California Home Energy Rating Systems Program, Phase 2 Docket 08-HERS-1

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Environmental Design/Build
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While the Big Bold Goals may seem like a daunting task, they are within our current technical ability. Reaching them on an industry wide scale will not be an easy task by any means.

Big Bold Goals for the Residential Sector.

- All new homes Net Zero Energy by 2020.
- Transforming the HVAC industry.
- 25-45% from 1990 levels Reduction of existing residential energy use by 2020.

I see reaching the goals as less of a technical problem than a social, cultural, political, and economic problem. We have the technical knowledge and ability to build houses that dramatically reduce energy use, and can produce 100% of the use, if not more (they are building Positive Energy Buildings in Europe). What we don't really know how to do is move all the players (customers, contractors, developers, Architects, Engineers, Politicians, Bureaucrats, Utilities, etc.) to demand and produce the best performing buildings based on current best practice/knowledge. Even though we know that doing so, is in everyone's long term interest, and cost effective.

While California has managed to keep per capital electrical consumption relatively flat, it could have, and need to trend downward. Several trends have kept this from happening; a growing population, increasing house size, and decreasing household sizes, have driven suburban sprawl. Much of this has happened in the hotter inland valleys, with a huge increase in Air-Conditioning. Without our past efforts at reducing energy use, and increasing energy efficiency, the trend would have been upward, but we gobbled up our savings with bigger houses in hotter climates.

Suburban sprawl has brought many negative impacts, traffic congestion, increased travel times, increased miles driven, pollution, etc. Sprawl has probably increased energy use more than what we have saved by our past efforts and will be a difficult trend to address.

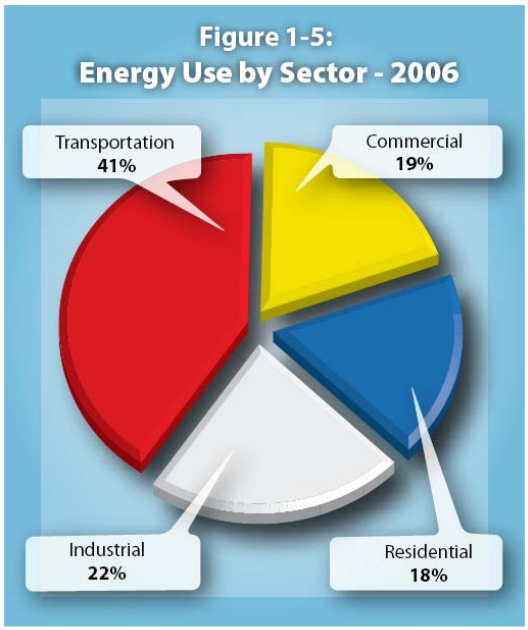
"Smart Growth" is touted as a solution, but unless, and until we really address all the issues and create communities that meet diverse needs, will be a band aid. Smart Growth will not stop suburban sprawl as long as we don't address the full range of issues driving it; Increasing population, increasing house size, decreasing household size, the disconnect between where people live and where they work, shop, socialize, recreate, etc.

The land use issue is far more difficult to solve than achieving the 3 Big Bold Goals above.

How you solve a problem has something to do with how you define it, and how you look at information. Title 24 energy code, and energy efficiency programs have placed most of the attention on peak electrical consumption. While this is a very important issue, it will not in itself achieve the Big Bold Goals. In the past his focus has limited our view and range of solutions that need to be worked on.

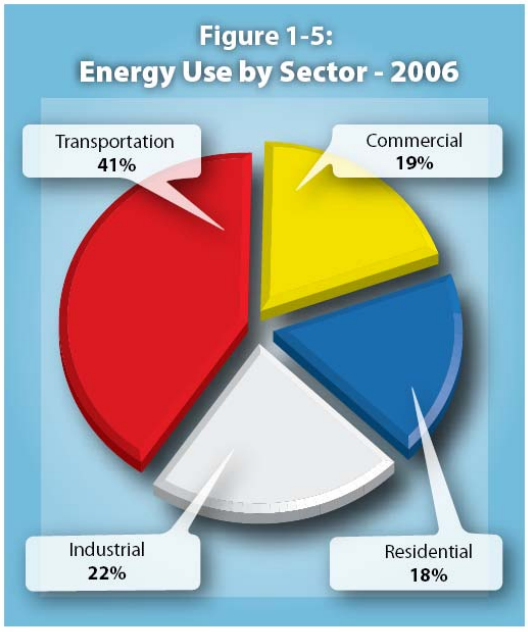
I have been working to understand our energy use, and the issues involved. I don't have access to all the information I would like, and have many unanswered questions. I have been looking at some of the information I have access to, and have been looking at the data in a different way than I usually see it. It is helping me to understand, and give perspective, to what the problem is, and what possible solutions are. I don't know what all the answers are, but I do know that we know what many of them are.

We use too much energy, and so much of what we use is wasted. The amount of renewable energy is only 11.5% of our total use. Even with our aggressive goals of increasing renewable, at our current use, and projected increases, renewable will play a small role in total. Renewable are not always less expensive, and even if they were, trying to meet our current or future use is not the best path. As we reduce our total energy consumption through aggressive conservation and efficiency, renewable will play are larger role, and require less investment.



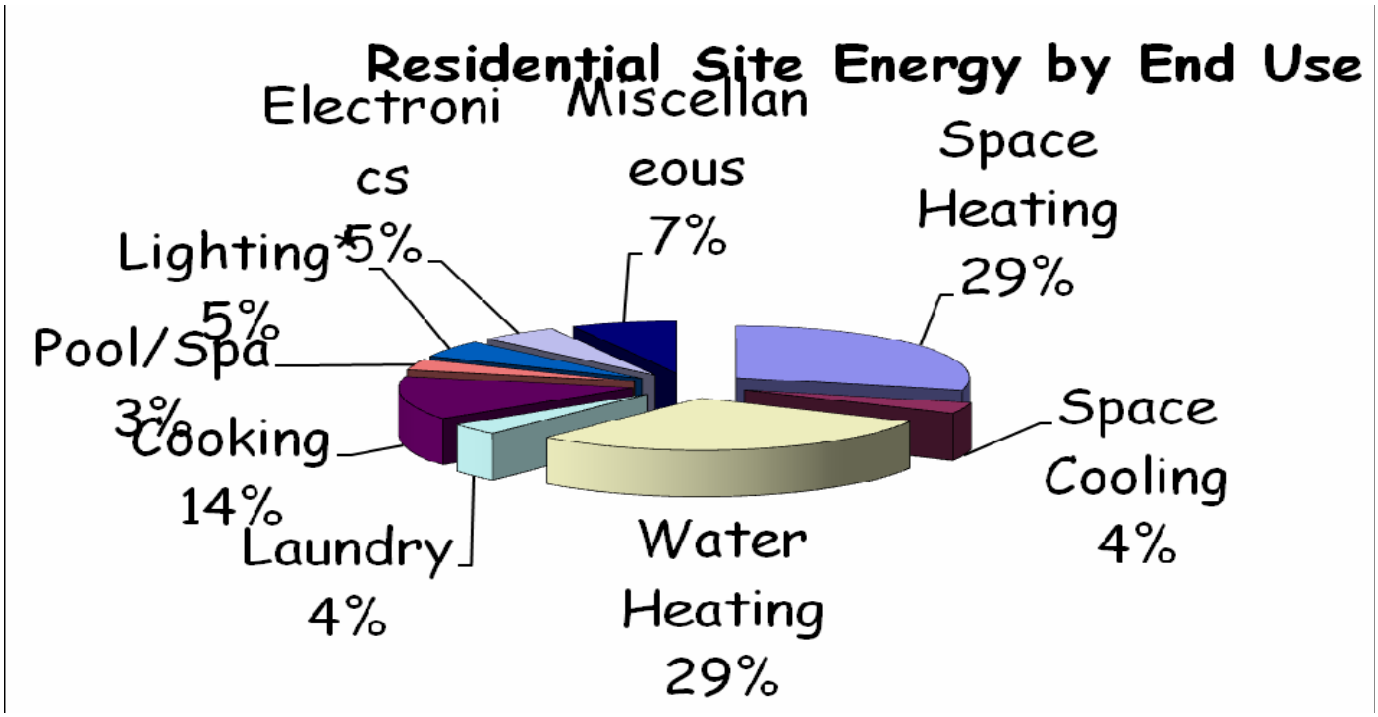
Source: California Energy Commission 2006.

Residential accounts or 18% of our total energy use, not an insignificant piece of the pie, and of course some of the 41% of energy use for transportation is related, so the total is actually somewhere between 18% and 59% (how much you could attribute to residential, commercial, or industrial uses, would be an interesting question to answer).



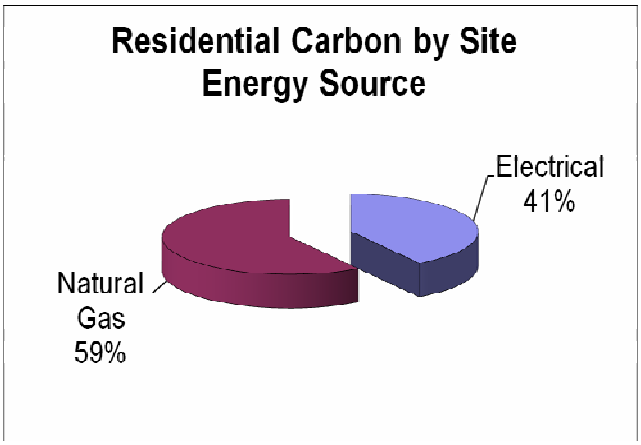
Source: California Energy Commission 2006.

So where does the 18% residential share go? I have only seen the data in total Kwh and Therms, and broken down as usage within each of those energy sources. I used the 2004 RASS data and combined the electrical and natural gas use, so I could understand the relative importance of the end uses. Doing so gives a different perspective than just looking at the end uses by energy source.



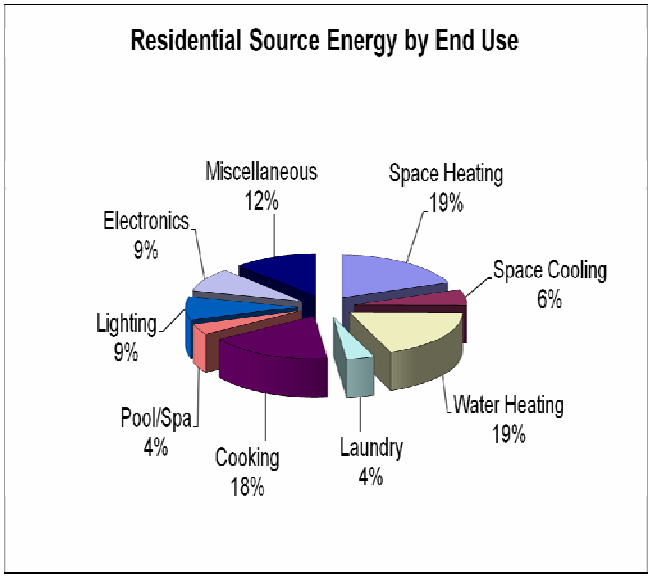
This is for all homes, new & old, single family and multi-family. Looking at it this way air conditioning is not a significant energy use in Homes (4% total, but higher for new homes). Space Heating & Water Heating are 29% each, or 58% of the total residential site energy use! With cooking the next largest end use at 14%. This is mostly natural gas, and the focus on the HVAC and peak electrical loads and air conditioning climates barely address space heating energy use.

If the goal is to reduce energy use, and greenhouse gas (GHG) reductions, we won't get there addressing 4% of the energy use. Natural gas accounts for about 59% of residential GHG emissions. So we need to focus on the larger end uses, and those with the largest emissions, as well.



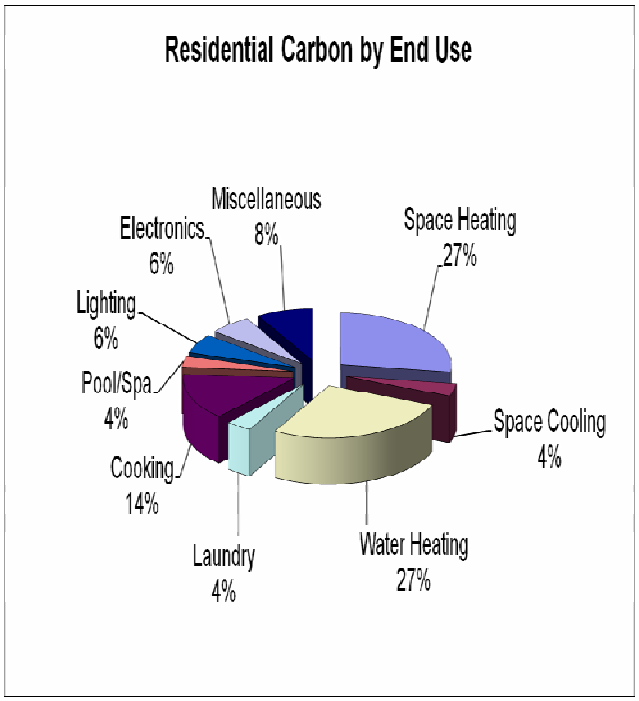
Source George J. Nesbitt Environmental Design Build

Of course site energy doesn't tell us the whole story, we would like to look at source energy. Space Heating and water heating are reduced to 19% each or 38% of the total source energy. Cooking is right behind at 18% (largely because of refrigeration). Air conditioning moves up to 6% of the total, still not that large.



Source George J. Nesbitt Environmental Design Build

And if we look at it from a GHG perspective it looks almost like the site energy chart.



Source George J. Nesbitt Environmental Design Build

Of course this data is for all homes in California, new and old, single family and multi-family, if we produced charts for each market segment, we would get different answers (new single family, new townhomes, new 2-4 unit MF, new 5+ unit MF, old single family, old townhomes, old 2-4 unit MF, old 5+ unit MF, and of course we could do it by utility, or climate). If we did this from a TDV perspective we would also get results, but this would be more difficult, and the data I have access to does not include (more unanswered questions) The important thing is to look at data in different ways, because any one view can give you a skewed perspective, and by looking at it in may ways gives you a more complete understanding of the different issues, and there relationship, and their relitive importance.

So lets look at more of the data from a different angle. In the Residental sector draft the following table is shown;

Type of Household	UEC	% Total	Ave # Residents	Ave. Sq. Ft.
Single Family	7,105	59%	3.21	1,787
Multi-Family	3,953	37%	2.6	997
Mobil Homes	5,662	4%	2.,26	1,167
Total	5,914	100%	2.96	1,541

At first glance we might think that Multi-Family housing is the most energy efficient, and this chart only showes electrical use. But is Multi-Family more energy efficient (it is more space efficient from a units per acre, or a residents per sf standpoint, and a material consumption standpoint)?

	kWh	Therms	Site kWh/ sf
Single Family	7,105	454	11.42
Multi-Family	3,953	269	11.87
Mobil Homes	5,662	235	10.75
Total	5,914	355	10.59

Source George J. Nesbitt Environmental Design Build

I added the natural gas use, normalized to kWh and divided by house size. Multil-Family has the highest per sf useage, with single family 2nd, and mobile homes the lowest. So looking at it this way we should be building mobile homes to save energy. If we looked at it from a source energy standpoint, multi-family is best, mobile homes are 2nd, and single family homes the least efficent. The difference between all 3 are small on a size basis. But energy use is not only a fuction of house size, although space heating and conditioning are more related to house size and detached vs. attached. As you make a a house bigger the sf use may go down, but because of the larger size uses more total energy. So house size may not be the best measure of energy efficency (but the energy code uses it). So lets look at it from an energy use per occupant standpoint.

	kWh	Therms	Site kWh/ Occupant
Single Family	7,105	454	6,357.35
Multi-Family	3,953	269	4,551.78
Mobil Homes	5,662	235	5,551.96
Total	5,914	355	5,511.96

Source George J. Nesbitt Environmental Design Build

Viewed from this perspective Mult-Family are the most energy efficient per occupant, with Mobile homes s 2nd and single family the least efficent. Probably a better measure of the energy efficency for the use.Multi-family is almost 30% more efficent per occupant than single family when viewed this way. So building a higher percentage of multifamily housing would seem to be be the a good way to go. Although we do have to be carefull, the only thing worse than low density auto dependent sprawl, is high density auto dependent sprawl.

So lets look at this from the standpoint of source energy per sf, so we can make the comparison to the European Passive House Standard (I have been working on the first certified Passive House in California, also the first retrofit in the U.S.).

	kWh	Therms	Source kWh/sf
Single Fami	7105	454	20.12
Multi-Fami	3953	269	20.59
Mobil Hom	5662	235	21.05
Total	5914	355	18.94

Source George J. Nesbitt Environmental Design Build

The Passive House Standard is 11.15 kWh/sf per year total source energy use (all end uses! Not just heating, cooling, water heating). As you can the average house in California is 50% above the standard. So on average we only need to reduce enrgy use by 33%! (close to our 25-45% recuction in existing energy use). These tables were all based on the average energy use, new and old, for all IOU's. We could break this down further, but I don't have the average household and house sizes to break it down further (more unanswered questions). It may be in the 2004 RASS report, but not v2, that I have.

While on a square foot basis we can save as much energy with multi-family as single family, MF has less total sf, and therefore less total energy to be saved. Of course the higher percentage of MF vs. SF the greater the toatal reduction of enregy use.

One of the keys to building more MF is making it attractive to thouse that buy, or would by SF homes. Townhomes would seem to be more attractive to many.

NEW RESIDENTIAL SECTOR COMMENTS

Most of the new homes are buit by larger developers, and in some ways is easier to make major improvements than with the smaller custom builders. There are fewer people involved that need to be educate. Although due to the long development timelines, and inertia it is hard to change quickly.

As a HERS Rater I get to see lots of Title 24 CF1-R's, and my job is to verify some or all of the report depending on the project or program participation. I see room for improvement. The area take offs are often wrong (lots of gross rounding, missing assemblies, things modeled wrong, better items installed in the field than modeled, credit not taken when it could, lack of understanding of the code, credit that could have easily been taken when you already have a HERS Rater, etc., and this is even from long standing consultants). I teach a Title 24 energy code class, and perform modeling myself.

- The quality of the consultants modeling could be greatly improved.

Since only 15% or so of new homes participate in utility programs, we do not know what percentage of homes are what percentage better than code. Consultants usually model minimum compliance. Most projects are probably better than modeled, at least on paper (of course we know that they may not perform due to all of the installation problems, but I won't go into that here).

- We need to collect all Title 24 CF1-R's in the state.
- We need to have as-built modeling.

My analysis showed that basing energy use or efficiency on house size alone may not be the best metric. Larger houses may have lower sf usage, but have higher total usage. I know that that the energy code does scale some things based on house size. We need to look at the energy code and how budgets are set. One thing I dislike is the standard budget sometimes changes based on type or location of some features.

- We need to think about having a fixed sf budget for various bins of house sizes.
- We need to think about having different budgets for various occupancy types (SF vs. MF)
- We need to reduce the sf budget as a house gets larger.
- We need to have fixed budgets regardless of how you choose to build.
- We need to beter verifiy the computer modeling with actual field results.

The more of an integral process we can develop from site selection, layout, building layout & orientation, assembly sellection, equiment selection, installation quality, and verification the better. We can achieve greater savings by optomizing the whole (the future) rater than the parts (the past).

EXISTING RESIDENTIAL SECTOR

So once we have built a new home and someone buys and occupies it, it becomes an existing home. Old and new homes usualy use more energy than they need to for what we get out of them, and have a host of other health & safety, IAQ, comfort, and durability issues. There are more existing homes than new homes built every year, we can not just build new to reach our goals, even if they

performed at their best (which we know most don't). Nor can we afford to just let existing homes deteriorate, or tear them down to build an new larger and more energy using home.

The difficulty with the existing home market is there a way more players, from the clients to the subcontractors and installers. Another difficulty is it is more expensive to redue than to build new, so less "cost effective". Dispite these and other difficulties, there is so much room for improvement, and we can't meet any of our goals without tackeling existing homes with 10 times the effort of the new home market.

As a General Contractor and Building Performance Contractor I have over 20 years of experience remodeling and repairing mostly single family homes. I have performed most of the trades. I have a AS degree in Architecture and Construction Management, and was certified as a Building Inspector. I am a HERS Rater for Existing Homes, and a GreenPoint Rater as well. I have extensively trained myself at PG&E Pacific Energy Center and Energy Training Center. I am mostly self tought, in the sense that I have little to no "formal" training, for better and worse. Existing Homes are my life.

In my experience I have found that I can do 3 things that will save more energy that the best HVAC system that you can design and install, regardless of weither the house already has ceiling and wall insulation.

- Air Leakage Reduction; By reducing leakage we address the larges component of Winter heat loads.
- Insulation; by insulating walls that aren't, adding more ceiling insulation when it's less than R-19, and closing the crawlspace vents.
- Duct Leakage; by sealing the ducts to less than 6% (90% of the time) and as low as 10%.

By doing these 3 things I consistantly calculate greater energy savings than "high" efficiency HVAC equipment, with proper sizing, duct design, and installation. And the 3 things will provide greater benefits to the customer than the HVAC system, especially comfort wise. The cost can be less than or more than the HVAC equipment, depending on house size and weither it is insulated or not.

Windows don't play a major role from an energy or cost savings standpoint, and aren't cost effective in there own right. Most people who havent addressed my 3 items complain of no savings and all the other negitives of existing homes. There are other ways we can address windows, especially in older homes of better architecural quality.

- Weatherstriping; Especially on double hung windows, and casement.
- Exterior Shading; Trees, awnings, porches, shutters, screens, etc..
- Window Film; Low E film

On of the difficulties with existing homes is that at times the owner may bring in a specialty subcontractor to do one task. It might be painting the exterior, or a new roof, or electrical work, etc.. I often observe that an oportunity to air seal, or insulate is lost, or damage is done to the thermal boundry. Sometimes the only, or the best acess to do work is when or before something else happens.

We need to encourage people to address the house as a whole system. They need to pring someone in to create an Home Improvement Plan, to recognize the opportunities for improvement.

Time of Sale Audits; The Real Estate Insustry is slowly warming up to the idea, although they will always wory about killing a sale. Some of the problems with time of sale are does the seller do it, or the buyer? Often sellers do work to prepair for sale, will they perform work thay is not currently valued in the market? Sellers will do work that makes it more difficult to make improvements, more costly, and make poor choises. Sellers will do work that than needs to be redone. Sellers will do work that the buyer will then remove because it did not fit their tastes or needs. Buyers should have more incentive

to inspect the house's condition and identify what work needs to be done, rather than being surprised with large repair bills. Buyers have the difficulty of doing work before the sale "closes", and then the rush to move in, and cost of delay.

Appriasal; We need energy upgrades to be valued in the market beyond maybe "it has a high efficiency furnace..".

Realitors; We need them to recognize that full disclosure of a properties condition (good and bad) is a good thing in the long run.

Sellers; We need them to recognize that their improvements may not be in the buyers best interest.

Buyers; That they benefit only from work being done correctly.

Mortgage Brokers; That the energy improvements have value.

Time of Sale Audits are a very improtant entry point because buyers often do work before they move in, and withing the first year or two of being there. The question is how to make it work with the "competing" interest of the various parties, and get improvements made, and made correctly.

RECO; What I have seen and experiennced with RECO's is limited, but I don't think it has been very successful.

Energy Auditing; RESNET is working on a national standard for auditing that might have 3 levels of auditing.

Checklist; Performed mainly by home inspectors to visually identify various energy measures, without any recommendations for improvement, but the sugestion that you may want a more comprehensive inspection.

HERS Rating; Visual inspection with some testing, computer modeling with recommendations, and HERS Index.

Comprehensive Audit; everything a HERS Rating has, with or without HERS Index, additional testing (including Combustion Safety) and scope of work for recommendations.

The Checklist lacks any reference for the seller or buyer to make a decision that they might want to make improvements. It only tells you what insulation level you have, and not what a minimum recommended level for your area might be. So it does not seem that it will be a good tool to motivate people to make improvements. The difference in cost, and complexity between the Checklist and a HERS Rating or Comprehensive audit is large. The difference between a HERS Rating and Comprehensive Audit or realitively small.

HERS Ratings have not been that effective in California in the past. Few homes in many areas would qualify for a EE Mortgage. Few lenders will do an EEM. Few Realitors and Mortgage Brokers are fimilur with them. They add a level of complexity to the sale/purchage. Since in California we like to use an "independent 3rd party" model, there has never been an infrastructure of trained and qualified contractors to refer people to do the work.

Building Performance Contracting; The model of the contractor doing an "audit" and performing the improvements has been more successful. However there have been problems. HVAC contractors have often been targeted, but Whole House, or House is a System, or Building Performance Contracting is realy the domain of the General Contractor. How many HVAC contractors want to become insulation contractors, window contractors, plumbing contractors, etc.. to truly address the whole house. The same goes for other subtrades. The General Contractor is more use to performing, and subcontracting multiple trades. As an industry we still don't have good definition of what is a "Building Performance Contractor", what the qualifications are, what an "audit" or "diagnosis" is, no method for calculating savings, what performance targets we are trying to achieve, etc..

Developing the industry around a "Whole House" or "House is a System" is critical to achieving our goals in a cost effective manor.

I was a contractor in the RCP Program (Residentail Contractor Program) back in 1991 just before it ended suddenly. It was great, in order to get a rebate, the customer had to hire a contractor that was in the program. The contractor had to go through some training (minimal I admit), and adhear to certain MINIMUM Industry Standards. The utilities provided some verification, some up to 100% of the work. The program generated plenty of leads, and was advertised fairly well. The program had a high cost from my understanding, and was far from perfect.

We need our utility rebate programs to work more like the RCP program then they have since (let any unqualified contractor install measures wrong without any oversight). The utilities should promote whole house auditing as an entry to the program. Customers or Contractors only get the rebates using the program certified contractors. The contractors should have to go through more extensive training (previous training should qualify for those of us already trained). Contractors should meet all Minimum Industry Standards (some still need to be defined better, BPI, Resnet, ?, etc..). HERS Raters can provide the program verifications. I think that contractors should have 100% verification for the first 3 to 7 jobs, then a minimum of 15% for some quantity of jobs, then they can join a VSP (Verified Service Provider) and do 100% self verification with HERS Rater testing 1 in 30 jobs for quality controll. I think we have enough of an industry at this point, and some of us couldn't make a living if we wanted to in some markets (partly due to cooling climate focus, and the San Francisco Bay Area is easy to meet 15% above code, but few have participated).

HVAC SECTOR

I have worked on a M&V project that reviewed HVAC changeouts that received large sums of incentives. As we all know none had ducts with less than 6% leakage. Aproximately 75% had low airflow (less than 350 cfm/ton). Aproximately 75% had improper refrigerant charge. And the list could go on. But all of the instalations looked very professional.

Obviousely this industry has a long way to go to perform at minimum industry standard as the baseline. There is much focus on new technology and high technology as some of the answer. I believe we need to keep systems simplier, so they are easier to design, install, and maintain, technology is part of the answer. In the future when all houses are positve energy passive houses, we will need less complicated hvac systems.

WORKFORCE DEVELOPMENT

Education is very key to meeting our goals, people will never do better than they know how, and usually less. Education is undervalued from a cost/benefit standpoint. How can you measure savings if you teach someone how to do their job properly, and they do it on every job there after.

We lack a formal education system in this country. What we have is often out of touch with best practices (I was in a AC charge class with an Instructor and students from a Junior College HVAC program, and the instructor was not aware of the proper charge checking procedures). Even when someone is beter trained, they meet resistance in the workplace to changing "this is the way we have always done it". The only advantage to not having a formal (ridgid?) training structure is that it may alow more experimentation and creativity. This can allow more inovation, although the industry as a whole may underperform more than it would in a more formal system.

We need to teach energy/environmant/green building to kids at a much younger age.
We need to have vocational education back in the High Schools.

We need to encourage High School students to pursue careers in the Building Industry (I took an "Introduction to Engineering" class at Berkeley High School in 1986.

We need energy/environmant/green building to be an integral part of all building trade programs, from the union programs, to other job training programs, junior college and university programs.

I have a saying, "Specialist need to be Generalist" and "Generalists need to be Specialist". What this means is that a Specialist in any disipline needs to know how to do their job properly, and understand how it fits within the whole. The Generalist (General Contractors, Architects) need to understand the whole, and all the Specialties. They don't have to know enough to do each and every Specialty, but how it fits in the whole, and what the improtant standards are for all the parts.

I have for the past decade and a half been interested in the subject of education and technology transfer. My father was a Mechanical Engineer at Lawrence Berkeley Labs. We do all this great reaserch, figure things out, develop processes and products, but the time it takes to get it into general practice is glacial (the glasciers are melting faster now) if they ever make it.

MARKET TRANSFORMATION

Of course everything we are talking about is market transformation. We need to not just transform the HVAC industry, but all sectors of the industry. The insulation industry needs a large effort to get QII (quality insulation installation).

BRANDING

We need to do a better job of marketing quality installation. The difficulty with educating the customer to buy quality, is they may only do it once, and then not for a long time. If you train a contractor to do it right on every job, then you have a positive impact on every job. Both are important, training contractors may be the better priority.

We tend to want to create our own brands here in California, and do thing differently then the rest of the country. This creates some confusion and has led to ineffective brands.

We need to build upon the national brands like Energy Star, Home Performanc with Energy Star, LEED, Nate, ACCA QI, etc.. We may want to hold to a higher standard in some cases than the rest of the country. This way people coming from other parts of the country may recognize the brand, and if they go elsewhere they will too.

RENEWABLE ENERGY

Renewable energy only supplies aprox. 12.5% of our total energy use in California. Even with our aggressive and expensive inititives to increase it's use, it is still a small part of the total, and will be unless we can cut our total use by 25-45% by 2020.

With the average California home using an average of 16,315.4 kWh per year it would require a 9 kWh PV system costing about $72,000! Beyond the reach of the average Californian, and a bad idea even if it was affordable.

I have noticed several issues surrounding renewable energy and especially PV.

1. Solar Energy is free. People seem to ignore that it typically requires an extra capital investment to capture the "free" solar energy. There is a cost to benifiting from the "free" solar energy, just

as it costs to purchase it from the utility. The avaerage cost of using "free" solar energy may or may not be less then the purchase cost.

2. Net metering reduces you incentive to use less energy, because you don't usually see how much you "use" and how much you "produce". I often see people present energy use figures for their homes pre and post PV and/or remodeling, but it is never clear if they use more or less total electricity (let alone energy). The solar subdivision in Sacramento that gets all the press appears to use more energy than the adjoingin subdivision.
3. Net metering takes away any incentive to produce more energy than you use. Since you can't get paid for it. I don't know what the proper value for the electricty, but it may not be the retail price as it is now.
4. Time of use rates for those who produce more electricty than they use in the peak period is an incentive to use more electrcity. Since you can't keep any "credit" for your "excess" sale (it's not excess electrical production, but excess value" people often look for more ways to use electricty, It may be electric heat, water heater, electric viehicle, etc., it may mean that they use more energy in total!
5. Peak load matching. Some think that PV is the perfect match, but the production peaks much earlier for a south facing system, and slightly earlier for a western. Shifting the peak (as well as reducing it) could make things match better.
6. System load matching. I don't fully understand when we produce electricty from what source through the day, week, month, and year. Renewables only produce when they are available, not necessisarly when we want to use it. We may need to shift when we use electricty.