Is California's Path To Net Zero Inadvertently Leading To An Increase In Carbon Production?

Energy Savings from Locational Efficiency Are Far Greater than Building Improvements and Should be Factored Into Code Requirements

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ABSTRACT: California's Energy Efficiency Standards for Residential and Non-residential Buildings, commonly referred to as Title 24 (T24) are biased against higher density housing located in temperate areas such as coastal communities. Further, they are biased against projects with a higher "people density", which typically includes affordable housing. As such, it can contribute to a reduced amount of development in already expensive service, jobs, and transit-rich areas, which in turn actually increases the over-all consumption of energy and resultant production of green house gases when the costs of getting to and from the building are factored in.

This paper discusses the several problems associated with Title 24 as it relates to the energy savings inherent in locationally efficient buildings, and proposes pathways to bringing the two into balance.

1. INTRODUCTION

It is already widely recognized that the locating development within service, jobs, and transit-rich areas produce significant reductions in over-all energy consumption, with corresponding reductions in the production of green house gases (GHGs). Indeed, California law embodies this concept in SB 375 (The Sustainable Communities and Climate Protection Act of 2008), and by extension the landmark law it was designed to help implement, AB 32 (The California Global Warming Solutions Act of 2006). One of the principles of SB 375, as outlined in Sections 1 (c) and (d), is that locational efficiency of development is of critical importance in meeting our carbon reduction goals:

1 (c): Greenhouse gas emissions from automobiles and light trucks can be substantially reduced by new vehicle technology and by the increased use of low carbon fuel. However, even taking these measures into account, it will be necessary to achieve significant additional greenhouse gas reductions from changed land use patterns and improved transportation. Without improved land use and transportation policy, California will not be able to achieve the goals of AB 32.

1 (d): In addition, automobiles and light trucks account for 50 percent of air pollution in California and 70 percent of its consumption of petroleum. Changes in land use and transportation policy, based upon established modeling methodology, will provide significant assistance to California's goals to implement the federal and state Clean Air Acts and to reduce its dependence on petroleum".[1]

This paper contends that there is a disconnect between SB 375 and the Energy Efficiency Standards for Residential and Non-residential Buildings, commonly referred to as Title 24 (T24). It looks at some comparative case studies that demonstrate that, as anticipated by SB 375, over-all carbon production, when factoring in transportation to and from the development is reduced, sometimes dramatically so as locational efficiency increases. Yet, as these same case studies show, at the same time energy performance, as measured by Title 24 actually declines.

We all know that developing in existing, urbanized environments is far more expensive than developing in outlying areas. Aside from increased land and soft costs, the construction type may be more expensive, parking might be structured (versus surface) parking, there would no doubt be NIMBY opposition increasing the time and expense of gaining entitlements, there might be higher impact fees, and frequently there would be costs for environmental clean-up to rectify polluted soil, upgrade municipal utilities, or to provide other mitigations. By not taking into account the energy savings inherent in locating a project in a transportation, service, and jobs-rich environment, and making it even more expensive to develop in such areas, Title 24 thus can be seen as working against SB 375

The paper concludes with a look at some existing and proposed methods of dealing with this issue, as well as suggests more comprehensive, effective, yet politically difficult solutions.

It is beyond the scope of this paper to test any of the proposed solutions, only to identify some directions for study and eventual adoption into a new, comprehensive energy code.

Similarly, this paper focuses on residential development only. While it can be deduced that similar conclusions can be applied to commercial development, the Author has not researched any case studies to confirm this.

2. TECHNICAL PROBLEMS

In addition to the direct conflicts with SB 375 discussed in the Introduction (See Section 1 above) we find the following technical aspects of Title 24 work at cross-purposes with the preference for locationally efficient development:

2.1: The Code does not take into account the full energy cost of inhabiting a building.
The Code is interested solely in energy consumption at the meter, and thus ignores the energy costs of getting to and from the building. When compared to an urban building, the energy expended to drive to and from a suburban building is far greater than the savings that can be had from even the most state-of-the-art “sustainably-designed” structure.

2.2: The Code has a built-in bias against buildings without air conditioning (AC).
The writers of the code wanted to make sure that a developer did not purposely leave out AC to reduce costs (and energy consumption in the T24 calculations), only to have the building residents add inefficient AC down the road. The Code basically works by comparing the proposed building to an idealized model which has air conditioning. There is no credit available for buildings in which AC is truly not required. This has led to the need to use hydronic systems to provide heat. Such systems require a high-temperature hot water system, separate from the domestic supply, piped throughout the building. For affordable housing projects built under Prevailing Wages, all this additional plumbing is particularly expensive.

2.3: Time Dependent Valuation (TDV).
Peak energy demand in California is in the late afternoons. West facing glazing increases heat gain at these peak periods. T24 responds to this by adding TDV multipliers to load calculations. In a suburban setting, it is easy to reduce west-facing glazing, but what if your infill urban site only opens to the west?

2.4: The Code does not take into account the size of units—or the number of persons living in those units.
Whether it’s two people in a 5,000 square foot house or 6 persons in a 1,300 square foot apartment, the Code makes no distinction for this “People Density”. Yet, when designing, we have to take into account the expected greatest load demand. Residents of affordable housing live in smaller units—and typically more people in those units, so loads are higher on a per-square foot basis. The result is to make it easier—on a per person basis—to make a 5,000 square foot mansion comply. A further complication, related to Problem #2 above, is that hydronic systems

often require wall-mounted radiators that make furniture placement in a crowded room even more difficult.

2.5 Net Zero:
California is on track to require that all new residential construction be Zero Net Energy (ZNE) by 2020. Current and foreseeable technology is capable of developing a ZNE building of three—and perhaps four—stories. Beyond that, the possibilities for energy generation (solar photo voltaic, solar hot water, etc.) as a percentage of building size are reduced—more so for every story. Shading by surrounding buildings and restrictions on orientation further reduce solar access and thus energy-generating capacity.

2.7: Affordable Housing Funding: Finally (and admittedly this is not a problem with Title 24 per se), these issues with T24 are exacerbated for affordable housing in another manner: Most funding agencies require (or award bonus points which, given the competitive nature of the funding is an outright requirement) performance at least 15% better than T24. In researching this issue, I interviewed Bruce Wilcox, who has been instrumental in writing the Residential portion of Title 24. He was shocked to learn that funding agencies require this. To paraphrase Mr. Wilcox: The Code was developed to provide a cost-effective pathway to compliance in every climate zone. To require performance better than Code is then by definition, not cost effective.

3. SAMPLE EVIDENCE: CASE STUDIES

As proof of these contentions, please consider the following two case studies, both for the same developer and with similar programs, but one located in a low density environment in the Central Valley, and one located in a central Bay Area city. They were both designed at the same time under the same 2007 Code requirements. Figure 1 below summarizes the comparison:

Project	A: Senior Housing, Oakland	B: Senior Housing, Central Valley
Program	73 units of affordable senior independent living apartments, plus attendant spaces.	43 units of affordable senior independent living apartments, plus attendant spaces.
Construction Type	6 stories total: 5 stories Type III-A (wood frame) over Type I (concrete) podium.	2 story, Type V-A Hour (wood frame), concrete slab-on-grade foundation.
Density	237 units/acre.	16.5 units/acre.
People Density	About 250 persons/acre.	About 18 persons per acre.
Parking	20 spaces in ground level podium garage.	37 spaces, all surface parking.
HVAC (residential)	No AC, hydronic heating (gas-fired).	Packaged terminal heat pumps.
Construction Cost	$187,710 per unit.	$124,653 per unit.
Title 24:	15.8% better than Title 24.	31% better than Title 24.
Carbon Footprint[2]	Approx. 9,094 lbs CO_2/person/year.	Approx. 13,885 lbs CO_2/person/year.

Figure 1: Comparison summary of two buildings, each with the same developer, program and cost requirements, but located in area of different locational efficiency.

While the assumptions in this analysis can be quibbled over, it would not substantially affect the 52% difference in CO_2 output per person in Building B over Building A. Yet a resident of Building A—and the developers and funders that have gone to great expense to locate them in a service-rich area—are given no credit by the Code for doing so. In addition, it is important to note that the cost comparisons here reflect only construction hard costs, and not the total development costs as noted in paragraph 2.5 above.

Moreover, as density increases, as with a high-rise project, the differences become even starker: Carbon production plummets as costs skyrocket. Figure 2 shows the same data for a 14 story affordable family housing building in downtown San Francisco, surrounded by other highrises where net-zero would be impossible to achieve:

Project	Building C: High-Rise Family Housing, San Francisco
Program	81 units of affordable family housing.
Construction Type	14 story, Type I (concrete), pile foundation.
Density	About 258 units/acre.
People Density	Up to about 900 people/acre.
Parking	No on-site parking except for service and accessible van spaces.
HVAC (residential)	No AC, hydronic heating (gas-fired).
Construction Cost	$395,000 per unit.
Title 24:	Barely made Title 24.
Carbon Footprint	Approx. 4,110 lbs/person/year

Figure 2: Comparison summary of building with even greater locational efficiency.

4. SOLUTIONS

So if the goal is to reduce energy consumption and thus reduce green house gas production, the California Energy Efficiency Standards for Residential and Non-residential Buildings should be modified to either eliminate the problems discussed, or even better, to incent development to locationally efficient areas.

4.1: Existing attempts to address these types of problems:

Other jurisdictions and green building rating systems are beginning to respond to the idea that when it comes to energy savings, it is “location, location, location” that is much more effective than building design when it comes to saving energy and reducing pollution. These include:

- LEED for Homes: The target points required for any given certification level are reduced as unit size goes down;
- Energy Star Qualified New Homes: Increases requirements for homes above a certain size;
- Marin County: New homes must better Title 24 by an increasing percentage as the home size increases. They clearly recognize the additional vehicle miles travelled that will be produced by bigger, more spread-out homes.

These approaches are all somewhat flawed. In the case of LEED for Homes, while the targets reduce arithmetically as the unit sizes decrease, the approach does not take into account “people density”—the total number of persons per acre in the project. For example, under the new LEED for Homes system, a housing project consisting of one bedroom apartments is at an advantage when compared to a project with multi-bedroom apartments, where the total people density will be greater.

In the case of the Energy Star and Marin County programs, the size at which penalties start to accrue is 4,000 square feet, resulting in a people density too low to affect any significant energy savings via locational efficiency. Yes, building performance is increased under these two scenarios, but as we have seen, these savings pale in comparison to those produced by locational efficiency.

4.2: Current Approaches to Modifying T24:

In response to lobbying by the author and other concerned parties, there is a growing sensitivity by persons involved with the writing of policy and codes to this issue. This is particularly true in regards to requirement that all new residential construction in California be Net Zero by 2030.

While the rules for ZNE are not yet set, current solutions under discussion include:

- Purchase off-site credits: Acknowledging that a high-density urban building cannot be made ZNE, but then requiring the developers of such buildings to purchase credits from off-site generators. Rather than reward the urban development, this adds to the cost and complexity of developing in built-up urban areas, reducing the possibility that such projects will be built in favour of lower density projects in suburban and even exurban locations, (including green field development) where total energy use and green house (GHG) production will occur.
- ZNE "equivalent": Lately, the idea of allowing a ZNE "equivalent" building is being forwarded as a possible trade-off where building density or location does not allow for on-site power generation. The crux of this solution lies in the definition of "equivalent". Some advance the idea that this is the scenario is that defined in the above paragraph.

  Others define equivalent simply as that the building would have to be as energy efficient as a typical ZNE building, but would not have on-site generation required to actually be ZNE. But there is opposition to this approach, as reported by Jon McHugh in his study 7,000 kWh to Zero in 8 Years Flat: A Strategy for Net Zero Energy Residential Buildings by 2020": "However, a "ZNE equivalent" building should not have the bragging rights of being called ZNE, as that would weaken the brand and value of ZNE for all the people who are making buildings that are truly ZNE". [3] Again, the counting of the cost of getting to and from the building in question is totally ignored, and buildings that conceivably cost the planet more in energy consumption and carbon production but are low-density enough to allow sufficient energy generation may be given favorable status within the Code.

However, this latter concept clearly comes closer to addressing the inequities seen in the current Code. But by itself, it does not address the more technical problems in the Code (listed in Section 2 above, nor does it recognize the higher development costs for a locationally efficient projects, nor the disconnect between greater over-all energy savings in such a project versus its greater difficulty in complying with the Code. Whenever these are discounted—whenever only energy consumption at the meter is considered, true energy savings suffer.

4.3: Short Term Fixes

Any adjustments to the Code to factor in the benefits of locational efficiency should first define what locational efficiency is. This should not be difficult, as there are currently in operation a number of different recognized systems for doing so. For example, some "green building" evaluation systems, such as the Green Point Rated[4] system administered by Build It Green award points for locational efficiency, with increases for greater proximity to shopping, public transit, etc. The "Walkscore" index[5] is an established methodology for rating neighborhoods based on certain proximity criteria, and is increasing being used by jurisdictions, the real-estate industry, and home and apartment seekers.

Another idea is that —subject to meeting certain minimum standards—the Code might be modified to provide an energy "bonus" for developing a locationally efficient building that would allow the developer to "buy back" a certain less degree of energy efficiency. For example, in the high-rise case study Building C, such a bonus might allow for the use of electric-resistance heating which is much less expensive to install than the hydronic systems now required (the Author estimates that this would have saved approximately at least $110,000—and possibly much more—in construction hard costs). Yes, energy costs over time would be increased and possibly passed onto the resident. The developer, depending on available funding and organizational goals, might choose to invest in the more expensive system, but at least there would be choice.

Such current restrictions in the code such as the TDV and the built-in bias towards no AC can and should be adjusted by the next Code cycle.

4.4: A More Comprehensive Direction

A truly balanced approach would factor in the energy efficiency inherent with a building located in a service, jobs, and transit-rich environment. Ultimately, governmental and utility policies should change to compensate the long-term sacrifice that inner-city residents and developers are making towards a greener future.

Any metric that is developed should factor in the much higher costs, both in construction hard costs and soft costs (land, taxes, insurance, governmental and professional fees), endemic to a locationally efficient project.

But while we don't need technical advances to achieve these greater efficiencies, we do need to surmount political momentum and entrenched stakeholders.

In each cycle, the Code is tweaked to ramp up requirements by an incremental amount. But the technically easy and relatively inexpensive methods for achieving these incremental savings, such as improved insulation, have already been implemented. Each code increase from here on out will have very significant impacts on buildability, with increasing requirements for locationally efficient buildings.

We have already discussed in Section 4.1 the ideas of adding penalties (e.g.: the Energy Star and Marin County programs) and in Section 4.3 a bonuses (e.g.: the "buyback" idea). Tightening the former would almost certainly meet stiff opposition from home builders, realtors, etc., while the latter does not have a great enough impact to offset higher costs for locationally efficient projects.

A more comprehensive approach, with ultimately the most energy savings, would be to combine the mandates of the CEC with the Air Resources Board (ARB), administers of SB 375 to develop an integrated energy and land use policy.

Finally, and perhaps most comprehensively, appropriate local, state, and federal policies must be modified to strike a proper balance for the viability of locationally efficient development. Some examples of what might be considered:

Local Level

- Current tax allocations, as well as user pricing structures for utilities and public transportation do not reflect the greater costs of delivering municipal services to less dense areas. Examples in the Bay Area include: The Metropolitan Transit Commission allocates a greater percentage per rider for BART than for the most urban transit districts. Meanwhile, on the user side, the longer the ride, the less per mile it costs. Another example is water pricing. The East Bay Municipal Utilities District has lifeline water rates for minimal users, which go up as usage increases, but then go down on a per-gallon basis for large domestic users.

State Level

- Sales taxes are currently distributed back to the jurisdictions which generate them. This has a "leap-frog" effect on development, as jurisdictions approve car-dependent regional shopping centers, often on green fields. This in turn spurs car-dependent, low density housing beyond, even further from urban centers. What would happen if the allocation of sales taxes was modified to work with the requirements of SB 375?

Federal Level

- It costs much more per passenger mile for a freeway than for transit, but federal transportation dollars still are allocated much more towards road construction.
- Home Interest Tax Deduction: The current high cap on this deduction incents the production and sale of larger homes.

5: Conclusion

So we see that as people density increases, energy consumption and production of greenhouse gases drop by orders of magnitude—more than can be achieved through incremental increases in energy efficiency.

Yet the momentum of regulatory agencies and the green building industry are focused on the smallest piece—improving building technology, ignoring the greater savings that accrue from locational efficient development, or inadvertently making it even more difficult to develop such projects.

Ultimately, local, state, and federal policies can be modified to provide the proper balance to incent locationally efficient development.

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7. REFERENCES

[1] See text of SB 375 at the California Air Resources Board website: http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0351-0400/sb_375_bill_20080930_chaptered.pdf

[2] *Based on the EPA online carbon calculator located at* *http://www.epa.gov/climatechange/emissions/ind_calculator.html* *and setting all parameters equal except for the differences in number of cars, each driven 10,000 miles per year at an average of 25 mpg. This figure is very conservative as the national average per vehicle is closer to 15,000 per year and the current national average mpg, when factoring in light trucks and SUVs, is below 25 mpg. Additionally, electricity use would actually be greater in Building B to power the AC. This would increase the carbon footprint for Building B even more.*

[3] McHugh, Jon. 2020ZNE.org. See http://www.2020zne.org/index.html

[4] Build It Green. Green Point Rating System. See http://www.builditgreen.org/_files/Admin/Collateral/2008%20Multifamily_Guide.pdf

[5] Walkscore. See http://www.walkscore.com/