNE goal, the focus has been on ZNE developments where ZNE home are mass-produced with accompanying economies of scale.

Consolidating Top Management Support

When policy makers call for significant changes in legislation or executive orders, this is but the first step towards realizing the policy objective. Once major changes are proposed to the status quo beyond aspirational "vision statements," these changes have the opportunity to create both risk and opportunity in the market. Those market participants who perceive more risk than benefit from the proposed changes may try to kill outright the changes or modify the changes to minimize their impact. A significant amount of time, resources and political capital can be expended only to have the key decision makers at the top fold on pursuing an aggressive agenda when key decisions have to be made. Thus it is important to call for declarations of support from key decision makers and implanting agencies. With repeated endorsements of the energy goal, potential opponents may be convinced of the benefit of working with the new order and new products may enter the market in the hopes of taking advantage of new financial opportunities afforded by the proposed changes.

Congress and DOE Top-Down Direction of National Model Codes

The Energy Policy Act of 1992 directed USDOE to participate in the development of national model codes and standards and help states adopt and implement progressive energy codes. To support this mandate, the Building Energy Codes Program (BECP) was created and started funding technical support of ASHRAE 90.1, the reference model energy code for nonresidential buildings and IECC, the model energy code for low rise residences. President Bush's signing of executive order 13423, "Strengthening Federal Environmental, Energy and Transportation Management," in 2007 is credited by Bland & Pitts (2012) as giving DOE the initiative to negotiate a memorandum of agreement with ASHRAE for the 30% increase of stringency of ASHRAE Standard 90.1-2010 as compared to the 2004 version. The executive order required that by 2015, USDOE increase the energy efficiency of government buildings by

30% as compared to a 2003 baseline. The MOU with ASHRAE reflected similar goals for all nonresidential buildings. Table 2 documents the notable increase in savings between the 2007 and 2010 standards with twice as much savings between the 2007 and 2010 ASHRAE standards as relative to the 2004 to 2007 versions. After the 2010 upgrade the level of top-down pressure on achieving even more stringent goals declined and this is reflected in the performance indicators; as compared to 2010, the 2013 ASHRAE standard declined by 7.5% for site energy and 8.4% in energy cost.

Table 2. Comparison of site energy and energy cost impacts of ASHRAE 90.1 versions 2004, 2007 and 2010 with and without plug loads (PNNL 2011, 2013, 2014)

	Includes Plug Loads				Without Plug Loads			
ASHRAE 90.1 Version	Total Site kBtu/sf	% Change	Total Energy Cost $/sf	% Change	Bld Site kBtu/sf	% Change	Bld Energy Cost $/sf	% Change
2004	73.9		$1.75		56.8		$1.37	
2007	67.8	-8.3%	$1.64	-6.3%	50.7	-10.7%	$1.26	-8.0%
2010	55.0	-25.6%	$1.35	-22.9%	38.2	-32.7%	$0.96	-29.9%
2010 Adj*	58.5	-20.8%	$1.42	-18.9%				
2013	54.1	-26.8%	$1.30	-25.7%	N/A	N/A	N/A	N/A

* The adjusted 2010 value is from the preliminary determination for ASHRAE 90.1-2013

California Assembly and Executive Branch Top-Down Leadership

The California Zero Net Energy goals were first released during Governor Schwarzenegger's administration. With bold goals outlined well into the future, there was some question about whether they would have the large direct impact on energy codes as alluded to in the CPUC 2008 Energy Efficiency Strategic Plan. With a change in Governors it was possible that there would be a change in focus as well. When running for Governor, candidate Jerry Brown's Energy Jobs Plan had enough ambiguity to allow postponing the ZNE goals, "We should establish a plan and a timeline to make new homes and commercial buildings in California "zero net energy"—highly efficient structures that use onsite renewable energy for all their electricity and natural gas needs." (Brown 2010).

However, once in office it was clear that the Brown administration also saw the benefit of a ZNE strategy. Executive order B-18-12 required *"… that all new State buildings and major renovations beginning design after 2025 be constructed as Zero Net Energy facilities with an interim target for 50% of new facilities beginning design after 2020 to be Zero Net Energy."*(Brown 2012). Thus the new Brown administration would require that the State government lead by example and that the efforts be ramped up.

Revisions to the AB 32 Scoping Plan, the CPUC Residential ZNE Action Plan and the CEC's Integrated Energy Policy Report (IEPR) all provide an opportunity for state agencies to communicate their latest thinking on a variety of topics. So far these documents have not changed their position on the 2020 residential Zero Net Energy goal, but to date (6 years later) there have not yet been major top-down changes to California energy codes to reflect these goals. However, the primary code change proposals for the 2016 version of Title 24 building energy efficiency standards are focused on residential ZNE measures. Similarly the majority of the efforts on the 2014 Title 20 appliance efficiency standards are targeted towards consumer electronics that increasingly makes up a larger share of residential energy consumption. In 2012, the CEC announced a three phase plan for adopting appliance standards for dozens of appliances in three distinct areas: consumer electronics (computers, game consoles, displays, servers etc.), lighting (outdoor lighting, small diameter directional lamps, etc.) and water & other topics (toilets, faucets, pools, spas, commercial clothes dryers, etc.).[2] Current measures under consideration for updates in Title 24 and Title 20 target 6 out of the 8 top ZNE measures in listed in Table 1.

Developing a Well-Coordinated Tactical Plan

Once the goal is clear, a detailed tactical plan is required to move from the overall vision and goals to a set of tactical objectives for larger set of market transformation participants. In California, a significant portion of this effort conducted by the California Energy Commission (CEC) and the Investor Owned Utilities (IOUs) operating under the auspices of the California Public Utility Commission (CPUC). At this point in time there is not a comprehensive coordinated effort to quickly move the residential building market from current practice to mass-producing Zero Net Energy homes. A coordinated tactical plan would seek to modify the existing relationships between the California energy efficiency programs and treat the long-term goals as organizing principles as the basis for new initiatives for each of the elements of the California energy efficiency portfolio. Figure 4 expands this concept and considers all the market participants that would be impacted by Energy Use Intensity (EUI) goals. .

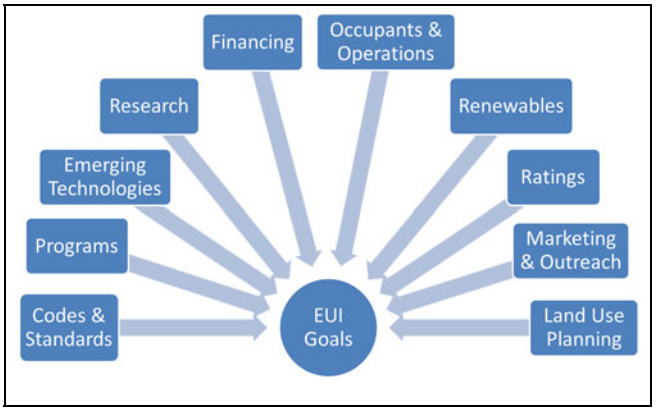

Figure 4. Sources of EUI goals for codes and standards. *Source:* HMG, 2012.

Tactical Plan Reflects the Code Decision-Making Process

Each code body has different procedures and protocols, biases and what combination of data, opinion, testimonials and support is considered sufficient for a code measure to be adopted. The tactical plan must be tailored to the code process it hopes to influence.

Cost-Effectiveness Criteria

Both ASHRAE 90.1 and Title 24 have a fairly rigorous approach towards showing cost effectiveness. Both are based on life cycle cost-effectiveness. However ASHRAE's approach uses flat energy rates while the California Title 24 approach uses a virtual real time rate with different electricity costs that vary by hour that is called time dependent valuation (TDV). The

[2] Order Instituting Rulemaking Proceeding, 2012, Docket # 12-AAER-2 http://www.energy.ca.gov/appliances/2012rulemaking/notices/prerulemaking/2012-03-14_Appliance_Efficiency_OIR.pdf

DOE appliance regulations have multiple economic metrics to consider including: consumer life cycle cost at 3% and 7% discount rates, simple payback. DOE also considers manufacturer economic impact and market availability.

The Title 20 appliance proceeding uses a flat energy rate that reflects utility rates and uses a life cycle costing approach to show cost effectiveness. The California Title 24 and Title 20 standards use a 3% real (inflation adjusted) discount rate.

Though the Warren-Alquist Act allows the CEC to adopt standards that are "cost-effective in their entirety," CEC staff has required that all measures are cost-effective when considered independently. This has filtered out requests for mandating technologies that are not cost-effective on their own. As a result, even though high performance buildings rely on integrated design, it is imperative that California efficiency programs collect energy, cost and feasibility data on a measure-by-measure basis.

Technical Feasibility

Standards based on technical merit that is formally documented, such as Title 24 and its CASE studies, rely on the research to provide an assessment of technical feasibility. In terms of feasibility, CEC staff is influenced by testimonials from design and construction practitioners.

The ASHRAE committees have a broad range of designers and manufacturers and thus usually someone on the committee has some direct experience with most technologies. However outside experts are invited to share their thoughts on the feasibility of a given measure. These outside experts are usually someone who is representing a company that has a financial stake in the outcome of the measures.

The IECC relies on a quasi-judicial voting process to evaluate technical feasibility. In the IECC procedures, evidence is provided to a technical committee for the first round of hearings, and arguments are provided on all sides. Similar procedures are used for the second round of hearings, except the technical and economic judgments are voted on by all the voting members (i.e. code officials) of the International Code Council (ICC).

Code Change Approaches

Single, large wholesale changes to Title 24 have not been requested by the Energy Commission. All the proposals are evaluated by the CEC efficiency division staff and are combined into a draft version of the standards. This draft version is reviewed by the public with public comments submitted as test or verbally in a workshop.

ASHRAE Proposals are submitted to a subcommittee (Envelope, Lighting, Mechanical, Energy Cost Budget (ECB), Format and Compliance). The committee in conjunction with the original commenter modifies the proposals and sends them to the full committee who can vote the proposal out for public review. In general most changes are small incremental proposals. Recent experience has indicated that the ASHRAE public review process is not very amenable to the large single proposal process. Concerns with a single section of a proposal can hold up the rest of a large proposal.

The IECC process described above allows comprehensive revisions to existing code to be proposed as a single item. Such was the approach that resulted in the significant changes in the 2012 IECC that were proposed jointly by New Buildings Institute, American Institute of Architects, and USDOE.

Governing Bodies

The Title 24 process is run by professional staff. They are gate keepers of the proposals but ultimately the Commissioners vote on adoption of the measures but rely heavily on the advice of CEC staff.

ASHRAE committees are staffed by volunteers who represent manufacturers, building designers, trade associations, researchers, national labs and utilities.

ICC proceedings are decided by a technical committee consisting of industry representatives for the first round of hearings, and arguments are provided on all sides. Similar procedures are used for the second round of hearings, except the technical and economic judgments are voted on by all the voting members (i.e. code officials) of the ICC.

Tactical Plan Leverages Team Capabilities

The tactical plan evaluates the activities of various programs and allies and considers how these activities could be modified to collect market data or demonstrate certain measures that are under consideration for future energy codes. Data collection is tailored so that it is in a format that is useful for code bodies. As an example, it is commonly accepted wisdom that programs that are attempting to promote deep savings solutions as one would expect for a ZNE home program would consider only an integrated design approach. Though this makes sense from an energy efficiency program approach, the data needs from a code development perspective requires that data be collected on a measure by measure approach. Data is needed in these smaller measure by measure levels because some code bodies do not allow one to submit grouped proposals.

The beneficial effects of cross program synergies don't flow in just one direction. Some Codes and Standards programs are able to access data on latest thinking on energy efficient technologies from a broader range of industry participants than might ordinarily interact with a given incentive program. In some cases, energy efficiency information is not available to evaluate the performance of a particular product. Codes and Standards programs can provide expertise on developing test methods, and in some cases advocate for "test and list" requirements which would mandate testing energy performance and listing this information in a database and/or on the label of the product. In addition, Codes and Standards programs are providing a reliable exit strategy for efficient markets which were hard to develop and might back slide after support is removed.

Frequent Feedback to Tactical Plan Leads

When the 2007 MOU was signed between USDOE and the ASHRAE Board of Directors, the outlines of this directive was communicated to the ASHRAE 90.1 subcommittees. In addition there was regular feedback to the ASHRAE 90.1 committee from the Pacific Northwest Laboratory on the progress indicators – how much energy was being saved relative to ASHRAE 90.1-2004. Thus in real time the ASHRAE 90.1 committee was receiving pressure in the form of technical information on how well they were able to meet the top-down 30% goal.

What is proposed here as an overview of a tactical plan for the California portfolio reorganized around the ZNE goals would require frequent assessment of progress on several fronts towards developing markets and collecting information in time for adoption of key measures into the building and appliance efficiency standards.

Tactical Plan Must Consider Multiple Paths to Goal

Appliance standards. According to the Residential Appliance Saturation Survey for new homes in California, only 46% of electrical consumption in the home is due to products that are regulated by the building code. Of the loads that are possible to regulate, federal preemption (Case et al. 2012) limits another 17% of total electrical loads from state equipment efficiency regulation (i.e. only the heating and cooling loads on these devices can be controlled by the California energy code, but the equipment efficiencies must match the Federal minimum efficiencies). Interior lighting is the largest single electrical end-use, but only the portion that is hard-wired can be regulated by the Title 24 building energy efficiency code.

The other 54% of electrical end uses not amenable to building code enforcement are those that are not hard-wired or permanent building features. However many of these end-uses, such as televisions, computers, clothes washers and portable lighting are regulated through state or federal appliance standards, and thus appliance regulations are a critical code vehicle for achieving the ZNE goal.

Between 2014 and 2022 approximately 70 new or updated state and federal appliance standards for residential, commercial and industrial end-uses, are projected to become effective. If these anticipated appliance standards are adopted, white good and plug load appliance energy usage could decrease between 22%-43%. The current HERS rating tool uses static values for many appliances which do not reflect new efficient equipment which will be required through new state and federal appliance standards. This tool and others need to be updated to reflect savings from appliances expected to occur by 2020.

Acceptance tests and HERS verification. The energy efficiency of buildings is not only a function of the efficiency of the components but how they are assembled. In the California building codes some residential energy efficiency measures require inspection and validation by a registered HERS rater. Similarly, in nonresidential buildings acceptance tests are required for lighting and HVAC controls to assure that the controls work as intended by the building energy standards.

Another aspect of the scope of the standards is the timeline for when building code apply in the building design, construction and operational phases. For the most part, building energy efficiency standards do not regulate operational efficiency of the building and focus on the design and to some extent on construction quality of the building.

Outcome based codes. A full outcome-based code based on building specific energy targets, offered as compliance option in Seattle, is not contemplated in the development of targets for this phase of Title 24. In the Seattle code, compliance under the outcome path is measured 12-36 months after occupancy, and fully regulates the ‘operational efficiency’ of the building.

Proxies for “operational efficiency”, such as unregulated equipment efficiencies and operational schedules, are used to set EUI targets in the top-down approach. Further calibration of the proxies, and eventual measurement of post-occupancy energy usage, will likely be needed to achieve actual ZNE performance levels contemplated in state policies. Regulatory structures, that require actions beyond traditional construction codes such as benchmarking and post-occupancy retrocommissioning, can be useful for this expanded scope. Both of these actions are now required in New York City.

Strategies for federal preemption. Federal preemption, as prescribed in NAECA, limits the states' and local jurisdictions' ability to require higher than federal minimum efficiency either through state appliance standards or directly through building codes. This has led states, utilities and efficiency advocacy groups to explore different strategies for encouraging high efficiency equipment in code (promoting performance above federal minimums),

One strategy that is compliant with federal preemption but gives the states the flexibility to require high efficiency equipment is an ”optional packages” approach such as used in Illinois, Maryland (through full implementation of IECC 2012) in Washington, much of Massachusetts (through the Massachusetts Stretch Code). The ”optional packages” approach contains one or more options that include equipment that are compliant with the minimum federal efficiency standards but is combined with other package options such as low power density lighting or photovoltaics; this allows for an alternate paths that building-specific alternatives that achieve equivalent additional energy savings while maintaining the minimum federal HVAC standards. The Additional Energy Efficiency optional packages in Section C406.1 of the 2012 version of the IECC exemplify this multi-path approach.

For federally regulated commercial equipment, if ASHRAE 90.1 adopts standards that are higher than federal standards, states may adopt those provisions in their building codes without violating preemption. There is therefore an opportunity for utilities and efficiency advocates to focus technical and advocacy efforts on the ASHRAE 90.1 mechanical committees that cover these products, because if ASHRAE 90.1 is improved, state building efficiency codes can follow suit without violating preemption law.

Implementing a Top-Down Codes Tactical Plan

Market Development

The top-down tactical plans have identified “technology trajectories” of measures that are targeted for future codes. These trajectories are based on projection of current trends and market intelligence of up and coming technologies. In some cases they reflect technologies used in other part of the country or other parts of the world. Market development or market transformation techniques are broadly used by energy efficiency programs. Under this paradigm we are not seeking full market transformation but rather a critical mass of product in the market to consider the technology market ready. This commercialization process allows for unanticipated results to play out.

Ideally, the a top-down approach would be considered over multiple code cycles such that time is given for market transformation, development of test protocols, and updates to energy simulation tools. This allows for the “phasing” of a measure to enter the market place.

Unlike the goals for many energy efficiency programs, the commercialization phase is not as focused on short term TRC cost-effectiveness and resource acquisition but information acquisition for preparation for code. As described in Eilert et al. (2012), the savings from a new construction program that influences a portion of the market pales beside the savings from an energy code change that impacts the entire new construction market and reduces first costs through commoditization.

Data Collection

Though the path to very efficient buildings may be through integrated design, in many cases the path to code adoption is by showing the feasibility and cost-effectiveness of individual measures. As a result, it is important to collect measure by measure data even if these measures are part of an integrated design.

For residential code change proposals, the measures must be able to be deployed at a subdivision level. Feedback from this scale of deployment including the cost trajectory with experience is compelling to regulators.

Scale is also needed for measures that are dependent on behavior. One needs a large enough sample to predict with confidence the average outcome of behavior based measures. As an example, a Title 24 upgrade proposal to require residential plug load controls was submitted for the 2013 code revision. (CASE 2011) This was rejected due to lack of test data documenting usage patterns and lack of confidence in energy savings.

Test Methods and Simulation Tools

Energy standards rely on being able to predict the energy performance of equipment and buildings. Thus a repeatable test method is required to write performance standards for appliances and simulation tools that can accurately describe the performance of combination of equipment are required for performance standards for buildings. These same predictive methods are required for energy efficiency programs. Thus programs that develop test methods and simulation tools help prepare the testing and simulation market for bringing these measures into code.

Proposal Development

Energy code change proposals provide the technical and feasibility information so that policy makers can make informed decisions whether to include the measure in the updated appliance of building standard. Thus coordination with a host of sources is critical including: efficiency programs, manufacturers, installers, end-users, etc. Credibility of the proposal is higher the more testimonials one gets from a variety of reliable sources. Contrary to popular belief, high market penetration is not critical for code adoption if the product is well-characterized and there is sufficient market experience.

Advocacy

Developing a code proposal is just the beginning of code advocacy. Key to effective advocacy is to have a credible well-regarded subject matter expert. That person typically not only knows the technology well, but also understands market for that product and knows many of the key participants. An advocacy campaign must understand what the decision makers are looking for in a proposal and deliver the information in the correct format. Advocates must identify supporters and develop narrative that the measure will save energy without creating an unintended consequence.

Portfolio Coordination

Code development bodies often work to fairly fixed deadlines that are often known well in advance. If one misses the deadline one may have to wait 3 or more years to get another chance. As a result, getting measures into code take a lot of planning and coordination. Thus the tactical plan has to be explicit and have a number of milestones or code cycles so that course corrections can be made well before it is too late. In some cases the result might be that the efficiency programs have uncovered that a given measure has a fatal flaw such as longevity or incompatibility with other building products.

The rest of the portfolio is also motivated to coordinate with codes and standards programs as many public utility commissions will no longer allow a program to incentivize measures that are now code required. Efficient design programs may be easier to market if they are helping designers prepare for a new code if they are providing support and incentive for early adoption of the code. Since code advocates have to keep looking ahead one or more code cycles, they can assist the incentive programs in identifying new measures.

Conclusions

This paper has described an alternative approach towards maximizing energy efficiency through appliance and building energy efficiency codes. A top-down approach sets a goal for energy codes and makes use of organizing the larger energy efficiency infrastructure towards these goals. If these goals are not declared to be aspirational but are instead a guidepost to consistent, organized effort, significant advances can be made as is evidenced by the tremendous gains made by the ASHRAE 90.1-2010 and the 2012 IECC energy codes.

- Bottom-up approaches to energy code development that rely on proposing efficiency measures that are adopted by most market participants will not likely be sufficient to attain the level of efficiency desired by various energy policy initiatives.
- A top-down approach to energy code development can more rapidly incorporate a wider range of feasible and cost-effective energy efficiency measures.
- A well-coordinated tactical plan can organize efforts to deliver planned inputs from a wider range of energy efficiency programs
- This tactical plan can result in re-organizing the activities that are conducted by various efficiency programs so that these programs are collecting data and preparing the market to demonstrate feasibility and cost-effectiveness of existing and new efficiency measures.
- The synergies from this type of approach provide added benefits to the entire energy efficiency portfolio.

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