

# **Thermal Optimization: A Private Sector Program for Energy Efficiency in Existing Residential Buildings**

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## *The Challenge*

The climate agreement signed at COP21 in December 2015 set ambitious greenhouse gas reduction targets, while the proposed Clean Power Plan requires electric utilities to play a key role in executing these goals. At present, the legal and political opposition to the Plan has made the results very difficult to predict, while the Paris accords remain hugely controversial in Washington and on the campaign circuit. Furthermore, market-based emission reduction strategies such as a carbon tax or a cap and trade scheme appear unlikely to gain political momentum. While public sector solutions to climate change deserve serious effort, these programs, proposals, and agreements are by no means guaranteed to be successful. Thus, national and international governance needs to also consider business solutions for creating a low-carbon future.

Buildings consume about 40% of the energy generated in the United States.<sup>1</sup> For homes, about 43% of the primary energy consumption and 54% of site energy consumption is for interior space heating and cooling.<sup>2</sup> This proposal offers a new option for reducing unnecessary consumption for maintaining interior space at a comfortable temperature.

Existing U.S. efficiency programs have done little to curb space conditioning energy or to improve the thermal performance of our country's 130 million homes, 44% of which were built before 1970.<sup>3</sup> "Major Opportunities to Reach Higher Electricity Savings by 2030", a recent American Council for an Energy Efficient Economy publication, states that "finding ways of increasing participation in whole-building retrofits is key to driving increased savings in this sector". While this acknowledges the high volume of energy used for space conditioning, the report goes on to predict that whole building retrofits will capture only 1% of near-term energy efficiency investments.<sup>4</sup> This projection indicates that space conditioning will remain the largest piece of homeowner energy expense.

U.S. efficiency programs are credited for installing conventional efficiency products such as windows, lighting, fiberglass insulation, appliances and thermostats. Because a home only has one meter, reduced consumption from efficiency products is estimated, and can't be verified with actual measurement. It's unlikely that these estimates account for all the variables in real life.

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Current efficiency programs address space conditioning with weatherization, which only improves accessible portions of the thermal shell. Weatherization leaves an unconditioned attic just inches above the living space, and does little to prevent heat loss through walls, the largest percentage of a home's thermal shell. A key feature of this proposal is the use of new construction thermal systems to upgrade existing residential buildings.

## *Thermal Optimization*

A home's thermal performance can be optimized by thoroughly installing an effective and continuous thermal seal. This reduces a home's propensity to use space conditioning energy. The improved thermal performance can be measured with established scoring systems, such as the "Home Energy Score" from USDOE.<sup>5</sup> Thermal shell improvement is the only efficiency upgrade that allows post-construction measurement. From this measurement, reduced consumption and emissions can be determined and monetized over the life of the home. Greater resilience is a separate benefit of improved thermal performance.

Optimization can be produced with existing technology and labor, and commercially-available materials. Siding, spray insulation and rigid insulation contractors already have the skills to achieve this level of performance. If a program is implemented on a neighborhood scale, cost would quickly be driven down, similar to the cost difference between a custom and a production home. No conventional efficiency measure can match the dramatic footprint reduction resulting from optimizing a home's thermal performance.

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## *The Optimized Home*

**U.S. SAMPLE HOME** (2000 sq.ft., single story, built to 1970 code & standards)

Monthly energy bill reduction \$ 50

Monthly on-bill payment \$ 50

**Net Customer Cost of Improvement** \$ 0

|                                     | <b>BEFORE</b> | <b>AFTER</b> |
|-------------------------------------|---------------|--------------|
| Space conditioning energy (kwh/Yr.) | 9000          | 4500         |
| Carbon emissions (lbs./Yr.)         | 16,000        | 6000         |

For the sample home, reduced kWh was evaluated with the Energy Trust of Oregon’s “Energy Performance Score” (EPS). As with most scoring systems, EPS has an energy score to convey a home’s kWh space conditioning energy requirement. The system also has a carbon score which converts kWh into pounds of carbon emissions.

Using EPS, I estimated that the average existing U.S. house has an energy score of 90, consuming 9000 kWh annually for space conditioning. After an optimization retrofit, the score would drop to 45 (4500 kWh annually). The sample home’s energy score is decreased by 50%, eliminating 4500 kWh in space conditioning energy annually.

The pre-retrofit energy score of 90 converts to 16,000 pounds of carbon, while the post-retrofit score of 45 represents only 6,000 pounds of carbon. The value of this measured demand reduction will invariably increase over the life of the home.

High performance products, such as rigid insulation from Dow and spray insulation from BASF, are just starting to move into the energy retrofit market. Deep energy retrofits are encouraged through projects like Affordable Comfort Inc. (ACI)’s “1000 Home Challenge”, but homeowners do not allocate many of their retrofit dollars to the thermal shell. Even with incentives, only 28 homes have met ACI’s high performance standards.<sup>6</sup> Invisible efficiency cannot compete in a homeowner’s budget with flashy appliances, floors and countertops.

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## *Utility Financing*

Responding to historically low homeowner investment in thermal efficiency, this proposal shifts the retrofit investment to the home's energy supplier. A utility's interest to supply the home's energy is much longer in duration than the typical owner's duration of ownership. With a 15-20 year loan, a utility could generate a reasonable return, produce significant demand reduction, and secure the home as an energy customer through on-bill financing.

Given that most houses are similarly constructed, the cost estimate assumes the use of established, repetitive procedures for every optimized home.

**AVERAGE PER HOUSE COST ESTIMATE:** **\$11,000**

**RETROFIT COST RANGE:** \$8,000 to \$16,000 per house, with variables such as physical access to the thermal shell, sq. ft. of walls, and sq. ft. of roof.

The Rocky Mountain Institute estimates a \$150 billion residential energy upgrades market opportunity.<sup>7</sup> Utilities are capital intensive and accustomed to long-term investments. Faced with growing complexity and emission constraints, utilities can now look to thermal optimization as a viable demand-side investment.

A popular tool for energy efficiency projects is Property Assessed Clean Energy (PACE) financing which allows local governments to administer efficiency loans using private capital dispensed through the jurisdiction's property tax system. Homeowner loans support clean energy projects, including efficiency. Residential PACE has been limited due to the complexity of being secured by a home's mortgage. Utility financing eliminates the mortgage connection, as the investment is secured by the home's need for electricity.

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Utilities nation-wide offer their customers on-bill financed efficiency. For example, The United Illuminating Company (a Connecticut private utility) has an energy retrofit program which does not include transactions between homeowners and public agencies. It simply connects building contractors to the utility's energy customers and uses in-house, on-bill financing. With their ability to tie efficiency loans to the meter, rather than to the house or owner, utilities have the key to unlocking the energy asset in our homes.

## *Converging Trends*

Several trends combine to create conditions that would allow utilities to deliver high performance energy retrofits for both metropolitan and small town homeowners:

- Utilities are responding to emission constraints and state utility commissions with growing demand-side investment;
- Existing efficiency programs are not taking steps to reduce space conditioning energy, the largest portion of residential demand;
- Several home performance scoring systems have been developed;
- The insulation industry has created high performance thermal systems.
- Utilities are pursuing new opportunities to retain and better serve customers;
- RESNET has connected performance scoring to the energy code, and introduced real estate and appraisal professionals to the value of high performance;
- Utilities are facing disruptive challenges, including peak overload, power plant closure, constrained load pockets, customer retention and the popularity of renewables.
- Utility per-home investment in emission-reducing upgrades has jumped to a new level, with pilot projects in Arizona that install PV on customer homes, and a pilot in New York that will go further, with PV + storage in the customer upgrade.

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These trends improve the feasibility of a utility-scale program to optimize the thermal performance of residential customer homes. Occupants of an optimized home would enjoy greater comfort without new expense, and use the least amount of space conditioning energy.

The value of predictable demand reduction would allow utilities to offer optimized retrofits at no new cost to the current or future homeowner. And after on-bill accounting for the retrofit cost, the homeowner's energy bill would drop.

A utility-scale Thermal Optimization Program would change several elements commonly found in US energy efficiency programs:

- shift energy retrofit investment from homeowner to home's energy supplier;
- elevate energy performance standard;
- target the largest piece of residential energy demand, rather than smaller pieces;
- measure demand reduction, rather than using a calculation;
- improve technology from weatherization, which upgrades accessible portions of the thermal shell, to optimization, which thoroughly seals the entire thermal shell;
- require no tax dollars or government agencies

With a focus on the largest part of residential energy use, the private sector could take a big step toward a low-carbon future. As a private sector program, the utility, construction, and insulation industries could collaborate to reduce the residential footprint.

As an expanded utility service to residential customers, thermal optimization would give local economies a much-needed jolt. The task may seem large, but the value of greater resilience and fewer emissions would increase over the life of an optimized home and provide immense returns on the initial investment. The future utility will invariably have to optimize the use of electricity for every customer.

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Rick Barnett produced this proposal as a guest writer for the Climate Institute. Thermal optimization was developed through a series of articles at <http://www.energycentral.com/authors/1413/Rick-Barnett> . He is the CEO of Green Builder (1996), a retired retrofit contractor, and was a key figure in the early '80's expansion of the Oregon waste hauling industry's recycling programs. He holds a B.A. in Psychology and an Interdisciplinary Master's in Environmental Management from Oregon State University.

## Notes

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