A Suite of Effective Policies for Energy Efficiency in Commercial Buildings

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Introduction

The potential for saving energy in commercial buildings through increased efficiency is virtually limitless. The growing number of buildings worldwide that provide top level energy services while consuming no energy from outside sources, on net, documented in the New Buildings Institute (NBI) report,[i] demonstrates the feasibility of reducing energy use at the building site by about 100%.[1,2] These observations include retrofits of existing buildings as well as completely new construction. Furthermore the NBI report found that these buildings show no consistent trends of higher construction costs than conventional buildings.

These conclusions supplement the findings of a growing number of efficiency potentials studies that find that large increases in energy efficiency in commercial buildings are feasible and economically attractive.[ii] While the NBI net-zero buildings study is much more optimistic about the potential, this optimism is fully consistent with the caveats expressed by the authors of the more widely disseminated potentials studies cited, both in the text and in response to questions at formal presentations: the potentials studies by design systematically leave out efficiency potentials that are subject to uncertainties or that the authors are concerned will be perceived to be "unrealistic" or even just controversial.

This author has identified eight systematic biases that cause the large-scale studies of efficiency to underestimate the potential.[iii] This paper will discuss the two most significant of them—the reliance on device-by-device compilations of efficiency measure costs and savings rather than whole-building or whole-system savings, and the failure to consider continual improvement.

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[1] The compilation includes net-zero-capable buildings whose energy consumption is so low that photovoltaic generation that *could* be installed on-site would supply 100% of the energy consumed but that have not actually installed the solar generation. Even without the PV, energy use is reduced by more than 75%.

[2] Onsite electricity generation is not the same as energy efficiency, but in practice any generation that reduces load to zero (but not below) in any given hour is indistinguishable from efficiency for most policy purposes. This paper acknowledges but does not dwell on this distinction because the effect on emissions and off-site energy needs between near-100% and fully-100% savings at a time at least 15 years from now is not interesting. Shorter time periods than 15 years are also uninteresting because a retrofit program that attempted to do the job faster would not be economically effective: it would create a boom-bust economy in the construction sector.

The contrasting results obtained by relying on "widget-based" compilation of efficiency potentials compared to whole-building-based studies is discussed in the National Academy of Sciences (NAS) efficiency study referenced in Endnote ii. That study finds a savings potential for the commercial buildings sector of about 30%, but also contains a long discussion of whole-building results that demonstrate much larger savings.

The research on net-zero buildings shows that energy efficiency in the commercial sector is not a *technology* problem: We have the technology right now to zero out commercial building energy use over the next decade or two at a reasonable cost (at worst) or no cost (at near-best) or at negative cost (at best). The technology and economic challenge is to solve *it more optimally over time*.

The real challenge is to implement this technology through policies that lead to this optimization. That is why the rest of this presentation is on policy.

This large potential for savings is evidence of massive failures of the market – failures that affect efficiency technologies at all points along the technology adoption curve from research and development to product introduction through widespread adoption.[iv] These failures of market forces range from relatively straightforward problems that in principle could be solved but in practice have not been, such as split incentives between landlords and tenants to invest in efficiency on one hand and to manage energy use through good operations on the other, to more fundamental problems such as systematic tendencies for humans to make decisions irrationally.[v]

Fortunately, the same efficiency potentials analyses show that these failures can be overcome by policy. This paper discusses the specific types of policies that have been demonstrated to succeed. It argues that rather than place primary responsibility on a single policy type, **a suite of policies** can work synergistically to make markets function well in energy efficiency. Making markets in efficiency work well not only leads to adoption of known technologies, but also spurs the introduction of new technologies and methods that achieve greater savings with improved non-energy benefits at lower cost.

The suite of policies discussed in this paper focuses on the commercial buildings sector, but they are broader. This breadth is important for several reasons. First, policy-makers are more likely to be attracted to policies that work across the board rather than for one subsector. Second, commercial buildings affect energy use in more ways than just what shows up on the meter: their location determines how much transportation energy will be used by the workers, customers, and visitors to the building,[3] and their choice of construction materials affects industrial energy use. Furthermore, these interdependencies are not trivial second-order effects—their magnitude is comparable to that of direct energy use,[vi] so ignoring them can lead to large problems of sub-optimization.[vii]

At the outset, it is important to define, for the purpose of this paper, what we mean by energy efficiency. We define energy efficiency as the provision of the same (or higher) level of energy service for less energy use,[4] and implicitly assume, when we refer to efficiency, that it is cost-effective, in the

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[3] The discussion here assumes that commercial buildings are offices, schools, etc., but high-rise and mixed-use residential buildings are classified as "commercial." In this case, the location determines the amount of driving the residents do, including shopping trips, recreation, education, and work.
[4] This definition is consistent with the definition used for the buildings sector in the National Academy of Sciences efficiency study cited in reference ii.

sense that the combination of energy and energy service benefits exceeds the incremental costs (if any) of the efficiency.[5] Conservation, on the other hand, can be defined as becoming satisfied with a lower level of energy service. We note below that Operations and Maintenance quality does not fit into this definitional paradigm very well, and is often ignored in potentials studies such as those noted above as an energy reduction option.

This paper next proceeds to a discussion of how one could construct a suite of policies that works in market-based ways to encourage continual improvement in energy efficiency technologies and designs from a baseline of current best practices.

Policies That Work

A. A suite of policies versus a silver bullet

The wide array of failures of the market that confront energy efficiency technologies suggests that a wide variety of policies are needed to make markets function effectively. This is important because an approach to net-zero buildings is unlikely to be accomplished solely with existing technologies.

To get significant market share of net-zero buildings will require continual improvement in technology and design, as well as in operations and maintenance procedures for buildings.

One can imagine two approaches to getting to zero. The first approach is to expand the market share – currently minimal, although growing quickly – year by year, until it encompasses the majority of the market. This is not how most major improvements in efficiency have occurred, but it may work in this case, since the incremental cost of net-zero buildings has not been distinguishable from the data compared to conventional buildings. In other words, the NBI study finds no statistically significant difference in overall construction costs between net-zero buildings and conventional buildings, despite the fact that each of the individual measures employed in the net-zero buildings, in particular the photovoltaic generation, generally do carry a positive incremental cost.

The second approach, which is more consistent with the progress that the U.S. and other countries have made in the areas where the most improvement in efficiency has occurred – residential refrigerators, new homes in California, the overall operations of a few leading industrial companies, such as 3M – has been that improvements in efficiency are incremental. Indeed, the process of continual improvement with incremental changes in technology and performance is typical of the functioning of markets that work.

[5] Onsite generation is broadly consistent with this definition in that it also does not reduce energy service levels. However, it frequently fails to be cost-effective when considered on its own, and the grid consequences are different. See Endnote ii; this paper also downplays the difference between efficiency and on-site generation because the bulk of the net reductions in the NBI study are delivered by pure efficiency measures, and an even greater share by only that portion of generation that reduces load but does not send power back to the grid. Also, as noted, the purpose of an efficient potentials study is not to forecast future energy use but to set policy goals, including budget allocations that can take the nation (or any nation) in the right direction. The principle of continual improvement in Endnote ix suggests that any finely detailed projection of efficiency resources and their consequence on overall energy demand in year N will be superseded by a more refined projection in years N+1, N+2…

This can easily be seen by three objects that are commonly found in the briefcases of people like me, who travel: smart phones, digital cameras, and the storage media used in both. If one had asked the manufacturers of these types of products in 1995 whether they could foresee the types of products they are currently producing in 2014, none of them would have come close to the optimism that turned out to happen in the real world. The reason for this is that large changes are hard to visualize and design. But, when markets work, incremental improvements are made due to competitive forces; and these improvements compound over time. For example, the rate of improvement of digital storage, measured in megabytes per dollar spent, has improved at a rate of approximately 80% per year for over two decades.

This latter approach suggests that the best way to get to net-zero buildings is to save, say, 40% this year, 50% three years from now, etc., on an approach to zero energy consumption.

In order to make continual improvement work, we need to remove all of the barriers and failures to the market, and the rest of this paper suggests how we can do it.

B. Political advantages of a suite of policies

One of the more effective policies for commercial buildings has been energy codes for new construction. (Note that new construction does not necessarily mean new buildings; a number of systems, particularly lighting and air conditioning, commonly are replaced upon change of tenancy or when relatively short-lived equipment wears out and are subject to energy code requirements.) Energy codes can attract some level of political controversy, since they involve government regulation, which opponents can try to contrast with the outcomes of free markets[6].

Many of the arguments against energy codes suggest that carrots are more appropriate than sticks. A suite of policies includes a large number of carrots, some of which have a financial cost to utilities, government, or other administrators, while others have significant indirect cost. By doing as much as we can with carrots, and only what is necessary to do through the regulatory system, we can achieve a more attractive suite of policies that can be supportive by conservative as well as progressive thinkers.

A Suite of Policies

This section discusses a suite of policies that can apply to the entire economy that will promote energy efficiency through market-based mechanisms. The discussion will focus on those initiatives most relevant to the commercial building sector. The economy-wide policies fall into five generic categories:

- General economy-wide policies;
- Policies to accelerate market adoption of new technologies;
- Policies for the industrial sector;
- Policies for the transportation sector;
- General economic reforms focused on lending and valuing investments

These are discussed in order.

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[6] This argued contrast is invalid, because free markets with strong competition require some regulation (for example, standards for product quality) to work. See Endnote iv for a detailed discussion.

A. General economy-wide policies

The most important policy is to set a mandatory declining greenhouse gas emissions cap. A cap is important not primarily for the fact that it puts a price on carbon, but because it sets a goal that businesses, governments, non-profit organizations, and individuals will shape their actions to help meet. Pricing emissions has little effect on efficiency for two reasons: First, price elasticities for efficiency alone, when measured correctly, are quite low. Higher prices can encourage conservation action or better operation and maintenance behavior, and such behavior has often been confused in economic studies with a price elasticity for efficiency. Second, pricing carbon at the source does not necessarily translate into higher energy prices at the consumer level. The experience at the Regional Greenhouse Gas Initiative (RGGI) has been that the emissions saved by the types of policies discussed in this paper, and by incentives for renewable energy, have taken the pressure off the prices of fossil fuels and resulted in virtually no change in retail electricity rates. In California as well, emissions permits are trading near the bottom of the legally allowed range.

The importance of setting goals—in the absence of placing price pressure on consumers--should not be underestimated. Businesses commonly set goals for product introductions, sales, cost reduction, revenue growth, etc., and these goals guide organizational behavior in powerful ways. Economic models assume that businesses maximize profits, but actual business operation is based on setting goals that are not directly connected to profit maximization, particularly in the minds and job assignments of the people that are changed with meeting them, even when they tend to lead to that outcome.

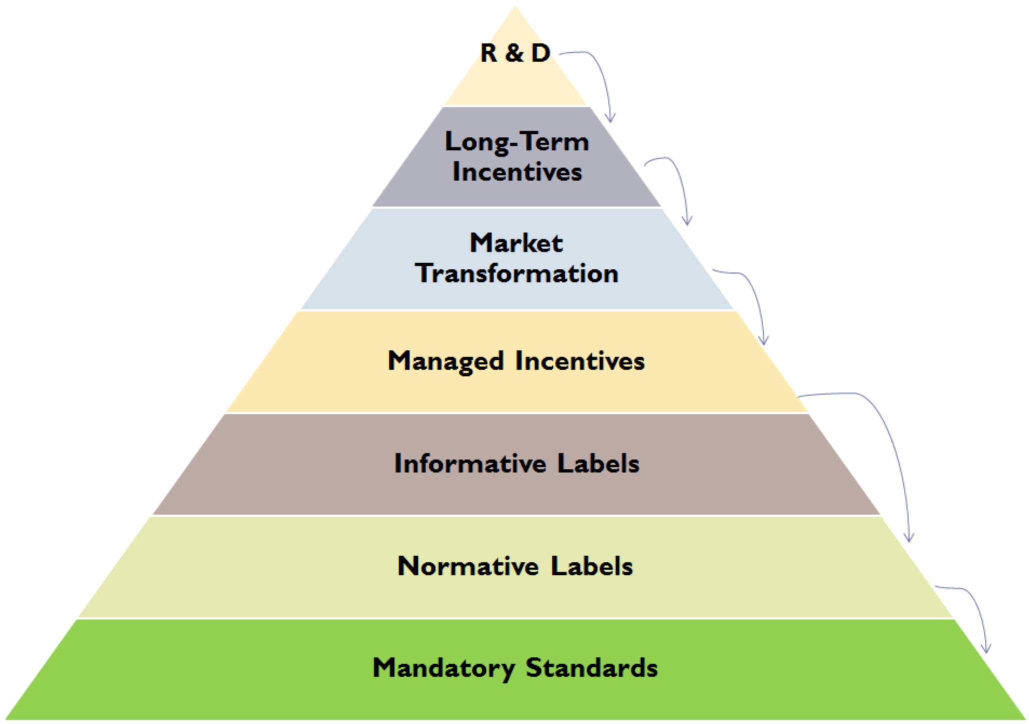
When emission caps have been set, for example in California, through the Regional Greenhouse Gas Initiative, and in Japan and the European Union, it is found that "cap-and-trade-and-walk-away" doesn't work very well (in California and RGGI, that was recognized from the start). The presence of a cap and the consequence – namely, higher energy prices if unconstrained emissions are higher than the cap – encourage the rest of the policies discussed in this paper. The degree of encouragement is powerful. For example, in California, the largest triennial reduction in allowed energy use in the energy code came immediately following the adoption of the California Air Resources Board's Scoping Plan.

A second sort of economy-wide effort is education and outreach on energy efficiency. This outreach would also promote conservation activities – defined as some combination of reductions in the level of energy services that the customer finds to be acceptable and improved operations and maintenance behavior.

B. Policies to accelerate market adoption of new technologies

This paper will focus on this particular effort because of its strong relevance to the commercial buildings sector. We noted earlier that market failures impede the introduction and acceptance of new technologies in the market. Along the entire chain of market adoption from R&D to universal acceptance, different policies are effective at different parts along this chain. Perhaps a better metaphor than "chain" is a pyramid, as illustrated in Figure 1. This figure, especially the arrows on the right, exemplifies the principle of continuous improvement.[viii]

Figure 1: Accelerating Market Adoption through Continual Improvement



The pyramid structure is chosen because the lower levels of the pyramid represent broader acceptance – greater market share but lower levels of energy efficiency improvement. As we move up the pyramid, we move towards technologies and designs with increasingly larger energy savings, but declining market share.

At the bottom of the pyramid is mandatory standards, but before discussing mandatory standards, it is important to point out an element of infrastructure for the pyramid. It's hard to define a level of improvement in efficiency without some metric, some Key Performance Indicator or set of Key Performance Indicators for energy efficiency. Before we can undertake almost any step in the pyramid effectively, we need to design (and regularly update over time) test protocols to define and allow measurement of the Key Performance Indicators. This is not a simple or straightforward task, but it is one that has been done successfully for virtually wherever it has been tried. The Key Performance Indicators already exist for commercial buildings.[ix] They are the following:

- Operational ratings: The Energy Star program for commercial buildings provides operational ratings and they are one important Key Performance Indicator of overall building energy performance. They are not, however, a measure of energy efficiency because they do not control for many differences in energy service level and operation and maintenance effectiveness.
- Asset ratings: A protocol for doing them called COMNET already exists.[x] However, it is new and not yet in widespread use for the commercial sector. Nevertheless, it is based on similar calculations already done commonly for the U.S. Green Building Council's LEED program and for performance-based compliance with ASHRAE 90.1 and California's Title 24 energy code for commercial buildings.

- The O&M index: This metric does not measure energy efficiency, but provides a normalization factor to allow the O&M component of the Energy Star operational rating to be teased out. It can also be used to track progress in continually improving O&M procedures and outcomes.
- The energy service index: This index also provides a normalization factor that can be used in comparing asset ratings or operational rating. It is important because, when we are talking about net-zero energy buildings, we note that there are already hundreds of millions of net-zero energy buildings in sub-Saharan Africa and rural India that are not grid connected. These buildings are not exemplars of energy efficiency.

Mandatory Standards

Mandatory standards are at the bottom of the pyramid because they have essentially 100% compliance, particularly if implemented effectively. Part of the paradigm of continual improvement implicit in the pyramid says that they will be regularly revised to higher levels of efficiency. For commercial buildings, the typical revision period has been 3-5 years.

Standards (codes) for commercial buildings should rely on predicted whole-building energy performance rather than component-by-component prescriptions to allow the maximum amount of market focus. Market-based standards that do this will both encourage vendors offering more cost-effective ways of reaching the same level of energy performance to get their new technologies into the marketplace, and also will make revisions to higher efficiency easier politically. This latter effect occurs because one is not requiring a particular technology or design in all circumstances and risking the concern among stakeholders that they are not applicable or cost-effective in some particular circumstances.

In order to provide this market encouragement and allow for continual improvement, the standards must include the infrastructure noted above, such as COMNET or its equivalent for deriving energy efficiency ratings.

Mandatory standards are applicable not only to commercial buildings, but also residential buildings, appliances, industrial equipment such as pumps, fans, motors, transformers, etc., and to cars and other transportation vehicles.

Simple Normative Labels

These labels, such as Energy Star or LEED, provide a simple way of encouraging consumers to get to a reasonably high (higher than standards) level of energy efficiency. They can either provide one target level, as most Energy Star programs do, or multiple levels, as LEED and virtually all normative labels in other places such as in Europe, Australia, etc. do. These normative labels will encourage consumers to purchase more efficient buildings or components in buildings and generally achieve this result without the need for any financial incentive.

Informative Labels

These labels provide information on the energy consumption of a building or a component thereof without suggesting any particular level. They often encourage higher levels of efficiency than those required of normative labels. For example, the requirements for Energy Star for new homes are typically in the range of approximately 70-75 on the RESNET HERS index scale, but in 2013, about half of all new homes built in America were rated and the average rating was 64, about 10% better than the Energy Star specification. If energy performance is to be included in financing and capital assets, which we recommend later, the basis for this is the informative label and that’s what makes it so important.

Asset ratings are already required and in use in Russia and many member states of the European Union.

Managed Incentives

Managed incentives are programs such as those run by utilities (in most cases), or nonprofits or state energy agencies (in other cases). They are managed in the sense that the Administrator has a fixed budget for energy efficiency, which is divided into line items for particular end uses or energy-using devices. The incentives are managed to that budget level, thus, if market uptake of a given technology exceeds expectations, the incentive may be terminated or reduced; conversely, an incentive that is not achieving its goals might be increased or changed (or simply dropped as being an assumed failure). The required budgets for these programs are significant: current expenditures in the U.S. average about $100 per household per year (including the expenditures for commercial and industrial sectors) and still have not come anywhere near achieving the efficiency potential; the program administrators with the most effective programs in terms of annual percent savings are continually finding more opportunities to expand their programs.

Managed incentives can only work for projects at levels of efficiency that are reasonably and widely available: a utility or state agency or nonprofit would run into customer relations difficulties by offering a program requirement which customers found impossible or unreasonably difficult to meet.

Market Transformation

Market transformation programs are run to incentivize the next level of energy efficiency: levels that are theoretically available in the sense that products may show up in catalogs or at trade shows, but are very difficult to obtain. Program administrators banded together some 20 years ago to form the Consortium for Energy Efficiency, which establishes competitively fair specifications for advanced levels of energy efficiency that voluntarily can be adopted by program administrators throughout North America. These programs provide targets for manufacturers that assure some level of harmonization so that they can design for these levels of efficiency. Market transformation programs proved necessary when program administrators observed during the late 1980s that even the largest utilities did not serve markets of sufficient size to make it worthwhile for manufacturers to design a new higher-efficiency product, and that inconsistent efficiency specification among administrators led to confusion and inaction at the manufacturer level.

The progression of these voluntary specifications to ever higher levels of efficiency over the years[xi] is evidence of their high effectiveness.

Long-Term Incentives

Market transformation has to be premised on the existence of technologies that can meet a given specification. In many cases, the specification is set at a level that can be met by more than one manufacturer, in order to assure strong competition. But what if there are levels of efficiency so high that no one produces them, despite engineering analysis showing that they are feasible?

In this case, long-term incentives are needed. Long-term means about 5 years (as opposed to 20 years): long enough for an equipment manufacturer to build an assembly line knowing that the first three years or five years of production from the line will receive the incentive. Long-term incentives, since they require extensive investment from manufacturers or from design professionals who must take additional classes or training to learn how to design to state-of-the-art levels of efficiency, need to have some assurance that this investment will pay off.

A managed incentive where the provider finds that after having made his/her investment, s/he is too late in the queue to qualify for the funding, will not work for major changes in efficiency. The industry needs more assurance than this in order to justify investments. Thus the budget for long-term incentives must be essentially unlimited. This is still a conservative approach, because a runaway success that winds up costing far more than expected also implies dramatic savings in energy that are far beyond what anyone expected, provided, that is, that the qualifying level of efficiency is set high enough.

U.S. examples of long-term incentives include tax incentives for efficient new homes and commercial buildings. The experience with these is relatively thin, but convincing. The new homes tax incentives adopted by the U.S. Congress in the Energy Policy Act of 2005 were set at a level that had not been achieved by more than a couple of hundred homes nationwide, cumulatively, at best. Over the next four years, the level of market share of compliant buildings rose steadily to the level of 10% of the market. The air conditioner specification could only be met by some one dozen products out of over 100,000 on the market when it was written. But data on the sales-weighted average efficiency over the next four years strongly suggest that it was another success story.[xii]

Research and Development for New Technologies and Design Principles

R&D ought to have two different types of focus: a focus on basic technologies, similar to most of the research currently done by the U.S. Department of Energy and more market-oriented research and development currently done by California's Electric Program Investment Charge (EPIC). It should have both a national and global focus, as increasingly, the techniques and designs used for commercial buildings are the same everywhere in the world, or at least everywhere in the prosperous part of the world.

How do we know these policies work?

These policies have been evaluated on an individual level in numerous reports and analyses. Many of them are utility regulatory-focused studies on the effectiveness of the almost $10 billion in "managed incentives" that North American utilities currently spend annually on efficiency programs. Since these studies have significant economic consequences in terms of utility revenues and tariffs, they are hotly contested in regulatory proceedings, and would not be able to demonstrate consistently effectiveness that was spurious.

A more comprehensive way of showing that efficiency policies work is to look at the macroeconomic trends in energy consumption for jurisdictions that have pursued them aggressively over decades, compared to those that have not. Figures 2-4 show the results of these comparisons. Figure 2 compares energy consumption per capita in California, which has pursued efficiency relatively consistently since the mid-1970s, to the rest of the country. It shows a trend of continual improvement relative to the other 49 states. Some have questioned the validity of this figure as evidence of the effectiveness of efficiency, arguing that de-industrialization in California explains the divergence. Figure 3 disaggregates the comparison by sector, and shows consistent trends for all three major consuming sectors, disproving this assertion without even getting into the validity of the de-industrialization argument. Figure 4 looks at the macro-scale effects of only one major policy—energy codes for new buildings—and generally finds the expected relationship between the adoption of newer, more stringent energy codes (at one point in time) and overall electricity use.

Figure 2: Meeting Long Term Climate Goals –California's Experience

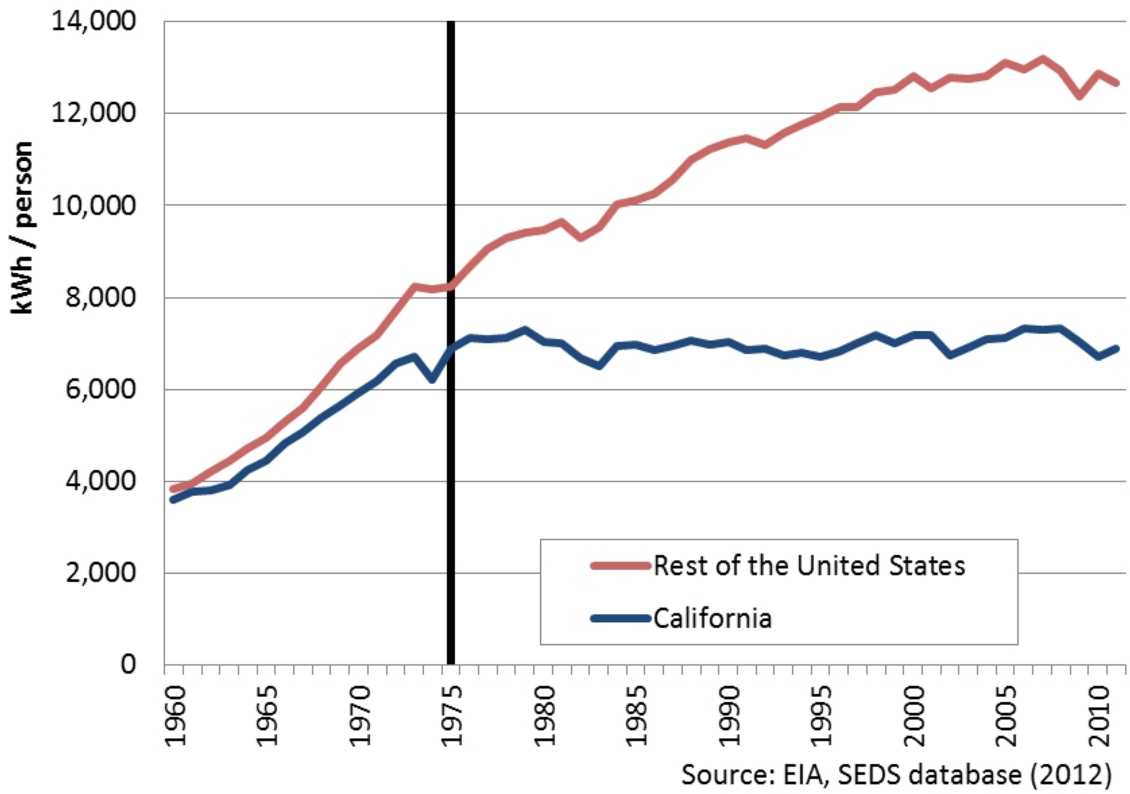


Figure 3: Trends for all three major consuming sectors

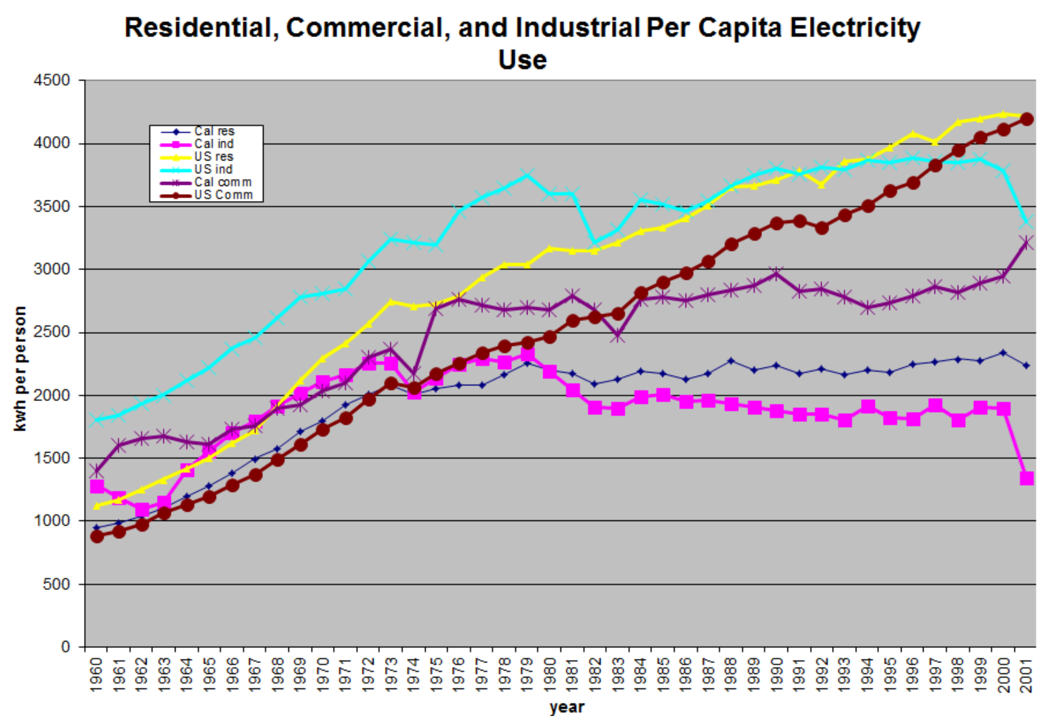
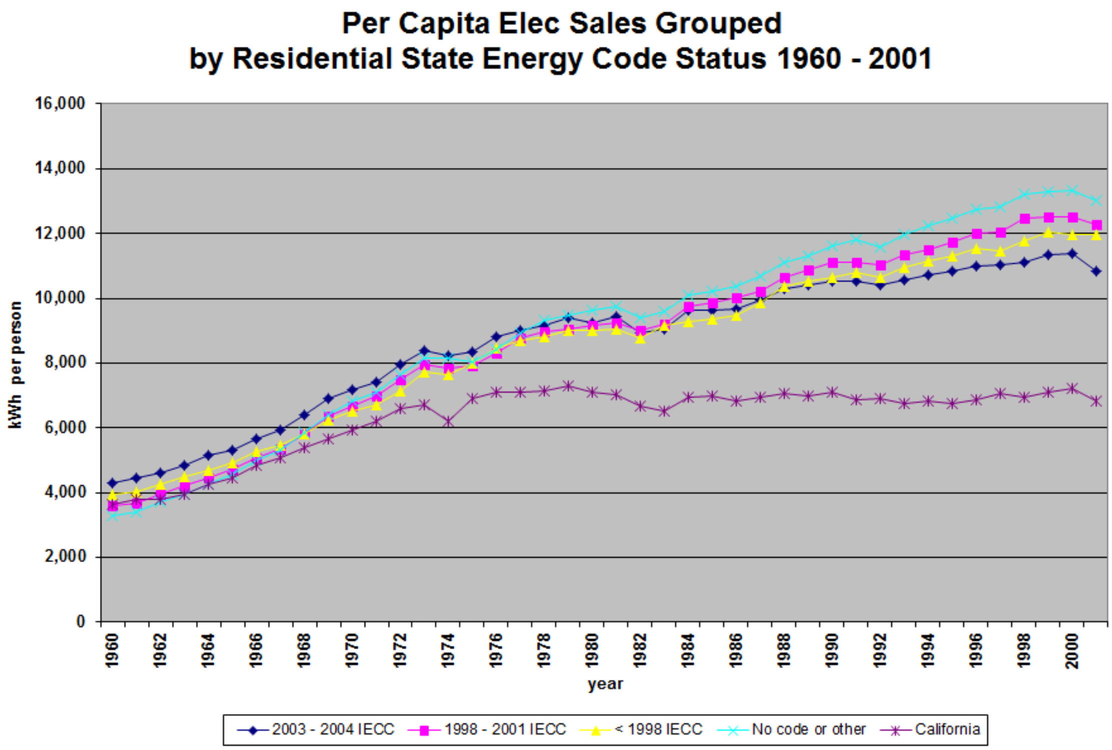


Figure 4: Energy codes for new buildings



These figures are all ***attempts to falsify the hypotheses*** that:

1) Policies that are expected to save energy don't really reduce consumption statistically significantly; and

2) Observed reductions in consumption are smaller than predicted. In the case of California, they are about 4 times larger.[xiii]

They offer powerful evidence refuting these two hypotheses.

C. Policies for the industrial sector

Policies for the industrial sector are important not only in their own right, but because these policies overlap some uses that occur in commercial buildings. More significantly, they are relevant because of the impact of commercial buildings on the economy through the energy used to construct, remodel and demolish them, can be reduced by industrial sector policies. These policies include:

- Standards for mass-produced equipment. Recently DOE has initiated proceedings on fan efficiency, and in the past decade or so, has moderated motor efficiency and transformer efficiency. Other mass-produced equipment could also be handled in the same way as described using the pyramid metaphor. Some of these equipment types are also widely used in buildings.

- Managed incentives. Many program administrators already employ managed incentives for the industrial sector. But, these programs are less effective than they could be because they generally require the program administrator to draw a direct connection between a single piece of equipment and metered energy savings, and ask unanswerable questions about the extent to which the more efficient equipment would have been installed anyway without the program rather than looking more broadly at complete systems. This problem affects the buildings sector as well. Equally importantly, these programs ignore the savings that can be achieved by improved operation and maintenance.

- Continual improvement programs. Programs such as the Department of Energy's Superior Performance program and the international standard that is supporting the program ISO 50001 can be used to achieve significant energy savings by a clever choice of key performance indicators by the user (the utility customer). It is possible to distinguish O&M improvements from equipment and process efficiency improvements and to achieve continual improvement in both of these. A new policy would be for utilities and other program administrators to provide incentives for particular levels of achievement in continual improvement programs.

  An increasing number of program administrators are still doing this and the Consortium for Energy Efficiency has a program that they call "Strategic Energy Management" (SEM). ISO 50001 and SEM are also of direct relevance in the commercial buildings sector because commercial buildings are within the scope of both programs, and both allow the use of Key Performance Indicators such as the O&M Index to include savings from operational improvements as well as those from narrowly-defined energy efficiency. Note that most SEM programs find that operations and maintenance improvements account for the majority of savings. But O&M improvements are largely absent from discussions of efficiency potentials or policies, perhaps because the definition of efficiency used for the commercial buildings sector is ambiguous concerning whether O&M "counts" as efficiency. Nevertheless, improved O&M in commercial buildings is yet another method of reducing energy impacts and saving costs, and it can be implemented as part of a broad SEM policy.

- Including supply-chain in calculations and goals. As noted above, supply-chain for energy in buildings is almost as significant as direct energy use in the building, and as we approach zero-net energy will become the dominant factor in commercial building energy use. The World Resources Institute has developed methodologies for calculating supply chain energy, and wider use of these methodologies will open up opportunities for energy efficiency, that to author's knowledge has never been included in efficiency potentials studies in the past for any sector.

D. Policies for the transportation sector

Again, much of this discussion is relevant to commercial buildings because where they are located makes a big difference in their energy impact. This is most particularly true for high rise residential buildings (considered commercial buildings by most analysts). There are two separate approaches to saving energy in the transportation sector: vehicles can be addressed with the same sorts of policies applicable to buildings and appliances. But second, reducing demand in the transportation sector without reducing energy service can be facilitated.

This is often referred to as "smart growth." It involves two primary components: Integrated land use and transportation planning, as currently being implemented following the California's Sustainable Communities and Climate Protection Law (Senate Bill 375) of 2008. This process, which has been embraced with enthusiasm, once it was promulgated by the California legislature and quantitative goals proposed by the California Air Resources Board, by the Metropolitan Planning Agencies that are charged with carrying it out, is already resulting in changes in the allowable use of higher density, especially near transit facilities, and in encouraging transit options that make more economic sense than the alternatives. Smart growth can also be facilitated by lending reforms, as discussed below. The effect of smart growth on energy savings can be quite large: gasoline savings from smart growth are likely to be comparable in magnitude to motor vehicle standards, even at current levels.

E. General economic reforms focused on lending and valuing investments

1. Reform underwriting to account for energy and transportation costs

Owners of Energy Star homes have a 32% lower mortgage default rate than owners of conventional homes, and the likelihood of default is linearly related to the HERS rating of a home.[xiv] Thus, including energy efficiency costs in mortgage underwriting will increase the security of home mortgages as well as qualifying buyers to invest more heavily in energy efficiency. At current mortgage rates, a 20-year payback in energy efficiency is cost effective on a cash-flow basis and will qualify the owner for enough additional money to pay for all such efficiency improvements. This kind of reform benefits all parties: the buyer, the national need for efficiency, the lender, the investor seeking greater security for income investments, and the government and private infrastructure that responds to defaults.

It is even more important to count transportation in costs in mortgage underwriting because they are so large. The median price of a home in the U.S. is the low $200,000's, but the cost of transportation to and from the home (assuming it is built in urban sprawl, where most new housing has been built for the last half-century) at current gasoline prices exceeds $375,000 over 30 years. This figure is some five times the cost of utility energy, and about twice the size of a median loan!

Ignoring this factor in making loans in the first decade of this millennium was a substantial contributing force to the economic recession which currently still affects most Americans. Location Efficiency has been found to be a powerful predictor of mortgage defaults:[xv] both a large influence as well as highly statistically significant, a factor that has been ignored (but not refuted) by the lending industry.

Reforming lending will also provide housing in smart growth areas where demographic analysis by the Urban Land Use Institute suggests that most new demand for housing will occur for the next 20 years.[xvi]

2. Reform appraisals and pro-forma's for evaluating buildings

Most commercial buildings are appraised based on the net operating income (NOI) method, where NOI is multiplied by a capitalization rate to derive the value of a building and determine how much money an owner can borrow based upon that appraisal.

But even though energy costs are some 20% of NOI on average, differences in energy costs are not accounted for in the appraisal. That market failure means that while the rest of the building's characteristics are evaluated on the basis of capital investments, energy is considered a cash flow. Capitalization rates have been in the 5% range for the last several years. Thus an energy improvement that saves $100,000 a year is expected to pay back in 2 or 3 years, and is valued implicitly at $200,000-300,000 while a marble lobby that adds $100,000 to expected rental income is valued at $2,000,000. This asymmetry is clearly a major barrier to efficiency investment, especially for buildings when the owner expects to sell them in the near future.

If building energy ratings were incorporated into capital valuation, efficiency would be able to compete on a level playing field with other investments. This would complement the effect of the other policies.

Integrating Sectors

When buildings were relatively inefficient, as was the case when the energy efficiency began in the 1970's, most analysts looked at building energy use as consisting entirely of energy used in the operations of the building energy at the meters. This approximation has become less and less accurate as buildings have become more and more efficient and we've learned more about the impacts of the building, particularly in the transportation sector. As noted above, for relatively efficient buildings, at the level of California's Title 24 standards in 2011, the total level of energy efficiency in buildings is divided roughly equally between the energy used in operations, the energy used in traveling to and from the building, and the energy used to construct the building. Therefore, if our policy approach is limited to the energy used directly in the building, we are ignoring about two thirds of the positive effects of efficiency policy. Stated in reverse, we can about triple the effectiveness at energy savings of commercial buildings if we look at the effects on the economy more comprehensively.

Structural policies

Reform utility regulation to align profit motives for utilities with those of their customers

The discussion of managed incentives takes for granted that utilities will be amenable to their own or others' operation of programs to encourage customer energy efficiency. This is not the case in many states and in most foreign jurisdictions. Utilities whose revenues are tied to volumetric sales will find that a reduction in sales reduces revenues and profitability, particularly between rate cases. Reformed utility regulation can correct for this factor and also provide financial incentives for successful efficiency (and renewable energy) programs. This enables utility support of all the rest of the levels of the pyramid.

Build infrastructure to support the broader policies

- Demonstration centers.
- Web-based and published guidebooks.
- Feedback on usage to homes, buildings, and industry; energy management systems that provide feedback to energy users.
- Conservation and Efficiency: educate the public about the difference between them and how efficiency is valuable in all cases whereas conservation may appeal to some consumers but not to others.
- Use of Energy Management System Standards such as ISO 50001, both for commercial buildings and other sectors.
- Provision of training and certification of individuals who can perform audits for commercial buildings (RESNET already does this for residential buildings).

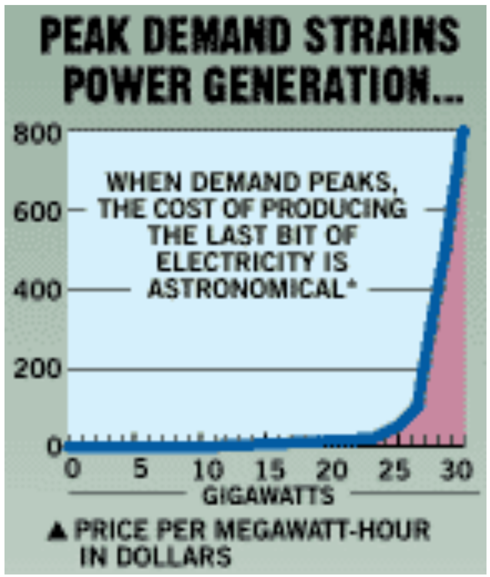
Develop markets and whole building retrofits for both homes and commercial buildings

Legislation is currently under consideration by the U.S. Congress that would help do this by providing grants or tax credits for a short time period on a sliding scale based on percent energy savings. These programs probably do not need to be long-term, because once ratings are widely used in lending and appraisal, cost effective efficiency should occur naturally through market forces, but this policy will help jump-start the market.

What isn't on this list?

Energy pricing is missing from the list because it is relatively unimportant in encouraging efficiency. Instead, the linkage tends to go in the opposite direction: efficiency encourages lower energy price (see Figure 5. However, higher energy price does help improve the regulatory and advocacy case for stronger standards. Energy price may also be important in promoting on-site generation, if zero net energy buildings are a *specific policy goal* rather than a *broad direction for large energy demand reductions*.

Figure 5: Small Reductions in Demand Yield Large Reductions in Price



These Policies Mutually Reinforce

The protocols used to develop informative labels underlie all of the other policies, and help encourage them to work in a more performance-based way. For example, managed incentives for home retrofits would have to specify particular levels of insulation, window quality, etc., in order to be implementable; whereas programs based on labels based on energy ratings can encourage market competition for the cheapest way to comply. Managed incentives also leverage the infrastructure for code adoption and enforcement and can "test drive" a higher specification to see whether it is appropriate for use in a future code.

- Reform financing criteria will accelerate the effects of all other policies
- Everyone loves voluntary programs rather than mandates…until you consider who is willing to pay for them. Is it more conservative to spend $3,000 to get a builder to make a home 20% more efficient when you could require it for a cost of only $500 for the government to inspect it, or virtually nothing if the inspection is delegated to a third party as the International Energy Conservation Code of 2015 allows?

What about Conservation?

Conservation has its place in a suite of energy policies. But there are several reasons why it should not be counted on as a significant source of energy demand reductions.

Most countries will face periodic and unpredictable shortages of electricity (for example, the Fukushima tsunami, or a drought in a hydro-dependent region). The world faces periodic price spikes for oil and gas. If conservation is a fundamental part of a region's energy plan, then if something goes wrong unexpectedly there is no "fat" that can be cut.

Thus, efficiency policy should encourage low energy use with high levels of energy services…that can be cut back temporarily without much pain.

Improved O&M procedures seem to fall into a void in the space between "efficiency" and "conservation." This report argues that they should be considered to be a form of efficiency and encouraged through policies such as Strategic Energy Management. We note that some companies have achieved long-term continuing improvements in energy performance due primarily to improved O&M, and that there is an O&M Index that we have defined that can measure this performance independently of the other dimensions of efficiency.

Efficiency Policy Progress in the U.S.

How has the U.S. done?

While no jurisdiction has implemented all of the policies suggested here, most of the effective and interesting activity in the United States has occurred at the state and local level. Even here, progress at all levels has been intermittent. Periods of activity and interest in energy efficiency have alternated with periods of lack of attention.

This section follows the structural outline above and provides an evaluation of how the U.S. has done in implementing them.

Setting an Emissions Cap

The U.S. as a whole failed to set an emissions cap, even after an ambitious law passed the House of Representatives in 2009. California has set a mandatory cap at both legislative and administrative levels for 2020 and 2050 consistent with IPCC goals. Several Northeast U.S. states established a mandatory cap for the utility sector.

Setting mandatory standards that encourage performance-based compliance:

Congress established fuel economy standards for cars in 1975 that the current Administration upgraded twice. The first upgrade arguably was triggered by California's prior action. This regulation should reduce gasoline use dramatically in the future, but only after some 25 years of stagnating vehicle efficiency and declining fuel economy.

Congress called for appliance efficiency standards beginning in 1975 and 1978, but states promulgated the first standards starting in 1975, influencing national action**.** Most of the national standards until the last 3 years were in response to state initiation, and were adopted legislatively.

Congress required national building standards in 1975 but rescinded authority in 1981**.** States and nonprofits developed model codes that improved at a very, very, slow rate, except in California.

Accelerating Market Adoption

Informative labels to provide the information needed to establish property values for energy efficiency

Building labeling programs were developed at the state level. States wanted DOE to adopt a national model but DOE was unable to promulgate anything. RESNET (an NGO: www.resnet.us), created by states, developed the national model instead—it is now an ANSI standard. EPACT 2005 required DOE to develop a rating system for commercial buildings but it did not act. Eventually NGOs created COMNET for nonresidential buildings (www.comnet.org). EPA created the Energy Star operational rating about 2000 and it has grown to a high market share.

Simple normative labels

Energy Star was initiated about 1990 by the Environmental Protection Agency—it covers dozens of products and building types, but does not cover cars. LEED was initiated by an NGO around 2000.

Managed incentives for modest improvements (~15%-30%) beyond the standards.

These programs were initiated by utilities in the late 1970s after advocacy by environmental organizations. They are regulated at the state level. Different utilities have different degrees of enthusiasm, but sector is growing at 20%/yr. at almost US$ 10 Billion. A state program has been proposed for cars but not implemented; however, a national program has been implemented.

Market Transformation: regionally or globally coordinated targets for new efficiency technology or design

Organizations such as CEE and NBI, NWEEA, NEEP, etc. were created in the 1990s; all are private-sector initiatives. The Golden Carrot program for refrigerators surfaced about 1988 (initiated by utilities and NGOs with active participation by EPA and Washington State). No programs exist for cars.

Long-term (~5-year) incentives for 50%-75% savings

None of the incentives was long term, but new homes and HVAC equipment incentives were successful; commercial buildings incentive was not as effective due in part to lack of a DOE rating system.

Research and Development for new technologies and design principles

R&D budgets fluctuated and were subject to partisan politics. States have established R&D funds focused on market-oriented research. The industry performs very little research not motivated by previously mentioned policies.

Policies for the Transportation Sector

Vehicles can be considered similarly to buildings and appliances. Very little activities have been undertaken outside of the mandatory standards, informative labeling, and R&D areas; very little effort has occurred on vehicles other than cars.

Smart growth can be facilitated by: Integrated land use and transportation planning, as implemented using California SB 375. Little progress has been made on this integration at the national level, although some local areas set good examples; instead local land use planning has been guided by federal models that promote sprawl and try to limit roadway congestion by adding capacity and spreading out traffic generators.

Structural Policies

More than 20 U.S. states have reformed utility regulation to align customer benefit with utility profit. The building of infrastructure to support the broader policies above has been dependent on funding, and funding usually subject to other policy goals being adopted first.

No significant action has been taken to reform mortgage underwriting to account for energy and transportation costs, despite the consequences to investors and to the deficit.[7]

Develop programs to create markets in whole-building retrofits for both homes and commercial buildings

Some proposals are currently before Congress, and some initial state efforts have been implemented. For example, state retrofit programs are fixing some 100,000 houses per year. This is enough to retrofit the entire U.S. housing stock by the year 3000.

Conclusions

While the U.S. has doubled GDP per energy use since 1973, the minimal progress made on many of these important policies show that it could have done much better if it had tried and can do so in the future. This is demonstrated by the outcomes in individual states where higher effort has paid off in terms of improved outcomes. However, the fact that no jurisdiction has implemented all or even most of the policies recommended here suggests that progress on energy efficiency in commercial buildings as well as other sectors could accelerate dramatically with higher levels of interest. The process of developing and analyzing policies, such as this paper has done, could lead to a better understanding of how to realize the full potential of efficiency.

Globally, no other country seems to have done dramatically better than the U.S. And within regional trading blocs, some states have done significantly better, just as is the case with the United States.

An interesting conclusion from the author's personal experience is that various barriers to energy efficiency do not seem to depend on the state of economic development or the type of economic system. Rather, they seem universal to the human cognitive process and the methods of business organization that are common throughout the world. Thus, there is great opportunity to implement these policies and dramatically improve efficiency and energy demand outcome worldwide.

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