Home Performance in Paradise: a Case Study

by Griffin Hagle

Editor's Note: Home performance is a tough enough business in colder climates. But what about when it's 72 degrees Fahrenheit and sunny nearly year-round? San Diego's weather has helped earn it the motto 'America's Finest City,' but occupants of poorly performing buildings here largely face the same problems as in the rest of the country; allergies, noise, pests, mediocre comfort systems and more can make indoor environments anything but a paradise.

Using a net zero energy retrofit of his 1,100-square foot home as a case study, a sustainability expert explores the readiness of contractors to design coherent solutions, the consequences of relying on utility rebate programs, and how best to communicate the value of home performance to homeowners stuck in the "mild climate" mindset.



Sunshine, beaches, and sparkling pools: few cities can compete with San Diego's lifestyle. Housing costs are high, but natural gas is cheap, and solar electricity gets cheaper by the day. Considering that you could probably live comfortably year-round in a treehouse, why should anyone fuss with building performance in the first place? Wayne Longdon offers an answer to that question.

I first met Wayne last year at a meeting of the San Diego Passive House Alliance. The chapter's vice president and a longtime resident of Cardiff, just up the coast from San Diego, he's pushed against the "green glacier" of inertia in mainstream construction for decades.

Retrofits are an especially hard sell. Energy savings alone rarely return the investment in this climate, leaving most people feeling trapped in inaction. (When I once described the comfort problems in my own rented 90-year-old bungalow to the property owner, she told me, "That's just how old homes are.")

Of course, doing nothing has its costs. Many neighborhoods are spread across wooded canyons that supply a steady stream of critters to garages, crawlspaces, and attics. A homeowner once told me she could hear mice "tap-dancing" on her recessed lights at night. Temperatures countywide rarely resemble the beachfront idyll of travel brochures. The lack of an air conditioner during the summer can be shrugged off near the coast, but in poorly performing homes further east it's a nightmare. As in any major city, noise and air pollution can be problematic. One in ten houses has a pool, most using egregiously inefficient single-speed filtration pumps.

These are problems, Wayne knows, for which home performance has solutions.

His opportunity to make his case lies in an 1,100-square foot house that his wife, Nicola, inherited from her late father. Built in 1970 and located in sunny, inland Escondido, it's the poster case for an upgrade: poor insulation, single-pane metal windows, an atmospheric gas furnace and no air conditioning. The couple plans to complete upgrades this summer in time for their USGBC chapter's Green Homes Tour in October, then rent it to their son and his family.

Choices and the Consumer Perspective

Wayne made his wish for a case study with middleclass appeal clear from the outset. This wasn't going to be Casa Aguila, a multimillion dollar Passive House (the county's first) underway in rural Ramona. Several years of single-person occupancy in a modest house means less apparent fat to trim. Having had no past or future responsibility for the energy bills, payback was an abstract idea, but solving problems wasn't. With a firm budget of \$35,000, a tenth of the home's present market value, he set out to discover just what kind of performance—results—his money could buy.

Wayne solicited estimates from contractors as would any reasonably informed home buyer who was interested in a comfortable, healthy home capable of consuming zero net energy. He purposefully chose not to disclose his expertise to those he didn't know. Each was left free to design the solution they thought would best realize his vision.

He sought out both general contractors and individual solar, HVAC, roofing, window, and insulation providers. At least eighteen total bids were received for all or part of the project from 15 different companies. Most striking was the difference in the five HVAC proposals. Our new load calculation called for (at most) 6,244 Btus heating and 13,965 Btus cooling, but the proposed condenser capacities ranged from 1.5 to 4 tons. Bizarrely, despite the carefully explained net zero goal, two companies pitched new gas furnaces, rated at 45,000 and 80,000 Btus.

The insulation bids were somewhat easier to compare, but still far from uniform. Some included air sealing, and some broke it out as a surcharge (which seems like (con't page 10)

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charging more for a car with an "optional" fourth tire). The house area is split between a vaulted tongue-ingroove ceiling and an attic, but most bids addressed only the latter. To be fair, the vaulted ceiling mostly spilled over into the roofers' realm; several included an option for exterior rigid insulation under a cool roof. The solar bids were a relative bright spot. All could be evaluated on their price per watt, which fell between \$3.62 and \$4.74. All included online system monitoring and some kind of production guarantee, a seemingly minor detail, but one which helps explain homeowners' lopsided perception of value between efficiency and renewables.



Wayne's mystery shopping experiment had been revealing. He expressed particular frustration at the scattershot HVAC proposals; a difference of a half-ton or ton might be expected, but how was a layperson supposed to evaluate a 2.5 ton spread? Where was the performance guarantee? We concluded that in the absence of better information, a reasonable person would choose the highest tonnage for their money.

Rebates Can Be Obstacles on the Road to Net Zero

There is growing recognition in the industry and increasingly, in mainstream media, that utility programs have failed to scale home performance. Indeed, four years in, Energy Upgrade California has fallen notoriously short in both project volume and savings realized. Having taught several BPI certification classes for a program implementer during its 2011 rollout, Wayne was well aware of its history and limitations. As a homeowner on a fixed budget, though, he still wanted to see what rebates were available.

I offered to run a few scenarios for him. My initial model using TREAT software generated a best-case incentive of nearly \$5,000, with a catch: he couldn't switch heating fuels. Modeling the more climateappropriate heat pump brought it to zero. Ouch. We'd hit another frustrating roadblock, though not an unexpected one.

While the reasons some utilities cannot directly support fuel-switching are understandable, it says something about the design of programs like Energy Upgrade California that they discourage a shift from fossil fuels, even as net zero building codes loom on the horizon. The most motivated homeowners, like Wayne, will arguably remain undeterred by perverse incentives, but we have to do better than asking others in his position to walk away from \$5,000 to do what's best for their home.

Of the fifteen companies that bid, four were active in the program, but only one called attention to it in their proposal. As more than a few contractors in California and elsewhere have put forth, the juice just isn't worth



the squeeze. That "juice" is currently doled out based on theoretical future savings rather than measured performance, so contractors have no reason to deliver work that actually performs (and every reason to race to the bottom). The industry knows it, and some of its brightest minds are tackling this very problem: Nate Adams and Ted Kidd's One Knob program and Matt Golden's Open EE Meter tool both aim to simplify the way residential efficiency is measured and rewarded. *(see the Resources)*

As of this writing, Wayne hasn't quite figured out his incentive situation. He's considered upgrading the enclosure, taking a smaller rebate, and purchasing a heat pump after the fact. It seems somewhat cloakand-dagger, but it might be his best option, though it remains unclear how program administrators would respond. My experience is that they're as frustrated as anyone when incentives backfire. On the other hand, they know as well as any of us that a program that needs this type of maneuvering to engage participants is no program at all. The southwest-facing roof, which will be replaced and a layer of rigid insulation added to it, is ideally situated for solar, and the array itself will further reduce radiant gain to the open-beam ceiling beneath it, lowering cooling loads. A 2011 study by researchers at UC San Diego found that ceilings shaded by solar panels are five degrees Fahrenheit cooler than under exposed roofs. This is a phenomenon familiar to anyone who's parked their car under the solar canopies becoming increasingly common in California parking lots.

The home's test-in leakage was 2,515 CFM50. Using painter's tape to seal the windows brought it down to 1,559 CFM50. A pressurization test with a smoke machine (remember to be a good neighbor and alert your local fire department first!) revealed most of this was came from connections between the house and the attic. The target for the finished home is 700-800 CFM50.

When Savings Aren't the Story

Many of us are fortunate enough to learn our trade from people who deeply share our values. This can be a mixed blessing. The world of building performance tends to suck us in, giving us tools and concepts with which to understand, and maybe even begin to solve, the almost incalculably dire problems facing humanity. It's immensely empowering. But it doesn't give us everything we need to succeed.

The honeymoon is over once we discover that consumers' values don't usually align with ours. We do what we do because we know how good living in high-performance homes can be. But too often we unwittingly speak the language of less. Psychologically, efficiency is conflated with conservation, which does

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not evoke comfort, security, or social status so much as thrift and primitivity. If we can't communicate that home performance is about sophistication, not sacrifice, our blower doors might as well be time machines set for the 1970s.

I have access to a wealth of sophisticated instruments from the lending library at San Diego Gas & Electric's Energy Innovation Center. We're using over two dozen devices to monitor temperatures, humidity, CO2 concentrations, and sound levels in Wavne's house before and after the retrofit. For example, with a smartphone decibel meter app and a boombox, we can visually compare the sound transfer through the old and the new windows. Showing such comparisons to a homeowner makes it clear that we're going to

enhance, not ask them to reduce, their lifestyle.

As mentioned above, the solar bids included guarantees. In other words, the customer can be reasonably confident they'll get that which they were promised, and have recourse if they don't. Such certainty is all but unheard of in home performance, but we can change that. We must.

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My Observations, and a Prediction

Performance guarantees that are based on measured results need to become widespread for the home performance industry to live up to its name—and catch up to photovoltaics. Rebate programs have ignored this

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to their peril, and as the case of this net zero retrofit in Escondido, Calif. shows, created perverse incentives that thwart homeowners trying to do the right thing. It's time for the industry at large to acknowledge this failure and move beyond rewards that rely on theoretical savings.

For homeowners, uncertainty of the results also makes evaluating contractor proposals in an applesto-apples fashion almost impossible for average consumers. This becomes even more important in mild climates where energy savings rarely make comprehensive upgrades financially appealing. We need an

industry-wide tool for assessing home performance work.

It can be tempting sometimes to predict that the energy efficiency nut is about to crack wide open. Indeed, the first fractures have begun to appear: smart meters, advanced controls, innovative program delivery, and the "Internet of Things" all hold promise. Still, the decisive rupture will never be a technological victory, but an emotive one. When we've mastered the storytelling to the extent we've mastered the science, we'll finally have an industry.

Follow-on Resources:

Learn more about One Knob Consulting: http://oneknobconsulting.com/

Learn more about Open EE Meter: http://www.openeemeter.org/

San Diego Gas and Electric: Energy Data Request Program (downloadable aggregate and average monthly energy usage by ZIP code and user type): https://energydata.sdge.com.