Code Driven Portfolios

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ABSTRACT

California energy efficiency policy documents explicitly state that all new California homes shall be zero net energy (ZNE) by 2020 and all new, and 50 percent of existing commercial buildings, shall be ZNE by 2030 (CEC 2011, CPUC 2008). Since voluntary programs typically reach a small share of their target market each year, achieving these visionary goals implies an essential reorganization of the energy efficiency portfolio planning to directly support ZNE-focused codes and standards.

This paper posits that policymakers and portfolio designers must "Begin with the End in Mind" (Covey 1989), in contrast to traditional thinking that begins with research and development and ends with regulation. Working backwards from specific policy objectives, energy efficiency portfolio designers identify codes and standards milestones that drive demonstration projects, incentive programs, and education and training activities required to create code readiness for the next code cycle. Longer term regulatory objectives, or future code cycles, guide research and development and emerging technologies activities designed to validate commercial feasibility for intermediate commercialization steps.

Code-driven planning (CDP)[1] reorients short-term program practices to a more strategic focus on long-term market transformation. Within a single program cycle, this shifts focus from incentive program cost-effectiveness to the larger payoff from future regulations, which is akin to coupling savings from voluntary program measures that fail to meet minimum cost-effectiveness criteria with savings from future regulations, thereby creating a cost-effective lifecycle time series.

Policy Foundation

Given California's continued leadership in energy efficiency, renewable energy, and climate change mitigation, we presume that a few of the ideas presented here, which are based on the California paradigm, will be useful to others. We begin with an overview of California's policy infrastructure, since the importance of a strong policy foundation cannot be overstated: as policymakers (governors, legislators, and commissioners) come and go, policy documents continue to guide portfolio planners and implementers.

One of the most important policy documents in California is the original Energy Action Plan (EAP), which established a loading order for energy resources: it begins with energy

[1] For the purposes of the paper, "Code-driven planning" refers to planning that impacts legally-enforceable energy-related regulations for buildings, appliances, and equipment. Terminology is not always consistent across different jurisdictions, but this planning refers to regulations often referred to as "Appliance and Equipment Standards" and "Building Energy Codes", or variations thereof. Furthermore, "Codes and standards" and "regulations" are used interchangeably throughout this paper.

conservation and energy efficiency, followed by renewable energy and distributed generation, and finally clean fossil fuels (EAP 2003). Assembly Bill 2021 strengthened the EAP by requiring the California Public Utilities Commission (CPUC) and California Energy Commission (CEC) to, on a triennial basis, identify potential cost effective electric and natural gas savings and set 10-year goals for investor- and publically-owned utilities (AB-2021 2006).

Schedules for achieving the State's energy efficiency goals are driven by California's Global Warming Solutions Act, which required the California Air Resources Board (CARB) to adopt limits in California's greenhouse gas emissions equivalent to 1990 levels by 2020 (AB-32 2004).[2] The Climate Change Scoping Plan required by AB-32 identifies specific strategies for reducing per capita emissions from 14 tons to approximately 10 tons. For example, key recommendations include expanding energy efficiency programs and building and appliance standards (CARB 2008). Consistent with AB 32, the California Long Term Strategic Plan (Strategic Plan) guides utility program planning. For example, Big Bold Energy Efficiency Strategies include, "All new residential construction in California will be zero net energy by 2020" (CPUC 2008). AB 1109 requires the California Energy Commission to "reduce average statewide electrical energy consumption by not less than 50% from 2007 levels for indoor residential lighting and by not less than 25% from 2007 levels for indoor commercial and outdoor lighting, by 2018" (AB 1109 2007).[3] These goals are re-iterated in the most recent Integrated Energy Policy Report (CEC 2011) indicating that CEC, CPUC and CARB are working in concert to implement these policy goals.

The timing of the energy efficiency and renewable generation goals are also synergistic with the California State Water Control Board *Resolution No. 2010-0020* (CSWRCB 2010), which would phase out once-through cooling by the 19 coastal power plant complexes with a total 21 GW of capacity over the 2010 to 2029 time period. The cost of upgrading a power plant's cooling system from once-through cooling to wet cooling (cooling towers) ranges between $2.5 million to $108 million per site (ICF Jones et al. 2008). Through energy conservation and distributed renewables, some of this cost may be avoided if a plant can be mothballed, rather than retrofitted.[4]

The Roles of Codes and Standards

State policy goals for achieving transformation before 2020 dictate the use of regulation for energy efficiency products and services. Transitioning a measure from a voluntary program to regulation significantly expands market coverage, and resolves market failures (such as split incentives and knowledge asymmetries) that cannot be fully corrected through incentives or through education and training. Additionally, regulations comprise an effective market intervention when the incremental costs of the efficient product is high relative to the base case, thereby causing an excessively long payback period, or when unit savings are too small to justify program administration costs.[5]

[2] Responsibility for controlling GHG emissions is shared by the California Energy Commission and the California Climate Action Registry.

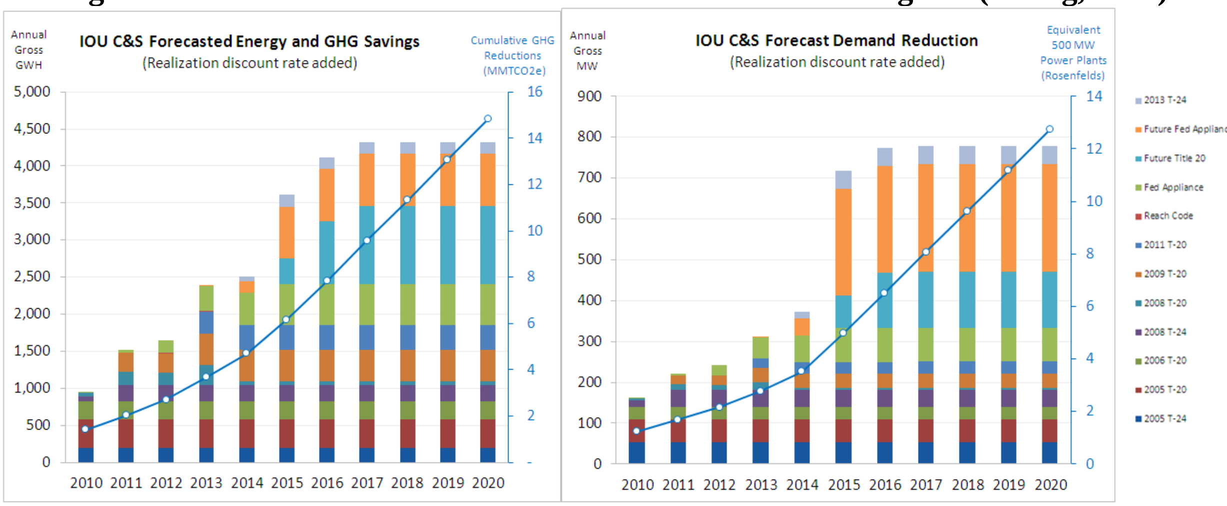
[3] In addition to identifying sweeping goals for California, the Strategic Plan has a direct impact on the design of IOU energy efficiency programs. IOUs are expected to incorporate objectives in program implementation plans and respond to specific recommendations for residential, commercial, industrial, and agricultural sectors, for crosscutting activities such as education and training and codes and standards, and for other specific objectives.

[4] In some cases it may be cheaper to upgrade transmission to out-of-state generators.

[5] Others measures simply do not respond to rebate programs for one reason or another.

Regulations deliver enormous savings year after year. Since its inception in 1998, California's Codes and Standards (C&S) Program has proposed approximately 80 new building codes and 60 new appliance standards in California, and affected 40 federal appliance standards.[6] Figure 1 shows that by 2020, gross energy savings in the California IOU territory will grow to 4,370 GWh per year, corresponding to 14.8 million metric tons of CO_2e.[7] Demand reductions will be 780 MW each year starting in 2016, corresponding to a total of roughly 12 Rosenfelds.[8]

Figure 1.Benefits from California's Codes and Standards Program (Zhang, 2012)[9]



Note: Benefits are shown for the California IOU service territory, which accounts for 72% of electrical sales.

Another consideration is the cost of the displaced generation. Most new in-state generation is natural gas, either a combustion turbine for short duration loads or a combined cycle plant for base load and medium duration loads. The capital costs for natural conventional combustion turbines and combined cycle plants are around $1,000/kW. However, since energy efficiency measures do not emit greenhouse gases or other pollutants, a more useful comparison might be to consider the displaced cost of a combined cycle plant with carbon capture and storage, which is estimated to be around $2,000/kW (EIA 2010). Thus, with the estimated total demand reduction of 6,400 MW by 2020, the power plant capital cost savings are $12.8 billion without even considering the fuel and maintenance costs.

Non-Energy Benefits

Energy efficiency occupies an important nexus between society and business: it embodies the ideal model of shared value that may be created by corporate social responsibility (Porter 2006). Utilities benefit from the positive effects of reduced demand: fewer power plants and less

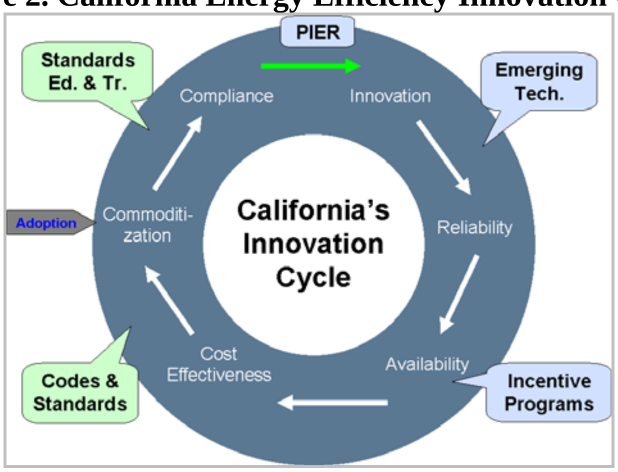
[6] New may refer either to updates to existing regulations or to expansions in scope of California regulations. Whereas IOUs have a direct role in proposing new regulations in California, influence on Federal standards usually comprises research and analysis of USDOE proposals, followed by comment letters.
[7] Gross savings attributable to IOUs include only those that are realized in respective service territories. Net savings incorporate corrections for naturally occurring market adoption and attribution, a measure IOU contribution to public proceedings.
[8] A Rosenfeld is equivalent to one 500 MW power plant.
[9] Mr. Zhang maintains a database for codes and standards savings that has become the basis of IOU reporting and CPUC planning in California.

infrastructure, fewer emissions and allowances required to satisfy cap and trade obligations, and improved corporate citizenship and customer satisfaction; society also benefits from wealth generation, increased employment, and growth in innovation (Pope 2012). For example, by 2015 and 2020, energy savings will reduce annual customer bills by $180 per account and $450 per account, respectively.[10] These shared benefits will be reinvested in local economies by millions of customers. In addition, by 2020, an estimated 1,670 new full-time equivalent jobs will be created in California each year (Wei 2010).[11] Estimates based on Wei are likely conservative since compared to previous standards, more direct labor will be required to capture the benefits of recent advances in Title 24 building codes.[12]

Innovation Benefits

Figure 2 illustrates how regulations advance innovation in energy efficiency. Following research and development, voluntary programs support commercialization of emerging technologies. Then, adoption into code stimulates the development of new, differentiated products in response to the transition of a high margin product to the industry standard. For example, outdoor adaptive lighting (motion-controlled bi-level lighting that dims to low light output when no motion is detected) was championed by the California Lighting Technology Center (CLTC) through the CEC-administered Public Interest Energy Research (PIER) program. After CLTC documented the energy savings associated with bi-level motion-controlled parking lot and parking garage lighting, utility emerging technology programs sponsored demonstration projects for evaluating the feasibility and energy savings, followed by incentive and information programs. The California statewide codes and standards program developed a codes and standards enhancement (CASE) proposal that evaluated the cost-effectiveness and feasibility of an outdoor adaptive lighting standard based on CEC criteria, then advocated for its inclusion in the 2013 Title 24 standards.

Figure 2. California Energy Efficiency Innovation Cycle



[10] This example is based on averaging gross energy savings attributable to PG&E over PG&E's 5.1 million accounts, multiplied by 13.78 cents/kWh (EIA 2011).
[11] Based on 0.38 FTE jobs per GWh saved. This is an average of the energy efficiency range of 0.17 to 0.59 job-years/GWH presented in Wei (2010).
[12] Additional contractor labor is associated with new requirements for insulation, ducts, plumbing, controls, etc., and increased reliance on verification both residential and nonresidential codes.

The innovation cycle varies by measure. Compact hot water distribution systems reduce hot water energy consumption by reducing the volume of water that must be expelled from piping (leaving the tap or shower running) before hot water is available at the faucet or showerhead. Designing buildings in which bathrooms and sinks are clustered around the water heater and using smaller diameter pipe saves both water and energy (typically natural gas), which is used to heat the water. In this case, the research results were adopted into code as a design change without an intermediate commercialization step.[13]

Figure is admittedly an ideal depiction of an extremely complex industry; indeed, only a small fraction of products that are adopted into code can be tracked through all publically funded programs from beginning to end. And while specific technologies are often identified for targeted incentive programs, successful market transformation does not rely only on prescriptive programs. Performance-based programs, for example, provide incentives for energy efficiency without the need to identify specific measures, thereby allowing the market to pick winners.

The performance approach is supported by the 2011 Integrated Energy Policy Report (IEPR), which forecasts the CEC's intent to improve building performance by 20-30% in each triennial update.[14] Triennial updates to building codes force a step function improvement in building performance, including improvements to lighting quality, thermal comfort, and air quality.[15] More generally, empirical evidence for the positive impacts of regulation on innovation is supported by a growing body of academic literature. For example, the Porter Hypothesis posits that corporations do not optimally allocate capital and labor, and therefore benefit from well-designed regulations (Ambec 2011).

Economic Leverage

Economic leverage from regulations comes in at least three varieties, and the first is fairly straightforward. Since codes and standards do not require ongoing incentives, large savings may be achieved at significantly less cost than voluntary programs.[16] The pool pump example in Figure 3 shows the drastic impact of moving a technology from incentive program to code: while savings increased dramatically, incentives were no longer needed and could be shifted to other technologies.

In general, the Program Administrator Cost (PAC)[17] ratio for a C&S program may easily exceed ten, compared to a ratio of around three for incentive programs. This indicates that portfolios with a large code component may be pushed towards a more innovative mix of measures. For example, higher rebates required to commercialize new technologies which have benefit/cost (B/C) ratios less than one may be subsidized by codes and standards.

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[13] The primary market interventions for this measure will be training of building designers and plumbers and outreach to building officials describing the new piping requirements.

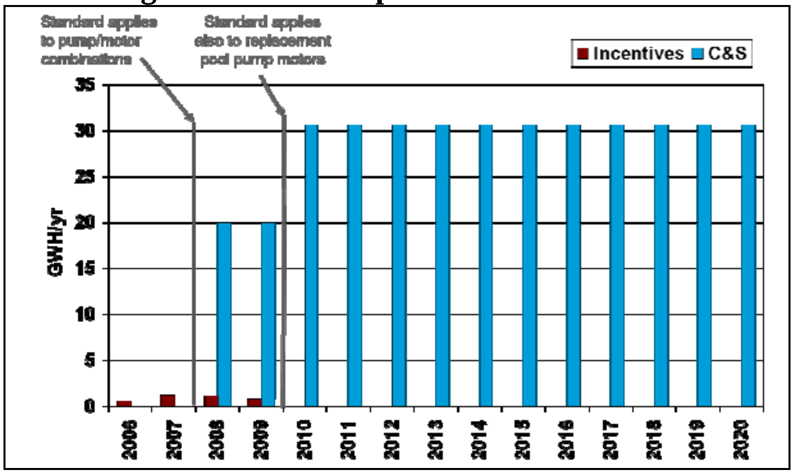
[14] 2013 Title 24 building efficiency regulations are expected to increase performance of regulated loads in residential and nonresidential buildings by approximately one-third.

[15] These, in turn, increase productivity and academic performance.

[16] Compliance with regulations usually falls short of 100 percent but assuming a compliance rate between 80% and 90%, best estimates from the most recent CPUC evaluation of the statewide C&S program, savings from improvements to code will be much greater than an equivalent voluntary program measure.

[17] The Program Administrator Cost (PAC) and Total Resource Cost (TRC) are two cost-effectiveness tests required by the California Public Utilities Commission. For additional detail, see CPUC (2008).

Figure 3. Pool Pumps: Transition to Code



A second form of leverage occurs through commoditization, described above. The transition to code converts a premium-priced product to a commodity product, which causes a drop in its price. Due to competition, this price drop may occur rapidly after code adoption if the difference in production costs between standard and premium products is low prior to adoption. Production volume increases caused by regulations allow fixed costs to be spread over a market-wide number of units, compared to fewer units required to satisfy innovator and early-adopter demand. This increased volume drives learning associated with the manufacturing of individual products as well as experience across a range of products within supply and distribution channels, which further decreases costs. For example, US Department of Energy (DOE) research found that the cost to achieve annual fuel utilization efficiencies for water heaters and energy efficiency ratios for air conditioners dropped by 55-60% between 1997 and 2011 (Desroches et al. 2011). Since regulations impact large numbers of units for a given measure, C&S Total Resource Costs (TRC) ratios are dominated by incremental costs that are expected to decrease after adoption. Hence, the C&S element of a portfolio can subsidize an incentive program element that may not achieve a TRC > 1.

A third form of leverage arises from differences in methodologies and assumptions used to evaluate cost effectiveness. The cost-effectiveness evaluations for a building code or appliance regulation are based upon the cost-effectiveness to the consumer. The utility-focused TRC cost-effectiveness methodology compares both the incremental measure cost and the program costs relative to the life cycle avoided cost for the utility.

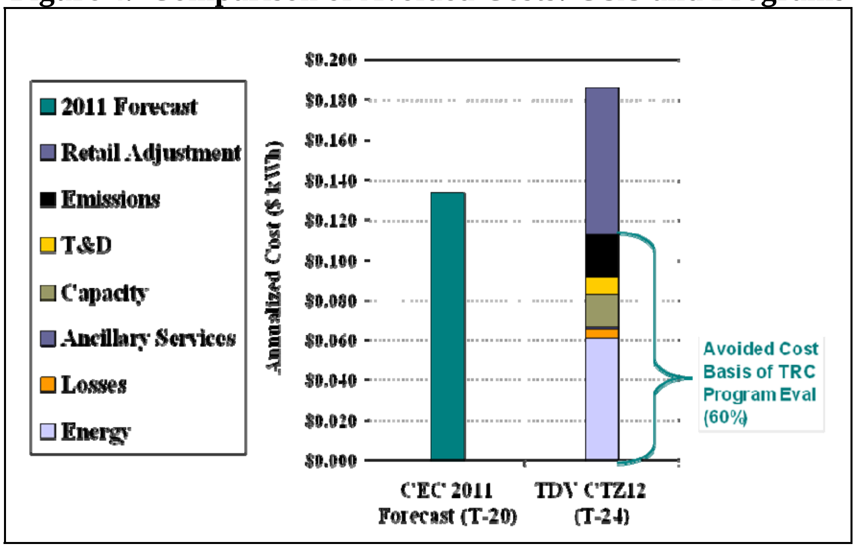
The CEC evaluates new standards proposals based on life cycle cost-effectiveness using net present value (NPV) <u>to the consumer</u>. For appliances, NPV inputs include incremental measure costs, incremental maintenance costs, benefits from energy efficiency savings estimated from <u>average customer rates</u>, and a 3% societal discount rate. For building proposals, NPV inputs include incremental first costs and maintenance costs, and efficiency energy cost savings benefits, which use time dependent valuation (TDV) values with an embedded 3% real discount rate and forecast of energy costs <u>to the consumer</u>.[18] USDOE evaluates appliance standards based on average national energy prices <u>to the consumer</u> and high (7%) and low (3%) discount rates. By contrast, the CPUC uses TRC to evaluate both incentive programs and the Statewide C&S program. Inputs to TRC include incremental measure and program administrative costs, benefits

[18] For residential buildings the CEC uses a measure life of 30 years, and 15 years for nonresidential buildings.

estimated from present valued avoided costs to the utility, and a cost of capital discount rate of 8-9% (Lee, 2012).

As shown in Figure 4, CEC's TDV analysis includes a rate adjustment that is not present in the CPUC's TDV analysis; moreover, CPUC discount rates are higher than the CEC's (McHugh 2012). These differences, coupled with longer measure life and the expectation of a reduction in incremental costs after adoption, create economic leverage that is useful and even critical for achieving ZNE goals. Code-driven economic leverage is greatest for residential buildings for which a group of measures in a residential new construction rebate program may produce a low TRC score (e.g., TRC < 1), yet easily meet the CEC's criteria of decreasing cost to consumers over the life cycle of the building.

Figure 4. Comparison of Avoided Costs: C&S and Programs



Code-Driven Portfolio Planning

In December 2011, the California Public Utilities Commission (CPUC) issued an Administrative Law Judge's Ruling Regarding Program Guidance for the 2013-2014 Energy Efficiency Portfolio. In this ruling, the CPUC recommended that IOUs "…redesign portfolios such that Codes and Standards become an essential strategic component, with identified timelines and budgets for different C&S initiatives supported by incentives and rebates to encourage code readiness and compliance" (CPUC 2011). This recommendation describes a code-driven portfolio (CDP).

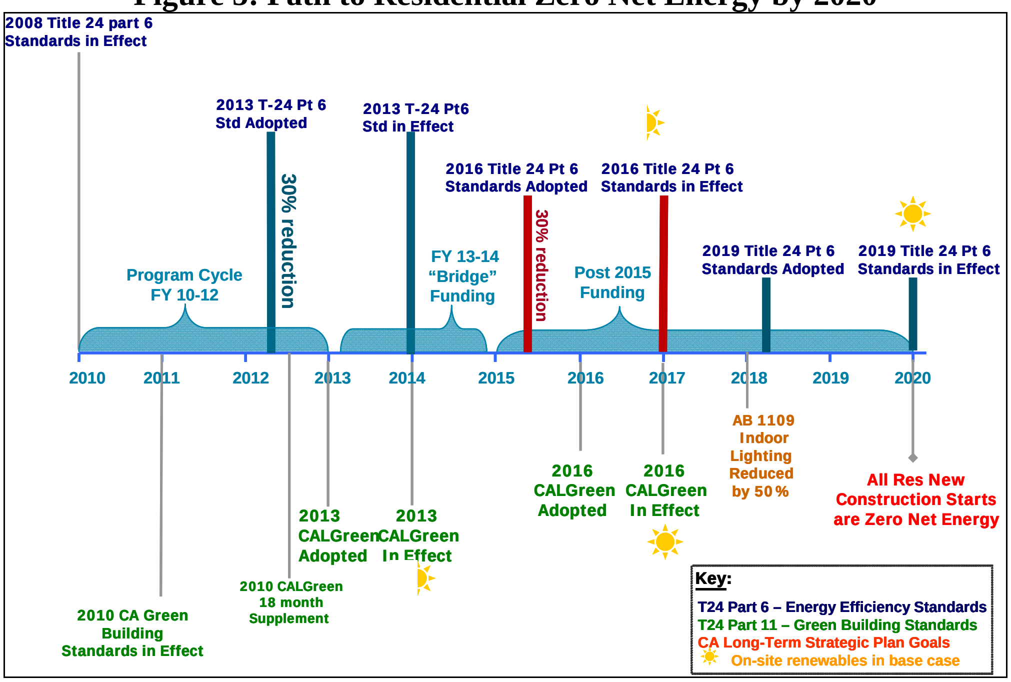
In the following sections, we describe the looking-backwards elements of CDP, including state policy objectives and milestones, technical requirements for achieving objectives, voluntary program support, education and training, and research and emerging technologies.

Objectives and Milestones

This example assumes California's policy objective of achieving ZNE in all new residential new construction by 2020, clarified to mean "all new residential construction will be ZNE or equivalent." The concept of equivalency allows residences to comply even when the site is not amenable to renewable energy generation (i.e., shaded infill construction, etc.), without watering down the concept of zero net energy. Additionally, we assume a definition of ZNE consistent with the economic basis of the Title 24 energy code, time dependent valuation (TDV). Since TDV includes a value of carbon emissions, "A ZNE home is one for which the societal value of energy consumed by the building over the course of a typical year is less than or equal to the societal value of the on-site renewable energy generated (i.e., a whole house HERS rating equal to or less than 0)" (McHugh 2012).

Figure 5 shows major milestones between early 2012 and 2020. In early 2012, the CEC is wrapping up the 2013 code cycle with adoption of new Title 24 Building Efficiency Regulations anticipated by mid-2012, with an assumed effective date of January 1, 2014. Consistent with the 2011 IEPR, we assume that the CEC will target a further 30% increase in residential new construction efficiency during the 2016 code cycle, and again in the 2019 cycle. Also shown is the AB 1109 residential objective of a 50% reduction in indoor lighting by 2018; for residential new construction, this objective must be embodied in the 2016 code cycle.

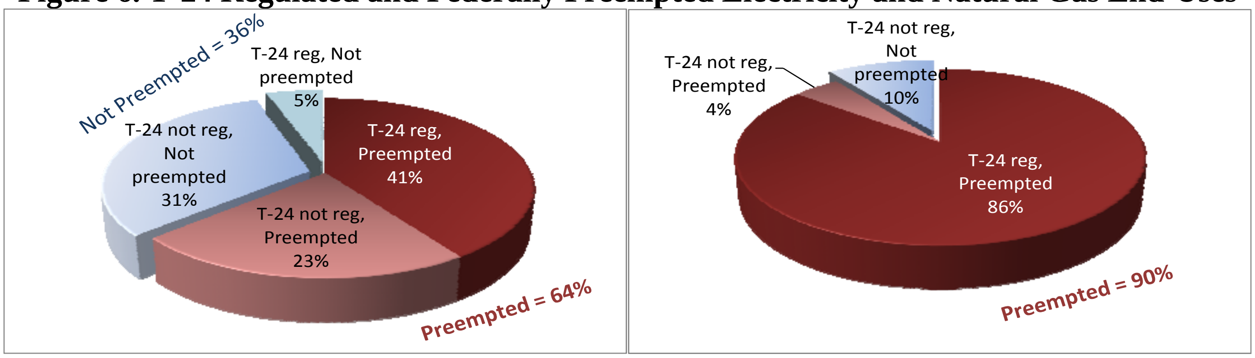
Figure 5: Path to Residential Zero Net Energy by 2020



Of particular importance to CDP planning is US Department of Energy (DOE) authority to set energy performance standards for most equipment serving major residential end uses: heating and cooling equipment, water heating, and lighting. Federal preemption poses a serious constraint on California's efforts to achieve its policy goals for several reasons: California is preempted from specifying higher performance, since DOE conducts rulemakings less frequently (6 year cycle, at best) than California, and DOE typically sets performance levels less than what could be justified for California's conditions (Chase et al. 2012). As shown in Figure 6, preempted measures account for approximately 64% of electric end uses and 90% for natural gas in a home, so engaging in DOE rulemakings is a critical ZNE activity.

An alternative preemption strategy is the "dual path" strategy, which was adopted by the 2015 International Energy and Conservation Code (IECC) for nonresidential occupancies and in the 2011 Oregon Residential Specialty Code. Under the dual path strategy, the primary compliance path (PCP) allows equipment minimally compliant with the federal appliance regulations as long as the equipment is bundled with renewable generation or some advanced energy efficiency measure. The availability of the PCP also allows a secondary compliance path (SCP), which contains equipment that exceeds the federal efficiency regulations. California has yet to take a similar approach to preemption, but given the challenges to achieving the next 30% reduction in energy consumption and having a code that is "cost-effective in its entirety," the dual path strategy will be increasingly attractive for meeting both of these objectives.

Figure 6. T-24 Regulated and Federally Preempted Electricity and Natural Gas End-Uses



a) Residential electricity

b) Residential natural gas

Consumer electronics, a rapidly growing non-preempted load, is a primary CEC target for increasing efficiency through Title 20 Appliance Efficiency Regulations, as are selected lighting and other miscellaneous appliances.

Measure Identification

Table 1 contains a preliminary list of secondary compliance path (SCP) measures planned for the 2016 Title 24 building code cycle.

Table 1: Potential 2016 Measures

Envelope and Lighting	Mechanical and DHW
Ducts in conditioned space or ductless HVAC	Condensing water heater or solar DHW
Walls - R-21 + R5 in all CZs	Compact water distribution
Coastal compressorless comfort	Low W/cfm fan system
Tested Infiltration < 3 ACH 50[1]	Controlled mech ventilation[1]
Windows 16% of floor area[2]	EER 14+ AC[3]
All high efficacy lighting[1,2]	Condensing furnace[2,3]
[1] ET Research Required, [2]Trade-offs allowed with PV, [3] Fed min eff with PV	

These measures are expected to achieve a roughly 30% increase in efficiency relative to the 2013 code. Based on the definition of ZNE provided above, all appliance loads must be considered relative to the photovoltaic requirement in the primary compliance path, so SCP also includes the most efficient ENERGY STAR appliances.

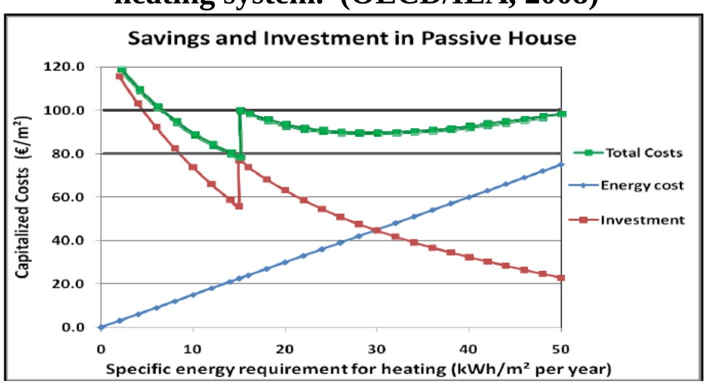
SCP measures identified in Table 1 are based on the assumption that preempted equipment may exceed performances stipulated by DOE as long as minimally compliant products are allowed in the PCP described in the previous section.

An important change in 2016 regulations will be to bring ducts into conditioned spaces or eliminate them altogether as a significant source of heat gain and loss. In its most effective form, the HVAC unit is also in the conditioned space, which would preclude the most common furnace type currently used – the atmospheric draft minimally efficient furnace. Thus, there is significant synergy with the sealed combustion condensing furnace that would be ordinarily preempted as a code requirement. Alternative methods of providing heating without bringing combustion supply air into the conditioned space include combined space and water heating or heat pump space heating.

The current standard prescriptively requires R-21 cavity insulation (6" thick high density insulation) plus R-4 (1" foam) continuous exterior insulation for the more extreme climate zones. In milder climates, the wall insulation requirements are R-15 cavity insulation (4" thick high density insulation) plus R-4 continuous insulation. It is possible that thicker walls with more insulation also make sense in coastal climates as part of the concept of the "Coastal Compressorless Comfort Home," a home that has envelope features (low SHGC glass, overhangs, thermal mass and low conductance assemblies), which make it comfortable without an air conditioner.[19] If comfort models predict that cooling is rarely needed, the builder/owner can substantially reduce his first cost by not installing air conditioning when a home is built.

A similar concept was used for setting performance targets for the passive house standard in Europe. In Europe, space conditioning systems are heating only and as shown in Figure 7, the analysis for their efficiency standard found that once annual heating loads were below 15 kWh/m^2, the ducted space heating system could be eliminated at a fairly large cost savings.

Figure 7. Passive House cost-effectiveness curve with discontinuity from elimination of heating system. (OECD/IEA, 2008)



What is interesting about this European Standards development is that if the cost savings associated with the elimination of the space heating system were not considered, the minimum life cycle cost would have been at around double the heating loads or 30 kWh/m^2-yr. Currently most standards development processes are still using the paradigm that does not include the opportunity to reduce or eliminate mechanical systems.

[19] To conduct this evaluation, one needs to have a whole building simulation tool that includes a comfort model. In support of the 2013 Title 24 standards, a human comfort model was added to the residential compliance simulation that accounts for air temperature, radiant temperature and air movement.

For appliances, the objective is to minimize PV costs through Title 20 regulations of non-preempted equipment. In addition to comprising the fastest growing load in homes, consumer electronics are an attractive target since many have an effective useful life (EUL) of approximately five years. If the CEC completes a Title 20 rulemaking during the next two years and sets effective dates based on a one-year statutory requirement implementation beginning in 2015 would provide time for stock turnover and realization of savings.

With only eight years remaining until 2020, there is little opportunity to reduce loads through DOE regulation. A typical DOE rulemaking requires three years to complete, followed by a three to five year delay between adoption and implementation; hence, DOE proceedings beginning after 2012 will deliver few ZNE benefits.

Incentive Programs and Reach Codes

In a code-driven portfolio (CDP), incentive programs serve two strategic functions: preparing the building industry for adoption of new standards and preparing for implementation. For simplicity, this example includes two measures that we expect would improve efficiency in new homes by approximately 15%: ducts in conditioned spaces and high efficacy lighting.[20]

Table 2. Participant and Total Resource Cost Test for Example Residential Ducts in Conditioned Spaces and Lighting Program[21]

Year	Homes /yr	Measure Cost	Admin Cost	Rebate cost	Energy Avoided Cost	PAC B/C Ratio	TRC B/C Ratio
2013	100	$280,500	$84,150	$112,200	$329,494	1.7	0.90
2014	200	$534,286	$160,286	$213,714	$658,989	1.8	0.95
2015	400	$1,017,687	$305,306	$407,075	$1,317,977	1.9	1.00
2016	800	$1,938,452	$581,535	$775,381	$2,635,954	1.9	1.05
2017	2,400	$5,538,433	$1,661,530	$2,215,373	$7,907,862	2.0	1.10
2018	40,000	$87,911,636	$500,000		$131,797,703	263.6	1.49
2019	40,000	$56,050,000	$30,000		$131,797,703	4,393.3	2.35
2020	40,000	$56,050,000	$30,000		$131,797,703	4,393.3	2.35
2021	40,000	$56,050,000	$30,000		$131,797,703	4,393.3	2.35
2022	40,000	$56,050,000	$30,000		$131,797,703	4,393.3	2.35
Totals		$321,420,993	$3,412,807	$3,723,743	$671,838,789	94.1	2.07

Table 2 shows the results of conducting a five-year incentive program to establish code readiness, followed by adoption. While the incentive program TRC ratios are low, the TRCs and PACs of the code program are high, and well above 1.0 for the combined savings stream from both the incentive program and regulations. The main finding is that evaluation of the EE

[20] In practice, additional measures from Table 1 would be added to achieve 30%, and while the EE program TRC will drop even further, the C&S TRC would be expected to remain well above one.

[21] Program assumption is that 23 luminaires are upgraded per home at an initial cost of $35 each (primarily LEDs for a total cost of $805 per home) and that design changes that result in ducts being in conditioned spaces are around $2,000. It is assumed that the effect of the program is to reduce measure cost by 5% per year. Incentive program administration costs are 30% of measure cost and incentive costs are 40% of measure costs. Though the adoption date is 2017 it takes a year before houses permitted are completed. In 2019 it is assumed that the code change makes the measures common practice and thus costs of ducts in conditioned spaces drops by 40% to $1,200 per home and incremental lighting costs have dropped by 75% to $200/home.

program in isolation does not capture the longer term combined benefits of a code-driven portfolio: $671 million of avoided cost and a TRC net present value of $347 million.

From a CDP perspective, demonstrating feasibility is the main goal, to which energy savings and achieving a specific market share are secondary. Demonstrating feasibility entails working with builders to increase experience with new technologies and develop comfort with eventual regulations. In addition to providing incentives, utilities will need to provide design assistance and work with building industry change agents to identify and resolve problems. In a CDP, reach codes will comprise a strategic delivery channel for incentive programs. Since local governments will insist that reach codes be cost effective and achievable, one tier of reach codes must incorporate incentives in the cost-effectiveness analysis.

CDP planning can reduce program redesign and reduce administrative costs. For example, the current residential new construction program has a program entry threshold of 15% beyond the 2008 standards baseline, and while the new proposed program would represent a 45-50% increase in energy efficiency, the program would not need to be redesigned until 2016, in preparation for 2019.[22] In contrast, a program redesign is necessary between the 2008 and 2013 standards to utilize the opportunity to prepare industry for new regulations between adoption (mid-2012) and implementation in 2014. This change would help developers who choose to skip 2008 standards and jump from projects based on 2005 standards to projects directly based on 2013 standards.[23]

Education and Training

Similar to incentive programs, CDP education and training has two primary objectives. The first is to equip the building industry with the knowledge to comply with new regulations. For example, building efficiency for the 2013 code cycle is estimated to exceed that of 2008 efficiency by approximately 33%, and standards include new prescriptive measures that are not common for some builders: roof deck insulation, hot water distribution systems, HVAC duct sizing. To reduce industry opposition to adoption, IOUs have committed to completing a needs assessment in 2012, followed by education and training. These activities are especially important since it is highly unlikely that new incentive programs will be implemented to support 2013 standards. Moreover, a need for continuous education and training is anticipated to support an expanding workforce for the next several years. In 2012, construction of single family homes is at historic lows of 25-30 thousand houses per year. Industry representatives expect the housing market to gradually return to normal rates of construction of 150-200 thousand circa 2016.

The second objective of CDP education and training is to improve compliance with existing regulations. CDPs that support frequent aggressive updates to regulations imply strong support for voluntary compliance improvement activities.[24] While utilities do not have authority to conduct enforcement activities, voluntary approaches to improving compliance increase grid savings realized from changes in regulations. In 2010 and 2011, the goal of IOUs was to reorient educational activities around role-based training and adult leaning practices driven by needs

[22] Implementation would begin in 2017.

[23] Large subdivisions require years to complete, so skipping 2008 might avoid the need to permit houses in a single subdivision project under two regulations.

[24] Maintaining separation between local government enforcement activities and voluntary utility programs is imperative, since enforcement by utilities would reduce interest in energy efficiency and education and training programs.

assessments. The initial needs assessment highlighted the importance of building basic knowledge of standards among local governments and Title 24 consultants. Role-based training has been extremely successful and supplants the tradition of updating industry practitioners through comprehensive “spray and pray” presentations. In 2012, role-based training is expanding to include HVAC and lighting trades.

The complexity of standards remains a significant challenge to improving compliance, given resource constraints of most local governments. A number of efforts to assist the compliance industry in California are underway. A Compliance Improvement Advisory Group comprised of industry leaders meets periodically to identify systemic problems and work towards solutions. New, more rigorous, certified energy analyst examinations are being developed to increase competency of Title 24 consultants and improve accuracy of compliance documentation. Another project seeks to identify best practices among local governments with the intent of supporting transfer to others.

More generally, infrastructure development must deal with the enormous diversity of enforcement processes that arises from over 500 building departments, large and small, across 16 climate zones. Moving to an electronic infrastructure is imperative; processes regarding permitting and electronic submission of compliance documentation must be standardized. As a standard practice, this approach will support document retention and reduce overall cost to the state.

In addition to development of an electronic infrastructure, linking incentive programs to compliance improvement education and training will accelerate infrastructure development and increase portfolio realization rates. New construction incentive programs could require that compliance documentation be completed electronically by certified energy analysts, and that incentives be conditional on matching the project to the CEC electronic repository. For project types known to have low compliance (such as HVAC alterations), another approach would be to require that program participation be conditional on contractor certification that specified compliance improvement training has been completed.

Emerging Technologies and Research

By the end of 2012, high quality (CCT<2900 K, CRI > 90) dimmable LED luminaires are needed for all main home hardwired lighting applications: 4”, 5”, and 6” recessed cans, bath bar, surface mounted ceiling, and pendant lights. Bath bars in particular represent one of the largest lighting loads in a home, and demonstration projects are urgently needed for incorporation into the 2013 residential new construction program. Research and/or demonstration are needed for other residential measures in 2016/2019, for example, sealed combustion furnaces, indoor air quality and low infiltration homes.

Utility Management

CDP planning represents a significant change to utilities that have for decades conducted the business of energy efficiency based on incentive programs. And while some utilities have engaged in C&S activities for a dozen or more years already, incentives have remained the focus of planning. The transition to CDP requires top-down planning that pushes the portfolio to a more innovative mix, so fewer measures and programs will be individually cost effective. It will require greater emphasis on long-term planning with the use of improved modeling tools.

Successful implementation of CDP requires a change in mindset for most program or product managers to include code readiness as a goal and cross-functional integration that maximizes portfolio accomplishments. Strong leadership, and perhaps a change in reward systems, will be required to effect this change.

CPUC and CEC Oversight

At the time of this writing, a number of issues that will determine the success or failure of CDP remain outstanding. Since CDP implies accelerating the transition from incentive programs to code, CPUC policy must reflect the objectives that it seeks to attain. In particular, equal credit must be given for savings from incentive programs as from codes and standards. Decisions that impact how utilities are rewarded must be based on sound principles to avoid structural barriers within the portfolio. The need for more frequent redesign of programs due to changes in code baselines requires faster response and greater flexibility regarding work paper and program approvals. Longer planning horizons require policies that promote consistency in implementation.

Conclusions

Code-driven portfolios establish specific portfolio objectives based on future changes in regulations. The residential ZNE example in this paper demonstrates that technology objectives may be established years in advance of anticipated adoption and implementation, and that incentive program and education and training activities may be identified to support code readiness. A key conclusion of this paper is that an integrated portfolio that includes both voluntary and involuntary market interventions is essential to achieving aggressive policy goals. While the requisite shift towards a more innovative mix of technologies may cause incentive programs to fail traditional cost-effectiveness tests, the portfolio as a whole will pass societal costs tests with the inclusion of codes and standards benefits.

Looking forward, nonresidential ZNE policy goals will lead to identification of interim goals, such as ZNE by building type on the path to 2030. CDP planning will be required to achieve these nonresidential ZNE objectives and the goal of transitioning existing building stock to a state energy use that is compatible with a sustainable future.

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