Residential Integrated Ventilation Controller (RIVEC)

Commercialization Analysis

April 1st 2013

Lawrence Berkeley National Laboratory

Residential Integrated VEntilation Controller (RIVEC) **Date: April 1st, 2013**
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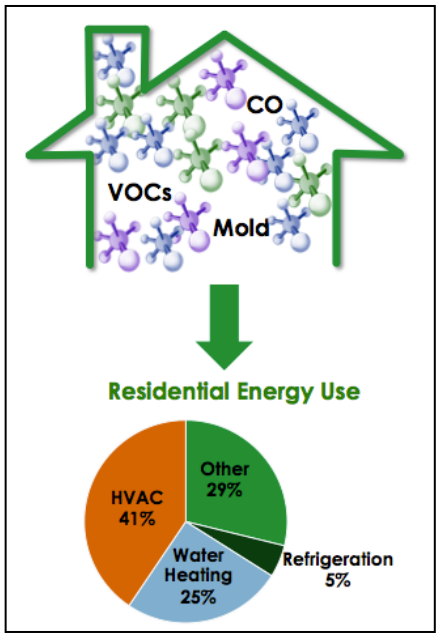
Technology

People spend over 90% of their lives indoors and indoor air pollutants constitute a considerable health risk, especially for the young, the elderly and those with respiratory problems.[1] Indoor air pollutants can originate from many sources, including adhesives, paints, and varnishes, some of which contain lead or volatile organic compounds like formaldehyde.[2] Other types of pollutants include mold, mildew, dust and exhaust from gas stoves, ranges and furnace. [3] Maintaining safe indoor air quality requires ample circulation of outdoor air to prevent buildup of the pollutants.[4]



Source: DOE[7]

Over the past few decades, new and existing homes have become increasingly airtight. [5] While this has led to dramatic energy savings in heating and cooling, the increased level of air tightness restricts outdoor air intake, causing a buildup of indoor pollutants such as carbon dioxide and mold.[6] As a result, there is a greater need for newer or recently weatherized homes to have mechanical ventilation to ensure a safe and healthy indoor air quality level.

While continuous circulation of outdoor air using a dedicated primary house fan is an effective way to eliminate buildup of harmful pollutants, it is not an energy efficient solution, since excessive ventilation reduces the effectiveness of heating and cooling systems that are trying to control indoor temperature.

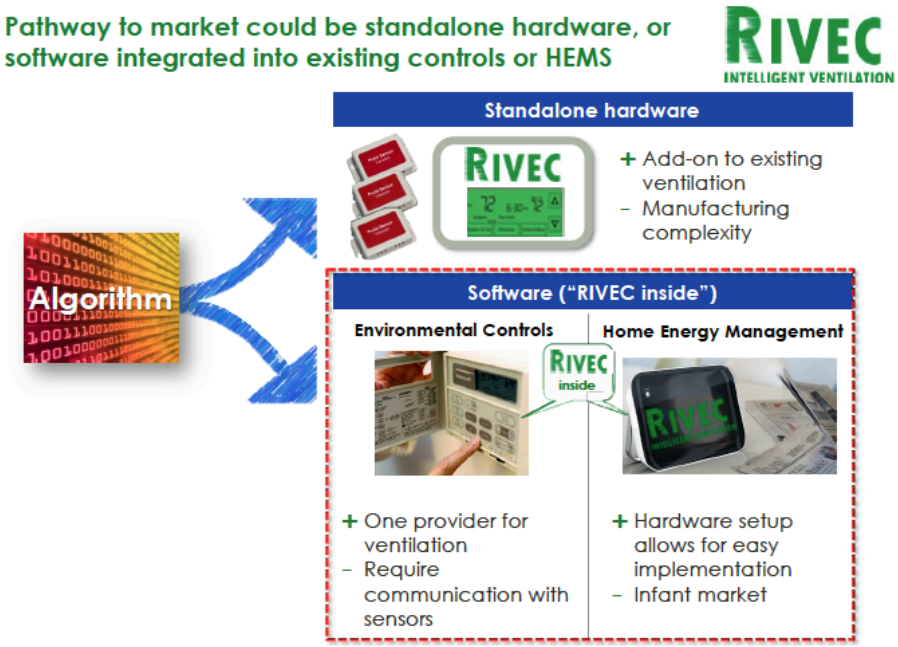
The RIVEC system provides a balance between air quality and energy efficiency. RIVEC's algorithms ensure a safe level of indoor air quality, while maximizing the energy efficiency of the ventilation system used to achieve that quality. RIVEC provides intelligent control to a primary house fan, such as a bathroom fan or whole-house fan, while monitoring other sources of ventilation from appliances like dryers and kitchen exhaust fans. The system is also customized for each individual home, taking into account size, number of rooms and climate. Field tests have demonstrated that RIVEC can save 13-44% of ventilation energy consumption, depending on the climate and whole building ventilation system used.

Applications

The RIVEC system is best deployed in one of two ways:

Standalone hardware: A standalone hardware solution would entail a fully functioning standalone package, including sensors and a control unit with an installed RIVEC algorithm.

Software implementation: A software implementation would involve partnerships with hardware manufacturers (for example ventilation controls, home environment controls, or home energy management manufacturers) in which the RIVEC algorithm would be adapted for integration in the hardware components developed by the manufacturer.



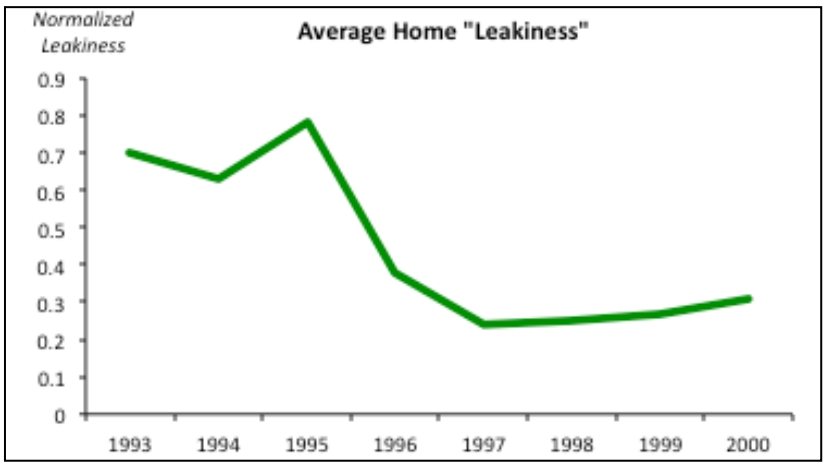
Market

Two market segments exist: New Builds and Retrofits. Segmenting the product focus between new builds and retrofits is an important product design and business model choice. From a technical standpoint, RIVEC could accommodate either installation pathway, but there are significant differences in the market size, supply chain, and the value proposition in these different markets.

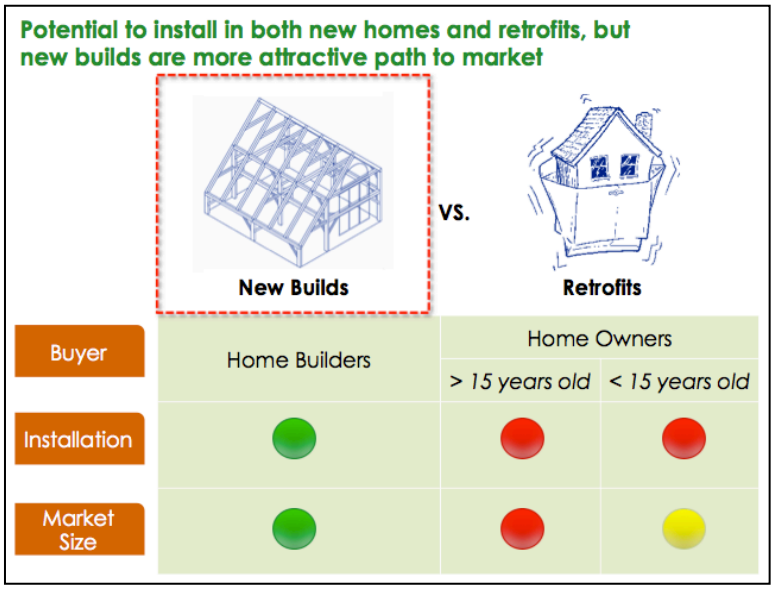
From a volume standpoint, the existing US housing stock dwarfs new constructions,[8] but actual retrofits that offer tight housing envelopes remain limited. Home energy efficiency standards at both the state and federal level, along with rising electricity costs, have encouraged more retrofits in recent years, yet the total number of Energy Star retrofits in the last decade (75,000) is less than the Energy Star certified new homes in 2009 alone.[9] The new home segment promises several advantages over the retrofit segment, as both technical and distribution challenges also make the retrofit market a difficult segment to address:

Fragmented Channel: Smaller independent contractors or small businesses generally complete retrofits and offer direct sales to individual residential customers. These players are often early adopters of new technologies (a plus for RIVEC), but their ability to place large-volume orders, a key to significant market penetration, is limited.

Technical challenges: Our industry research indicates that the average tightness of the housing envelope in these units, even after a retrofit, is generally insufficient to require ASHRAE 62.2-prescribed ventilation. One contractor related that a house would have to be essentially torn down to the studs and rebuilt in order to achieve the tightness required. The graph below (Average Home "Leakiness") indicates that new homes constructed before the mid-1990s are far from tight enough to activate the new standard.



Source: Sherman & Matson (2002)[10]



The table below offers an overview of the pros and cons of each market segment (new homes and retrofits) and the incentives for the players in the market (builders, home owners, contractors, HEMS suppliers, and utilities).

Market Segment Comparison

	New Homes	Existing Homes		Other	
	Builders	Home Owner	Contractor	HEMS Supplier	Utility
Value Prop	Green advertising Compliance Cost savings (substitute?)	Air quality Energy savings Compliance Convenience (auto) Sound reduction		Additional systems control Air quality Compliance	Peak-shifting Lower consumption
Key Features	Plug'n play (existing ventilation) Hardware	Easy install Hardware (restricted)		Increased function TOD response	TOD Response
Price Point (WTP)	LOW	HIGH		LOW	LOW
Gross Margin		MEDIUM		HIGH	LOW
Volume	HIGH	LOW		HIGH	HIGH
Distribution Channel	Concentrated Bulk	Fragmented High cost		Partnerships	Various w/ Incentives

Competitive Landscape

RIVEC competes more with non-intelligent ventilation control systems or 24/7 fan operation than feature-competitive ventilation control. All markets that touch residential ventilation are fractured with no dominant players, but the HVAC and ventilation markets have a handful of large, deep-pocketed players that drive the market state-of-the-art.

Most common solution for meeting minimum ventilation levels has operating cost and efficiency disadvantages

RIVEC
INTELLIGENT VENTILATION

	Common Solution VS.	RIVEC
How	Primary fan running constantly	Ventilate only when needed (no over-ventilation)
Purchase Price	**Low**: Meet standards with cheapest components	**Low**: Low marginal cost
Operational Cost	**Moderate**: Uses 20% more energy	**Low**: Saves homeowner 20% of ventilation cost

Driving Forces

Two predominant market forces, ASHRAE 62.2 and the Energy Star standard, drive RIVEC's potential market. Focusing on new build construction in states that have adopted or will adopt ASHRAE 62.2 and have extreme weather offers the greatest opportunity, with a potential market size of $123 million by 2013.

It is also important to recognize that the US housing market has experienced a significant structural shift since the sub-prime mortgage crisis began in 2006, a shift that clearly impacts RIVEC's target market. New home starts collapsed from a September 2005 high of 2.3 million homes (annualized) to only 0.5 million starts (annualized) in February 2011. Such massive contraction undoubtedly affects the potential market size for RIVEC. However, it is reasonable to assume the US market will return to a pre-crisis level of around 1 million new homes by 2015. In addition, the regulatory imperative for devices compliant with ASHRAE 62.2 means that market penetration will likely be a more important metric than total market size.

Currently, 18 US States have adopted codes that include ASHRAE 62.2, implicating 160,000 new single-family homes built in 2009. Based on our estimates of the ASHRAE 62.2 rollout (above), the potential market for RIVEC will grow to 615,000 new homes by 2013.

Intellectual Property

Published patent application US 2011/0151766 A1 available at www.uspto.gov. RIVEC is available for licensing or collaborative research.

Licensing Strategy

Given the ventilation control technological advantage that the RIVEC team has and the manufacturing and distribution advantages that large players in the ventilation and home environment controls markets have, we recommend that RIVEC initially supply software to controls players and eventually move into supplying software to HEMS players.

The optimal licensing model may be a fixed-fee license with royalty payments per install and a minimum installation commitment.

Next Steps

Companies interested in licensing this technology may contact ttd@lbl.gov or call 510-486-6457.

For more info:

Inventor Iain Walker and other Berkeley Lab researchers discuss the energy efficient home of the future here.

Endnotes

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[1] US Environmental Protection Agency, *The Inside Story: A Guide to Indoor Air Quality*, http://www.epa.gov/iaq/pubs/insidestory.html last accessed May 3, 2011.

[2] http://www.epa.gov/iaq/pubs/insidestory.html.

[3] http://www.epa.gov/iaq/pubs/insidestory.html.

[4] http://www.epa.gov/iaq/pubs/insidestory.html.

[5] Max H. Sherman and Nance E. Matson, "Air Tightness of New U.S. Houses: A Preliminary Report," LBNL, Mar. 2002, 1.

[6] http://www.epa.gov/iaq/pubs/insidestory.html.

[7] US Department of Energy, 2009 Buildings Energy Data Book, *Chapter 2: Residential Sector* http://buildingsdatabook.eren.doe.gov/ChapterIntro2.aspx last accessed May 16, 2011.

[8] The US Census Bureau estimates total housing units in the US reached 130.8 million in 2010. US Census Bureau, Press Release Jan. 31, 2011, *RESIDENTIAL VACANCIES AND HOMEOWNERSHIP IN THE FOURTH QUARTER 2010* http://www.census.gov/hhes/www/housing/hvs/qtr410/q410ind.html last accessed May 16, 2011.

[9] https://www.energystar.gov/ia/home_improvement/HPwES_Utility_Intro_FactSheet.pdf

[10] Sherman, 6.