DOCKETED	
Docket Number:	19-IEPR-06
Project Title:	Energy Efficiency and Building Decarbonization
TN #:	228292
Document Title:	Bruce Severance Comments Inclusive Finance Model May be the Only Way to Reach Rental EE Market
Description:	N/A
Filer:	System
Organization:	Bruce Severance
Submitter Role:	Other Interested Person
Submission Date:	5/15/2019 5:02:59 PM
Docketed Date:	5/16/2019

Comment Received From: Bruce Severance
Submitted On: 5/15/2019
Docket Number: 19-IEPR-06

Inclusive Finance Model May be the Only Way to Reach Rental EE Market

Additional submitted attachment is included below.

The Inclusive Finance Model May Be the Only Way to Reach Low Income and Rental Markets in the Volumes Required to Transform the California Housing Market.

Preliminary Review of Research by Ardenna Energy on Inclusive Finance and Climate Variables

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Introduction:

Inclusive Financing Model Achieves High Market Acceptance in Rental Markets

Few social challenges pose a single policy solution, but the inclusive finance (IF) model seems to present the only proven way to reach the otherwise unreachable rental and low to moderate income markets with broadly needed home energy improvements. While rebate incentive programs such as Energy Upgrade California have had lower than 1% acceptance among homeowners –even among those who can afford upgrades, inclusive finance pilot programs have achieved 40% to 90% acceptance levels in low income and rental markets in the Southeast – without requiring ratepayer rebate funds.

This fiscally conservative approach - that is not confined by rebate program budgets - banks on the high probability of delivered energy savings among target properties that meet a specific criteria. The success of inclusive finance pilot programs, and their ability to remove the usual barriers to energy efficiency markets, point to the only cost effective way to ramp up the total number of energy upgrades performed in California from 11,000 homes per year to 500,000 homes per year, which is the volume we must achieve within a few years to meet the state's SB100 climate mitigation goals. Given a rental market that represents over 45% of all California households*[1], any other finance strategy would very likely depend on massive rebate programs with 80-100% rebates for the rental and low income markets. This would amount to a government giveaway to the tune of about $8-10 billion per year for 20 years for which there are no conceivable funding sources. An appropriately designed inclusive finance model can accomplish this monumental task without burdening consumers with financial risk - and without burdening the state's ratepayers and taxpayers. So how does this win-win-win financial model work and can it be applied on projects that include partial electrification and zero-ready projects?

Inclusive Finance Model Removes Barriers to Energy Upgrades

When 47% of all California homeowners and 61% of all renters say "housing costs are a strain for their families"*[2], any proposition that involves additional expenditures in order to achieve energy savings that pay off over 10 to 15 years is not an attractive offer to most households. Homeowners are largely resistant to assume loans to improve home efficiency even if there are rebates available. The majority of renters are low to moderate income (LMI) and have no interest in improving a landlord's property at their own expense; landlords are not inclined to invest in efficiency while most renters pay the utilities. These economic pressures and the "rental Catch-22" pose barriers that all prior rebate-based programs fail to overcome. A handful of inclusive financing (IF) pilot programs in the US have demonstrated an impressive ability to overcome such market barriers, while presenting a value proposition that is both easy to understand and hard for residents and homeowners to turn down.

In existing pilot inclusive finance programs, the value proposition to the resident offered by a utility or residential energy services company (ESCO) is simple: the resident is guaranteed at least 10%-20% utility bill savings immediately and up to 40% savings when the home upgrades are paid off in 15 years. The renter or homeowner is not asked to sign a loan to cover the upgrade costs, and they do not have to be convinced that the energy savings will actually cover the cost of such a loan. The utility's contractor or ESCO inspects the property to assess potential energy savings, and using their own historical data, they make a low risk assessment that the property will produce sufficient energy savings to cover the cost of improvements. In short, the success of the IF model hinges on a utility's ability to accurately assess a property's potential to be immediately "cash positive" and produce sufficient energy savings to offset the cost of improvements, and still immediately lower total utility bills. Because the offer to the resident is informed by historic home performance data and a clear qualification criteria, the ESCO or utility can guarantee a reduction in total energy bills with minimal risk of loss. Either a utility or an energy services company (ESCO) may broker the energy upgrade offer, and the utility's costs are minimal because the program is paid for with predictable energy savings.

The risks to all parties are minimal: Default rates on pilot IF programs have been extremely low, in large part because the resident agrees that failure to pay the utility bill will result in termination of utility services –as is normally the arrangement already. Given the extremely low .01% default rates seen in pilot programs, these loan guarantees may also be partially backed by the State of California. The renters or homeowners pay for the investment in the form of a payment or tariff included on the utility bill, a "tariff-on-bill" (TOB). The total energy savings are substantial enough to also guarantee a reduction in resident's total utility bill to make the value proposition irresistible. Residents no longer have to sign for loans without absolute certainty that the energy savings are going to materialize to pay for the loan. And if the program is based on aggregated and metered energy savings that are not paid from rebate funds, the utility has a much more cost effective program for meeting much more ambitious energy efficiency targets with vastly reduced marketing and rebate expenditures. If some percentage of homes is only marginally cash positive for any reason, the diminished energy savings of those homes can be partially offset with the addition of solar which has more predictable returns on investment. Utilities also benefit significantly from halved HVAC loads, thereby reducing future investments in expanded grid capacity while facilitating grid harmonization of renewable sources. This is in fact a win-win for all parties.

The key feature that allows the IF model to work is the *qualification of the property* for a loan or "tariff" rather than *qualifying the resident for a loan*. If the property has high energy savings relative to investment - a high ROI, the potential for energy savings, clearly outweighs the risk of investment in home improvements by either a utility or an energy services company (ESCO). Inclusive financing pilot programs in Arkansas, Kansas and Kentucky have achieved up to 90% acceptance rates*[3] even in rental and LMI markets, a market penetration rate which is approximately 40 to 400 times greater than California's current energy efficiency programs.

The "cash-positive" criteria assures transferability of the tariff agreement to new residents after initial residents move, thus allowing the model to appeal to renters and landlords as well as homeowners who may be contemplating a sale. A new renter is willing to assume the tariff agreement, only if there is a guarantee of reduced energy bills, so the financial model works only if the energy savings are predictable and measurable. The positive cash flow requirement naturally targets smaller homes that present the most energy savings first. Typically they are in "high-load" climate zones, and are older, leakier, and less insulated, with outdated mechanical equipment (space and water heaters).

However, the cash-positive criteria can limit the job scope and budget in some ways: a 15-year loan term is required on all equipment with a 15 to 20-year life expectancy, and this limits total energy upgrade and electrification budgets to the total annual energy savings times this 15-year life, a total of about $11,000 to $12,000. However, this $12k budget can be extended if the right amount of solar PV is added to the project, to adequately increase the ROI and insulate against relative fuel price volatility or if two-tiered amortization schedules are considered.

The Constraints and Requirements of the Inclusive Finance Model

Although the model outshines conventional energy rebate programs with its very high acceptance levels and penetration into multiple market segments without rebates, other limitations inhibit it's applicability to electrification programs and "deep retrofits", energy upgrades that produce 50% or greater energy savings through both building shell improvements and equipment upgrades. Due to the cash-positive requirement and current rules that limit financing to 15-year amortization schedules required to match projected equipment life, the few inclusive financing pilot programs in the U.S. are generally for efficiency improvements totaling less than $12,000. Although this scope and budget maximum could theoretically be increased to $15,000 if building shell measures such as air sealing and insulation were allowed to be phased on longer amortization schedules than equipment, such phased amortization schedules have no precedent and are not currently under consideration.

Building shell improvements are critical to grid management and "grid harmonization" because they allow HVAC loads to be dramatically reduced, the principal variable that drives grid capacity. The most dramatic savings in the energy upgrade program come from reducing duct leakage and building envelope leakage. Compared to other energy improvements, these produce the greatest energy savings per dollar invested in most homes, where average duct leakage is over 30% due to widespread failure of traditional cloth-backed duct tape.*[4] However, air sealing the attic and crawl space usually involves removing old insulation in order to see all of the air sealing problems, and even greater synergies are achieved when ducting is not suspended from the ceiling of the attic, but dropped to the floor and deeply buried in blown insulation which can cut cooling loads and HVAC system capacities in half. A handful of corollary HVAC measures developed by Rick Chitwood have demonstrated the possibility of removing a 5-ton split system and replacing it with a 1.5-ton to 2-ton ducted heat pump, a methodology which in theory can cut peak HVAC loads to a third of their current demand on the grid. Such efficiencies, if systematically executed on a statewide basis, would greatly reduce the grid capacity and corresponding electric utility investment required to meet increasing loads due to electrification of existing residential buildings.

So how can this whole-house optimization be accomplished using the IF model for $12,000 to $15,000 per household? The answer is in part that the households must be carefully selected based on prioritized criteria that target higher cost fuels such as propane and direct electric, high HVAC load climates must be targeted before low-load climates, and smaller homes must be given preference over larger homes in order to keep total project budgets in line with the constraints of the IF model. If natural gas furnaces are being replaced with ducted heat pumps, it may not be cost effective to do so unless both furnaces and split AC systems are being replaced simultaneously, and then careful attention must be paid to relative fuel costs to assure the energy savings required to make the projects cash positive. However, the strategy of using HVAC optimization strategies to cut HVAC loads by 50% to 70% helps keep relative operating costs (fuel versus electricity) at parity.

Thinking Outside the Conventional Program Box

Although the inclusive finance model works well for electrification measures when electric utility rates are competitive with the fuels being replaced and moderate energy savings can be realized, some creative program design is required in order to adapt the high-acceptance inclusive finance model to the higher cost deep-retrofit and electrification objectives required to minimize grid impacts. Given typical equipment costs and per-square foot costs to insulate and seal attics, deep retrofits on small 1000sf single family homes with 40% to 50% energy savings already approach the $15,000 maximum budget.. So a key cost trade-off that needs to be assessed is whether or not investment in deeper energy retrofits is worthwhile for utilities to subsidize in some cases where energy savings may be more marginal or more expensive to achieve, and if grid capacity expansion and upgrade costs can actually be avoided., However, as we shall see, adding some solar PV to the package can significantly reduce the risk that combined utility bills after upgrades does not meet the cash-positive requirements of the IF model.

Given the lessons learned from the Energy Upgrade California program, it is doubtful that these deeper retrofits can be executed in much higher volumes without some “wrap around” rebates and incentives that assist in paying for corollary costs which will arise on some projects, such as panel and circuit upgrades and asbestos abatement costs. If deep retrofits (40-50% energy savings) reduce peak HVAC loads far more significantly than moderate retrofits (25-30% savings) the cost to utilities of subsidizing some of these costs on some projects may be worth the investment, provided PUC rules accommodate to allow such fuel switching, especially when retiring a regional gas infrastructure and avoided infrastructure maintenance makes it cost effective for a utility to offer such program alternatives.

California’s recent passage of SB100 mandates a planned transition to a carbon-free economy by 2045. Most research corroborates that building decarbonization is a centerpiece strategy for meeting these legislated requirements. Although RNG remains a viable combustion alternative, the projected supply of RNG given in-state resources is less than 25% of what is required to meet the projected 2050 demand, so some electrification of household appliances appears to be inevitable. The need to expand the current energy upgrade market from 11,000 to 500,000 retrofits per year in a very short time frame – and make electrification affordable - is a daunting and complex task that forces us to consider completely new business and financial models to broaden market acceptance of both deep energy retrofits and electric heat pump space heating and water heating. The key to the success of the IF financial model is a clear-eyed risk assessment of the target homes and households that minimize upgrade costs and maximize energy savings.

At the rate of 11,000 residences per year, the pace that energy efficiency improvements were completed over the last decade, it would take approximately 900 years to significantly improve the energy efficiency of all pre-1999 residences. If you believe the climate science, we simply don’t have that much time. Adding electrification to most residential structures makes this challenge even greater. If we are to mitigate climate change in the most cost effective manner, and stop global warming at 1.5 degrees C., the current rebate driven programs must be expanded 50-fold and accelerated to meet the 25-year (2045) objectives of SB100 – without significantly adding to rebate funds contributed by the state or IOUs. This seems at first glance to be an impossible task, but it is the challenge before us, and there are workable solutions.

It requires new paradigms and not just more money for marketing and rebate funding. The inclusive finance model is the only financial model that offers some prospect of a sea change that could meet all of these requirements and objectives. The tariff on-bill (TOB) model that qualifies the property as a cash-positive low-risk candidate rather than qualifying the resident removes significant market barriers and offers not only a prospect but a track record for achieving very high acceptance levels for both low and middle income projects. No other financial or incentive models offer a viable path for retrofitting the 45% of the state's housing stock that are rental properties.

Other Institutional Disincentives and Obstacles

Other institutional obstacles contribute to disincentives, such as contractor license law restrictions that create disincentives for HVAC contractor participation in a "whole-house approach" to HVAC system optimization. This disincentive tragically misses the best opportunities for energy efficiency improvements at point-of-sale for the HVAC equipment. Building "shell" improvements should be performed at the same time. Otherwise HVAC systems are installed now to meet the load of inefficient shells will have too much capacity to for the building shell efficiencies if they are upgraded later. The synergistic benefits of deeply burying ducts which can cut total capacity required in half is also lost.*[5] If HVAC contractors were allowed by the CSLB to operate as primary contractors for all "incidental" attic and crawl space improvements that improve building shell performance, and which affect their load calculations and improve indoor air quality, they would be motivated to include these whole house measures in their scope of work. Under the current business model, if they raise such efficiency issues with the client, they lose money and time because they are required to bring in a general contractor, who dictates a schedule to them and who reaps all of the profit while they lose money due to downsized equipment. Clearly the current business model needs to change to remove such disincentives, and this will require thoughtful accommodation by the California State License Board in its interpretation of shell improvements being "incidental" to an HVAC contractor's load calculations.

Other Key Risks to Manage on Inclusive Finance Projects

There are a number of important risks to assess when qualifying a property for IF funding: the "healthy" condition of the existing property, the presence of water damage, mold, indoor air quality problems, roof leaks or structural problems, could put the property at risk of becoming uninhabitable. Such existing conditions would render it a poor investment for utilities and lenders to perform energy upgrades. The potential for water damage or mold in older properties also underscores the importance of drainage around the property, and details such as rain gutters, bath fans and fresh-air ventilation (like ERVs), rodent proofing and subfloor air sealing when there is a raised. Recent medical research indicates that 24% of the general population carry the gene that predisposes them to chronic inflammatory response (CIRS), a condition that can make some members of the same household much more ill when exposed to the same environmental conditions.*[6] Air sealing a house with any kind of water damage problems exposes the contractor and the utility to liability, and such site conditions should disqualify the property for IF funding – unless there are "wrap-around" rebates or sister lending programs to address such issues, or the homeowner can afford to pay for them separately.

Evaluation of Existing Site Conditions, Efficiency Measures and Their Cost-Effectiveness

There are often challenges if attempting to make existing buildings near zero energy, or "net-zero energy" meaning they produce the same or more energy from their solar systems or other onsite renewables to offset their loads over the course of a year. There are always extremely cost effective measures with high returns on investment (ROI), and others that have lower ROI. And there is always some point of diminishing return on investment wherein it is simply not cost effective to attempt deep retrofits on every project because of site-specific conditions or variables that make it impractical to do so. Energy analysts evaluate project specific conditions and look for the "low-hanging fruit" - energy upgrades that are low in cost and high in energy savings that typically include, attic and crawlspace air sealing, and high R-value insulation in the attic. Crawl space insulation, it turns out, is less important than many other measures depending on climate zone and it is less cost effective than just air sealing a leaky subfloor. So more marginal improvements, those that produce less energy savings per dollar invested, should be carefully evaluated and trimmed from the package to minimize risk exposure, especially if they are easily added or upgraded at a later date.

Similarly, a home or apartment unit with vaulted ceilings and which has recently been re-roofed, does not lend itself to a cost-effective addition of roof insulation which would have needed to be installed in the form of high-density rigid foam sheeting above the old roof deck and below the new roof shingles. In this case, adding rigid insulation above the new roof would make the new roof shingles a sunk cost, and this measure is of sufficient importance that adding other efficiency measures that are less cost effective would make it much more difficult to achieve 30% to 50% reduction in HVAC loads. Given these costs trade-offs and ROIs, a home with these features is not a good target for the IF model – at least not in the market introduction of the program.

Vaulted ceilings, inaccessible attics and crawl spaces, and ducts buried in wall or ceiling assemblies are perhaps the most common existing conditions that can significantly decrease cost-effectiveness of energy upgrades. Homes or condominiums with any of these conditions are not the best candidates for an inclusive financing program, because positive cash flows will be inherently harder to achieve. Homes with both accessible attics and crawl spaces would fit within the scope of the IF model only if they are very small, less than 1000sf and preferably less than 800sf. In short, slab on grade construction allows deeper retrofits on larger homes within the IF project scope.

For many homes built between 1950's and 1978, chrysotile asbestos insulation is sometimes found on the outside of metal ducts, which must be removed by a certified abatement contractor following very stringent process controls and disposal methods. This usually costs in the range of $3,000 to $5,000 for a 1500sf to 2000sf home. Such asbestos contamination may affect 10-15% of the housing stock, and if it is not covered by a separate rebate or assistance program, it's presence on the site would impede the use of the inclusive finance model.

Another problematic building condition arises when ducting in a pre-2000s vintage two story home is run through the floor assembly between the first and second floors, and most of the ducts are not accessible for leak repairs. Homes built before 2001 pre-date the introduction of UL181 duct tapes and have an average duct leakage rate of 30%. If ducts can't be accessed, a blown duct-sealant method such as AeroSealTM would need to be employed which usually adds $1500 to $2500 to the cost of a project. The limited accessibility of ducts also inhibits proper duct sizing modifications which may be preferable to meet HVAC system airflow and temperature balancing requirements, a significant disadvantage that can poses the risk of safety issues in the case of gas furnaces that are installed with insufficient airflow which stresses heat exchangers and can lead to premature failure. Improper duct sizing can also lead to customer complaints regarding comfort poor temperature balancing with any type of system. In general it is best to avoid homes where large amounts of ducting is buried in wall or floor assemblies, but if such conditions exist in homes built after 2001, they could be duct tested, and if "duct leakage to outside" (DLTO) is below 10%, the ducting can be used as is.

Homes with unattached garages cannot be retrofitted with the "integrated" heat pump water heater (HPWH) models that have the compressor integrated on top of the tank and that are designed to extract heat from the garage in order to heat the water in the tank using a refrigerant cycle. These units are not generally designed for outdoor locations, and more expensive HP equipment with a separate outdoor unit may be required at higher cost which also cannot generally be covered within the scope of the IF model.

Given all of these existing conditions, there will be a 15% to 20% segment of the market for which a 30% to 50% reduction in energy use will simply not be feasible, within the $12,000 to $15,000 budget constraint of the IF model. Energy efficiency measures will need to be carefully evaluated to meet cost and payback criteria of the inclusive finance model.

The individual measures that will become standard in future IF model energy upgrade "packages" must meet carefully evaluated and prescribed cost-effectiveness criteria. On this note, much has been learned from prior energy efficiency programs and there are volumes of data that have been obtained by utilities and program managers regarding which measures are most cost effective and which produce the highest ROI and energy savings. The goal should *not* be to blindly maximize energy savings on every project. This would actually increase risk of a lower ROI and cause cash-positive margins to grow thinner, risking the success of the IF model – especially where any kind of fuel switching is implemented. Phasing upgrades may be an alternative strategy for marginally cash-positive properties. For example, one approach may be to install some .95 AFUE gas furnaces on marginal projects over the next few years, but pre-wire all of those projects, making them all-electric ready for the next air handler and HPWH replacement. In all cases, careful criteria should be developed to evaluate feature cost-effectiveness relative to site conditions, resulting in prescriptive menus of measures that are proven to yield high energy savings relative to investment. The investor-owned and municipal utilities are well versed on these trade-offs, and it will be fairly straight forward given a clear risk assessment, to create project selection criteria that will optimize the IF model for standard energy upgrade and possibly electrification measures.

Emerging and Sunsetting Technologies

Technologies are also evolving, and whereas some were cost-effective a decade ago, they have since been eclipsed by new technologies with lower initial and lifecycle costs. For example, most solar thermal installers will tell you that solar thermal systems may still be cost-effective in larger multi-family structures with centralized hot-water systems, but they have proven to be more costly to install and maintain in single family homes than integrated-type HP hot water tanks. That cost-trade-off has been well documented for about 7 years, yet solar thermal rebate programs persist, and HPHW systems which are now far more affordable have not qualified for these rebates for the last ten years. Many stakeholders are pressing for extension of the solar thermal hot water rebates, and clear criteria need to be developed so that these rebates are only offered on the large central multi-family projects where they are most cost-effective. Rebates on smaller residential projects need to be extended to HP water heaters plus PV systems that are more cost effective with lower maintenance costs. Any other compromise is a waste of rebate funding.

On a related note, some equipment manufacturers are now integrating heat pump hot water heaters and space heaters into a single system which share the same outdoor compressor thereby lowering cost, and with the added benefit of “heat recovery” features that use waste heat from the air conditioner to heat water with significant potential energy savings, load reduction and grid harmonization benefits.

Eliminating Low-ROI Efficiency Measures to Optimize Cost-Effectiveness

Other measures that often have low returns on investment and which may be prioritized to the point of crossing them off of the cost-optimized upgrade list include dual-glaze windows, crawl-space insulation (most climate zones), and blown wall insulation in pre-1970 homes. Although hugely popular among home owners, window replacement generally has returns below 2% ROI which yield 50 to 80 year paybacks when interest is factored. Unless existing windows are extremely leaky, the increased U-factor of new windows produces surprisingly low efficiency benefits and window tinting is a far more cost-effective measure to reduce solar heat gain. Homeowners tend to see high home improvement value in dual glaze windows, and they are known to add to resale value, but their actual contribution to energy efficiency is rarely cost effective, with statistically few exceptions. Given the typical .28 to .33 U-factor (R-3 value) of dual glaze vinyl windows, replacing single-glaze windows with dual-glaze just for this minor U-factor improvement in a small fraction of the wall assembly is not cost effective as borne out by energy modeling, especially when the R-11 to R-13 bat insulation that was installed 20 years ago is typically derated to R-7 because of gaps and poor installation quality*[7] that is typical in older homes. Altogether excluding window replacement from a TOB efficiency program would not compromise the most promising efficiency opportunities. These improvements could be suggested to the property owner to pay for separately when leakage is an issue.

Pre-1970 homes often have no wall insulation, but the absence or degradation of moisture barriers in pre-1970’s homes makes the addition of blown cellulose insulation a poor choice as it is susceptible to moisture damage. The introduction of blown fiberglass, although less susceptible to water damage, may inhibit the wall assembly from drying out as quickly as when the cavity was empty, leading to possible moisture damage and mold on the inside of the drywall or plaster. When moisture barriers may be compromised, the only way to safely increase wall R-value is to add exterior foam insulation outside the existing wall, preferably with a rain screen or wall drainage and drying system, and then adding a new lap-siding or stucco finish. Unfortunately, such measures are far too expensive to be considered for the scope of inclusive finance programs, and the only cost effective solution is to eliminate blown wall cavity insulation as an included measure. The only exception may be on a south-facing wall that gets sufficient sun summer or winter to dry quickly, and wherein there is a history of heat gain problems in a predominantly cooling load (hot) climate.

Some crawl-space insulation is preferable to none, but access in crawl spaces is often difficult which increases the labor content of such a measure and can easily make it less cost-effective. Because heat generally rises in a structure, much more heat is lost through holes and poor insulation in the ceiling making subfloor insulation a secondary concern in most climate zones. Far more important than subfloor insulation is air sealing the floor, particularly in pre-1970 homes with diagonal plank subfloors that are known to leak as much as eight to ten times more than the rest of the building envelope combined. This is also an indoor air quality (IAQ) concern because homes with raised foundations infiltrate up to 40% of their makeup air from the crawlspace when bath and range fans are present. The most cost-effective solution for sealing a diagonal subfloor is a 1" layer of sprayed urethane foam under the subfloor, but the use of this air sealing method requires 36" of clearance between the subfloor and the dirt floor of the crawl space, otherwise the chemistry does not atomize and catalyze sufficiently and high-toxicity outgassing can result. On homes with insufficient crawl space clearance, the gaps between each plank of the floor must be carefully filled with a caulking gun or foam gun with a narrow application nozzle and applied sparingly to assure the safety of occupants. Given these cost and IAQ issues, it is advisable to target slab on grade structures for the introductory IF program market.

Combining PV Solar with IF Model Energy Efficiency and Electrification (EE+E+PV)
Although it is conventional wisdom that energy efficiency is more cost effective than PV solar, this is true on some homes and not others. It is always true that it is better to perform energy efficiency upgrades before solar is installed so that the PV system can be sized for the reduced loads of the home. However, if electrification of major appliances such as water heaters, heating and cooking appliances are added to the mix, it is not always clear from models or calculations what the total adjusted household demand will be. Just how cash positive a given project may be depends on a number of site specific variables as well as resident conservation behavior. Because of this ROI variability, energy efficiency plus electrification (EE+E) poses a risk on some projects that total combined utility bills may increase. Under the inclusive finance model, the risk of realizing energy savings and an ROI is not assumed by the resident, but by the ESCO or utility that invests in the upgrades, so it is critical to use every tool to make energy savings more predictable, and solar PV is just such a tool.

Adding PV solar with its highly predictable ROI and reduced electric utility costs moderates and minimizes the risk of EE+E projects. If sized to cover most of the electrified home load, solar installations can hold electric utility costs below $.18/kWh, minimizing or eliminating financial risk to lenders and ESCOs and assuring that all of the inclusive finance requirements will be met.

A detailed, but yet unpublished analysis by Ardenna Energy confirms that solar systems combined with EE+E on projects significantly increases the applicability of the inclusive finance model across a range of climate zones and fuel switching scenarios. Although the total budget on the EE+E portion of the inclusive finance projects would cap at $12,000 to $15,000, the simultaneous install of PV solar under a higher cap that aimed at offsetting 75% to 90% of household loads would be very favorable for both IF model risk reduction, grid capacity impacts and the grid harmonization of electrification measures, provided that PV system output does not exceed the adjusted energy demand.

Under the Ardenna Energy analysis, maximizing the size of the PV system without overproduction appears to be most favorable to the resident and the ESCO or agency that is assuming the risk that the package upgrades taken together will produce a sufficient ROI to pay off the loans and tariffs as well as meet the cash-positive requirement.

Given the synergies of bundling these energy upgrades, there is significant opportunity to encourage and incentivize large solar installers to evolve into ESCO-type contractors that perform all of the energy upgrades and pre-sell HVAC equipment into homes that have aging equipment- before the equipment fails. These solar installers would need to have general contractors' licenses in order to have all of these EE+E+PV services bundled under one service contract. This would offer utilities a turn-key service for energy upgrades and solar. The ESCO would need to assume the responsibility for evaluating every site to cost-optimize every upgrade and assume the risk of making the electrification of appliances go cash positive. If such residential ESCOs performed these jobs to the benefit of the electric utilities, prior IF pilot programs indicate that repayment of the tariff on the property must either be on-bill, or legally linked to the utilities right to shut off power when the ratepayer is in default on repayment of the tariff to defaults at a low level.

The Whole-House Approach to HVAC Load Optimization and the Status Quo

Through extensive in-field research by organizations like the CEC (California Energy Commission), Lawrence Berkeley Labs (LBL) and the Building Performance Institute (BPI), a "whole-house approach" to optimizing HVAC system design has evolved over the past two decades that is not frequently followed by HVAC contractors in the field. This whole-house approach looks at cost-effective "thermal load reduction" wherein building shell improvements can allow significant down-sizing of HVAC equipment. This system optimization has been taken to new heights by CEC researchers such as Rick Chitwood that have integrated new methods to reduce duct and envelope losses on existing buildings. These new school methods allow the typical 2000s.f. home to be serviced with a 2-ton heat pump (HP) ducted space heating system servicing 1000sf per ton instead of a 5-ton unit servicing 400sf per ton. Because the majority of HVAC contractors are unaware of these new school methods, and do not view any improvements to the building shell as within their scope, statewide contractor training is a critical element to transformation of the housing market. New business models, incentives for HVAC contractors to engage in this level of optimization and new contractor certification and continuing education requirements are critical, or the ESCO will arrive only to find an old school job was just installed without proper system sizing, making it infeasible to optimize the home after the fact.

Prioritizing Target Market Segments with an Inclusive TOB Electrification Program

Given the RMI study entitled the "Economics of Electrification", and similar studies by ACEEE, it is clear that electrification projects are most cost-effective in specific target markets: 1) New construction where gas infrastructure can be eliminated to the new development; 2) Homes served by propane, particularly in high heating load climates; and 3) High cooling load climates where summer electric bills are high due to AC loads, and in homes wherein both the furnace and AC system are old and in need of simultaneous replacement. Whether fully electrifying residences or not, any TOB electrification program should clearly target these primary markets first to maximize cost effectiveness, energy savings and positive cash flows for residents. Electrifying homes that are heated primarily by natural gas in predominantly heating load climates where AC is not used is not the most appropriate primary market for electrification using the IF model due to higher relative replacement costs and thinner fuel cost margins.

Grid Carbon Intensity and Rate Design Impacts on ASHP Electrification Paybacks

Air-source heat pumps (ASHPs) and heat pump water heaters (HPWHs) are often touted at EE conferences as key technologies that will enable the rapid decarbonization of California's economy, and they are. However, where water heaters can be designed with DR features that allows them to run primarily when power rates and the carbon intensity of the grid is low, ASHP's are not as easily "grid harmonized" by pre-heating or pre-cooling spaces to better match energy supply and demand curves on the grid, especially in older leakier buildings. If electric utility rates are lowest when the carbon intensity of the grid is low as is needed, to incentivize both DR technology (demand response) and load shifting including occupant behavior, then heat pump HVAC peak usage and this carbon-optimized rate design will run into conflict. In other words, carbon optimized rate design will tend to increase electric HVAC operating costs in both cooling and heating load climates, and this rate conflict problem will be magnified as projected electrification causes peak HVAC loads to shift from a summer to a winter peak as is expected by 2030. However, this HVAC operating cost issue specific to rate design is not without clear solutions if the problem is anticipated and more clearly defined in advance.

Home battery systems can be added to load shift, but given the marginal load shifting savings to the consumer, and current battery costs, it is not yet clear that the ROI of home installed batteries will be sufficient to improve the ROI of inclusive finance projects as well as meet the IF budget cap of $15,000. Utility scale batteries have greater ROI and grid harmonization benefits to the utility than batteries installed in homes have to the resident. Installing batteries "behind the meter" appears to increase rather than decrease the risk that a project funded through a tariff-on-bill or inclusive finance program may not meet the cash-positive requirement.

Peak residential HVAC demand runs from 5 to 9 mornings and evenings, but peaking more in the evening, which means ASHPs will face higher than average utility rates during these evening peak demand periods which currently coincides with high carbon intensity on the grid. This negatively impacts the ROI of heat pump HVAC, and the most cost-effective way to address this problem will be to: a) perform deeper retrofits to minimize HVAC peak loads, and; b) accelerate the greening of the grid by reducing carbon intensity during these peak HVAC usage periods. Solutions to this ASHP/carbon-intensity problem requires a broader view of macro-economic variables that influence the cost competitiveness, and grid harmonization of renewable grid sources as a whole.

Rapid and large-scale investment in offshore wind where winds blow more consistently is viewed as a source of "baseload" renewable energy that would complement solar PV and help harmonize supply and demand on the grid. Contracts for over 8,000 MW of offshore wind on the East Coast are already signed and projected to be completed by 2024. Similar economies of scale should be targeted for the West Coast. Fast-tracking this climate mitigation strategy with significant economies of scale would maximize the carbon reduction achieved through the electrification of buildings, and it would assure price stability of renewable electric utility rates over the next 20 years, a prospect that assures the highest ROI for electrification projects, thereby minimizing risk on inclusive finance projects. The economics of offshore wind are already so favorable that it is more economical to shutter 42% of all the coal-fired generation plants today than to continuing to operating them at a loss compared to renewable alternatives. This investment in offshore wind which can be installed on three coasts as well as the Great Lakes, can save the US up to $78 billion in energy costs annually*[8] This strategy would also reduce the reliance on mass storage batteries as modulators of grid power and the life-cycle costs associated with batteries.

FOOTNOTE REGARDING ATTACHED SPREADSHEET APPENDICES: This analysis is accompanied by attached Excel spread sheets which outline specific packages of energy upgrade and electrification measures for moderate (25-30% savings) and deep energy retrofits. These illustrate that the package of upgrades for the EE+E portion of the IF project improvements must be simplified to stay within the program constraints. Within the $15,000 budget constraint of the IF model, deep retrofits (energy efficiency plus electrification) can be completed on single family dwellings with slab footings and accessible attics if they have under 1500sf. Moderate energy upgrades can be completed in homes that meet this criteria and which do not exceed about 1800-2000sf. However, the attached estimates include a list of “additional items” that may be required or advantageous on a given project and these are not included in the scope of the base packages and would need to be funded with other “wrap around” rebates or funding.

FOOTNOTES:

*1 Department of Numbers, California Residential Rent and Rental Statistics, Sept. 2017, https://www.deptofnumbers.com/rent/california/

*2 Public Policy Institute of California, California’s Housing Challenges Continue, January 2018, https://www.ppic.org/wp-content/uploads/r-118hjr.pdf

*3 ACEEE, On-Bill Financing Gains Ground but Faces Barriers to Wider Adoption, By Annie Gilleo, April 2019, https://aceee.org/blog/2019/04/bill-financing-gains-ground-faces

*4 Lawrence Berkeley National Lab, Sealing HVAC Ducts: Use Anything But Duct Tape, By Paul Preuss, August 17, 1998, https://www2.lbl.gov/Science-Articles/Archive/duct-tape-HVAC.html

*5 Measuring Home Performance: A Guide to Best Practices for Home Energy, By Lewis G. Harriman and Rick Chitwood, 2011, Report to the California Energy Commission's Public Interest Energy Research Program

*6 See survivingmold.com

*7 Building Performance Institute, 2006, Batt Insulation Derating Charts, See: https://www.google.com/search?rls=com.microsoft:en-US:IE-Address&q=BPI+batt+derating+charts&tbm=isch&source=univ&sa=X&ved=2ahUKEwieybHsxPvhAhXKjlQKHerFDHAQsAR6BAgIEAE&biw=1280&bih=604#imgrc=ixkFXJxOiu6Z5M:&spf=1556755153435

*8 Plunging Prices Mean Building New Renewable Energy Is Cheaper Than Running Existing Coal By Megan Mahajan with contributions from EI, Energy and Innovation Policy and Technology, From Forbes online: www.forbes.com/sites/energyinnovation/2018/12/03/plunging-prices-mean-building-new-renewable-energy-is-cheaper-than-running-existing-coal/#4be7de4f31f3